Value investment strategy:
Robustness test and application of Piotroski’s model in 4 different markets

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Abstract

Background A common goal for many investors is to beat the market. However, only a few are able to do so consistently over a long time. The random walk theory and the efficient market hypothesis are two widely accepted theories that state that it should not be possible to consistently generate abnormal returns in an efficient market. There are though some contradicting results that argue against market efficiency and a lot of those studies have value investment in common. Joseph Piotroski was in 2000 able to generate a value investment model that consistently beat the market between the years 1976-1996.

Purpose The purpose of this paper is to test Piotroski’s model on stock markets with different size and maturity to evaluate if the model, as an investment strategy, can generate a better risk adjusted rate of return than a comparable market index. Unlike recent studies done on Piotroski’s value investing model, we will add a number of additional comparison portfolios and use two different valuation models to determine the source of return variation.

Method This thesis employed a quantitative research method with a deductive approach. With data from four markets with different characteristics regarding efficiency and development, we performed an ex-ante test from 1995 to 2009. By employing Piotroski’s model, each stock on the four markets was given a score from 0-9; a portfolio for each market was created by the stocks that received a score of 8-9. They were then compared with portfolios from the same market based on the small-firm- and book-to-market anomaly. We also performed a test between the markets to see if Piotroski’s model worked better in low efficiency or developed countries. All portfolios in this thesis were risk-adjusted with two different models, CAPM and the Fama & French three-factor model. Since these models use various factors to risk-adjust we have tested if they generate a different valuation of the same portfolio.

Results Our study has shown that Piotroski’s model is not able to generate significant abnormal returns compared to our portfolios based on anomalies, our results also give an indication that by removing the anomaly premium the model might be destroying value instead of creating it. An explanation to why the model works in Piotroski’s study and not in ours could be the different method of risk adjustment. Piotroski uses a simple method by deducting the market return while we use two models that are taking additional factors into account. Our results are also able to show that choice of the valuation model does have a significant effect on the risk-adjusted return and could therefore affect the end-results of a study. Last of all our results do not give any support for the hypothesis that Piotroski’s model works better in countries with low efficiency compared to high efficiency or in countries that are developed compared to emerging.
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1. Introduction

1.1 Problem background

The random walk theory states that in an efficient market, large numbers of rational investors are trying to predict future market value with current available information. Because of that, the prices of individual stocks reflect the aggregated knowledge of past events, current available information and expected future events. The fluctuation of price occurs because of temporary disagreement between actors and more importantly emergence of new unpredicted information, therefore the price movement is random and cannot be predicted (Fama, 1965, p. 56). This concept eventually laid the foundation of efficient market hypothesis (EMH). There are many similarities between the theories and both shares the idea that investors shouldn’t be able to consistently achieve abnormal return after adjusting for risk.

Academically, EMH is one of the dominant theories that many models are based on. Still, no theory is without fair share of criticism. In an article “The Superinvestors of Graham-and-Doddsville” written by Warren Buffet (1984), he showed how 9 funds managers successfully beat the market for decades, which challenges the idea of efficient market. Proponents of EMH explain the situation that it is fully normal, given the amount of investors available, few are bound to succeed. The counterargument is while the 9 managers have little in common with each other, they all employ value investment strategy, which might prove that their success is more than a statistical fluke.

Value investing is an approach designed to purchase securities whose stocks seems to be under-priced, often using fundamental analysis based on key ratios such as book-to-market or price-to-earnings. Studies show that this approach has very promising result outperforming both growth stocks and the markets as a whole. In a study conducted by Fama & French (1992), they showed that using a three factors model consisting of market risk, book to market ratio and size of the companies, the model explains the variation of cross-sectional return far better than beta alone. This empirically proves that there are correlation between size of company, book to market ratio and returns of companies in US firms, this is also referred as small firm anomaly and book to market anomaly. Critics believes that large portion of these abnormal returns stems from increased risk premium associated with high book-to-market (HBM) ratio and small firms, the reason being HBM are often signs of being financially distressed and small firms runs higher risk of bankruptcy. The return distribution of small and HBM firms seems to also support that idea (Fama & French, 1992, p. 452).

During year 2000, Joseph Piotroski got widespread publicity for his paper, Value Invest: The Use of Historical Financial Statement Information to Separate Winners from Losers (Piotroski, 2000). The basic idea is using accounting based fundamental analysis to screen HBM stocks using 9 different tests. By long stocks with the highest ranking and short those with lowest, he was able to shift the entire return distribution of HBM portfolio. The back test showed a 23% annualized gains from 1976 to 1996, twice the S&P index (Piotroski, 2000, p. 33). Piotroski hypothesize that the risk premium is not the only reason for abnormal returns. Empirical evidence showed that the screening model worked far better for companies with small market
capitalization, and these smaller firms with high book to market ratio are often neglected by analysts. It is possible that this lowered information efficiency being partial explanation for the abnormal return.

Since the publishing of Piotroski’s paper, many have tried to improve the model and replicate the result in other markets with various results. Except Piotroski’s study on the American market, Aggarwal & Gupta (2009) have made a similar study on the Indian stock market and Gerber, Johansson and Johansson (2009) did a study on the Swedish stock market. All the aforementioned studies were able to show that Piotroski’s model outperformed the market index. Both Piotroski and Aggarwal & Gupta did however use a very simple method to adjust the risk, which could have worked in favour for the model. Gerber et al. used a more robust method to risk-adjust and they where still able to show that Piotroski’s model generated an almost 10 % higher return than the Swedish index (Gerber, et al. 2009 pp.38).

The interesting part is the variation in results which seems to differ depending on the information efficiency in that particular market, which supports Piotroski’s hypothesis. If there is a correlation between market efficiency and return generated by Piotroski’s model, then an objective measure of market efficiency could screen out markets where Piotroski’s model should work better. This paper is designed to examine factors which determine the efficiency of Piotroski’s model and then test the robustness of the model using several different markets and valuation models.

1.2 Problematization and Research Question

In theory, value investing is not possible if the market is truly efficient. Any deviation of price and intrinsic value will be remedied by investors’ immediately (Bodie, Kane, & Marcus, 2009, p. 345). However, since information is not entirely free, analysts tend to pay less attention to firms with small market capitalization and/or sustained poor performance for some time. Thus it is reasonable to believe information isn’t equally efficient everywhere in a market. Different markets have also different level of regulation and maturity, therefore the level of information asymmetry might also differ across different markets (Bodie et al., 2009, p. 347). Our research questions have thus been divided into a two-step process to measure the performance of the model.

Question 1: Will Piotroski’s model, as an investment strategy, outperform comparable indexes based on market anomalies?

As a further step the following question has been formulated:

Question 2: Does Piotroski’s model work better in its preferred environments?

Environment in this case incorporates the efficiency of a market and in which state the country’s economy is, that is if it is developed or emerging. According to Piotroski (2000) and J.M. Griffin, Kelly and Nardari (2009), investment-models like Piotroski’s should be most effective in a developed country with a low efficiency. There are many ways to measure market efficiency, in this case we adopt the delay measure proposed by Hou & Moskowitz. Simply put, delay is a
measure of sensitivity between current returns and past market-wide information (Kewei & Moskowitz, 2005; Mech, 1993).

Since value investors do not believe that market is truly efficient, this assumption of non-efficiency could then affects their choice of method for risk adjustment. The difference in method could be the reason why certain models seem to be profitable. Therefore it is necessary to analyse how the selection valuation method affects the risk adjusted return, thus we form our final research question.

*Question 3: Could the choice of valuation method have significant impact on the risk adjusted return?*

### 1.3 Purpose

The purpose of this paper is to test Piotroski’s model on stock markets with different size and maturity to evaluate if the model as an investment strategy is able to generate a better risk adjusted rate of return than a comparable market index. Unlike recent studies done on Piotroski’s value investing model we will add a number of additional comparison portfolio and use two different valuation models to determine the source of return variation. The findings of this study will come into use by institutional fund managers or other professional investors who, depending on the results, could either use the investment strategy to create a winning portfolio or reject the model in favour for other more profitable strategies.

### 1.4 Delimitation

In this paper we will limit our research to 4 markets. The obvious reason being including every market available is simply too time consuming, therefore we will choose markets that are at the opposite end of observed efficiency. This should at least show some level of correlation if market efficiency affects the return of the model. The time period for the study will be between 1995 and 2009 because of the limitation of data available in Datastream, but we believe that this period should serve well as a robustness test for the model since it includes two major financial breakdowns and booms.
2. Theoretical Framework

2.1 Theories of Efficient markets

This thesis is based on value investment strategies and will test whether the use of a specific strategy constructed by Joseph Piotroski (2000) can produce a portfolio of stocks with a higher yield than the rest of the market. Anomalies that previous researcher like Banz (1981), Fama & French (2008) and Schwert (2002) have proved to exist are also taken into consideration to maximize the effects of Piotroski’s investment strategies. Ultimately this thesis will be a test of how efficient the reviewed financial markets in our thesis are. The efficient market hypothesis and the random walk theory both implies that there should not be room for any excess returns since all the available information already are incorporated in the price of the stock, and the only way to gain a higher return is if higher risk is incorporated into the portfolio. If this were true then there would be no use for investment strategies like Piotroski’s value investment model. Empirically Piotroski’s model was able to achieve an annual return at 23%, which is twice the result for S&P during the same period (Piotroski, 2000, p. 33). This result gives the indication that the efficiency in US market is questionable and perhaps exploitable.

To understand how prices of securities shifts, we will first review two of the most popular and established theories that explain market efficiency, the Random Walk Theory and the Efficient Market Hypothesis.

2.1.1 The Random Walk Theory

The idea behind the random walk theory is that movements in stocks are independent; this means that any previous movement in the market price of the stock cannot be used to foresee the future movement.

Kendall (1953) was one of the first scientists to test the randomness of stocks. He found that without external information, there is no way to predict movements on the exchange for a week ahead. The random walk theory has been tested numerous times since then; Eugene F. Fama who is one of the most influential researchers within this area concluded that there is no dependence in stock-price series that would be regarded as important for investment purposes, in other words, past history cannot be used to increase the investors expected profits (Fama, 1965, p. 87).

The random walk theory got a lot of attention after the release of A Random Walk Down Wall Street (Malkiel, 1996), the book emphasizes the theory of random walk in a more entertaining way. A well-known experiment from the book is when Malkiel lets his students create a time chart by flipping a coin every day over a period of time and each side of the coin represented ½ point up or down. They then showed this chart to a chartist who gave the recommendation to buy the stock immediately (Malkiel, 1996, pp. 142-143).

Efficient market hypothesis is closely related to the random walk theory. If we assume that the market is efficient and all available information is reflected in the individual stocks, then the market price of a stock will be very close to its intrinsic value. However, even if there are a lot of
investors that have the same information, it is still likely that some investors interpret this information slightly different. This means that the investors will get a slightly different view of what the price should be for the security and thereby make the market price cycle around the security’s real intrinsic value. Fama, (1995, p. 76) argues that if these discrepancies between actual price and intrinsic value were systematic rather than random, then investors would take advantage of this phenomenon and thereby neutralize and make the movement random once again.

There is however studies that have found that markets are not following a random walk. A study made by Worthington & Higgs (2004) on 20 European markets showed that the majority of the countries did not meet the criteria’s for a random walk behaviour. There are more studies that show the same results as Worthington and Higgs which makes it difficult to draw any general conclusions about the random walk theory, it seems that studies show very different results even though they are using the same methods. Whether it depends on the efficiency of the country, the economic situation during the tested time-period or the degree of development in the researched country is left for other researchers to study in the future.

2.1.2 Efficient Market Hypothesis

While efficient market hypothesis share many similarities with the random walk theory, one important distinction is the separation into 3 subgroups. The subgroups are:

- Weak efficiency – all past prices are reflected in the current price.

- Semi strong efficiency – all public information available is calculated into current price.

- Strong efficiency – All information available is calculated into current price.

Even in the weakest form of market efficiency, all historical prices and returns are reflected in the current price. This would mean that technical analysis shouldn’t be able to outperform the market since all available information is already incorporated in the market price (Howells & Bain, 2005, p. 544).

In the semi strong efficient market, information that is accessible by general public are quickly absorbed and reflected in the market price. This includes not only historical prices and returns but also fundamental data such as earning announcements or relevant information that might affect an industry such as changes in oil price. It is believed that most markets operate within this level of efficiency, and therefore it is not possible to outperform the market using fundamental or technical analysis without inside information (Howells & Bain, 2005, p. 544).

In Strong efficient market all information is reflected in the market price, even insiders don’t have any advantage. This level of efficiency is quite difficult to test. In theory, the information asymmetry between insiders and outsiders should give the former a significant advantage, because of that there are very strong regulations against insider trading, thus the observable
trading by insiders do not outperform the market (Howells & Bain, 2005, p. 544). So even in the unlikely event that the market is strong efficient, we wouldn’t really know.

Most of EMH proponent believes that financial markets across the world are semi efficient. If it is true then Piotroski’s model shouldn’t yield risk adjusted abnormal returns. However, the key word we chose to focus on in this paper is efficiency. Given that all markets are semi efficient, there is no reason to believe that they are all equally semi efficient. In a recent study by J. M. Griffin, Kelly, & Nardari, (2010), the authors performed a large scale study across 56 markets divided among developed and emerging markets. Their finding is that while information are being incorporated in the stock price faster all over the world, but there are still significant differences between countries, especially in small firms. We have selected two developed and two emerging market pair both at the opposite end of efficiency measure.

### 2.2 Measuring market efficiency

Traditional asset pricing theory often assumes that markets are frictionless, information flows freely and investors behaves rationally and have well diversified portfolios (Bodie et al., 2009, p. 280). The empirical evidence shows however otherwise. Incomplete or asymmetrical information exist everywhere because of the high cost to obtain information either in form of time or money, investors don’t have the same access to all information. Taxation and short sale constraints further limit investors’ opportunities to fully diversify (Saffi & Sigurdsson, 2011). All these market frictions delays information diffusion, which can be measured as the average delay in time that the share price responds to information (Hou & Moskowitz, 2005, p. 982). In this case, by information we mean any news or data that would influence a company’s fundamental value, regardless whether is it private or public.

Measuring how private information affects market efficiency is not a straight forward task, the nature of private information is that they are not available for everyone, which makes them difficult to observe and calculate. One of the method suggested by Bhattacharya is to measure abnormal return variation near earning announcement (Utpal Bhattacharya, Daouk, Jorgenson, & Carl-Heinrich Kehr, 2000). The result generated by this method is however difficult to interpret. Empirically most developed markets have much higher return variation near earning announcement compared to emerging markets, with some exception for China, Hong Kong and India. This lack of reaction demonstrated by emerging markets indicate that the information may already be leaked to the public, while developed markets with sufficient investor protection and better short selling ability displays larger variation near earning announcement. In the short term, one can argue that emerging markets is more efficient because of the information leakage, price seems to incorporate all available information at all times. But large volume of trading based on private information reduces the profitability for market maker, which has to in turn increase bid-ask spread to mitigate the additional risk taken (Clinch & Lombardi, 2011; Easley & O’Hara, 2004). In the long term, the damaged caused by informed trading might hurt liquidity enough to lower market efficiency (Brunnermeier, 2005, p. 437).

For public information we use Hou and Moskowitz delay regression, which is a sensitivity measure of current stock returns against 4 weeks of lagged market returns (Kewei & Moskowitz,
This approach is fairly intuitive, using market index movement as public information we can compare the speed of various securities incorporating information in their prices. The calculation is based on the difference in the coefficient of determination between a normal valuation model based on simple linear regression and one including 4 additional coefficients to capture return stemmed from delay one to four weeks after. The difference in R-square is then the measurement of delay.

2.3 Anomalies

Anomalies can be described as empirical evidence that seem to be inconsistent with maintained theories of asset-pricing behaviour (Schwert, 2002). According to Schwert (2002) there are two explanations to why these anomalies occur, one indicates market inefficiency, and the other indicates inadequacies in the underlying asset-pricing model. If the market is inefficient there will be possibilities for investors to make money through arbitrage.

Anomalies have a tendency to disappear after they have been documented in financial journals, this may be a consequence of investors that take advantage of the anomaly. By purchasing the companies that are undervalued and short-selling the ones that are overvalued force the stock prices towards its equilibrium price. Another possible explanation that Schwert (2002, p. 2) discusses is the “over-discovery” of anomalies that researcher might find, these anomalies are only present because of a bias in the sample selection and thereby the anomaly is not applicable in the “real” world.

There are many documented anomalies that have been tested on different markets and in different time-periods. Some well-known anomalies are the size effect, the book-to-market ratio, the weekend effect, the momentum effect and the January effect. Although many of these anomalies are interesting we have decided to focus on the two most relevant anomalies for our study which we will present in more detail, these are the size effect (small-firm effect) and the book-to-market ratio anomaly.

2.3.1 Small firm effect

The asset pricing model of Sharpe, Lintner and Black has laid the foundation for how people observe the relationship between risk and return. In a well-diversified portfolio, the return is a positive linear function of the portfolio beta against the market index. Since beta measures both the correlation and magnitude, in theory it is sufficient to explain the variation of returns in different stocks, but the empirical finding however suggests otherwise. In a study conducted by Banz (1981, p. 3) examining the relationship between market capitalization and return, he found that between the period of 1936 to 1976, small firms had on average higher risk adjusted return compared to large firms, which he then referred to as size effect. There are many attempts to explain the anomaly, some says it is partially due to the increased riskiness in small firms, since they are more likely to go bankrupt. Other explanations are smaller firms have fewer to none analysts following them, while this negligence incur higher cost to obtain information for investors, it also raises the possibility to make informed investment decision, which leads to higher return (J. M. Griffin et al., 2010, p. 3256).
In 1992, Fama and French proposed a three factor model using beta, market capitalization and book to market ratio. The model worked exceptionally for US market and explained the variation of cross sectional return far better than beta alone. Recent robustness test of the model holds well in different markets, especially when augmented with an additional momentum factor (Fama & French, 1992).

While there is no denying the small firm effect exist, proponents of asset pricing model argues that it is not necessarily an anomaly. Beta is often used as a single period measurement, but the characteristic of the market is different during bear and bull, therefore the higher volatility of small firm is better captured using variable beta.

### 2.3.2 Book-to-market

Book equity-to-market equity (BE/ME) or book-to-market ratio is a business ratio that is often used in fundamental analysis to find over- or undervalued securities, this ratio is also known as the Price-to-Book (P/B) ratio when the formula is reversed.

\[
Book\ to\ market = \frac{Book\ value\ of\ firm}{Market\ value\ of\ firm}
\]

The book value of a firm is calculated by subtracting the intangible assets and liabilities from the total assets, while the market value of a company is the market-price of a share multiplied with the total number of outstanding shares for the firm.

Studies done by Lakonishok, Shleifer, & Vishny, (1994), Fama & French, (1992) and Capaul, Rowley, & Sharpe, (1993) all show that there is a correlation between a high book-to-market ratio (low price-to-book ratio) and abnormal returns. In Fama & French’s paper (1992, pp. 440-442) they study the American stock-market between July 1963 to December 1990, the results they got from the study showed that the portfolio containing the stocks with the highest book-to-market ratio on average gave a return about 1.5 % higher per month compared to the portfolio containing the stocks with the lowest book-to-market ratio. The study of Lakonishok et al., (1994, pp. 1565-1566) used the same market and the same time period as Fama & French and they found that value stocks (top 20 % with highest book-to-market ratio) outperformed glamour (bottom 20% with lowest book-to-market ratio) in 17 out of 22 years.

There are conflicting theories why this anomaly exists, Lakonishok et al., (1994) talks about the two most common explanations; risk and naïve investors. The first explanation that high book-to-market stocks are fundamentally riskier is rather straightforward, the investors of value stocks bear a higher risk when investing and the higher average return is merely a compensation for the risk.

The other explanation, that investors are naïve is a bit more complicated. The supporters of this explanation argue that if the book-to-market ratio is high the stock gets undervalued and if it is low the stock gets overvalued. Overvalued stocks, or glamour stocks, are well-known companies that are popular among investors due to their growth potential, stability and past performance.
The reasons why they are being overpriced can differ but the general idea is that investors are naïve and overreact to the available information and pay too much for the stock. Undervalued stocks or value-stocks have usually done badly in the past and as a reaction to this, naïve investors oversell these shares and therefore they become undervalued.

What makes high book-to-market stocks produce a higher return is still a on-going discussion but the study done by Capaul et al., (1993) on 6 different European markets during 1981-1992 showed that value stocks outperform glamour stocks even after risk-adjustment, these results conflicts with the idea that the higher return is merely a compensation to risk and that there might be something else behind this phenomenon.

2.4 Valuation models

Comparing portfolio return is a difficult task since the assets may have different volatility. In order to measure the performance objectively between investment models, risk adjusted return is often employed, also known as alpha. How the alpha is calculated depends on the valuation model used. In this thesis we will use CAPM and Fama French three factor model as valuation model to determine the risk adjusted return.

2.4.1 CAPM

The most common and well known model to determine the appropriate rate of return for a security is the Capital Asset Pricing Model (CAPM). In this model there are few variables that are used for its estimation, based on a combination of beta, risk free rate (Rf) and the return of the market (Rm). The risk free rate is usually substituted using a treasury bill from a financially strong country. The riskiness of the security is determined by using its beta (β) which is a measure of how volatile the stock is compared to the market as a whole.

