Stockholm School of Economics
Bachelor Thesis in Accounting and Financial Management
May 2017

Value investing;

A quest for alpha in the Nordic region

Back-testing the strategies developed by Joel Greenblatt and Joseph Piotroski

Abstract:

This thesis evaluates the performance of the Magic formula and F-score. The investment strategies are applied to the entire Nordic region over the period of 2005-2015 and the returns evaluated using the CAPM and Fama & French's three-factor model. The success of each investment strategy is found to be dependent on the measure of risk, and while the Magic formula manages to generate excess return, the F-score produces a higher alpha when tested using the CAPM and Fama & French's three-factor model. Furthermore, the estimation of the SMB and HML factor portfolios suggests that over the course of 2005-2015 the Nordic region appears to have a positive size premium and a negative value premium.

Keywords: MFI, F-Score, Value Relevance of Accounting Measures, Value Investing, Abnormal returns, CAPM, Fama & French’s three-factor model, Efficient Market Hypothesis

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[1]First of all the authors would like to thank their tutor Stina Skogsvik for her guidance and support. Additionally, the authors are very appreciative of the insightful comments from the opponents and fellow students during the seminars.

1. Introduction

1.1 Background

Greenblatt and Piotroski are two of the most popular practitioners of the investment paradigm called value investing. The philosophy is derived from the ideas of Benjamin Graham and David Dodd (1934) and has since been made famous by the high-profile investor Warren Buffett, amongst others. Generally the idea involves performing fundamental analysis in order to find securities valued below their intrinsic value, and by buying cheap stocks investors gain a “margin of safety” which allows them to make investments with minimal downside risk. This hopefully allows them to identify bargains in the stock market. (Mihaljevic 2013)

Whether it is possible to do so have for long been a subject of academic debate. In 1970 Eugene Fama further developed the efficient market hypothesis which states that all securities are fairly priced, and that prices fully reflect all available information. According to the theory there would not be possible to outperform the market without taking on additional risk proportional to the higher returns. When reviewing the theory Fama (1970) found support of the market being in a semi-strong form of efficiency, and that stock prices should fully reflect all publicly available information.

Despite so some investors, including Benjamin Graham, Warren Buffett, and John Templeton, have systematically managed to beat the market using fundamental analysis. Further evidence supporting the case for a weak form of market efficiency is Ou & Penman (1989) who showed that financial statements contain information that can be used to forecast future stock returns, Lev & Thiagarajan (1993) who found a set of accounting fundamentals to have strong value relevance while Abarbanell & Bushee (1998) showed that those measures can be used to generate an annualized abnormal return of 13.2%. Numerous other investment strategies have also been developed with the purpose of exploiting various market inefficiencies.

Having established it is possible to generate abnormal returns, what is the easiest way to do so? If you ask Joel Greenblatt the answer would be - by magic. The successful hedge fund manager and adjunct professor Joel Greenblatt (2006) is the father of an investment strategy named “The Magic Formula Investing” which identifies companies that trade at low valuations whilst having high returns on capital. Using a stock ranking methodology based on those ratios he consistently managed to beat the market by 18.4% per annum. Various academics have published studies which shows that several other market anomalies exists as well, amongst those the over performance of high book-to-market firms is one of the most well-known (Rosenberg, Reid & Lanstein 1985, Lakonishok, Shleifer & Vishny 1994).This anomaly has been combined with nine fundamental key ratios into an investment strategy developed by the American professor Joseph Piotroski (2000) called the “F-score”. His model has shown the ability to single out both winners and losers amongst the high book-to-market firms, resulting in an annualized return of 23%.

1.2 Purpose

The two investment strategies, F-score and MFI, examined in this thesis have been thoroughly tested in the US market, but do they work in the Nordic region as well? This thesis aims to find out whether this is the case. Moreover, the study also aims to compare the results of the two models and will therefore have considerable practical relevance for an investor seeking to invest in the Nordic stock market. As