CAPM formula:

\[ R = R_f + \beta (R_m - R_f) \]

R = return of the portfolio

Beta = beta of the portfolio

Rf = risk-free rate

Rm = return of the market

CAPM has received a lot of criticism for being inaccurate in predicting asset return. Fama and French are two of the biggest critics of CAPM and in 1992 they published the well-known paper called *The Cross-Section of Expected Stock Returns* where they tested if different firm-characteristics such as leverage, size, book-to-market and Earnings/Price ratio (E/P) can capture the cross-sectional variations in average stock returns. The study was made based on the NYSE, AMEX and NASDAQ between 1963-1990 (Fama & French, 1992). They found that market β
didn’t seem to have any roll in explaining the average returns on the reviewed markets. They did however find that the combination of size and market-to-book equity capture the cross-sectional variation in average stock returns that is related to leverage, size, book-to-market equity and E/P (Fama & French, 1992, p. 445). Because of these results, Fama and French thought that there was a need for a model that can explain the cross-section of expected stock returns better than the traditional CAPM, that lead them into constructing the Fama French Three-factor model.

2.4.2 Fama French three factor model

The Fama-French three factor model is a further development of the Capital Asset Pricing Model where two additional factors have been added. As we explained earlier, studies have showed that small cap firms outperform large cap firms and value stocks (high book-to-market ratio) outperform glamour stocks (low book-to-market ratio) on a regular basis. These two anomalies are called small-firm effect and book-to-market effect and it is these two factors that have been added in the Three-factor model.

Fama French three-factor model

\[ R = R_f + \beta \cdot (R_m - R_f) + \beta_s \cdot SMB + \beta_v \cdot HML \]

- \( R \) = return of the portfolio
- \( \beta \) = beta of the portfolio
- \( R_f \) = risk-free rate
- \( R_m \) = return of the market
- \( \beta_s \) = corresponding coefficient, the value of this factor depends on how the portfolio is weighted. If the portfolio consists of a majority of small capitalization stocks the value of the coefficient will close to one, if there is mainly large cap stocks it will turn towards zero or negative.
- \( \beta_v \) = same as Bs but in this case it is the book-to-market value that determines the value of the coefficient. With a majority of high book-to-market stocks the value will turn towards one and if the portfolio contains a majority of low book-to-market stocks the value will be closer to zero.

\( SMB \) = stands for Small (cap) Minus Big (cap). As the name suggests this is a measure of the excess returns that small cap firms have generated against large cap firms. It is normally calculated by subtracting the average return of a portfolio with 50% small cap firms with 50% large cap firms.

\( HML \) = Stands for High (book-to market) Minus Low (book-to-market). Just like the SMB this is a measure of the excess returns value stocks have against glamour stocks. A minor difference is that the top 30% versus bottom 30% are subtracted instead.
2.5 Jensen’s Alpha

Suppose two portfolios have identical return over an investment period, rational investors would select the one with lower volatility or demand higher return to compensate the additional risk taken in the other portfolio. Now with endless possibilities to combine a portfolio, we need a method that objectively rate the performance of the portfolio that is comparable with others, one of the methods is called Jensen’s alpha.

The method was first used by mutual fund manager Michael Jensen to evaluate how various portfolios performed using risk adjusted returns. The theory behind is quite intuitive, just compare the actual return with a predicted return using a suitable market model, most often CAPM. Should the alpha be consistently above zero, then that could mean the portfolio is performing better than the market (Bodie et al., 2009, p. 826). A generalization of the alpha is that it captures all factors that are not included in the market model, regardless whether it is a manager’s ability of stock picking or various anomalies we earlier mentioned.

\[
\alpha_j = R - R_f + \beta (R_m - R_f)
\]

Jensen's alpha = Portfolio Return \[\text{Risk Free Rate} + \text{Portfolio Beta} \times (\text{Market Return} - \text{Risk Free Rate})\]

The formula above displays CAPM’s alpha, which calculates the marginal return of the portfolio where excess market return is considered as the only factor. The same method can also be used with the three factor model, by using this model the alpha is adjusted with two additional coefficients.

\[
\alpha_j = R - R_f + \beta_s (R_m - R_f) + \beta_s \times SMB + \beta_v \times HML
\]

2.6 Value investing

Value investing has existed long before Piotroski’s paper. The main philosophy derives from the teaching of Ben Graham and David Dodd at Columbia Business School in 1928 and further developed during 1934 in their book Security Analysis (Graham & Dodd, 1934). Graham colourfully portrays the overall stock market as someone with deep emotional problem, and market price is set by his mood swing rather than rational thinking. Each day market value of a company could shift significantly without any changes in the firm’s intrinsic value. While this illustration directly clashes with efficient market hypothesis, there are some empirical observations that may prove that “Mr. Market” may very well be how the market operates, especially during economic meltdown or financial bubbles. It is noteworthy that after the great depression, Graham used his investment model to screen for value stocks and often found stocks priced less than their liquidation value. (The value of a firm that immediately closes down and sells off all tangible assets) While the same bargain are less likely to be found today, the idea of value investment remains to analyse a business using fundamental analysis to estimate its intrinsic value. If the market value is far below the estimated intrinsic value, the stock should be added to the portfolio. The difference between intrinsic value and market price is called margin
of safety. Since it is difficult to accurately determine fair value of a firm, the margin provides investors a form of protection against estimation error.

2.6.1 Piotroski’s model

Value investing in high book to market ratio firms has existed long before Piotroski’s paper. Earlier research showed that a portfolio that consists of High Book-to-Market (HBM) firms outperform the market average. In the three factor model, Fama argues the book to market ratio captures financial distress of the company, the higher return associate with HBM is therefore justified by additional risk. Simultaneously, HBM represent companies that have been neglected by analysts because of their poor historic development, but will yield abnormal return when the mispricing eventually corrects itself. We have looked into two studies that have been done with Piotroski’s model as a base, where one looks into the Indian market (Aggarwal & Gupta, 2009) and one looks at the Swedish market (Gerber, Johansson, & Johansson, 2009). The researchers in these studies were able to generate a substantially higher return than index, even after risk-adjustment. The study that was made on the Swedish market has not been peer-reviewed but after looking into the methods of the studies we believe that the results can be considered to be valid.

Earlier research on fundamental analysis often require some form of earning forecast as input for various valuation models. Since financial analysts are less prone to follow poor performing firms associated with HBM firms, there are less reliable forecasts available.

Piotroski’s model relies on 9 different financial performance signals that can be extracted from financial reports. The information are based purely on accounting data and requires no forecast, therefore the reliability of the data should be higher given the accounting standard is adequate in that market. Interpretation of the performance signal is however not always unilateral, for example changes in leverage could be both positive and negative depending on the financial situation of the company. The 9 performance signals are separated into 3 subgroups. The first four measure profitability of the firm, the following three measures changes in financial structure and liquidity, and the last two determine operational efficiency (Piotroski, 2000, p. 7). Here are the signals Piotroski chose and how to interpret them.

<table>
<thead>
<tr>
<th>Profitability:</th>
<th>Shortening:</th>
<th>Calculation</th>
<th>Score 1 if:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Return on Equity</td>
<td>ROA</td>
<td>Net income before extraordinary items scaled by Total Assets</td>
<td>ROA &gt; 0</td>
</tr>
<tr>
<td>Changes in Return on Equity</td>
<td>ΔROA</td>
<td>Current years ROA less the previous year’s ROA</td>
<td>ROA_{t} &gt; ROA_{t-1}</td>
</tr>
<tr>
<td>Cash-flow from operations</td>
<td>CFO</td>
<td>Funds from operations scaled by total assets</td>
<td>CFO &gt; 0</td>
</tr>
<tr>
<td>Accruals</td>
<td>ACCRUAL</td>
<td>net income before extraordinary items minus cash flow from operations</td>
<td>Accruals &gt; 0</td>
</tr>
<tr>
<td>----------</td>
<td>---------</td>
<td>---------------------------------------------------------------------</td>
<td>-------------</td>
</tr>
<tr>
<td>Financial structure and liquidity:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Changes in Leverage</td>
<td>ΔLEVER</td>
<td>Current year’s long term debt divided by total assets minus previous years leverage.</td>
<td>Leverage_{t_1} &lt; leverage_{t-1}</td>
</tr>
<tr>
<td>Changes in Liquidity</td>
<td>ΔLIQUID</td>
<td>the current ratio of the company at the current year compared to last year</td>
<td>Liquidity_{t_1} &gt; liquidity_{t-1}</td>
</tr>
<tr>
<td>Equity Offerings</td>
<td>EQ_OFFER</td>
<td>Are there any equity offerings?</td>
<td>No equity offerings</td>
</tr>
<tr>
<td>Operational efficiency:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Changes in Turnover</td>
<td>ΔTURN</td>
<td>current year asset turnover ratio less the prior year asset turnover ratio</td>
<td>Turnover_{t_1} &gt; Turnover_{t-1}</td>
</tr>
<tr>
<td>Changes in Margin</td>
<td>ΔMARGIN</td>
<td>current year’s gross margin ratio less the prior year’s gross margin ratio</td>
<td>Margin_{t_1} &gt; Margin_{t-1}</td>
</tr>
</tbody>
</table>

Figure 1: Summary of Piotroski’s signals. (Piotroski, 2000, pp. 7-9)

The first two signals in the profitability group are Return of Asset and changes in Return of Asset, where return is defined as net income before extraordinary items compared against total asset in the beginning of the year. ROA is normally perceived as how effective a firm can generate profit using its asset, therefore this ratio differs in various industries and usually compared against an industry norm or firms previous year performance. In this case, Piotroski (2000, p.7) define any positive ROA and positive trend compared to last year as a positive signal regardless of their size, and they are rewarded with 1 point. He explains that value firms with high book to market ratio usually have poor historical earnings, any positive return and trend is a sign that these firms will be able to generate positive earnings in the future (Piotroski, 2000).

The other two signals in the profitability group are cash-flow from Operations and Accruals. Piotroski took the same approach for CFO as ROA, where any positive cash-flow from operations regardless of size is awarded with 1 point, 0 otherwise. He also defined Accrual as CFO subtracted by ROA, and a positive value is awarded 1 point. The relationship between earnings and cash-flow is important, especially for a firm with poor historical performance. Because these firms need cash to reinvest in order to secure future profitability, while short term earning driven by accrual adjustment will damage long term profitability.

The next group of performance signals measure the firms leverage, liquidity and source of fund.
The first signal in this group is changes in the company’s financial structure, or leverage. According to the Modigliani–Miller theorem (Modigliani & Miller, 1958), leverage doesn’t change the value of the company, otherwise an arbitrage situation would occur where investors could artificially lever a company by borrowing money and purchase an unlevered firm. The proposition is however only true in a world without taxes. When adjusting for tax effect the additional debt provides a tax shield that increases the firms’ value, this effect diminishes at an accelerating rate when cost of financial distress surpasses the benefit from tax shield. The theoretical optimal leverage is therefore when the firm’s value is maximized when account for a tax shield and cost of financial distress. Changes in leverage could therefore be both positive and negative depending on which effect is larger. In a growth company, increased debt could be viewed as a positive signal, the owner believes that they can generate enough funds to repay the debt and doesn’t want to dilute profits from the current shareholders. In this case however, Piotroski (2000, p.8) argues that an increase in leverage for firms that are already in financial distress sends a negative signal. Raising funds means the company internal generated funds are no longer sufficient; debt taken under these situations will most likely governed by covenants that reduce financial flexibility. Any increase in leverage will score 0 while decrease or no changes in leverage will score 1.

The second signal is changes in liquidity, which Piotroski (2000, p.8) define as changes in current ratio between current and last fiscal year. Unlike leverage, current ratio measures a company’s ability to meet its short term liabilities. While the specific range for current ratio differs among industry, a too low current ratio typically reflects companies’ inability to repay short term debt without refinancing, and a too high current ratio is usually a sign of inefficient use of financing facilities. To assess the implication of changes in current ratio, an analyst normally has to look at individual components in current asset and current liabilities to determine the cause. Based on Piotroski’s observation, an increase in current ratio is most often a positive signal for HBM firms, therefore he chose to score 1 for positive changes and 0 for none or negative changes.

The third signal is equity offering. According to the pecking order theory, equity offering is used when no other options are viable (Myers & Majluf, 1984). This is because the different options of financing have different cost associated with them. Internal funding is considered the cheapest option since retained earning hasn’t been taxed yet and issuing cost is low. Debt-financing is more expensive than internal funding with higher issuing cost, but in some situation it could send a positive signal to the market as earlier mentioned. Equity offering is used as a last resort because not only is it more expensive than internal financing and debt, it also sends a negative signal to the market that the company can no longer refinance investments with internal funds and has exhausted available debt financing options. Piotroski (2000, p. 8) score any issuing of common equity with 0, otherwise 1.

The last two signals measures operational efficiency of a firm. Changes in turnover and margin both attributes to a firm’s ability to generate profit. Changes in margin is defined as current year’s gross margin ratio compared against last year’s gross margin ratio, an increase is awarded with 1 point and signifies that the company either is able to reduce production cost and/or raise the price of the product. Margin alone is however a poor indicator since increase in margin could be at the cost of reduced sales. Therefore it is used in conjunction with changes in turnover. In this case,
changes in turnover are defined as current asset turnover ratio compared against last year asset turnover ratio. Asset turnover ratio assesses the productivity at a given amount of assets, an increase means that the firm has an increase in sale or that less assets is used to produce same amount. A positive change in turnover is awarded with 1 point (Piotroski, 2000, p. 8).

The 9 binary tests will rank every stock with a score between 0-9, this is the company’s F_score. Piotroski (2000, p 8-9) adopted this straightforward approach because it is easy to implement, there is no need to refit data every year, no complicated probability assigning, yet this simple screening method still achieved significant abnormal earning. Piotroski (2000) mentioned in his paper that this is no way an optimal model nor was it his intention, he only wanted to device a simple method that could separate a strong value firm from weak one.

2.7 Diversification

Diversification can be illustrated with an old gnome that says “don’t put all your eggs in one basket”. The idea behind diversification is that it is supposed to allow the extreme good and bad returns to cancel each other out, by doing this the variability, or risk, is reduced without affecting the expected return (Keown, 2010, p. 392). However, risk can be divided into two different types when discussing diversification; one is systematic risk and the other one is unsystematic risks. Systematic risk is referred to as the risk that cannot be eliminated through diversification, these are events that affect the market as a whole and not just individual stock. The recent activities in southern Europe and the risk of countries going bankrupt is an example of systematic risk since this would affect almost every stock on the market negative and can therefore not be diversified away. Unsystematic risk on the other hand is the variability in returns of an investment that is due to events that are unrelated to the overall market, for example if the oil-company’s latest finding turns out to be dry or if the firm gets a product recall (Keown, 2010, p. 393). To avoid these company-specific risks diversification by investing in different companies and industries can be very effective.

The modern thoughts about diversification origins from Harry Markowitz and his article called “Portfolio selection” (Markowitz, 1952). Markowitz was able to show that there is a connection between expected return and variance, where variance is undesirable. In his article he explained that an investor might choose to have a low variance and receive a low expected return or if he would like a higher expected return the variance will also be higher (Markowitz, 1952, p. 82). In other words the higher expected return you want the higher risks you have to take.

The number of securities needed to form an optimal diversified portfolio is thoroughly debated. Most researchers agree that diversification should be increased as long as the marginal benefits exceed the marginal costs. The best way to get a diversified portfolio would be to buy all stocks in the market, that way you are completely shielded against unsystematic risk, but if you include the costs of buying every stock this idea will be untenable. For quite a long time a study done by Evans & Archer, (1968, p. 767) worked as a benchmark. In their study they raised doubts about the economic justification of portfolios containing 10 or more securities. A later study opposed to this statement and came to the conclusion that a well-diversified stock-portfolio should contain at least 30 stocks (Statman, 1987, p. 362). Statman (1987) showed a table of the relationship
between standard deviation of stocks relative to the number of stocks in a portfolio, we have constructed a figure with his data as base to illustrate this relationship.

![Figure diversifiering](image)

**Figure 2: Ratio of portfolio standard deviation to standard deviation of a single stock. Source: (Statman, 1987, p. 355)**
*(constructed out of data that the article provides)*

We will apply and consider the ideas behind diversification, if possible, when we construct our own portfolios for testing Piotroski’s model.

### 2.8 Generation of Hypotheses

With the above theories as a starting point the hypotheses have been generated for different ways to test Piotroski’s model in markets with different forms of efficiency and development. We will focus on three parts, model performance based on anomalies, differences between markets and differences between valuation models.

#### 2.8.1 Anomalies

The book-to-market anomaly and the small firm effect are two anomalies that occur in this thesis that have been proved to yield abnormal returns even after they have been adjusted for risk (Aggarwal & Gupta, 2009; Capaul et al., 1993; Fama & French, 1993; Lakonishok et al., 1994). These anomalies occur frequently in Piotroski’s model, one criterion is for example that only the top 20% of the companies with the highest book-to-market ratio should be included in the portfolio, he also argues that the model works better on small companies rather than large ones. Even if Piotroski markets his model as an easy way to find undervalued stocks it still involves a lot of steps and requires 11 different ratios to calculate F_score. Since the model is based on anomalies premium we want to rule out that it isn’t just the anomalies that are doing the job and that Piotroski’s screening process actually contributes to the abnormal returns as well.
Because of that we created one portfolio based on small firms and one portfolio based on high book-to-market firms and compares the abnormal return generated.

**Hypothesis 1a:** A portfolio based on stocks that are selected with Piotroski’s model are not able to generate a risk adjusted return that is higher than a portfolio based on small cap stocks using CAPM valuation model.

**Hypothesis 1b:** A portfolio based on stocks that are selected with Piotroski’s model are not able to generate a risk adjusted return that is higher than a portfolio based on small-firm stocks using Fama French Three Factor valuation model.

**Hypothesis 2a:** A portfolio based on stocks that are selected with Piotroski’s model is not able to generate a risk adjusted return that is higher than a portfolio based on high book-to-market stocks using CAPM valuation model.

**Hypothesis 2b:** A portfolio based on stocks that are selected with Piotroski’s model is not able to generate a risk adjusted return that is higher than a portfolio based on high book-to-market stocks using Fama French Three Factor valuation model.

The small-firm and book-to-market anomalies are both well-established and they have been proved to generate abnormal returns in studies by Banz (1981), Capaul et al. (1993) and Lakonishok et al. (1994). In previous research these anomalies have proved to generate abnormal returns when they are tested separately, it is therefore reasonable to believe a combination of two anomalies can generate even better results. Using the combination portfolio as benchmark we test if Piotroski’s model can generate excess return that surpasses a simple portfolio relying solely on anomaly premium. The following hypothesis is formed to test that.

**Hypothesis 3a:** A portfolio based on stocks that are selected with Piotroski’s model is not able to generate a risk adjusted return that is higher than a portfolio based on companies that are both small and have a high book-to-market ratio using CAPM valuation model.

**Hypothesis 3b:** A portfolio based on stocks that are selected with Piotroski’s model is not able to generate a risk adjusted return that is higher than a portfolio based on companies that are both small and have a high book-to-market ratio using Fama French three factor valuation model.

### 2.8.2 Piotroski’s model in different Environments

Piotroski states in his paper that the model should be most effective on small companies that few analysts follows, but more importantly resides in an environment with slow information-dissemination (Piotroski, 2000, p. 3). There are a numerous methods for measuring market efficiency, Hou & Moskowitz (2005) presented a method where the delay of a market was used as a tool to measure the effectiveness. This method was then used by J.M. Griffin et al. (2010) in a study where he was able to rank 56 countries based on how effective their markets were. With the help of Griffin et al.’s study and the hypothesis from Piotroski’s regarding where his model should be most effective in mind we generate the following hypothesis.
Hypothesis 4a: A portfolio based on stocks selected by Piotroski’s model from a market with high delay does not generate higher return than a portfolio based on markets with low delay selected by Piotroski’s model after both being risk adjusted using CAPM.

Hypothesis 4b: A portfolio based on stocks selected by Piotroski’s model from a market with high delay does not generate higher return than a portfolio based on markets with low delay selected by Piotroski’s model after both being risk adjusted using Fama French three factor model.

A common notion among investors have been that emerging countries have a weaker form of efficiency and therefore a better place to make informed trades compared to developed countries. Griffin is however able to show that common investment strategies based on past returns and earnings are less effective in emerging countries compared to developed countries (J. M. Griffin et al., 2010, p. 3257). According to the results of Griffin we should not be able to generate a higher return in emerging countries compared to developed countries by using Piotroski’s model. We would thereby like to test the following hypothesis.

Hypothesis 5a: A Portfolio based on stocks from emerging countries which are selected by Piotroski’s model does not generate a higher return than that has been risk-adjusted by CAPM than a portfolio based on stocks from developed countries that are selected by Piotroski’s model.

Hypothesis 5b: A Portfolio based on stocks from emerging countries which are selected by Piotroski’s model does not generate a higher return than that has been risk-adjusted by the Fama & French three-factor model than a portfolio based on stocks from developed countries that are selected by Piotroski’s model.

2.8.3 Comparison of valuation model

Earlier studies have shown that Piotroski’s model can pick stocks that are more profitable than the index, even after risk adjustment (Aggarwal & Gupta, 2009; Gerber et al., 2009). One of these studies uses excess market return while the other one uses the Sharpe ratio to measure the risk-adjusted returns. The lack of beta coefficients in both methods assumes that portfolios have no correlation with the overall market. In our study, we use Jensen's alpha as measurement to check if the portfolios are able to generate excess returns when risk adjusted using CAPM. One major criticism for capital asset pricing model have been only using β to measure the risk and thereby not being able to explain the returns of portfolios in a satisfying way (Fama & French, 1992, 1993), therefore we chose to also include the Fama French three factor model in our study. As the name suggests they remedied the single beta problem by incorporating two additional factors in their model. Doing so not only were they able to gain coefficients of determination, the return were also further dissected and distributed to individual anomaly. Including both valuation models will also allow us to compare the difference in result and identify whether method of valuation has any impact on the risk adjusted return.

Hypothesis 6: The risk adjusted return generated using Fama French three factor model is not different from one generated using CAPM.
3. Method

The method chapter will start with a theoretical part where we will have a discussion about the scientific approach, our preconceptions and the literature search. To study this investment strategy we have chosen the most common way which is a quantitative study with a deductive research approach. The theoretical section will be followed by method of data collection where we first argue which countries we have chosen and why. Followed by a description of the collection and sorting of the data that we will use for our study. Since there are a lot of ratios to keep track of in Piotroski’s model we will describe them and how they are constructed before we motivate our choices of the portfolios that will be created. After the data collection section a chapter will be dedicated to regression and statistical tests that we will use for the analysis. To conclude the methodology section we discuss the reliability and validity of this study.

3.1 Preconceptions

When performing a scientific study with a positivistic perception of knowledge it is important that it is done in an objective manner. According to Johansson-Lindfors, (1993, pp. 25-26) previous experiences, education and social background can influence your perception of knowledge and the problem formulation. To make our study as credible as possible it is important that we take this into consideration while we are doing our study and exclude our personal preconceptions as much as possible, that way this study will be objective and the results of the study are not influenced by our own opinions.

Neither of the authors have worked with any kind of investment strategies professionally before, there is however a mutual interest in stock trading and pricing of stocks.

3.2 Literature search

To be able to find relevant information about earlier studies we used keywords and key phrases to start with. We have mainly used the database Business Source Premier (EBSCO) that is available through the library at Umeå University. Business Source Premier is a research database that contains the full text from more than 2200 journals in the area of finance, marketing, accounting and economics, just to mention some. Some of the keywords and key phrases that we used are: high market-to-book ratio, Piotroski, Efficient market hypothesis, market anomalies, value investing, book-to-market, market efficiency, measuring market efficiency, price-to-book ratio.

Piotroski’s investment model has not been excessively used in other research papers, according to EBSCO his paper “Value Investing: The Use of Historical Financial Statement Information to Separate Winners from Losers” which were written in 2000 and has only been cited in 34 of the thousands of articles that are available through EBSCO. If you do another search at just “Piotroski” (his model is often called the “Piotroski model”) there are only 27 peer-review articles in which his name figures, this can be compared with a search of “Efficient Market Hypothesis” which generates 1097 hits. The results from our searches in EBSCO gives you a hint of the number of studies that has been done in this area, there are however only a few of these
articles that follow the Piotroski models criteria’s strictly. We therefore believe that there is a need for more research in this area.

We have tried to only search for “peer reviewed” articles in business source premier, thus we know that the articles we have chosen is of high quality. There are some thesis written by other students that have tested Piotroski’s model that not have been peer-reviewed, in these cases we have gone through the methodology section to make sure that their results are valid. There have been some cases where we knew the title and author of an article but could not find it in the database, in those cases we used other scientific databases provided by Umeå University, like Emerald Journals and EconBiz. If the articles where not found by using these databases we used Google’s search engine. When Google was used to find sources we checked through the articles critically to make sure that is actually was the article we were looking for, and that it was the original version.

There are a few articles that have had more influence in this thesis than others. Except for Piotroski’s paper which we base this thesis on the delay studies written by Griffin (2010) and Hou & Moskowitz (2005) has also had a large influence. We use Griffins study as a base for the choice of our markets to study and Griffin bases a lot of his study on the delay measuring devices Hou and Moskowitz developed. Different research papers by Fama and French are also frequently cited in this thesis.

A lot of articles where found when they were cited in other Articles, for example if we read an article about anomalies written by Fama and French they could refer to another study written by Schwert which we then would look up to see if was useful to our study as well. To be sure that the information we collect is not tampered with we use only primary sources, with few exceptions when referring to grand theories in textbooks.

### 3.3 Scientific approach

The scientific approach deal with the relationship between theory and empiricism where there are two main approaches, deduction and induction. As we mentioned above we will mainly have a deductive approach in this study. When you have a deductive approach a simple way to describe the working process is that you go from theory to empiricism, while in an inductive study you do the opposite and start off with an empirical study and then form a theory based on the results (Johansson-Lindfors, 1993, pp. 55-57).
Figure 3: Typical working progress for a deductive study. Source: (Bryman, Bell, & Nilsson, 2005, p. 23)

Figure 3 shows a typical working process for a deductive study, this is the approach we will follow in our study. We start off with the previous knowledge that we have received from earlier research in this area, in our case the main theory of our study is the value investing strategy made by Piotroski, (2000). The next step is to derive one or more hypotheses about the theory that will be put through an empirical review. The first two steps will decide what kind of data that will be necessary to test these hypotheses and it is therefore important that the researchers can deduce hypotheses that can be translated into researchable entities. The findings of collected data are then used to either reject or fail to reject the hypotheses. If the theory needs to be revised the researchers need to apply to an inductive approach and describe the consequences of the results for the theory behind the research (Bryman et al., 2005, pp. 23-24).

3.3.1 Epistemology & Ontology

When doing a scientific study the researchers behind the analysis might have a very large influence on how the end-result comes out. To make our study more credible and transparent we will declare our epistemological and ontological views on what science is, how data should be interpreted and how to draw any conclusions out of the results we get. While doing this we hope that the results of our study will give a fair view of the research questions we are testing.

Our epistemological view explains what we regard as acceptable science. When you are doing a scientific study there are two main branches, the first one is positivism and the second one is hermeneutic. Positivistic researchers advocate the use of scientific methods, with a clear distinction between theory and practice (Bryman et al., 2005). Positivism is a widely spread
theory and because of that there are some dissensions about what the standpoints of this philosophy of science really are. There are however some aspects that most supporters agree on that are important for this theory, for example; the purpose of the theory is to generate hypothesis that can be tested and then legal explanations can be drawn on the basis of the results, this is also known as a deductive study. Other important aspects is that the research should be unbiased and only things that can be confirmed using your senses should be considered “real” science (Bryman et al., 2005).

Followers of the hermeneutic tenet use theory and method in their research, but they also try to find an explanation of the human behaviour in the research. The hermeneutic epistemology is closely related to the Verstehen (German for understanding) approach that also put a lot of weight on understanding (Bryman et al., 2005). A typical field of research within the hermeneutic is history where old texts are rendered, with the bible as one of the most researched areas.

Just like the case with epistemology there are two main philosophies in ontology, these are known as objectivism and constructionism. Ontology explains the social entities art or nature, according to Bryman et al. (2005, pp.33-35) the important thing in this context is whether social entities can or should register as objective units that cannot be affected by social participants or if they should be viewed as constructions that are made up by the participants opinions and actions.

As authors of this research papers we think that positivism and objectivism fit our profile best, these philosophical theories are also closely related and one of the cornerstones in a positivistic study is that it have to be objective. Since we are doing a quantitative study in finance we rely on mathematical formulas and statistics, this leaves little room for own interpretation and we will have hypothesis to base our explanations on. To make our study more credible it is important that others can recompose our study and get the same results as us; this might not be possible if our own thoughts are involved. In a quantitative study it is common for the researchers to have objectivism as an ontological approach, this means that we accept social phenomenon that lie beyond our intellect and that we can’t influence (Bryman et al., 2005, pp. 33,40).

3.3.2 Research strategies

When a financial study on investment strategies is done it is almost exclusively made as a quantitative study. In this thesis we have referred to about 30 financial articles which all are using a quantitative approach. Figure 4 shows the main differences between the two strategies and these differences shows why a quantitative study is preferred over a qualitative one. First of all objectivism is a crucial part, when you are dealing with investment strategies there is no room for your own interpretations but what is demanded is objective data that is a direct image of the reality. Natural science is also heavily rooted in the financial world, where people act after given rules.
A quantitative study is in other words a research strategy that put emphasis on quantity of data, testing of theories and the natural scientific models and norms (Bryman et al., 2005, pp. 39-41). Since we are testing an accounting-based fundamental analysis stock selection strategy on whole markets and during a considerable time-period our data will consist of millions of numbers that will be tested and verified by statistical models to reject the possibility of statistical randomness. In that sense we think that a quantitative research strategy is the only option for our study.

### 3.4 Data Collection

#### 3.4.1 Choosing countries

We want to test market efficiency’s impact on Piotroski’s value investment strategy, therefore we need to base our choice of markets purely on their efficiency in an objective manner. The method we selected is based on Hou & Moskowitz (2005) delay regression.

The model was originally constructed to further explain the cross sectional variation not captured by the three factor model. Hou & Moskowitz found in their study that delay premium is strongest among small, value, illiquid, volatile and poorly performing stocks (Hou & Moskowitz, 2005, p. 983). Since Piotroski’s model was designed to perform in small and value firms, its success in US firm could partially derive from delay, therefore we want to test the possibility whether Piotroski’s model will perform better in markets with higher delay.

To process all weekly prices available on all markets from 1995 to 2009 is very resource intensive both in terms of time and data, something that we lack as students given the time span and access. For this reason we have relied on earlier research conducted by (J. M. Griffin et al., 2010). In their paper “Measurement and Determinants of International Stock Market Efficiency, they measured the efficiency of 56 individual markets using three different methods. The public information efficiency in their study was measured using the delay regression method as Hou & Moskowitz proposed. The result they found can then be further processed to suit our needs.

The screening process starts with compiling a list of all major markets of both developed and emerging markets. The list in Griffins paper consist of 28 emerging markets and 28 developed
markets, their classification is based on World income classification at the end of November 2005. While we realize that delay premium might be higher in certain smaller markets that are not on the list, the strict criterion of Piotroski’s model renders us unable to use small markets without taking unnecessary diversifiable risks described earlier. Therefore, markets must have sufficient amount of stocks with good quality of data. The data Griffin has gathered comes fromDataStream that has reasonable reliability although it contains substantial missing data on fundamental values, but it shouldn’t affect Griffin’s result because price information is the only requirement to calculate delay.

In Hou & Moskowitz study they found that delay measure on individual stocks is extremely noisy, by creating a portfolio the estimation error can be decreased considerably. In an earlier draft Griffin has divided all stocks to five equally weighted portfolios based on market capitalization, each portfolio is also rebalanced each year at the end of calculation period during June (J. Griffin, Kelly, & Nardari, 2006). Since Piotroski model uses only the top quintile of firms, we will also rank each market based solely on delay in the top quintile portfolio instead of the market delay as a whole.

*Formula for measuring delay:*

**The unrestricted formula**

\[
 r_{i,t} = \hat{\alpha}_{i,t} + \hat{\beta}_{0i} r_{m,t} + \hat{\beta}_{1i} r_{m,t-1} + \hat{\beta}_{2i} r_{m,t-2} + \hat{\beta}_{3i} r_{m,t-3} + \hat{\beta}_{4i} r_{m,t-4} + \epsilon_{i,t*}
\]

**The restricted formula**

\[
 r_{i,t} = \hat{\alpha}_{i} + \hat{\beta}_{0i} r_{m,t} + \epsilon_{i,t*}
\]

R-squared from the formulas are used for delay calculation

\[
 Delay = Adj. R^2_{unrestricted} - Adj. R^2_{restricted}
\]

Where:

- \( r_{i,t} \) = Return on stock \( i \) in week \( t \).
- \( r_{m,t} \) = Return on market in week \( t \)
- \( \alpha_{i} \) = excess return generated by the stock
- \( \beta_{0} \) = beta coefficient for each week
- \( \epsilon_{i,t} \) = residuals

The restricted formula is very similar to CAPM model where there is only one beta that describes the relationship between market and the stock return. In the unrestricted formula, 4 additional beta coefficients are added to measure the correlation between the stock return and market return.
four weeks back. Since delay measure could easily be confused with infrequent trading, any stocks that trade less than 30% of all trading days are excluded from his study.

The difference between the restricted and unrestricted model is due to lagged return that happened one to four weeks before the calculation week. Therefore, by comparing a coefficient of determination of each model, the additional explanatory power of the unrestricted model is also due to lagged return. To compensate increased R-square in the unrestricted model caused by increased number of coefficients, adjusted R-square is used instead for comparison.

After regressing each portfolio a list is generated that consists of markets with the highest delay to those with the lowest. From the list we select one market from the extreme ends of both sides. This will yield two markets with the highest and lowest delay from developed markets and two from emerging markets. These markets will then be scanned in Datastream for size and data quality. If the market doesn’t contain sufficient amount data for our study we will move on to the next market in line until four markets are generated. Those four markets will be our primary source for testing Piotroski model.

Given the results of the study conducted by J. M. K. Griffin, Patrick J. Nardari, Federico, (2010) we selected 4 different countries to include in our study. The countries we chose to include are:

Table 1: Countries included in study

<table>
<thead>
<tr>
<th>Developed Countries</th>
<th>Large Delay</th>
<th>Small Delay</th>
</tr>
</thead>
<tbody>
<tr>
<td>South Korea</td>
<td>Chile</td>
<td>India</td>
</tr>
<tr>
<td>France</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

France shared the first place over countries with the largest delay together with the United Kingdom. The reason we chose France over the UK was that the observed delay in the portfolio with lowest market capitalization had far higher delay in France. South Korea was the 6th country that had the shortest delay. We decided to use this country despite that there were 5 countries with a shorter delay, this was due to the small size of their market and the fact that Datastream did not have sufficient data upon initial screening. Countries with smaller delay than South Korea was for example; Luxembourg, Cyprus and Greece.

Chile was the country with the second largest delay among emerging countries only outstripped by the Czech Republic. In the initial screening Chile had better quality data and the Chilean market had a better spread of company sizes than the Czech’s. The country with the shortest delay of our 4 chosen countries was India. The country was however only number four in the ranking of emerging countries with the smallest delay. Our first thought was to use China since they are one of the countries with a smaller delay than India but still had a sufficient number of companies in their market. Unfortunately this was not possible due to the large transparency issues that China has which means that there were very little data available from the companies that operate there.
3.4.2 Data collection and construction of portfolios

We have collected fundamental data from the four countries of our choice. All our data has been taken directly from Thomson Datastream Advanced by Thomson Reuters, this database contains financial data, stock prices, fundamental data for individual stocks, bonds, interest rates and a whole lot more from countries all over the world. This is a commonly used database for similar studies like ours and since it’s a rather expensive database to use our only access has been through Umeå university library. Our selection of time period was limited by the available information in Datastream and influenced by the different levels of accounting regulations. This effect is more noticeable for emerging markets where accounting standard was or still is subpar. For a market such as India more than 80% of the companies lack partial information before the period of 1995 in datastream, which is why we limited our study between from 1995-05-31 to 2009-05-31, this gives us 14 years of useful data. Since we don’t have data regarding when fiscal year ends for each company and we need a static point in time to calculate return, we arbitrary chose May 31st as the beginning and the end of our calculation period. This is with the assumption that majority of the companies have fiscal year similar to normal calendar year, and that annual report is produced within 5 months after fiscal year ends. The strict criterion proposed by Piotroski makes statistical inference unsuitable and therefore census data were used for all four countries. Because of the limitation of Datastream license, we need 5 years worth of data for each year to indirectly calculate the different business ratios required for the 9 signals, this meant that we had to download data from 1992-05-31 to 2010-05-31. We needed 11 different variables to get all signals and with 5 years worth of data for each year, which resulted nearly 3 million lines of data that needed to be processed.

We have chosen to use the “all share” lists for each country in our study, the “all share” list contains every business that’s ever been listed on an equity market in the chosen country. These lists also includes companies that has gone bankrupt, merged with another company or just been banned from the stock-market. Included are also new companies that were initiated after 1992. Thanks to these thorough lists the risk of getting survivorship bias is minimal. A survivorship bias occurs when you only study the companies that still exist and have stocks registered on a stock market today. By only take account of these stocks your results may be skewed.

The lists from Datastream were downloaded to Microsoft Excel. The downloaded data consisted of the company name followed by the requested key-figures. Since we needed eleven different key-figures we got eleven rows with the same company name followed by the eleven requested key-figures, which are: market to book value, total assets, long term debt, net income before extraordinary items, current ratio, common shares outstanding, net sales, gross income, fund from operations and stock price. To make the data easier to work with we wanted to rearrange the layout of our spreadsheets so that the name of the company only appeared on a single row followed by all data we collected about that specific company. This meant a lot of copying and pasting since our data consisted of nearly 3 million lines. Thanks to Visual basics for applications (VBA) we were able to record a macro that repeated all steps that were required to convert the eleven rows of data to a single row. By manipulating the code in our macro we were able to make the macro repeat itself until all rows were sorted. By doing this we not only shortened the time it would take to rearrange this by hand but also removed the risk of any human errors that might
occur when performing a repetitive work like this. There is however a risk of using a macro. Since they repeat our instructions regardless of the data, there is a risk that the macro gets out of sync if there are, for example, only 10 rows of data for a company. To make sure that this has not been the case we have gone through our data manually and made random samples to verify the data integrity.

After that our list had to be further refined by removing all companies without the calculation years stock prices, companies with stock prices that doesn’t changes over the calculation year are also removed since they are most likely companies that have been merged with others and isn’t actively traded anymore. Our next step was to remove any company that was delisted before the calculation period for that particular year. The delisted companies were founded using search and replace function in Excel, every company name that were followed by the term “dead” was manually checked and removed if necessary. What remained is our core data that we used to build our study and our comparison indexes on.

3.4.3 Piotroski’s nine signals

Our goal has been to download and use the same key ratios that Piotroski uses in his fundamental analysis straight away. This was however impossible due to either a lack of data from Datastream advanced or in some cases a limited access of data in the license that Umeå university library owns in Thomson Datastream advanced. This meant that we had to download the individual components of some key ratios and then put them together in a way that meets the standard Piotroski used. To ensure replicability we will explain each signal and how we converted the data.

Return on assets (F_ROA): Piotroski defines this as net income before extraordinary items scaled by Total Assets and it is this ratio we have used as well, thus if ROA is positive the company gets one point, else zero.

Cash flow from operations (F_CFO): In this case we used Funds from operations scaled by total assets in our study which is how CFO is normally calculated. A positive CFO gives one point, else zero.

Δ Return on assets (F_ΔROA): This is defined as the current years ROA less the previous year’s ROA, if the result is positive the score is one otherwise zero. Since we don’t have access to ROA directly, we calculated ROA using current and previous year’s fundamental data.

Accruals (F_ACCRUAL): This variable is defined as current year’s net income before extraordinary items minus cash flow from operations and it is these figures we have used as well. Companies score one point if CFO>ROA and zero otherwise.

Δ Leverage (F_ΔLEVER): We used the same components as Piotroski to calculate leverage, which are current year’s long term debt divided with current year’s total assets. The previous year’s leverage is then subtracted and if the result is positive a score of one is given, else zero.
\( \Delta \text{Liquidity}(F_{\Delta LIQUID}) \): This is simply the current ratio of the company at the current year compared to last year. An improvement of the ratio is awarded with a score of one, else zero. In our study current ratio was already available in Datastream, it is defined as the current years assets divided with current years liabilities at fiscal year-end.

\( \Delta \text{Shares outstanding (EQ_OFFER)} \): This is also a quite straightforward ratio where Piotroski award companies that have not issued any common equity with one point and zero otherwise. In our study however we were not able to find data about any issue of common equity, instead we looked at the total common shares outstanding and if there was an increase of shares the score was zero, if the number of shares were unchanged or reduced the score was one. The problem is we are unable to separate split or reverse splits from issuing of new stocks, our solution is manually check companies where shares outstanding have changed substantially since splits tends to affect number of shares much more violently than issuing new shares.

\( \Delta \text{Margin (F_{\Delta MARGIN})} \): This ratio is defined as the firm’s current gross margin ratio less the prior year’s gross margin ratio, if the ratio is positive the firm is awarded with one point, else zero. The gross margin ratio is calculated by dividing the firm’s gross margin with the total sales.

\( \Delta \text{Turnover (F_{\Delta TURN})} \): The last ratio is defined as the firm’s current year asset turnover ratio less the prior year asset turnover ratio. If the ratio is positive a score of one is awarded, zero otherwise. The calculation that both Piotroski and ourselves have used to get the asset turnover ratio is the Total assets scaled by beginning of the year total assets.

F_score: The F_score is the total score a company gets when all the points from the ratios above are added together, the range of scores a company can get goes from a low of 0 to a high of 9.

\[
\text{F}\_\text{SCORE} = \text{F}\_\text{ROA} + \text{F}\_\text{CFO} + \text{F}\_\text{AROA} + \text{F}\_\text{ACCRUAL} + \text{F}\_\text{ALEVER} + \text{F}\_\text{LIQUID} + \text{F}\_\text{MARGIN} + \text{F}\_\text{TURN} + \text{EQ}\_\text{OFFER}
\]

3.4.4 Portfolios

For each country, we will create six different portfolios where one of them serves as our market index. The market index is an equally weighted portfolio that includes all stocks traded publicly in that country’s market. Since our study includes four different countries, the total number of portfolios will be 24. Portfolios that will be included beside market index are:

High book-to-market ratio: This portfolio will consist of the top 20 % of companies with the highest book-to-market ratio. Hence forward also called ratio portfolio.

Small market capitalization: Consists of the 20 % of companies with the smallest market capitalization. Capitalization is calculated by taking the number of common shares outstanding the current year and multiply with the price of the stock as of the 31\textsuperscript{st} of May the current year.

Combination: The Combined portfolio is a combination of book-to-market and market capitalization where we only include the companies that are found in both the previous portfolios. To distinguish these shares, we began to sort each country's stock lists by the size of
the company’s book-to-market value, we then gave the top 20% with the highest value a dummy variable with the number 1 while the rest of the shares were given the number zero. The same procedure was then repeated but this time the list was sorted by the company’s market capitalization where the top 20% with the smallest market capitalization was given the value 1 and the rest of the companies a value of zero. We were then able to add up the values that the companies received in a new column and thus distinguish the shares with a value of 2 and therefore meet the criteria’s necessary to be included in the combined portfolio.

_Piotroski strict:_ The criteria’s that has to be met to be included in this portfolio is first of all to have a F_score of at least eight, the second criteria is that the company have to be in the top 20% of companies with the highest book-to-market value. These are the criteria’s for buying stocks that Piotroski uses in his model.

_Piotroski All:_ In this portfolio we have decided to remove the book-to-market criteria that Piotroski is using in his model. This means all companies with an F_score of 8 of higher will be included. By doing this we will hopefully be able to include more companies in the portfolio which should decrease unsystematic risks. Since three factor model also risk adjusts for book to market ratio, the difference between strict and all could reveal the source of excess return.

### 3.4.5 Risk-free rate

To be able to risk-adjust CAPM and Fama & French three factor model we need to have a risk-free rate. We have chosen to use government bonds with a maturity of five years for the respective country. The five year government bond is a well-established substitute for the theoretical risk free rate.

We downloaded the rates from Thomson Datastream advance, our first thought was to make a study between 1994-2009 but due to limitations of our available data we have to shorten the time span by one year and make the study from 1995 instead. We believe that this will have little overall effect on our study since a 15 year time span should give us more than enough data for us to draw conclusions of the study. In France our risk-free rate is the “France treasury bill 5 years - bid rate” (code FRTBL5Y). In South Korea and India we use the “India t-bond 5 year - red. yield” (code INBD5YR) and the “Korea treasury bond 5 year - red. yield” (code KOBDY5Y). We encountered some problems when we were to download the data from Chile. As it turns out their first issue of government bonds was released in 2002. Since the United States are one of Chile’s the most important import- and export countries we decided to use the “US Treasury const mat 5 year (w) - middle rate” (code FRTCW5Y(IR))” instead. To be sure that Chile’s and USA’s interest rates were equivalent we compared their benchmark interest rates from the last 15 years, and although Chile’s rate is a bit more volatile than United States’ they follow each other quite well.
Some questions might be raised whether government bonds in countries like India, Chile and South Korea can be considered to be risk-free. France has been given the highest credit rating from both Moody’s (Aaa) and Standard & Poor (AAA) and should therefore be considered risk-free. USA’s T-bills are considered to be one of the most secure investments in the world, even though they have received some criticism in the later years. Chile has also got a relatively high rating which further justifies our choice of using the US T-bills as risk-free investment in Chile who gets an A+ from S&P and a A3 from Moody’s. As we mentioned above India and South Korea might raise some concerns about their abilities to fulfil their obligations. This criticism might be legislative in India’s case who gets a BBB- from S&P and a Baa3 from Moody’s. South Korea is given an A from S&P and an A1 from moody’s which is classified as a “strong capacity” to meet its financial commitments. A BBB- and a Baa3 are however expected to have an “adequate capacity” to meet its financial commitments (MorganStanleyIndividual, 2010). We do however feel that the five year government treasury-bill in India is the best alternative to use as a risk-free comparison rate.

3.5 Statistical tests

In this section we will explain the statistical method and concepts used to calculate our results. Since the portfolios are rebalanced annually, the first step will be calculating the annual rate of
return. For single period calculation there are usually two methods to calculate return, the arithmetic and the logarithmic return.

### 3.5.1 Rate of return

Most quantitative research tend to use log return since they are time additive, mathematically convenient and is a close approximation when dealing with small returns, especially when used for short reinvesting period such as one month or week. Time additive means two periods log return equals to the sum of the two log returns. When assuming continuously compounded rate of return, the derivation of log return is simpler (Bodie et al., 2009, pp. 823-824). The log return is however not without flaws. While it is time additive, the behaviour of log return is not linear in portfolio return, and therefore not suitable when calculating weighted return of each stock in a portfolio. The formula for logarithmic return is

\[
\log_{\text{return}} = \ln \left( \frac{V_f}{V_i} \right)
\]

\( V_f = \text{Value of the portfolio/stock now} \)
\( V_i = \text{Value of the portfolio/stock last period} \)

The second method is the most common method for calculating return. Arithmetic return for single period is also called the yield, which most financial institutions use to display annual return. In our case, we calculate annual return on high volatile market where the difference between the two methods is much greater, even though arithmetic return is not time additive, it suits our need better and will generate result closer to the actual dollar return. Therefore, for single period, we will use the arithmetic return. The formula is

\[
\text{r}_{\text{arith}} = \frac{V_f - V_l}{V_l}
\]

\( V_f = \text{Value of the portfolio/stock now} \)
\( V_l = \text{Value of the portfolio/stock last period} \)

The formula is changed slightly to incorporate dividend

\[
R_{i,t} = \frac{(P_{i,t} + D_{i,t}) - P_{i,t-1}}{P_{i,t-1}}
\]

\( R_{i,t} \) – Return for the stock i for year t;

\( P_{i,t} \) – Price of stock i at the end for our calculate year t, price adjusted for split and reverse splits.

\( D_{i,t} \) – Dividend per share of stock i for year t
\( P_{i,t-1} \) – Price of stock \( i \) at the end for our calculate year \( t-1 \), price adjusted for split and reverse splits.

The stock price data from datastream has already adjusted for split, reverse splits and included the dividend to simplify calculation. Therefore it was possible to use the data directly without modification.

With single period return on all the stocks for each year we can calculate the arithmetic average return for each year using the following formula.

\[
\bar{r}_{\text{arithmetic}} = \frac{1}{n} \sum_{i=1}^{n} r_{\text{arith},i} = (r_{\text{arith},1} + \cdots + r_{\text{arith},n})
\]

The annualized return calculated using this method is very common however far from ideal. As we mentioned earlier arithmetic return is not time additive but more importantly cause calculation to bias toward positive return. For example, if the portfolio return is 50% gain one year and 50% loss the second year, arithmetic average would yield a result of 1 as if there are no changes to the portfolio while the true value of the portfolio would have dropped 25% given that the entire portfolio was reinvested each year. To compare between the returns generated by our portfolios we have chosen to include geometric average as comparison to arithmetic average. Geometric average is a quick and relative fair way to compare performance of each portfolio for the calculation period, the method doesn’t give any premium to portfolio that has high volatility since big losses require extreme high return to recover. This method reflects the actual dollar return for investing during the entire calculation period. During the Asia financial crisis some portfolio lost 75% of its initial value which would require 400% gain to restore its original value. The formula for geometric average is

\[
\bar{r}_{\text{geometric}} = \left( \prod_{i=1}^{n} (1 + r_{\text{arith},i}) \right)^{1/n} - 1
\]

Of course, geometric average rate of return, also known as the true time-weighted rate of return, is not perfect. Being time weighted, the result generated is only true for the specific period, and is highly sensitive to any changes in calculation period.

3.5.2 Regression analysis

To compare each portfolio objectively we need to rely on regression analysis. In this thesis we will use CAPM and the Fama French three factor model to determine the profitability of each portfolio. The reason we chose to use two valuation models is because their comparison may be able to fill the gap how investment strategies with positive alpha can exist in an efficient market.

CAPM is a linear model where beta describes the relationship between the dependent variable \( y \) and explanatory variable \( x \). Since there is only one explanatory variable we will use simple linear regression to determine the correlation. The idea is to fit a straight line through all the data points
while minimize the sum of squared residuals of the model. The intercept of the model will act as 
alpha, which indicates the amount of excess return generated or lost after adjusting for risks 
(Howells & Bain, 2005, p. 178).

3.5.3 Beta Calculation

Before going through the practical detail how to implement CAPM into our calculation, it is 
necessary to explain beta calculation. Normally, calculation of beta in most financial books are 
displayed as following

\[ \beta_a = \frac{Cov(r_a, r_p)}{Var(r_p)} \]

Since beta is also the coefficient of a linear regression that explains the relationship between y 
and x, beta can also be defined as the slope of CAPM function. With the theoretical risk free rate, 
both calculations will yield the same result since risk free rate by definition is default free and 
doesn’t change given it is held until maturity. In our case the portfolios are rebalanced each year 
with different stocks, not only does the overall market return change, the risk free rate offered in 
that market during that specific year also changes. To simplify, we will calculate beta as the 
coefficient that defines relationship between x and y instead of averaging 15 beta calculated using 
covariance and variance for our calculation period.

3.5.4 CAPM implementation

CAPM formula:

\[ R_{pt} = R_{ft} + \beta(R_m - R_f) + e_t \]

This is the original CAPM formula; before it can be used in regression analysis some 
rearrangement is required.

\[ R_{pt} - R_{ft} = \alpha + \beta(Rm_t - R_{ft}) + e_t \]

Risk free rate is moved to the left side, so the excess return above the risk free rate of the 
measured portfolio acts as the dependent variable. The market excess return above risk free rate 
acts as the independent variable. With these inputs we are left with three unknowns, the 
coefficient beta, the intercept alpha and the residual e that can now easily be determined using 
regression analysis.

Some of the results that will be generated from CAPM that we will focus on are coefficient, 
intercept, adjusted R-square and p-value.

Coefficient or beta determines the relationship between the dependent and independent variable, 
in this case the excess return of the portfolio return over risk free rate against excess return of the 
overall market above risk free rate. In CAPM, beta is also used as a measure of systematic risk.
Intercept or alpha is a measure of risk-adjusted return; it can be used to benchmark portfolios with different volatility as we explained in the chapter Jensen’s alpha.

R-square is also known as the coefficient of determination, which is a measure of the variation that is explained by the particular model. CAPM can typically explain 85% of all cross sectional variation. Although R-square doesn’t have any cut off point, it gives a rough indication how well the model is explaining the variations. We have chosen to use the adjusted R-square to give a more fair comparison between CAPM and the three-factor model. If we were to use the “normal” R² the three-factor model would gain advantage since it has more coefficients, the adjusted R² however adjusts for this and gives us a better tool to compare the models.

P-value is the probability of spotting a test statistic that is at least as extreme as the one observed. Usually a significance level is chosen before the test is conducted. In our case significance level of 95% is selected. If P-value is less than 0.05 we will then reject our null hypothesis, which in most cases means the portfolios alpha is significant different from zero. P-value has been criticizes for mainly two reasons, first is that the significance level is chosen arbitrarily, so “significant” results can be attained by choosing the proper level. The second critic is that an insignificant p-value could just mean the number of samples is insufficient.

3.5.5 Fama French Three Factor Model

\[ R_{pt} - R_{ft} = \alpha + \beta(Rm_t - Rf_t) + \beta_s * SMB + \beta_v * HML + e_t \]

With the Fama French three factor model new independent variables and coefficient are introduced, making it a multiple linear regression. We have two new coefficient s and h that describes the correlation between return with size and book to market ratio. The independent variable SMB and HML is calculated by constructing a zero-sum portfolio.

For SMB the variable is calculated by ranking every firm in the market using their market capitalization. The difference between longing 50% of the smallest firms and shorting 50% largest creates a zero-sum portfolio. Its return represents premium for investing in small cap companies.

HML is another independent variable that is based on a zero-sum portfolio created by ranking all firms using book to market ratio. The 30% of the firms with largest book to market ratios are longed using equal distribution, and vice versa for 30% of the firms with smallest ratios. The return represents the risk premium for investing in companies with high book to market ratio.

Using the Fama French three factor model is quite different from the CAPM model. The regression analysis will not only test the returns correlation against the market fluctuation, but also keep track of the correlation and variation in size and book to market ratio. This way it can detect how much each source is contributing to the total return. The alpha generated in the three factor model excludes risk premiums from the anomalies.
3.5.6 T-test

After the generation of risk adjusted alpha using CAPM and Fama French 3 Factor model, we need to compare the intercepts between the markets and portfolios in order to test our hypothesis. The method we chose is t-test using student t-statistics. It is suitable because it can be used to assess whether two populations have the same mean when the standard deviation is unknown (Bodie et al., 2009, p. 362). In this case, if our alphas that are generated in different markets and portfolios have the same average. Another reason why t-test is best suited for our hypothesis testing is because the paired two sample t-test also takes into account the correlation between alphas for each year.

To generate the data for paired t-test, we need to calculate the risk adjusted alpha for each year manually. This is done by using the coefficients calculated with our earlier regression analysis to estimate an expected return according to the model. The difference between the actual return and the expected return for that specific year is then the alpha that we need.

With the acquired alpha we can calculate the t-stat using the following formula for paired two sample t-test.

\[
t = \frac{(\bar{X} - \bar{Y})}{\sqrt{\frac{n(n-1)}{\sum_{i=1}^{n}(\bar{X}_i - \bar{X})^2}}}
\]

Where:

\[\bar{X}_i = (X_i - \bar{X})\]
\[\bar{Y}_i = (Y_i - \bar{Y})\]

In this T-test, the degrees of freedom are normally the number of paired observations minus one. Because of the two step calculation process, we must adjust the degrees of freedom manually to reduce risk of type I error. The 15 observations must be adjusted for the t-test, beta and alpha for CAPM calculation, reducing degrees of freedom to 12. For three factor model the additional two regressor for size and ratio coefficients further reduce degrees of freedom to 10. This will affect the critical value that the t-stat will be tested against.

3.6 Assumptions

Most of the statistical tests are performed under certain assumptions, violation of these assumptions often result in type I or type II errors.

The first assumption for both simple and multiple linear regressions is the assumption of linearity. If the relationship between independent and dependent variable is not linear, the result produced may have poor fit and result low R-squared. The assumption is difficult to confirm especially in multiple regression where graphical visualization is near impossible. For simple linear regression, scatterplot can be made to visually confirm the linearity.
The second assumption is the normality of the variables or residuals in the regression analysis. Violation of this assumption can distort the relationship between the variables and significance test. Even though most studies on stock markets are based on the assumption of normal distributed variable, normality test shows often that the stock market tends to be kurtotic. Meaning that the distribution curve has fatter tails and extreme values occurs more frequently than normal distribution.

3.7 Bonferroni Correction

In the CAPM implementation we already mentioned that the chosen significance level is 95%. However, since the Piotroski’s model must endure multiple comparisons, the risk of type I error, or false positive, will also increase proportionally. To counteract the problem we use the Bonferroni correction, which maintain the type I error rate \( \alpha \) at 5% by dividing the error rate with the number of tests performed. For example, in hypothesis 3, 4 and 5 Piotroski’s model is tested against three portfolios within the same market, to maintain at 5% \( \alpha \), the critical value for t-stat must be 98.33%. This approach is more conservative, reducing type I error at the cost of type II.

3.8 Criticism

One of the most important task when conducting a research study is that the model used is measuring what it is supposed to measure, this criterion is called validity. We used the CAPM and Fama French three-factor model to calculate our alpha’s and these methods are well recognized and frequently used by researchers. We did however encounter some problems when we were to select a substitute for the risk-free rate for our four markets. Finding a risk-free rate is a central part of our study since it is vital part of risk-adjustment of the portfolios. As we explained in one of the previous chapters the most common solution is to use a government bond from a financially stable country, we were however unable to do so in three out of the four countries. In our opinion France is the only country that meets the criteria’s of a genuine risk-free rate. France is also the only country out of the four that has been given the highest credit rating from all the large credit rating agencies. India and South Korea both have government bonds but their credit ratings are not as high to be regarded as risk-free, we did however decide to use these rates since they were the best available alternative, India had the lowest rating but is expected to have an “adequate” chance to meet their financial commitments.

A different solution that we looked into was to use a nearby, more stable country that has a lot of influence of the studied countries where the bond return have strong correlation. In the case of India and South Korea our first thought was to use a bond from China, this proved to be quite difficult due to lack of transparency, we were therefore not able to find any historical data about the rates on Chinese t-bills or bonds. This method was however used in the case of Chile where they didn’t have a government bond for the entire investment period. Since Chile’s largest trading-partner is the United States we compared their benchmark interest rates and they seem to be highly correlated. Therefore we decided to use American t-bills as risk-free rate as substitute for Chile. The choices we made for these problems might have some effect on the end-result of our study, especially when risk-adjusting our portfolios.
Our data collection has mainly been through Thomson Datastream Advanced, as this is a source that is commonly used in similar studies we believe that its reliability is high. However, we did encounter some problems that we explained in previous chapters. Namely the lack of data in the earlier years of the study and that the license Umeå University Library disposes does not contain all the necessary ratios. Many of these problems have been possible to circumvent by downloading individual components for the key ratios and then construct Piotroski's signals that way, but in the problem of missing data, we have not found any solution. We did make attempts to find fundamental data in other ways, such as visiting the companies' websites, but without any success. It seems that some companies just don’t have any public annual report on their website. The companies that do not have complete data and thereby cannot get any points in Piotroski's test might skew the results of the study, given that these missing companies are not randomly distributed. One can however see this as criticism of the model in that it requires large amounts of reliable data to construct.

Reliability deals with the question if a study will produce the same results if the study is tested again or if it’s influenced by random conditions. There are three main elements you have to consider when you are talking about reliability, these are; stability, internal reliability and inter-observer consistency. Stability implies that the result of a measurement should not fluctuate significantly. Internal reliability questions whether different parts of a test measure the same thing and inter-observer reliability arise when there are several persons that have to make subjective decisions when you, for example, are categorizing data (Bryman et al., 2005, pp. 48, 93-95).

Since we are doing a quantitative study we are not exposed to any subjective decisions, instead our most critical stage has been to sort and rearrange the downloaded data. As we described earlier, this procedure was semi-automated using a macro designed in Microsoft Excel. This macro has both advantages and disadvantages, the disadvantage is that it is static and thereby repeats exactly the same procedure no matter what our data looks like, and this means that there is a risk that it will be out of sync and render all subsequent data unusable. To avoid this, random samples were taken and controlled to ensure our data is correct. During the sorting process all bankrupted firms were also included. We each had to look up the stocks that are no longer traded for each year and then check the date when the stock was delisted. Since Datastream includes the date the specific share were delisted or merged with other firm, we could make use of a search/replace function in Microsoft Excel to check if the date of delisting was before or after the 31/5 that year. All shares delisted before this date were excluded from the study. Since this was done manually, there is a risk of human error that a share that should be removed has been left, and vice versa. However, due to the large numbers of observations, this is not something that will affect the study significantly.

An important thing when you are doing a quantitative study is that it’s possible for other researchers to use the same method and the same tests and hopefully get the same results. This is called reproducibility and it basically means that the procedure of the research is rigorously described so that other researchers can replicate the study. The reason for researchers to replicate a study might vary but one explanation could be that the result does not correspond to other studies made in the same subject. In our study, all steps, from the collection of data to the
statistical testing of the model are closely described throughout the research paper so that no questions should be raised on how we have performed our study (Bryman et al., 2005, p. 48).

In selecting the countries to include in our study, we used earlier study by J. M. Griffin et al., (2010) Since we are interested in testing whether the efficiency of each market affect the outcome of Piotroski's model, we have chosen to use the above study that tested the market efficiency in 56 different countries whereof 28 of them are emerging countries and 28 are classified as developed Countries. As we have explained earlier they measured the efficiency of each country with a delay regression. Since we have chosen two countries from the extreme ends of the scale in both emerging and developed countries, we hope to get indications of whether market efficiency affects returns. To rely on someone else's work can be seen as something negative when you do a study like this. In this case however, we believe that there is neither time nor resources to do its own study in this area before we test Piotroski's model. However, we did scrutinize Griffins work thoroughly before using the results. The article has also been peer-reviewed and is published in a well renowned journal, which gives additional credibility. With this in mind we believe that by using his study we can put all our focus on our main research questions and thereby enhance our study.
4. Empirical finding

In this chapter we will display the empirical results from our study. Each market will start with a small presentation and a comment about the economic status of the market together with a table that displays the different portfolios and their annual returns and the number of stocks each portfolio contains. Each portfolio’s average risk-adjusted returns for both CAPM and the three-factor model will then be displayed together with their coefficients and r-square values followed by a short comment. The data that is displayed in this chapter will be the basis for our statistical test in the analysis-chapter.

4.1 South Korea

South Korea has grown rapidly in our calculation period. Despite the Asia financial crisis during 1997 where almost 2/3 of the values were wiped out, the market index still sustained an geometric average growth of 12.6% between 1995 and 2010.

We then created 3 additional portfolios as comparison indexes for the Piotroski model. The 3 portfolios consists of 20% of all companies with the smallest market capitalization, 20% of all companies with the smallest book to market ratio, and one portfolio consist of a combination of earlier mentioned criterion. Table 2 shows the average returns for each portfolio during the years 1995-2009.

From table 2 we can see that our small cap portfolio yield higher return than market index most of the time. The portfolio with small book to market ratio seem also more volatile than the index, the geometric average is slightly higher which means there should be at least some risk premium associated with the portfolio. Finally the combination of small cap and small book to market ratio portfolio greatly surpasses index in term of return, while the difference might seem small, the compounding interest adds up quickly. 10000 dollar invested in 1995 May would have grown to 66899 dollar in May 2010 in our original index but in the combination portfolio it would have grown to 172179 dollar.

Besides a portfolio created using top quintiles, we created two additional portfolios that are normally used as a measurement of premium in the three factor model. The two portfolios are both zero sum portfolios where half of the portfolio is placed in long positions and half in short. The difference between the yields is the premium. The first portfolios consists of return from the 50% of smaller companies compared against the return of 50% bigger companies, the size premium is 7.03% during the period. What really caught our eyes is the book to market ratio premium, when comparing return from the lowest 30% against top 30%, the ratio premium is 23.48% annually during our calculation period using CAPM. These premiums will be used later in three factor model to calculate coefficient for value and ratio loading.
Table 2: Average returns South Korea 1995-2009

<table>
<thead>
<tr>
<th>Year</th>
<th>Risk-free rate</th>
<th>Index</th>
<th>n</th>
<th>small-firm</th>
<th>n</th>
<th>Ratio</th>
<th>n</th>
<th>Combined</th>
<th>n</th>
<th>Piotroski Strict</th>
<th>n</th>
<th>Piotroski All</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>1995</td>
<td>11.80%</td>
<td>8.91%</td>
<td>499</td>
<td>5.61%</td>
<td>35</td>
<td>10.85%</td>
<td>100</td>
<td>26.02%</td>
<td>5</td>
<td>0.00%</td>
<td>0</td>
<td>9.58%</td>
<td>8</td>
</tr>
<tr>
<td>1996</td>
<td>12.10%</td>
<td>12.18%</td>
<td>531</td>
<td>2.20%</td>
<td>40</td>
<td>-11.26%</td>
<td>106</td>
<td>6.31%</td>
<td>12</td>
<td>-23.07%</td>
<td>4</td>
<td>-21.58%</td>
<td>17</td>
</tr>
<tr>
<td>1997</td>
<td>11.70%</td>
<td>-7.40%</td>
<td>712</td>
<td>-67.64%</td>
<td>45</td>
<td>-72.59%</td>
<td>142</td>
<td>-75.95%</td>
<td>9</td>
<td>-80.14%</td>
<td>1</td>
<td>-69.44%</td>
<td>6</td>
</tr>
<tr>
<td>1998</td>
<td>12.00%</td>
<td>179.79%</td>
<td>768</td>
<td>239.40%</td>
<td>52</td>
<td>196.59%</td>
<td>154</td>
<td>342.09%</td>
<td>14</td>
<td>364.20%</td>
<td>5</td>
<td>297.03%</td>
<td>16</td>
</tr>
<tr>
<td>1999</td>
<td>9.78%</td>
<td>45.06%</td>
<td>769</td>
<td>-43.40%</td>
<td>58</td>
<td>-28.07%</td>
<td>154</td>
<td>-28.84%</td>
<td>21</td>
<td>-50.56%</td>
<td>2</td>
<td>-39.06%</td>
<td>24</td>
</tr>
<tr>
<td>2000</td>
<td>8.44%</td>
<td>10.17%</td>
<td>870</td>
<td>29.60%</td>
<td>71</td>
<td>37.50%</td>
<td>174</td>
<td>2.61%</td>
<td>27</td>
<td>12.11%</td>
<td>3</td>
<td>22.60%</td>
<td>27</td>
</tr>
<tr>
<td>2001</td>
<td>4.92%</td>
<td>3.97%</td>
<td>985</td>
<td>21.22%</td>
<td>115</td>
<td>33.13%</td>
<td>197</td>
<td>35.00%</td>
<td>38</td>
<td>25.49%</td>
<td>5</td>
<td>40.48%</td>
<td>38</td>
</tr>
<tr>
<td>2002</td>
<td>5.66%</td>
<td>-23.72%</td>
<td>1120</td>
<td>-30.28%</td>
<td>119</td>
<td>-14.19%</td>
<td>224</td>
<td>-18.56%</td>
<td>41</td>
<td>-13.01%</td>
<td>13</td>
<td>-2.59%</td>
<td>62</td>
</tr>
<tr>
<td>2003</td>
<td>4.40%</td>
<td>-0.16%</td>
<td>1206</td>
<td>14.85%</td>
<td>128</td>
<td>17.08%</td>
<td>241</td>
<td>20.09%</td>
<td>46</td>
<td>-4.66%</td>
<td>12</td>
<td>-0.48%</td>
<td>72</td>
</tr>
<tr>
<td>2004</td>
<td>3.68%</td>
<td>54.74%</td>
<td>1261</td>
<td>81.77%</td>
<td>140</td>
<td>77.54%</td>
<td>252</td>
<td>62.06%</td>
<td>44</td>
<td>84.35%</td>
<td>11</td>
<td>59.40%</td>
<td>68</td>
</tr>
<tr>
<td>2005</td>
<td>4.89%</td>
<td>60.36%</td>
<td>1324</td>
<td>100.33%</td>
<td>282</td>
<td>99.27%</td>
<td>265</td>
<td>132.63%</td>
<td>111</td>
<td>45.36%</td>
<td>40</td>
<td>41.66%</td>
<td>136</td>
</tr>
<tr>
<td>2006</td>
<td>4.67%</td>
<td>45.54%</td>
<td>1411</td>
<td>59.82%</td>
<td>283</td>
<td>80.85%</td>
<td>282</td>
<td>87.46%</td>
<td>113</td>
<td>78.56%</td>
<td>18</td>
<td>50.42%</td>
<td>103</td>
</tr>
<tr>
<td>2007</td>
<td>5.52%</td>
<td>-1.43%</td>
<td>1478</td>
<td>-6.43%</td>
<td>293</td>
<td>15.89%</td>
<td>296</td>
<td>7.90%</td>
<td>65</td>
<td>43.37%</td>
<td>20</td>
<td>22.29%</td>
<td>83</td>
</tr>
<tr>
<td>2008</td>
<td>6.04%</td>
<td>-12.35%</td>
<td>1539</td>
<td>-6.60%</td>
<td>306</td>
<td>-4.92%</td>
<td>308</td>
<td>3.52%</td>
<td>81</td>
<td>13.62%</td>
<td>19</td>
<td>-7.66%</td>
<td>122</td>
</tr>
<tr>
<td>2009</td>
<td>4.81%</td>
<td>9.76%</td>
<td>1601</td>
<td>8.52%</td>
<td>321</td>
<td>24.38%</td>
<td>320</td>
<td>33.16%</td>
<td>80</td>
<td>31.03%</td>
<td>24</td>
<td>18.25%</td>
<td>131</td>
</tr>
<tr>
<td>Arithmetic mean</td>
<td>7.36%</td>
<td>22.34%</td>
<td>1072</td>
<td>27.26%</td>
<td>153</td>
<td>30.80%</td>
<td>214</td>
<td>42.37%</td>
<td>47</td>
<td>35.11%</td>
<td>12</td>
<td>28.06%</td>
<td>61</td>
</tr>
<tr>
<td>Geometric Mean</td>
<td>6.75%</td>
<td>12.61%</td>
<td>1072</td>
<td>11.39%</td>
<td>153</td>
<td>14.89%</td>
<td>214</td>
<td>19.47%</td>
<td>47</td>
<td>10.00%</td>
<td>12</td>
<td>11.04%</td>
<td>61</td>
</tr>
</tbody>
</table>
Geometric return gave us a quick overview of which portfolio performed best, it is however quite poor at giving any detailed information regarding the performance of each portfolio. In the in-depth analysis we will first use regression analysis to compare index with each portfolio. The result should allow us to separate abnormal return stemmed from higher beta and return from various premium. The coefficient of determination will also tell how well the model fit, these data will then be used as comparisons against Piotroski’s portfolios.

The first regression analysis we did was on the top quintile firms with the smallest market capitalization. The regression analysis gave the following result.

Table 3: Average of annual alphas, p-values and coefficients for the Size portfolio in South Korea from 1995-2009.

<table>
<thead>
<tr>
<th>Portfolio</th>
<th>CAPM BETA</th>
<th>CAPM Alpha</th>
<th>CAPM P- Value</th>
<th>3F Beta</th>
<th>3F Size loading</th>
<th>3F Ratio loading</th>
<th>3F Alpha</th>
<th>3F p-value</th>
<th>R² 3F</th>
<th>R² CAPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size</td>
<td>1.27</td>
<td>0.86%</td>
<td>0.91736</td>
<td>0.42</td>
<td>1.56</td>
<td>0.86</td>
<td>-23.21%</td>
<td>0.0046</td>
<td>95.08%</td>
<td>83.14%</td>
</tr>
</tbody>
</table>

With a beta of 1.27 it shows that a portfolio created from smaller firms has higher volatility, but for our calculation period, the alpha is less than 1% and statistically non-significant. This means while the portfolio is more volatile, there is not really any positive premium for our calculation period in South Korea according to CAPM. The adjusted coefficient of determination or Adj-R² is 0.8314, which means the regression analysis explains 83.14% of all the cross sectional variations.

The result changes drastically if we change the calculation method to three-factor model. Now the beta is at a much lower rate of 0.42, meaning the index movement don’t affect the portfolio as much as we earlier thought using CAPM. Value and ratio loading are 1.56 and 0.85, these values are additional coefficient that tells us how much the return correlates with size and ratio premium calculated in our earlier zero-sum portfolios. From the values it seems a sizable portion of the return are related to small market cap which is expected since this is a small cap portfolio, the high ratio loading indicates there are some correlation between size and book to market ratio. The alpha generated by three factor model is negative 23% and statistically significant at 95% level, suggesting the portfolio gives negative risk adjusted return when account for small cap and book to market ratio risk premium. The model has a Adj-R² of 0.9508 and does a far better job than CAPM at explaining the cross sectional variations.

The second regression analysis was based on the top quintile firms with the smallest book to market ratio. The regression analysis gave the following result.

Table 4: Average of annual alphas, p-values and coefficients for the Ratio portfolio in South Korea from 1995-2009.

<table>
<thead>
<tr>
<th>Portfolio</th>
<th>CAPM BETA</th>
<th>CAPM Alpha</th>
<th>CAPM P-value</th>
<th>3F Beta</th>
<th>3F Size loading</th>
<th>3F Ratio loading</th>
<th>3F Alpha</th>
<th>3F p-value</th>
<th>R² 3F</th>
<th>R² CAPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ratio</td>
<td>1.09</td>
<td>7.10%</td>
<td>0.37755</td>
<td>0.32</td>
<td>1.05</td>
<td>0.94</td>
<td>-16.51%</td>
<td>0.0445</td>
<td>92.05%</td>
<td>79.84%</td>
</tr>
</tbody>
</table>
The regression analysis based on CAPM shows the book to market ratio portfolio is slightly more volatile than the index with a beta of 1.09 and a promising alpha of 7.10%, showing that there is an 7% premium for investing in firms with small book to market ratio. The result is however not significant at 95% level due to large fluctuation between the years. Adj-$R^2$ is 0.7984 which means the CAPM formula explains 79.84 percent of all variations.

The result for the three factor model shares similarity with the small market cap portfolio, return has even smaller correlation with index now with a beta at 0.32. The size and ratio coefficient are 1.04 and 0.93, means most of the portfolios return can be traced to small cap and book to market ratio risk premium, again the coefficient are similar which indicates a strong correlation between size and ratio in the Korean market. Alpha is negative 16.6% and significant at a 95% level. The adjusted coefficient of determination explains 93.75% of all the variations.

The third regression analysis is based on the portfolio which utilizes a combination of small firm and book to market anomaly. The regression analysis gave the following result.

Table 5: Average of annual alphas, p-values and coefficients for the Combo portfolio in South Korea from 1995-2009.

<table>
<thead>
<tr>
<th>Portfolio</th>
<th>CAPM BETA</th>
<th>CAPM Alpha</th>
<th>CAPM value</th>
<th>P-</th>
<th>3F Beta</th>
<th>3F Size loading</th>
<th>3F Ratio loading</th>
<th>3F Alpha</th>
<th>3F p-value</th>
<th>R² 3F</th>
<th>R² CAPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combo</td>
<td>1.68</td>
<td>9.82%</td>
<td>0.33772</td>
<td>0.83</td>
<td>1.00</td>
<td>1.11</td>
<td>-17.17%</td>
<td>0.1524</td>
<td>91.62%</td>
<td>85.41%</td>
<td></td>
</tr>
</tbody>
</table>

From our earlier calculated geometric average return, this portfolio yields substantially higher return than other portfolios in Korea. From the regression analysis we can however see that the higher return mostly stems from a higher beta at 1.68, the CAPM alpha is 9.82%, however because of the large fluctuation in returns, the result is not statistically significant. Adjusted coefficient of determination is 85.41%, showing CAPM does a fairly good job explaining the variations.

The three factor model holds a similar pattern as earlier. Beta is reduced to 0.83 and the variations of return are instead explained by the variation in size and ratio premium. The coefficient for them is 1 and 1.11 indicate almost perfect correlation with premium movements. The alpha for the combination portfolio using three factor model is negative 17.17%, although not statistical significant.

As for the Piotroski portfolio, we encountered some problem. The investment model was meant to select from a portfolio that consists solely of high book to market value firms. However, due to the poor quality of accounting data in our database, a lot of firms have incomplete data, which in turn denied our ability to calculate Piotroski score. Even when expanding our search criterion to the entire market and long firms with points both 8-9 and short those with 0-1, the number of investment opportunities were still unsatisfying low. Out of 16590 investment opportunities spanned over 15 years, only 177 companies fulfilled the relaxed criterion for long positions and only 10 for short.
Table 6: Average of annual alphas, p-values and coefficients for the Piotroski strict portfolio in South Korea from 1995-2009.

<table>
<thead>
<tr>
<th>Portfolio</th>
<th>CAPM Beta</th>
<th>CAPM Alpha</th>
<th>CAPM Value</th>
<th>P- Value</th>
<th>3F Beta</th>
<th>3F Size loading</th>
<th>3F Ratio loading</th>
<th>3F Alpha</th>
<th>3F p-value</th>
<th>R² 3F</th>
<th>R² CAPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Piotroski strict</td>
<td>1.69</td>
<td>2.41%</td>
<td>0.85378</td>
<td>0.72</td>
<td>-0.05</td>
<td>1.76</td>
<td>-33.85%</td>
<td>0.0413</td>
<td>86.92%</td>
<td>77.66%</td>
<td></td>
</tr>
</tbody>
</table>

The regression analysis were done against the Korean market index for all stocks, in this case, CAPM showed a high beta of 1.69 with a small alpha at 2.4%, the result is not statistically significant at 95% level. For the three factor model beta is lower at 0.72, size coefficient is zero while ratio coefficient is 1.75. This means stocks selected by Piotroski’s model tend to move violently at the same direction as ratio premium. The alpha for three factor is however the lowest yet, negative 33.8% and statistically significant at 95% level. The adjusted coefficient of determination is still decent for CAPM explaining 77.66% of the variations while three factor model is able to explain 86.92%.

Table 7: Average of annual alphas, p-values and coefficients for the Piotroski all portfolio in South Korea from 1995-2009.

<table>
<thead>
<tr>
<th>Portfolio</th>
<th>CAPM Beta</th>
<th>CAPM Alpha</th>
<th>CAPM Value</th>
<th>P- Value</th>
<th>3F Beta</th>
<th>3F Size loading</th>
<th>3F Ratio loading</th>
<th>3F Alpha</th>
<th>3F p-value</th>
<th>R² 3F</th>
<th>R² CAPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Piotroski all</td>
<td>1.37</td>
<td>0.11%</td>
<td>0.99146</td>
<td>0.61</td>
<td>-0.44</td>
<td>1.56</td>
<td>-30.41%</td>
<td>0.0170</td>
<td>89.14%</td>
<td>78.09%</td>
<td></td>
</tr>
</tbody>
</table>

Since a relative large portion of the data is incomplete we decided to also apply Piotroski’s model on the entire market as well. The size and ratio coefficient should adjust automatically for the now less risky portfolio making the alphas directly comparable. Using the three factor model the alpha improved slightly to negative 30.41% and is statistical significant at 95%. The size and ratio coefficient is now -0.44 and 1.55. The adjusted coefficient of determination also slightly improved and explains 89.14% of all variations.

South Korea is an interesting case with an abnormally large premium for firm with high book to market ratio. One explanation could be due to the Asia financial crisis, it was a time of high inflation and market uncertainty.

4.2 India

As a developing country the India stock market has grown rapidly in the past two decades. Similar to Korea, India too suffered from the Asian financial crisis which wiped out half of the market value during the beginning of our calculation period. The high growth that followed still managed to obtain an impressive geometric average of 24.39% for the index which we can see in table 8.

In our table all three of our comparison portfolios yielded significantly higher return than the index, this effect is even more evident between 2000 and 2010. This could be due to beta effect since India enjoyed mostly positive growth during this period, to find out for sure, we need to use regression analysis.
Table 8: Average returns for India 1995-2009

<table>
<thead>
<tr>
<th>Year</th>
<th>Risk-free rate</th>
<th>Index</th>
<th>n</th>
<th>small-firm</th>
<th>n</th>
<th>ratio</th>
<th>n</th>
<th>Combined</th>
<th>n</th>
<th>Piotroski Strict</th>
<th>n</th>
<th>Piotroski All</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>1995</td>
<td>14.00%</td>
<td>-11.48%</td>
<td>181</td>
<td>-7.99%</td>
<td>17</td>
<td>-22.53%</td>
<td>36</td>
<td>-23.32%</td>
<td>8</td>
<td>-13.47%</td>
<td>2</td>
<td>-18.51%</td>
<td>15</td>
</tr>
<tr>
<td>1996</td>
<td>13.75%</td>
<td>-33.29%</td>
<td>204</td>
<td>-40.49%</td>
<td>21</td>
<td>-41.62%</td>
<td>41</td>
<td>-42.47%</td>
<td>9</td>
<td>-31.08%</td>
<td>3</td>
<td>-38.04%</td>
<td>20</td>
</tr>
<tr>
<td>1997</td>
<td>11.50%</td>
<td>29.68%</td>
<td>221</td>
<td>24.44%</td>
<td>34</td>
<td>16.28%</td>
<td>44</td>
<td>27.20%</td>
<td>21</td>
<td>32.85%</td>
<td>3</td>
<td>7.80%</td>
<td>17</td>
</tr>
<tr>
<td>1998</td>
<td>11.85%</td>
<td>4.90%</td>
<td>229</td>
<td>2.92%</td>
<td>39</td>
<td>2.52%</td>
<td>46</td>
<td>8.50%</td>
<td>27</td>
<td>73.91%</td>
<td>1</td>
<td>13.02%</td>
<td>14</td>
</tr>
<tr>
<td>1999</td>
<td>10.90%</td>
<td>32.43%</td>
<td>249</td>
<td>38.07%</td>
<td>43</td>
<td>51.82%</td>
<td>50</td>
<td>44.89%</td>
<td>23</td>
<td>16.03%</td>
<td>4</td>
<td>11.85%</td>
<td>32</td>
</tr>
<tr>
<td>2000</td>
<td>11.05%</td>
<td>-3.93%</td>
<td>298</td>
<td>-3.36%</td>
<td>44</td>
<td>31.63%</td>
<td>60</td>
<td>4.25%</td>
<td>24</td>
<td>158.42%</td>
<td>4</td>
<td>9.15%</td>
<td>28</td>
</tr>
<tr>
<td>2001</td>
<td>7.85%</td>
<td>31.71%</td>
<td>331</td>
<td>41.11%</td>
<td>48</td>
<td>61.88%</td>
<td>66</td>
<td>43.11%</td>
<td>27</td>
<td>216.33%</td>
<td>1</td>
<td>32.45%</td>
<td>35</td>
</tr>
<tr>
<td>2002</td>
<td>6.35%</td>
<td>33.91%</td>
<td>358</td>
<td>52.00%</td>
<td>57</td>
<td>66.04%</td>
<td>72</td>
<td>57.87%</td>
<td>30</td>
<td>85.48%</td>
<td>1</td>
<td>11.80%</td>
<td>30</td>
</tr>
<tr>
<td>2003</td>
<td>4.83%</td>
<td>90.80%</td>
<td>431</td>
<td>92.59%</td>
<td>65</td>
<td>147.43%</td>
<td>86</td>
<td>83.36%</td>
<td>31</td>
<td>40.15%</td>
<td>2</td>
<td>64.50%</td>
<td>38</td>
</tr>
<tr>
<td>2004</td>
<td>6.08%</td>
<td>171.76%</td>
<td>514</td>
<td>208.52%</td>
<td>71</td>
<td>335.33%</td>
<td>103</td>
<td>253.90%</td>
<td>33</td>
<td>256.89%</td>
<td>5</td>
<td>110.65%</td>
<td>53</td>
</tr>
<tr>
<td>2005</td>
<td>6.65%</td>
<td>89.92%</td>
<td>571</td>
<td>145.47%</td>
<td>86</td>
<td>149.28%</td>
<td>114</td>
<td>208.50%</td>
<td>40</td>
<td>67.66%</td>
<td>9</td>
<td>63.06%</td>
<td>79</td>
</tr>
<tr>
<td>2006</td>
<td>7.37%</td>
<td>24.94%</td>
<td>889</td>
<td>34.01%</td>
<td>104</td>
<td>39.63%</td>
<td>178</td>
<td>37.00%</td>
<td>28</td>
<td>81.00%</td>
<td>8</td>
<td>32.55%</td>
<td>102</td>
</tr>
<tr>
<td>2007</td>
<td>7.78%</td>
<td>23.75%</td>
<td>946</td>
<td>38.17%</td>
<td>117</td>
<td>71.03%</td>
<td>189</td>
<td>85.69%</td>
<td>47</td>
<td>57.20%</td>
<td>6</td>
<td>23.50%</td>
<td>102</td>
</tr>
<tr>
<td>2008</td>
<td>8.45%</td>
<td>-14.55%</td>
<td>1047</td>
<td>-18.56%</td>
<td>183</td>
<td>13.31%</td>
<td>209</td>
<td>-19.20%</td>
<td>95</td>
<td>-2.79%</td>
<td>11</td>
<td>-20.27%</td>
<td>113</td>
</tr>
<tr>
<td>2009</td>
<td>7.06%</td>
<td>53.11%</td>
<td>1081</td>
<td>76.87%</td>
<td>201</td>
<td>67.03%</td>
<td>216</td>
<td>79.83%</td>
<td>95</td>
<td>69.04%</td>
<td>13</td>
<td>56.38%</td>
<td>101</td>
</tr>
<tr>
<td>Arithmetic Mean</td>
<td>9.03%</td>
<td>34.91%</td>
<td>503</td>
<td>45.58%</td>
<td>75</td>
<td>65.94%</td>
<td>101</td>
<td>56.61%</td>
<td>36</td>
<td>73.84%</td>
<td>5</td>
<td>23.99%</td>
<td>52</td>
</tr>
<tr>
<td>Geometric Mean</td>
<td>8.61%</td>
<td>24.40%</td>
<td>503</td>
<td>32.23%</td>
<td>75</td>
<td>45.28%</td>
<td>101</td>
<td>39.10%</td>
<td>36</td>
<td>57.95%</td>
<td>8</td>
<td>18.54%</td>
<td>52</td>
</tr>
</tbody>
</table>
Table 9: Average of annual alphas, p-values and coefficients for the Size portfolio in India from 1995-2009.

<table>
<thead>
<tr>
<th>Portfolio</th>
<th>CAPM BETA</th>
<th>CAPM Alpha</th>
<th>CAPM P-value</th>
<th>3F Beta</th>
<th>3F Size loading</th>
<th>3F Ratio loading</th>
<th>3F Alpha</th>
<th>3F p-value</th>
<th>R² 3F</th>
<th>R² CAPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size</td>
<td>1.23</td>
<td>4.68%</td>
<td>0.21257</td>
<td>1.07</td>
<td>0.50</td>
<td>-0.08</td>
<td>3.28%</td>
<td>0.3885</td>
<td>97.12%</td>
<td>96.59%</td>
</tr>
</tbody>
</table>

Our first regression analysis showed that there is an positive alpha of 4.68% for investing in top 20% firm with the smallest capitalization. While the rest of the returns are explained by increased risk associated with beta effect, which is 1.23. The small alpha is however not significant at 95% due the relative high volatility of the market. Adj-R² shows that the CAPM explains 96.59% of all variation.

The three factor model showed also a positive but somewhat smaller alpha at 3.28%. Since this is a small market cap portfolio, size coefficient was expected to be high, but it maintained at 0.49 while ratio coefficient was at negative 0.07. Again the alpha is not significant because of the high volatility and rather small alpha. Adj-R² in this case explains 97.12% of all variations.

Table 10: Average of annual alphas, p-values and coefficients for the Ratio portfolio in India from 1995-2009.

<table>
<thead>
<tr>
<th>Portfolio</th>
<th>CAPM BETA</th>
<th>CAPM Alpha</th>
<th>CAPM P-value</th>
<th>3F Beta</th>
<th>3F Size loading</th>
<th>3F Ratio loading</th>
<th>3F Alpha</th>
<th>3F p-value</th>
<th>R² 3F</th>
<th>R² CAPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ratio</td>
<td>1.69</td>
<td>13.12%</td>
<td>0.07517</td>
<td>1.03</td>
<td>0.12</td>
<td>0.55</td>
<td>5.02%</td>
<td>0.2661</td>
<td>97.96%</td>
<td>93.68%</td>
</tr>
</tbody>
</table>

In our second regression analysis we compared top quintile firms with the highest book to market ratio against the index. The alpha intercept is much larger showing an 13.12% premium for investing in firms with high book to market ratio using CAPM model, the volatility of the portfolio is however also higher with a beta of 1.69. The p-value is still not significant although very close to the 95% limit. Adj-R² is at 0.94 which is unusually good for CAPM.

The three factor model for high book to market firm’s shows a non-significant alpha of 5.02%. Beta has been brought down to 1.03 and its variation comes mainly from ratio coefficient at 0.55. Size coefficient is at 0.12 which shows low correlation with ratio coefficient. The adjusted coefficient of determination explains 91.85% of all variations.

Table 11: Average of annual alphas, p-values and coefficients for the Combo portfolio in India from 1995-2009.

<table>
<thead>
<tr>
<th>Portfolio</th>
<th>CAPM BETA</th>
<th>CAPM Alpha</th>
<th>CAPM P-value</th>
<th>3F Beta</th>
<th>3F Size loading</th>
<th>3F Ratio loading</th>
<th>3F Alpha</th>
<th>3F p-value</th>
<th>R² 3F</th>
<th>R² CAPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combo</td>
<td>1.47</td>
<td>9.66%</td>
<td>0.27060</td>
<td>0.96</td>
<td>1.21</td>
<td>-0.08</td>
<td>4.71%</td>
<td>0.5955</td>
<td>89.64%</td>
<td>87.84%</td>
</tr>
</tbody>
</table>

Our third portfolio consists of stocks that both fulfil the smallest 20% in term of market capitalization and top 20% highest book to market. Using regression analysis alpha for CAPM model is 9.66% and a beta at 1.46. The result is however not statistical significant, in fact, the p-value was even higher than the small cap portfolio with only half the alpha. indicating the return was volatile and unpredictable. Adj-R² for the combination portfolio explains 87.84% of all variations.
The three factor model for the combination portfolio showed an alpha at 4.71% which was not statistical significant. Beta became smaller just like other portfolios to 0.95. The value of size and ratio coefficient was unlike earlier result, while we expected both high size and ratio coefficient because of the combination portfolio, only size coefficient was high at 1.21 while ratio coefficient were negative 0.07. Adj-R² for the three factor model explains 89.64% of all variations.

Table 12: Average of annual alphas, p-values and coefficients for the Piotroski strict portfolio in India from 1995-2009.

<table>
<thead>
<tr>
<th>Portfolio</th>
<th>CAPM BETA</th>
<th>CAPM Alpha</th>
<th>3F Beta</th>
<th>3F Size loading</th>
<th>3F Ratio loading</th>
<th>3F Alpha</th>
<th>3F p-value</th>
<th>R² 3F</th>
<th>R² CAPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Piotroski Strict</td>
<td>0.93</td>
<td>40.65%</td>
<td>-0.48</td>
<td>0.94</td>
<td>0.88</td>
<td>24.10%</td>
<td>0.2605</td>
<td>41.07%</td>
<td>31.93%</td>
</tr>
</tbody>
</table>

The Piotroski model displayed quite impressive results in India, generating the highest result among all portfolios. CAPM generated an alpha at 40.65% with a beta at 0.93, although it is not significant, most likely due to the irregular pattern caused by few data points. The adjusted coefficient of determination confirms the poor predictive power with a low result at 31.93%.

The three factor model generated instead a negative beta at 0.47, alpha is still quite large at 24.10% but not significant. The size and ratio coefficient are 0.93 and 0.88. Adj-R² shows however that even the three factor model can only predict 41.07% of all variations.

Table 13: Average of annual alphas, p-values and coefficients for the Piotroski all portfolio in India from 1995-2009.

<table>
<thead>
<tr>
<th>Portfolio</th>
<th>CAPM BETA</th>
<th>CAPM Alpha</th>
<th>3F Beta</th>
<th>3F Size loading</th>
<th>3F Ratio loading</th>
<th>3F Alpha</th>
<th>3F p-value</th>
<th>R² 3F</th>
<th>R² CAPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Piotroski all</td>
<td>0.72</td>
<td>-3.67%</td>
<td>0.96</td>
<td>-0.33</td>
<td>-0.07</td>
<td>-1.04%</td>
<td>0.7960</td>
<td>90.83%</td>
<td>90.53%</td>
</tr>
</tbody>
</table>

When we include all stocks with an F_score of 8-9 the results are not as impressive. CAPM generated an Alpha of -3.67% with a quite low beta at 0.72. The three-factor model generated an alpha of -1.04% with a beta of 0.96, the size and B/M coefficients are both negative at -0.33 and -0.07. Neither of the results is significant however. The adjusted R² -test shows a quite normal explanation of the variations.

4.3 France

France has had a quite normal return for a developed country, the geometric mean at the bottom of table 14 show that the return index on the market as a whole is 11.37%. There have been some years with negative return where the most recent global financial crisis in 2007-2008 and the IT-boom in 2001-2002 are the most significant ones. The time-period also includes times where the economy was in a boom, for example the years between the two major financial crashes.
Table 14: Average returns for France 1995-2009.

<table>
<thead>
<tr>
<th>Year</th>
<th>Risk-free rate</th>
<th>Index</th>
<th>n</th>
<th>small-firm</th>
<th>n</th>
<th>ratio</th>
<th>n</th>
<th>Combined</th>
<th>n</th>
<th>Piotroski Strict</th>
<th>n</th>
<th>Piotroski All</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>1995</td>
<td>6.92%</td>
<td>11.20%</td>
<td>555</td>
<td>-0.35%</td>
<td>111</td>
<td>11.17%</td>
<td>111</td>
<td>-4.22%</td>
<td>46</td>
<td>14.08%</td>
<td>10</td>
<td>15.71%</td>
<td>79</td>
</tr>
<tr>
<td>1996</td>
<td>5.16%</td>
<td>13.67%</td>
<td>635</td>
<td>14.38%</td>
<td>127</td>
<td>24.72%</td>
<td>127</td>
<td>26.91%</td>
<td>46</td>
<td>42.92%</td>
<td>7</td>
<td>16.37%</td>
<td>48</td>
</tr>
<tr>
<td>1997</td>
<td>4.78%</td>
<td>39.52%</td>
<td>730</td>
<td>30.08%</td>
<td>146</td>
<td>45.37%</td>
<td>146</td>
<td>27.86%</td>
<td>55</td>
<td>106.14%</td>
<td>5</td>
<td>58.90%</td>
<td>61</td>
</tr>
<tr>
<td>1998</td>
<td>3.72%</td>
<td>-10.02%</td>
<td>798</td>
<td>-10.48%</td>
<td>160</td>
<td>1.82%</td>
<td>160</td>
<td>-11.93%</td>
<td>71</td>
<td>1.13%</td>
<td>15</td>
<td>-10.13%</td>
<td>98</td>
</tr>
<tr>
<td>1999</td>
<td>4.45%</td>
<td>61.64%</td>
<td>858</td>
<td>85.62%</td>
<td>172</td>
<td>78.92%</td>
<td>172</td>
<td>140.45%</td>
<td>62</td>
<td>20.31%</td>
<td>7</td>
<td>55.09%</td>
<td>60</td>
</tr>
<tr>
<td>2000</td>
<td>5.19%</td>
<td>4.42%</td>
<td>899</td>
<td>2.26%</td>
<td>180</td>
<td>23.96%</td>
<td>180</td>
<td>8.43%</td>
<td>63</td>
<td>43.62%</td>
<td>6</td>
<td>6.41%</td>
<td>51</td>
</tr>
<tr>
<td>2001</td>
<td>4.13%</td>
<td>-12.23%</td>
<td>929</td>
<td>-6.78%</td>
<td>186</td>
<td>3.06%</td>
<td>186</td>
<td>2.13%</td>
<td>79</td>
<td>4.28%</td>
<td>11</td>
<td>-1.57%</td>
<td>50</td>
</tr>
<tr>
<td>2002</td>
<td>3.74%</td>
<td>-16.61%</td>
<td>939</td>
<td>-10.04%</td>
<td>188</td>
<td>-1.86%</td>
<td>188</td>
<td>-0.04%</td>
<td>79</td>
<td>-1.66%</td>
<td>13</td>
<td>-12.90%</td>
<td>46</td>
</tr>
<tr>
<td>2003</td>
<td>3.23%</td>
<td>40.71%</td>
<td>872</td>
<td>61.82%</td>
<td>174</td>
<td>60.35%</td>
<td>174</td>
<td>94.38%</td>
<td>68</td>
<td>536.18%</td>
<td>6</td>
<td>109.99%</td>
<td>46</td>
</tr>
<tr>
<td>2004</td>
<td>3.27%</td>
<td>37.54%</td>
<td>827</td>
<td>54.15%</td>
<td>165</td>
<td>64.62%</td>
<td>165</td>
<td>53.48%</td>
<td>61</td>
<td>34.53%</td>
<td>8</td>
<td>34.03%</td>
<td>71</td>
</tr>
<tr>
<td>2005</td>
<td>2.68%</td>
<td>37.14%</td>
<td>816</td>
<td>57.34%</td>
<td>163</td>
<td>61.24%</td>
<td>163</td>
<td>73.02%</td>
<td>62</td>
<td>44.63%</td>
<td>12</td>
<td>32.72%</td>
<td>129</td>
</tr>
<tr>
<td>2006</td>
<td>3.61%</td>
<td>27.15%</td>
<td>839</td>
<td>31.41%</td>
<td>168</td>
<td>50.69%</td>
<td>168</td>
<td>62.37%</td>
<td>57</td>
<td>23.76%</td>
<td>8</td>
<td>35.45%</td>
<td>96</td>
</tr>
<tr>
<td>2007</td>
<td>4.22%</td>
<td>-16.78%</td>
<td>889</td>
<td>-9.22%</td>
<td>178</td>
<td>-10.72%</td>
<td>178</td>
<td>1.04%</td>
<td>56</td>
<td>-13.87%</td>
<td>8</td>
<td>-17.98%</td>
<td>77</td>
</tr>
<tr>
<td>2008</td>
<td>4.13%</td>
<td>-27.88%</td>
<td>893</td>
<td>-18.30%</td>
<td>179</td>
<td>-19.26%</td>
<td>179</td>
<td>6.83%</td>
<td>53</td>
<td>-25.67%</td>
<td>7</td>
<td>-25.50%</td>
<td>79</td>
</tr>
<tr>
<td>2009</td>
<td>2.50%</td>
<td>26.62%</td>
<td>839</td>
<td>20.01%</td>
<td>168</td>
<td>59.39%</td>
<td>168</td>
<td>37.82%</td>
<td>53</td>
<td>24.15%</td>
<td>2</td>
<td>22.52%</td>
<td>36</td>
</tr>
<tr>
<td>Arithmetic mean</td>
<td>4.12%</td>
<td>14.41%</td>
<td>821</td>
<td>20.13%</td>
<td>164</td>
<td>30.23%</td>
<td>164</td>
<td>34.57%</td>
<td>61</td>
<td>56.97%</td>
<td>8</td>
<td>21.28%</td>
<td>68</td>
</tr>
<tr>
<td>Geometric Mean</td>
<td>3.98%</td>
<td>11.37%</td>
<td>821</td>
<td>16.35%</td>
<td>164</td>
<td>26.48%</td>
<td>164</td>
<td>28.97%</td>
<td>61</td>
<td>33.15%</td>
<td>8</td>
<td>16.83%</td>
<td>68</td>
</tr>
</tbody>
</table>
In conformity with the previous countries the combined portfolio gives an impressive return when you compare the geometric averages.

To find the reasons for what the basis of these high returns come from we will move on with the results from our regression analysis. The first portfolio is the one based on small-size companies.

Table 15: Average of annual alphas, p-values and coefficients for the Size portfolio in France from 1995-2009.

<table>
<thead>
<tr>
<th>Portfolio</th>
<th>CAPM BETA</th>
<th>CAPM Alpha</th>
<th>CAPM P-value</th>
<th>3F Beta</th>
<th>3F Size loading</th>
<th>3F Alpha</th>
<th>3F p-value</th>
<th>R² 3F</th>
<th>R² CAPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size</td>
<td>1.14</td>
<td>4.28%</td>
<td>0.17825</td>
<td>1.07</td>
<td>0.05</td>
<td>3.79%</td>
<td>0.1050</td>
<td>97.38%</td>
<td>89.92%</td>
</tr>
</tbody>
</table>

The size portfolio gives a positive alpha of 4.28 % using CAPM and 3.79% in the three factor model, none of them are statistically significant however. The three factor model shows that the size loading for this portfolio is quite high at 1.07 which implies that there are mainly small sized companies included, which should be the case since this is the size portfolio. As for the rest of the result they are not that protruding.

Table 16: Average of annual alphas, p-values and coefficients for the Ratio portfolio in France from 1995-2009.

<table>
<thead>
<tr>
<th>Portfolio</th>
<th>CAPM BETA</th>
<th>CAPM Alpha</th>
<th>CAPM P-value</th>
<th>3F Beta</th>
<th>3F Size loading</th>
<th>3F Alpha</th>
<th>3F p-value</th>
<th>R² 3F</th>
<th>R² CAPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ratio</td>
<td>1.15</td>
<td>14.26%</td>
<td>0.00003</td>
<td>1.14</td>
<td>0.22</td>
<td>0.36</td>
<td>7.21%</td>
<td>0.0062</td>
<td>97.33%</td>
</tr>
</tbody>
</table>

Our regression for the ratio portfolio shows an alpha of 14.26% for the CAPM that is significant at the 95% level. The three factor model gives an alpha of 7.21% also significant at the 95% level. As we can see the volatility of this portfolio is slightly higher than the Index with a beta of around 1.14 in both of the models. Our R²-tests also show that the three factor model is able to explain 97.33% of the variations.

Table 17: Average of annual alphas, p-values and coefficients for the Combo portfolio in France from 1995-2009.

<table>
<thead>
<tr>
<th>Portfolio</th>
<th>CAPM BETA</th>
<th>CAPM Alpha</th>
<th>CAPM P-value</th>
<th>3F Beta</th>
<th>3F Size loading</th>
<th>3F Ratio loading</th>
<th>3F Alpha</th>
<th>3F p-value</th>
<th>R² 3F</th>
<th>R² CAPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combo</td>
<td>1.38</td>
<td>16.24%</td>
<td>0.02542</td>
<td>1.08</td>
<td>2.02</td>
<td>-0.10</td>
<td>19.27%</td>
<td>0.0073</td>
<td>89.05%</td>
<td>71.59%</td>
</tr>
</tbody>
</table>

The combined portfolio gave an excess return of about 15% which is quite substantial, even more interesting is the fact that the alpha for the CAPM model is 16 % and for the three factor model it is a massive 19%, meaning that this portfolio have generated a risk-adjusted return that is well above the market index. The results are also significant at the 95% level. The reason behind the large alpha for the three-factor model is probably because of the high size loading number of more than 2, combined with a return of -10% for the SMB factor. The adj-R²-test shows that the models were able to explain 73.6 and 89.05% of the variations.
This portfolio was only including the companies that had an F_score of 8-9 and was situated in the top 20% with the highest book-to-market ratio. Due to the lack of companies with a F_score of 0-1 no companies where shorted.

The strict portfolio generated the highest geometric average return of all French portfolios at 33.2%, most of this return was due to a high volatility and despite a beta of over 2 in the CAPM we still got an alpha of 31% using this model. However, as we can see from the results of the three-factor model, most of the return can be explained from the book-to-market ratio and when the return has been adjusted for both size and ratio we are left with a negative alpha of -12.2%. None of the results are however statistically significant. An interesting fact is that our adj-R² test shows that the models where only able to explain 12.85 and 11.11% of the variations.

The last portfolio that contains all shares with an F_score of 8-9 gave us a geometric return that was about 4% higher than Index. According to CAPM we got an alpha of 5.45% using this model while the alpha from the three-factor model only showed an alpha of 0.7%. Both of the alphas are positive however even if the results are not significant at the 95% level. A interesting fact is that the coefficient of determination is higher in CAPM then the three-factor model.

### 4.4 Chile

Chile has had a stable growth for the 15 years that are included in our study. Ever since the government took over from the military in 1990 Chile’s economic reform has been a role model for other developing countries. The biggest slowdown in Chile’s economy started in 1997 when the Asian crisis made investors reluctant to invest money into developing countries, this slowdown lasted until 2002 when the market picked up its pace and started to generate large returns again. Chile was, like the rest of the world, influenced by the global financial crisis in 2007-2008, however Chile was not as affected as many western countries and only suffered a small negative return of 1.27% on the market index in 2008. During the whole studied period the geometric average for the index 14.9% per year. The results are displayed in table 20.
Table 20: Average Returns for Chile 1995-2009

<table>
<thead>
<tr>
<th>Year</th>
<th>Risk-free rate</th>
<th>Index</th>
<th>n</th>
<th>small-firm</th>
<th>n</th>
<th>ratio</th>
<th>n</th>
<th>Combined</th>
<th>n</th>
<th>Piotroski Strict</th>
<th>n</th>
<th>Piotroski All</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>1995</td>
<td>5.98%</td>
<td>-0.47%</td>
<td>67</td>
<td>16.58%</td>
<td>13</td>
<td>28.28%</td>
<td>13</td>
<td>42.02%</td>
<td>5</td>
<td>-1.59%</td>
<td>1</td>
<td>-2.14%</td>
<td>4</td>
</tr>
<tr>
<td>1996</td>
<td>6.48%</td>
<td>0.20%</td>
<td>71</td>
<td>-13.49%</td>
<td>14</td>
<td>-9.06%</td>
<td>14</td>
<td>-3.59%</td>
<td>6</td>
<td>12.34%</td>
<td>2</td>
<td>16.15%</td>
<td>3</td>
</tr>
<tr>
<td>1997</td>
<td>6.00%</td>
<td>-24.79%</td>
<td>81</td>
<td>-19.38%</td>
<td>16</td>
<td>-16.43%</td>
<td>16</td>
<td>-8.40%</td>
<td>9</td>
<td>-20.09%</td>
<td>3</td>
<td>-23.04%</td>
<td>13</td>
</tr>
<tr>
<td>1998</td>
<td>4.48%</td>
<td>5.16%</td>
<td>105</td>
<td>7.92%</td>
<td>21</td>
<td>8.93%</td>
<td>21</td>
<td>5.25%</td>
<td>7</td>
<td>2.60%</td>
<td>2</td>
<td>0.37%</td>
<td>11</td>
</tr>
<tr>
<td>1999</td>
<td>5.77%</td>
<td>16.20%</td>
<td>153</td>
<td>18.02%</td>
<td>31</td>
<td>6.95%</td>
<td>31</td>
<td>8.41%</td>
<td>9</td>
<td>7.89%</td>
<td>1</td>
<td>6.38%</td>
<td>9</td>
</tr>
<tr>
<td>2000</td>
<td>5.95%</td>
<td>12.70%</td>
<td>152</td>
<td>-2.72%</td>
<td>30</td>
<td>-7.36%</td>
<td>30</td>
<td>-2.75%</td>
<td>12</td>
<td>-16.74%</td>
<td>1</td>
<td>-1.21%</td>
<td>8</td>
</tr>
<tr>
<td>2001</td>
<td>3.94%</td>
<td>10.79%</td>
<td>153</td>
<td>21.88%</td>
<td>31</td>
<td>16.29%</td>
<td>31</td>
<td>4.82%</td>
<td>12</td>
<td>-39.95%</td>
<td>1</td>
<td>3.47%</td>
<td>11</td>
</tr>
<tr>
<td>2002</td>
<td>2.79%</td>
<td>29.79%</td>
<td>151</td>
<td>31.65%</td>
<td>30</td>
<td>20.33%</td>
<td>30</td>
<td>36.99%</td>
<td>11</td>
<td>-20.00%</td>
<td>1</td>
<td>20.23%</td>
<td>19</td>
</tr>
<tr>
<td>2003</td>
<td>3.07%</td>
<td>37.05%</td>
<td>152</td>
<td>73.52%</td>
<td>30</td>
<td>30.71%</td>
<td>30</td>
<td>60.11%</td>
<td>8</td>
<td>25.07%</td>
<td>1</td>
<td>35.08%</td>
<td>12</td>
</tr>
<tr>
<td>2004</td>
<td>3.29%</td>
<td>104.92%</td>
<td>161</td>
<td>316.61%</td>
<td>32</td>
<td>233.42%</td>
<td>32</td>
<td>315.14%</td>
<td>17</td>
<td>265.78%</td>
<td>4</td>
<td>89.07%</td>
<td>22</td>
</tr>
<tr>
<td>2005</td>
<td>4.03%</td>
<td>15.20%</td>
<td>168</td>
<td>45.01%</td>
<td>34</td>
<td>26.01%</td>
<td>34</td>
<td>21.43%</td>
<td>20</td>
<td>219.48%</td>
<td>4</td>
<td>42.91%</td>
<td>29</td>
</tr>
<tr>
<td>2006</td>
<td>4.66%</td>
<td>34.84%</td>
<td>174</td>
<td>26.40%</td>
<td>35</td>
<td>9.70%</td>
<td>35</td>
<td>9.46%</td>
<td>15</td>
<td>51.44%</td>
<td>3</td>
<td>46.02%</td>
<td>23</td>
</tr>
<tr>
<td>2007</td>
<td>4.26%</td>
<td>2.74%</td>
<td>177</td>
<td>8.91%</td>
<td>35</td>
<td>8.00%</td>
<td>35</td>
<td>17.51%</td>
<td>14</td>
<td>-8.31%</td>
<td>2</td>
<td>0.15%</td>
<td>28</td>
</tr>
<tr>
<td>2008</td>
<td>3.02%</td>
<td>-1.27%</td>
<td>164</td>
<td>-2.40%</td>
<td>33</td>
<td>-1.26%</td>
<td>33</td>
<td>2.14%</td>
<td>13</td>
<td>28.15%</td>
<td>1</td>
<td>4.89%</td>
<td>19</td>
</tr>
<tr>
<td>2009</td>
<td>2.41%</td>
<td>22.62%</td>
<td>175</td>
<td>-2.47%</td>
<td>35</td>
<td>17.22%</td>
<td>35</td>
<td>-3.68%</td>
<td>17</td>
<td>-1.91%</td>
<td>2</td>
<td>5.17%</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>Arithmetic Mean</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Geometric Mean</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4.41%</td>
<td>17.71%</td>
<td>140</td>
<td>35.07%</td>
<td>28</td>
<td>24.78%</td>
<td>28</td>
<td>33.66%</td>
<td>12</td>
<td>33.61%</td>
<td>2</td>
<td>16.23%</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Geometric Mean</td>
<td>4.21%</td>
<td>140</td>
<td>22.96%</td>
<td>28</td>
<td>17.40%</td>
<td>28</td>
<td>22.27%</td>
<td>12</td>
<td>16.57%</td>
<td>2</td>
<td>13.59%</td>
<td>15</td>
</tr>
</tbody>
</table>
When we continue with our regression analysis the size portfolio is first out.

Table 21: Average of annual alphas, p-values and coefficients for the Size portfolio in Chile from 1995-2009.

<table>
<thead>
<tr>
<th>Portfolio</th>
<th>CAPM BETA</th>
<th>CAPM Alpha</th>
<th>CAPM P-value</th>
<th>3F Beta</th>
<th>3F Size loading</th>
<th>3F Ratio loading</th>
<th>3F Alpha</th>
<th>3F p-value</th>
<th>R² 3F</th>
<th>R² CAPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size</td>
<td>1.80</td>
<td>-3.62%</td>
<td>0.65908</td>
<td>0.32</td>
<td>-0.19</td>
<td>0.95</td>
<td>-1.56%</td>
<td>0.5748</td>
<td>97.68%</td>
<td>77.88%</td>
</tr>
</tbody>
</table>

The size portfolio yielded a slightly higher return than index when we compare the geometric averages. When we adjust these returns for risk the outcome is completely different however and CAPM gives us an alpha of -3.62% while the three-factor model gives an alpha of -1.56%. Neither of the results is significant at a 95% level and the adj-R² shows that the models explain 97.68% and 77.88% of the variations. The reason the alpha from the three-factor model is lower than the one from CAPM might have to do with the size loading which is negative, this is quite strange since the portfolio is made out of small companies the size coefficient should theoretically be higher.

Table 22: Average of annual alphas, p-values and coefficients for the Ratio portfolio in Chile from 1995-2009.

<table>
<thead>
<tr>
<th>Portfolio</th>
<th>CAPM BETA</th>
<th>CAPM Alpha</th>
<th>CAPM P-value</th>
<th>3F Beta</th>
<th>3F Size loading</th>
<th>3F Ratio loading</th>
<th>3F Alpha</th>
<th>3F p-value</th>
<th>R² 3F</th>
<th>R² CAPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ratio</td>
<td>2.53</td>
<td>-2.96%</td>
<td>0.76905</td>
<td>0.83</td>
<td>0.41</td>
<td>0.82</td>
<td>-1.83%</td>
<td>0.5035</td>
<td>98.81%</td>
<td>82.12%</td>
</tr>
</tbody>
</table>

The ratio portfolio yielded the highest geometric return out of all portfolios in Chile with a return almost 8% higher than index every year. When you adjust the return in our models however the results show that there are no excess returns in this portfolio and the alpha is negative in both models although not significant. A notable thing from the results is that the beta from the CAPM is very high at 2.53 which imply that there are large fluctuations in this portfolio.

Table 23: Average of annual alphas, p-values and coefficients for the Size portfolio in Chile from 1995-2009.

<table>
<thead>
<tr>
<th>Portfolio</th>
<th>CAPM BETA</th>
<th>CAPM Alpha</th>
<th>CAPM P-value</th>
<th>3F Beta</th>
<th>3F Size loading</th>
<th>3F Ratio loading</th>
<th>3F Alpha</th>
<th>3F p-value</th>
<th>R² 3F</th>
<th>R² CAPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combo</td>
<td>2.38</td>
<td>-2.42%</td>
<td>0.83837</td>
<td>0.24</td>
<td>-0.02</td>
<td>1.26</td>
<td>0.05%</td>
<td>0.9861</td>
<td>98.60%</td>
<td>74.41%</td>
</tr>
</tbody>
</table>

The combined portfolio has once again one of the highest geometric returns out of all portfolios in the country at 22.3%. It does however look like the high returns once again is due to a large volatility in the portfolio. The beta from CAPM at 2.38 confirms this and after the risk-adjustment we were left with a non-significant alpha of -2.4%. The alpha from the three-factor model is just about positive at 0.005%, these results are not significant at a 95% level. The adj-R² shows us that the three-factor model is very good at explaining the variations in the three first portfolios with numbers between 98-99%.
Table 24: Average of annual alphas, p-values and coefficients for the Piotroski strict portfolio in Chile from 1995-2009.

<table>
<thead>
<tr>
<th>Portfolio</th>
<th>CAPM BETA</th>
<th>CAPM Alpha</th>
<th>CAPM P-value</th>
<th>3F Beta loading</th>
<th>3F Ratio loading</th>
<th>3F Alpha</th>
<th>3F p-value</th>
<th>R² 3F</th>
<th>R² CAPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Piotroski Strict</td>
<td>2.04</td>
<td>2.05%</td>
<td>0.91629</td>
<td>-0.41</td>
<td>1.22</td>
<td>4.88%</td>
<td>0.8021</td>
<td>47.11%</td>
<td>42.39%</td>
</tr>
</tbody>
</table>

The portfolio with companies that fulfil Piotroski’s strict criteria’s contains very few stocks. We were only able to get an average of barely two stocks per year. We did however get a higher return compared to Index even after the models had adjusted them. The alpha we got from CAPM was at 2% and from the three-factor model we got an alpha at 4.9%, neither of the results were significant however. Just like in our other countries the models have a hard time explaining the variations, this is illustrated with the adj-R² test which shows that only 47.11% is explained by the three-factor model and 42.39% by CAPM.

Table 25: Average of annual alphas, p-values and coefficients for the Piotroski all portfolio in Chile from 1995-2009.

<table>
<thead>
<tr>
<th>Portfolio</th>
<th>CAPM BETA</th>
<th>CAPM Alpha</th>
<th>CAPM P-value</th>
<th>3F Beta loading</th>
<th>3F Ratio loading</th>
<th>3F Alpha</th>
<th>3F p-value</th>
<th>R² 3F</th>
<th>R² CAPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pio All</td>
<td>0.86</td>
<td>0.43%</td>
<td>0.90234</td>
<td>0.86</td>
<td>-0.05</td>
<td>0.20%</td>
<td>0.9608</td>
<td>77.67%</td>
<td>80.96%</td>
</tr>
</tbody>
</table>

After we removed the book-to-market criteria from Piotroski’s model we were able to get some more companies into our portfolio. The geometric return from this portfolio was however 2.5% lower than our Index. After the return had been adjusted by our models we still got a small positive alpha from both the CAPM and the three-factor model, although not significant at a 95% level.
5. Analysis
In this chapter we will continue to process the data from the empirical section in order to answer the hypotheses. Starting by using the coefficients from regression analysis, we estimated the return for each portfolio according to the valuation model. Then by measuring difference between the actual return and the estimation for each year, we acquire the alphas necessary for the subsequent t-tests to answer our hypotheses.

Hypothesis 1

In Piotroski’s article he was able to shift the return distribution of the portfolio generated by his model compared to a high book to market portfolio. This would imply that the screening process using the 9 tests increases the return of his portfolio. Since the model is designed to operate with either small cap firms and/or firms with high book to market ratio, our first hypothesis is to test whether the screening process add additional value compared to a small cap portfolio

**Hypothesis 1a:** A portfolio based on stocks that are selected with Piotroski’s model are not able to generate a risk adjusted return that is higher than a portfolio based on small cap stocks using CAPM valuation model.

**Hypothesis 1b:** A portfolio based on stocks that are selected with Piotroski’s model are not able to generate a risk adjusted return that is higher than a portfolio based on small-firm stocks using Fama French Three Factor valuation model.

\[ H_0 = \mu_i = \mu_{il} \]
\[ H_1 = \mu_i > \mu_{il} \]

\( \mu_i \) = The average annual risk adjusted return generated by Piotroski’s model

\( \mu_{il} \) = The average annual risk adjusted return generated by small cap stocks

Table 26: T-statistics from one-sided two-paired t-tests for small-cap portfolios compared to Piotroski strict portfolio that’s been adjusted with CAPM.

<table>
<thead>
<tr>
<th>Hypothesis test 1a</th>
<th>CAPM</th>
<th>V1 = Piotroski</th>
<th>V2 = Small CAP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Market</td>
<td>South Korea</td>
<td>France</td>
<td>India</td>
</tr>
<tr>
<td>T-stat</td>
<td>0,17603864</td>
<td>0,85196813</td>
<td>2,08990114</td>
</tr>
<tr>
<td>Critical Value</td>
<td>Normal</td>
<td>1,782288</td>
<td>Bonferroni</td>
</tr>
</tbody>
</table>
Table 27: T-statistics from one-sided two-paired t-tests for small-cap portfolios compared to Piotroski strict portfolio that’s been adjusted with three factor model.

<table>
<thead>
<tr>
<th>Market</th>
<th>3 factor</th>
<th>V1 = Piotroski</th>
<th>V2 = Small CAP</th>
</tr>
</thead>
<tbody>
<tr>
<td>South Korea</td>
<td>-1.4685925</td>
<td>-0.545314877</td>
<td>1.4091628</td>
</tr>
<tr>
<td>France</td>
<td></td>
<td>1.812461</td>
<td>2.466014362</td>
</tr>
<tr>
<td>India</td>
<td></td>
<td>0.436069102</td>
<td></td>
</tr>
<tr>
<td>Chile</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

By observing the data in the empirical section and the one sided t-stat in the table above we can see the risk adjusted average alpha generated by Piotroski’s model is indeed higher than our small cap portfolio in every market included in this study when risk adjusted using CAPM model. This could mean that the screening process do add additional value. However, only the result in India was significant after adjusting for degrees of freedom. However, due to the multiple comparisons the Bonferroni correction is required to reduce type I error, then the result in India is no longer significant at 95% level.

When using the three-factor model only two of the four markets were able to generate a higher risk adjusted return using Piotroski’s model. This time none of the results were statistical significant using a one-sided t-test regardless using the conservative approach or not. The large negative t-stat in Korea seems to indicate that all return from the Piotroski model stems from a combination of the market, size and ratio premium, and the model itself actually destroys value. From these results we cannot reject our null hypothesis.

**Hypothesis 2**

Continuing from our previous hypothesis we now test whether the 9 tests add any value compared against a high book to market ratio portfolio.

_Hypothesis 2a: A portfolio based on stocks that are selected with Piotroski’s model is not able to generate a risk adjusted return that is higher than a portfolio based on high book-to-market stocks using CAPM valuation model._

_Hypothesis 2b: A portfolio based on stocks that are selected with Piotroski’s model is not able to generate a risk adjusted return that is higher than a portfolio based on high book-to-market stocks using Fama French Three Factor valuation model._

\[ H_0 = \mu_i = \mu_{ii} \]
\[ H_1 = \mu_i > \mu_{ii} \]

\( \mu_i \) = The average annual risk adjusted return generated by Piotroski’s model

\( \mu_{ii} \) = The average annual risk adjusted return generated by high book to market stocks

Table 28: T-statistics from one-sided two-paired t-tests for Ratio portfolios compared to Piotroski strict portfolio that’s been adjusted with CAPM
Hypothesis test 2a

<table>
<thead>
<tr>
<th>Market</th>
<th>CAPM</th>
<th>V1 = Piotroski</th>
<th>V2 = High Book to market</th>
</tr>
</thead>
<tbody>
<tr>
<td>South Korea</td>
<td>France</td>
<td>India</td>
<td>Chile</td>
</tr>
</tbody>
</table>

| T-stat   | -0.4836895 | 0.524711091 | 1.79149791 | 0.353513464 |
| Critical value | Normal | 1,782288 | Bonferroni | 2,403043314 |

Table 29 T-statistics from one-sided two-paired t-tests for Ratio portfolios compared to Piotroski strict portfolio that’s been adjusted with Three-factor model

<table>
<thead>
<tr>
<th>Market</th>
<th>3factor</th>
<th>V1 = Piotroski</th>
<th>V2 = Small CAP</th>
</tr>
</thead>
<tbody>
<tr>
<td>South Korea</td>
<td>France</td>
<td>India</td>
<td>Chile</td>
</tr>
</tbody>
</table>

| T-stat   | -1.9809974 | -0.648149614 | 1.29002324 | 0.477192531 |
| Critical value | Normal | 1.812461 | Bonferroni | 2.466014362 |

For the high book to ratio portfolio the Piotroski model was able to generate higher return in three of the four cases using CAPM valuation model. Again in this case India was the only candidate being statistical significant when not adjusting for the Bonferroni correction.

Using the three factor model most of the risk adjusted return have been shifted to size and ratio premium, leave none of the results statistical significant. South Korea were the extreme case where changing the valuation model made it significantly smaller than high book to market portfolio before correction. Again, this indicates that the model actually destroys value when excluding for size and ratio premium, and we cannot reject the null hypothesis. The contradicting results depend on which valuation model selected was not expected.

**Hypothesis 3**

Hypothesis 3 test whether Piotroski’s model or more specifically the 9 tests add value compared against a portfolio constructed with firms that both fulfil small cap and high book to market criteria.

**Hypothesis 3a:** A portfolio based on stocks that are selected with Piotroski’s model is not able to generate a risk adjusted return that is higher than a portfolio based on companies that are both small and have a high book-to-market ratio using CAPM valuation model.

**Hypothesis 3b:** A portfolio based on stocks that are selected with Piotroski’s model is not able to generate a risk adjusted return that is higher than a portfolio based on companies that are both small and have a high book-to-market ratio using Fama French three factor valuation model.

\[ H_0 = \mu_i = \mu_{ii} \]

\[ H_1 = \mu_i > \mu_{ii} \]
\[\mu_i = \text{The average annual risk adjusted return generated by Piotroski’s model}\]

\[\mu_{il} = \text{The average annual risk adjusted return generated by combination stocks}\]

Table 30: T-statistics from one-sided two-paired t-tests for Combo portfolios compared to Piotroski strict portfolio that’s been adjusted with CAPM

<table>
<thead>
<tr>
<th>Hypothesis test 3a</th>
<th>CAPM</th>
<th>V1 = Piotroski</th>
<th>V2 = Combination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Market</td>
<td>South Korea</td>
<td>France</td>
<td>India</td>
</tr>
<tr>
<td>T-stat</td>
<td>-0.975983</td>
<td>0.472561791</td>
<td>1.71043344</td>
</tr>
<tr>
<td>Critical value</td>
<td>Normal</td>
<td>1.782288</td>
<td>Bonferroni</td>
</tr>
</tbody>
</table>

Table 31: T-statistics from one-sided two-paired t-tests for small-cap portfolios compared to Piotroski strict portfolio that’s been adjusted with Three factor model

<table>
<thead>
<tr>
<th>Hypothesis test 3b</th>
<th>3factor</th>
<th>V1 = Piotroski</th>
<th>V2 = Combination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Market</td>
<td>South Korea</td>
<td>France</td>
<td>India</td>
</tr>
<tr>
<td>T-stat</td>
<td>-2.4713558</td>
<td>-1.069562636</td>
<td>1.20858306</td>
</tr>
<tr>
<td>Critical value</td>
<td>Normal</td>
<td>1.812461</td>
<td>Bonferroni</td>
</tr>
</tbody>
</table>

In the comparison with the combination portfolios none of the Piotroski portfolios had significantly higher return in any of the markets. The three factor model had the same result as CAPM where none of the results are statistical significant. It is however interesting to see how South Korea got an even larger negative t-stat, which would be statistically significant if we were performing a two tail test. From these result we are not able to reject the null hypothesis.

To summarize the results for the three hypotheses that concern Piotroski’s models profitability, we can see that using CAPM model, India was able to generate statistically significant higher return using Piotroski’s model than the small cap and high book to market ratio portfolios. However, these results are no longer significant using a more conservative approach by adjusting for Bonferroni correction. Using three factor model none of the results on all market were significant. The difference between CAPM and three factor model and the increasingly larger negative t-stat in South Korea seems to instead indicate that the return from Piotroski’s model is consisting of two parts. One part utilizing the anomaly premiums by only selecting high book to market firms and indirectly small cap firms due to correlation between the former two, while the second part generate a return from 9 tests screening process. What we found is the screening process may actually destroy value instead of creating it, proven by the significant negative t-stat in South Korea when anomaly premium have been removed using three factor model. If this is true, then it would be simpler and more profitable to simply construct an index portfolio based on our comparison portfolio instead of the rather data intensive Piotroski model. To further confirm this separation, we watched the stock return generated from the Piotroski portfolio picked from the entire market.
Table 32: Descriptive statistics for Piotroski portfolio generated from all stocks available in the markets

<table>
<thead>
<tr>
<th>Portfolio</th>
<th>CAPM BETA</th>
<th>CAPM Alpha</th>
<th>CAPM P-value</th>
<th>3F Beta</th>
<th>3F Size loading</th>
<th>3F Ratio loading</th>
<th>3F Alpha</th>
<th>3F p-value</th>
<th>R² 3F</th>
<th>R² CAPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>South Korea</td>
<td>1.37</td>
<td>0.11%</td>
<td>0.99146</td>
<td>0.61</td>
<td>-0.44</td>
<td>1.56</td>
<td>-30.41%</td>
<td>0.0170</td>
<td>89.14</td>
<td>78.09</td>
</tr>
<tr>
<td>India</td>
<td>0.72</td>
<td>-3.67%</td>
<td>0.32478</td>
<td>0.96</td>
<td>-0.33</td>
<td>-0.07</td>
<td>-1.04%</td>
<td>0.7960</td>
<td>90.83</td>
<td>90.53</td>
</tr>
<tr>
<td>France</td>
<td>1.14</td>
<td>5.46%</td>
<td>0.31487</td>
<td>1.08</td>
<td>0.48</td>
<td>0.25</td>
<td>0.76%</td>
<td>0.9251</td>
<td>70.19</td>
<td>72.18</td>
</tr>
<tr>
<td>Chile</td>
<td>0.86</td>
<td>0.43%</td>
<td>0.90234</td>
<td>0.86</td>
<td>0.12</td>
<td>-0.05</td>
<td>0.20%</td>
<td>0.9608</td>
<td>77.67</td>
<td>80.96</td>
</tr>
</tbody>
</table>

These portfolios have a higher average number of stocks each year and thus lower variation from unsystematic risk, both CAPM and three factor model is also able to explain the return variation much better than the strict portfolio. However, since these stocks are picked from the entire market, they are not able to enjoy anomaly premium to the same degree as the strict portfolio. The earlier significant result in India now yields negative result.

**Hypothesis 4**

Since Piotroski implies that his model is supposed to work better on markets with low information efficiency, we want to test whether there are any differences between markets with varied information efficiency. Using delay measure as a substitute for information efficiency, we formulated the following hypothesis:

**Hypothesis 4a**: A portfolio based on stocks selected by Piotroski’s model from a market with high delay does not generate higher return than a portfolio based on markets with low delay selected by Piotroski’s model after both being risk adjusted using CAPM.

**Hypothesis 4b**: A portfolio based on stocks selected by Piotroski’s model from a market with high delay does not generate higher return than a portfolio based on markets with low delay selected by Piotroski’s model after both being risk adjusted using Fama French three factor model.

These questions will be answered with the following hypothesis:

$H_0: \mu_i = \mu_{ii}$

$H_1: \mu_i > \mu_{ii}$

Where,

$\mu_i = \text{Average risk-adjusted return for a portfolio from a market with high delay.}$

$\mu_{ii} = \text{Average risk-adjusted return for a portfolio from a market with low delay.}$

We can see the results from the one-tailed paired two sample t-tests in table 33 and 34. The performed t-test can not show any statistically significant difference between the returns of
countries with a high delay compared to those with low delay. In table 1 where we compare the CAPM-adjusted returns, 3 out of 4 comparisons are negative which actually implies that it would be better to invest in countries with low delay. The results from table 34 shows that the three-factor model gives us two positive t-stats although none significant.

Table 333: T-statistics from one-sided two-paired t-tests for countries with high Delay compared to countries with low delay. The Piotroski strict portfolio that’s been adjusted with CAPM has been used for comparison between countries.

<table>
<thead>
<tr>
<th>Hypotheses 4a</th>
<th>CAPM</th>
<th>V1: high delay</th>
<th>V2: low delay</th>
</tr>
</thead>
<tbody>
<tr>
<td>Markets</td>
<td>France/India</td>
<td>France/Korea</td>
<td>Chile/India</td>
</tr>
<tr>
<td>T-stat</td>
<td>-0.24120</td>
<td>0.91440</td>
<td>-1.40856</td>
</tr>
<tr>
<td>Critical Value</td>
<td>Normal</td>
<td>1.782288</td>
<td>Bonferroni</td>
</tr>
</tbody>
</table>

Table 344: T-statistics from one-sided two-paired t-tests for countries with high Delay compared to countries with low delay. The Piotroski strict portfolio that’s been adjusted with three factor model has been used for comparison between countries.

<table>
<thead>
<tr>
<th>Hypotheses 4b</th>
<th>3 factor model</th>
<th>V1: high delay</th>
<th>V2: low delay</th>
</tr>
</thead>
<tbody>
<tr>
<td>Markets</td>
<td>France/India</td>
<td>France/Korea</td>
<td>Chile/India</td>
</tr>
<tr>
<td>T-stat</td>
<td>-1.04578</td>
<td>0.76923</td>
<td>-0.84084</td>
</tr>
<tr>
<td>Critical Value</td>
<td>Normal</td>
<td>1.812461</td>
<td>Bonferroni</td>
</tr>
</tbody>
</table>

The results from the performed test showed above leads us to the conclusion that investing in a market with higher delay does not generate a higher risk-adjusted return compared to investing in a market with low delay when using CAPM or Fama & French three-factor model to risk adjust. We are thereby not able to reject H0. These results contradicts with the thoughts Piotroski (2000) express, that markets with low efficiency should improve the models performance and thereby generate a higher return, given that delay measure can be used as a substitute for information efficiency. To our knowledge Piotroski’s propositions about market efficiency have never been tested before so they are based solely on theoretical knowledge.

The t-test showed that India, which is a country with a low delay, perform well against both of the high delay markets, these results are in line with the ones we saw in the geometric returns where India by far gave the highest geometric averages. Some of the high geometric return was explained when we risk-adjusted the returns but even after that India still had the highest Alpha’s of all markets. South Korea on the other hand was the market with the largest negative alpha when being risk adjusted using the three factor model. What these differences depend on is difficult to say, it might be a coincidence or it might have to do with the fact that South Korea is a developed country that have lower economic growth than India who is an emerging country. These are however merely speculations and to draw any definitive conclusions further research would have to be done.
Hypothesis 5

To see whether there is any difference in the risk-adjusted return on portfolios that developed countries generates compared to the risk-adjusted return portfolios from emerging countries generates the following hypothesis where formed:

**Hypothesis 5a**: A Portfolio based on stocks from developed countries which are selected by Piotroski’s model does not generate a higher return than that has been risk-adjusted by CAPM than a portfolio based on stocks from emerging countries that are selected by Piotroski’s model.

**Hypothesis 5b**: A Portfolio based on stocks from developed countries which are selected by Piotroski’s model does not generate a higher return than that has been risk-adjusted by the Fama & French three-factor model than a portfolio based on stocks from emerging countries that are selected by Piotroski’s model.

These questions will be answered with the following hypothesis:

\[ H_0: \mu_i = \mu_{ii} \]
\[ H_1: \mu_i > \mu_{ii} \]

Where,
\[ \mu_i = \text{Average risk-adjusted return for a portfolio from an developed country’s market.} \]
\[ \mu_{ii} = \text{Average risk-adjusted return for a portfolio from an emerging country’s market.} \]

The results from the one-tailed two paired t-test are showed in table 35 and 36. The performed t-tests do not give any statistically significant support to the statement that developed countries generates a higher risk-adjusted return than emerging countries do, this is the case whether you use CAPM or the Fama & French three-factor model. In table 3 there is only two of the tests that show a positive t-stat and one of those are very close to zero and the other is no way near being statistically significant at the 95 % level. The results from table four where the returns have been risk-adjusted by the three-factor model shows that none of the tests were able to give a positive t-stat.

Table 355: T-statistics from one-sided two-paired t-tests for developed countries compared to emerging countries. The Piotroski strict portfolio that’s been adjusted with CAPM has been used for comparison between countries.

<table>
<thead>
<tr>
<th>Hypotheses 5a</th>
<th>CAPM</th>
<th>V1: Developed</th>
<th>V2: Emerging</th>
</tr>
</thead>
<tbody>
<tr>
<td>Markets</td>
<td>Korea/India</td>
<td>Korea/Chile</td>
<td>France/India</td>
</tr>
<tr>
<td>T-stat</td>
<td>-2.23715</td>
<td>0.01559</td>
<td>-0.24120</td>
</tr>
<tr>
<td>Critical Value</td>
<td>Normal</td>
<td>1.782288</td>
<td>Bonferroni</td>
</tr>
</tbody>
</table>
Table 366: T-statistics from one-sided two-paired t-tests for developed countries compared to emerging countries. The Piotroski strict portfolio that’s been adjusted with three factor model has been used for comparison between countries.

<table>
<thead>
<tr>
<th>Hypotheses 5b</th>
<th>3 factor model</th>
<th>V1: Developed</th>
<th>V2: Emerging</th>
</tr>
</thead>
<tbody>
<tr>
<td>Markets</td>
<td>Korea/India</td>
<td>Korea/Chile</td>
<td>France/India</td>
</tr>
<tr>
<td>T-stat</td>
<td>-3.38554</td>
<td>-1.92670</td>
<td>-1.04578</td>
</tr>
<tr>
<td>Critical Value</td>
<td>Normal</td>
<td>1.812461</td>
<td>Bonferroni</td>
</tr>
</tbody>
</table>

Griffin et al. (2010) were able to show that it is more effective to use investment strategies based on past returns and earnings in developed countries compared to emerging countries. Based on the results we got from our t-tests we are not able to find any support to Griffins finding and thus we cannot reject our null hypotheses. Griffin made his study on 56 different countries and he also incorporated trading costs to his study, this is something we haven’t done in our study and this might influence the results. There is not much research done in this area that we know of and it is thereby difficult to draw any general conclusions just by looking at two studies, especially since they have contradicting results. By the looks of our results there is however clear that our portfolios from developed countries are not able to generate a higher return than those from emerging countries, instead it looks like it’s the other way around.

As we mentioned a possible explanation that our results differ from Griffins is the fact that he uses trading costs in his study, it is however difficult to know how much influence trading costs would have on the returns since he doesn’t mention the magnitude of these costs. We do however find it hard to believe that we would get any significant results even with trading costs in the view of the results from table 3 and 4. Another possible explanation that makes our results differ is the fact that Griffin made his study on 56 different countries from whom we have chosen 4. With a larger sample it is easier to draw general conclusions even if there are some markets that don’t act like the majority. With our relatively small sample there is a possibility that it is these exceptions that have been included in our sample.

Like the case in hypothesis 4 India stands out as a market once again. With its high geometric and risk-adjusted returns the developed countries generate a large negative t-stat. Since India shows these rather extreme results it would be interesting to look at other countries that are emerging and has a high market efficiency to see whether India is an extreme case or if it is a “normal” return for this category.

Hypothesis 6

This last hypothesis is designed to test the variability of result depending on the valuation method selected. The purpose is to see if change in valuation method have discernible pattern, and if this pattern could be explained by the changes in the assumptions necessary for the valuation.

Hypothesis 6: The risk adjusted return for Piotroski’s model valuated using CAPM does not differ from one generated using Fama French three factor model.

\[ H_0 = \mu_i = \mu_{ii} \]
\[ H_1 = \mu_i \neq \mu_{ii} \]

\[ \mu_i = \text{The average annual risk adjusted return generated by Piotroski’s model using CAPM} \]

\[ \mu_{ii} = \text{The average annual risk adjusted return generated by Piotroski’s model using Fama French three factor model} \]

Table 37: T-statistics from two-paired t-tests for returns adjusted by CAPM compared to three factor model.

<table>
<thead>
<tr>
<th>Hypothesis 6</th>
<th>V1 = CAPM</th>
<th>V2 = 3 factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Markets</td>
<td>Korea</td>
<td>India</td>
</tr>
<tr>
<td>T-stat</td>
<td>4,301150507</td>
<td>1,88897992</td>
</tr>
<tr>
<td>Critical value</td>
<td>One tail</td>
<td>1,76131014</td>
</tr>
</tbody>
</table>

From our table we can see that in two out four markets CAPM results is significantly different than results yielded with three factor model, therefore we reject our null hypothesis. The large difference between the two valuation models confirms the idea that the valuation method chosen to risk adjust has big impact whether the investment model is profitable or not. In other words, the success that Piotroski’s model had in US could just be due to the method used to risk adjust. It is therefore necessary to further analyse the risk adjustment measure used by Piotroski and compared it against CAPM and three factor model.

The way Piotroski risk adjusts the portfolio in his article is fairly straight forward, simply deducting the market return from the portfolio return. The main advantage is the simplicity, but doing so also assumes that his portfolio has no linear correlation with the systematic risk caused by the overall market. Also given that the comparison index used is the overall market while the stock picking process was based solely on high book to market ratio companies, Piotroski also make the assumption that high book to market companies does not add additional risk to the portfolio. This method will therefore show large positive alpha for any risky and volatile market where the calculation period have been positive.

Even though CAPM is similar to the method Piotroski used, one important distinction is the assumption of linear relationship between analysed portfolio and the overall market, this account for both volatilities on the stock market and risk free interest rate. Because Piotroski’s model base the stock selection in stocks with high book to market ratio, the increased risk and premium that comes with is partially caught by the beta, comparably leaving a slightly smaller alpha than method Piotroski used.

The three factor model assumes high market efficiency and that companies with small capitalization and high book to market ratio are more risky, the empirically observed premium is therefore justified for the additional risk taken. Using the three factor model for valuation will then dissect the portfolio return and assign each premium with a coefficient, these returns are then no longer a part of alpha, which is why the risk adjusted return dropped considerably on most markets in our data. Regardless whether size and ratio is a source of additional risk, it
doesn’t change the fact that Piotroski’s model didn’t provide a significant positive alpha on any of the markets for the 9 tests screening process, at best the stocks selected have high correlation with size or ratio premium which boosted its risk adjusted return for CAPM model. The large significant decrease in risk adjusted return when switching CAPM to three factor model also shows that the assumptions and choice of valuation model before the actual assessment of profitability could have far more impact than the investment model itself, making large positive alpha easily obtained by selecting poor valuation model.
6. Conclusion

The research questions that we formulated in the beginning of this thesis were as follows:

Question 1: Will Piotroski’s model, as an investment strategy, outperform comparable indexes based on market anomalies?

Question 2: Does Piotroski’s model work better in its preferred environments?

Question 3: Could the choice of valuation method have significant impact on the risk adjusted return?

By studying the French, South Korean, Indian and Chilean markets we have tried to answer the aforementioned questions. With this thesis we wished to contribute with further knowledge about the possible gains there might be if this model is used. We have found that there is a very poor collection of previous research’s done on Piotroski’s value investment model. The research that has been done have all found that the model is able to generate abnormal returns (Aggarwal & Gupta, 2009; Gerber et al., 2009; Piotroski, 2000). Piotroski and Aggarwal do however only use the market to adjust their return, we believe that this strategy to risk-adjust the returns is a bit too simple and acts in favour for the model. We wanted to see if it really was the model that gave the abnormal returns or if it was due to the small-firm and book-to-market anomaly. We therefore believed that a study where Piotroski’s model is applied and the returns are risk-adjusted by two of the most well-known methods for risk-adjustment namely CAPM and the three-factor model are necessary to see whether Piotroski’s model still is able to perform abnormal returns.

Our second research question seeks to answer the two statements Griffin et al. (2010) and Piotroski (2000) makes about the models ability to work in different markets. Piotroski claimed that his model theoretically should work best in markets with low efficiency while Griffin states that developed countries are better at generating abnormal returns when investment strategies based on historical data and prices are used. The research in these specific areas is very scarce and we believed that a study needed to be done to give some empirical results to Piotroski’s statement and to see whether Griffin’s claims are applicable to our chosen markets.

The third research question focuses on the selection of a valuation method and the impact it has on the risk adjusted return. Because value investment is based on the absence of market efficiency, it also affects investors’ choice of valuation model depending on the necessary assumptions.

In the theoretical chapter theories have been presented and we arrived at 6 different hypotheses to help us find the answers to the research questions. To answer the first research question we have investigated whether the portfolios from our 4 different markets generated by Piotroski’s model are able to generate a higher return after being risk adjusted by CAPM and three-factor model respectively than our portfolios that were based on the size and ratio- anomalies. Our first test was the small cap portfolios compared to Piotroski’s portfolio, although his model were able to generate a higher alpha in six cases out of eight they were not statistically significant. We got similar results when we compared the ratio portfolio and the combo portfolio against Piotroski’s
model, with CAPM as a risk-adjusting model both the ratio and combo portfolio generated higher alphas than Piotroski’s model in three out of four cases. With the three-factor model as risk-adjusting model the ratio and combo portfolio’s generated two positive and two negative t-stats. Neither of the portfolios so far showed any statistically significant result. With the data we have presented so far we are not able to reject any of the first three hypotheses, and have therefore come to the conclusion that Piotroski’s model is not able to outperform comparable indexes.

To answer our second research question we have used the same methods as in research question one, only this time comparing Piotroski’s portfolios between the markets. Our first tests were to see whether Piotroski’s model worked better on a market with high delay compared to a market with a small delay. We compared two markets at a time, one with high delay versus one with low delay until all four markets had been tested against each other. The tests showed no statistically significant results between markets with high and low delay. The same procedure was then used in the fifth hypotheses only this time we compared markets in developed countries against emerging countries. These tests showed, just like the previous tests, no statistically significant result. These data contradict the results Griffin et al. got from their study, although their data was based on an average of 56 markets. The results from the aforementioned tests concludes that the answer to research question number 2 is No, there is no significant evidence that show Piotroski’s model would work better in markets with high delay or being classified as developed.

To find the answer for the third research question we compared the alpha generated using CAPM against the three factor model. The result showed that in two of the four markets returns generated using CAPM differs significantly from the three factor model, their only difference being exclusion of anomaly premium. From this result our answer for the final research question is that the choice of valuation method has large impact on the risk adjusted return, making the result easily manipulated.

Table 38 shows a summary of the generated hypotheses together with their outcome.

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Description</th>
<th>Fail to reject H₀</th>
<th>Reject H₀</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypothesis 1a</td>
<td>A portfolio based on stocks that are selected with Piotroski’s model are not able to generate a risk adjusted return that is higher than a portfolio based on small cap stocks using CAPM valuation model.</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Hypothesis 1b</td>
<td>A portfolio based on stocks that are selected with Piotroski’s model are not able to generate a risk adjusted return that is higher than a portfolio based on small-firm stocks using Fama French Three Factor valuation model.</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Hypothesis 2a</td>
<td>A portfolio based on stocks that are selected with Piotroski’s model is not able to generate a risk adjusted return that is higher than a portfolio based on high book-to-market stocks using CAPM valuation model.</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Hypothesis 2b</td>
<td>A portfolio based on stocks that are selected with Piotroski’s model is not able to generate a risk adjusted return that is higher than a portfolio based on high book-to-market stocks using Fama French Three Factor valuation model.</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>
Hypothesis 3a  A portfolio based on stocks that are selected with Piotroski’s model is not able to generate a risk adjusted return that is higher than a portfolio based on companies that are both small and have a high book-to-market ratio using CAPM valuation model.

X

Hypothesis 3b  A portfolio based on stocks that are selected with Piotroski’s model is not able to generate a risk adjusted return that is higher than a portfolio based on companies that are both small and have a high book-to-market ratio using Fama French three factor valuation model.

X

Hypothesis 4a  A portfolio based on stocks selected by Piotroski’s model from a market with high delay does not generate higher return than a portfolio based on markets with low delay selected by Piotroski’s model after both being risk adjusted using CAPM.

X

Hypothesis 4b  A portfolio based on stocks selected by Piotroski’s model from a market with high delay does not generate higher return than a portfolio based on markets with low delay selected by Piotroski’s model after both being risk adjusted using Fama French three factor model.

X

Hypothesis 5a  A Portfolio based on stocks from developed countries which are selected by Piotroski’s model does not generate a higher return than that has been risk-adjusted by CAPM than a portfolio based on stocks from emerging countries that are selected by Piotroski’s model.

X

Hypothesis 5b  A Portfolio based on stocks from developed countries which are selected by Piotroski’s model does not generate a higher return than that has been risk-adjusted by the Fama & French three-factor model than a portfolio based on stocks from emerging countries that are selected by Piotroski’s model.

X

Hypothesis 6  The risk adjusted return for Piotroski’s model valuated using CAPM does not differ from one generated using Fama French three factor model.

X

6.1 Theoretical and practical contributions

The purpose with our study was to see whether Piotroski’s investment model was able to generate abnormal returns that would be of help to fund managers or other professional investor. That purpose has been fulfilled and we have been able to show that the 9 screening-tests didn’t provide an additional significant risk-adjusted return. Other than that, the main empirical contribution of our research’s serve as a robustness test for Piotroski’s model. In addition, our data reinforces the existence of a significant small cap and ratio premium for our calculation period. Our use of two different valuation models has given us the possibility to compare them and we have been able to show that the three factor model is superior against CAPM in term of explaining the return variation.

From a theoretical point of view, our research showed the relationship between how methods used to risk adjust affects alpha. This also explains how large risk adjusted returns can exist for prolonged duration even in effective markets simply by selecting the “right” risk adjustment method, which strengthens the position of efficient market theorem.
6.2 Further Research

The large variation in the coefficient of determination for Piotroski’s model shows either a lack of correlation with the overall market or it was caused by a large amount of missing data in datastream. Further research could use COMPUSTAT (Original database used by Piotroski) and revisit the US market during the same period as Piotroski’s article. This time using stricter valuation model to determine whether the risk adjusted return is based on anomaly premium or value added from 9 tests screening process. The study could also be expanded either in width by including additional markets or in depth by including more explanation variable.

Another area to explore is the fact how different investment models vary greatly in their risk adjustment method. As for value investment, one of the most common screening processes is using small market capitalization or high book to market ratio. These stocks have empirically proven premium attached to them, which we also observed in our zerosum portfolios across all markets in this study. Whether these premiums come entirely from added risk is still wildly debated. Since the assumptions of the premium origin differ between various valuation models, a large portion of the return can be distributed either as alpha or removed as risk premium before the analysis even begin, rendering model profitability easily manipulated. Therefore, further research is also required in valuation standardization for investment model comparison.

We performed this study on four markets with different characteristics. Since we only had one country for each character it is difficult to draw any conclusions whether our results was due to a coincidence or not. It would therefore be interesting to conduct the same study as we did but with more countries that fit each criteria. If that was done one might have a more robust foundation to use when these theories are discussed.
Reference list


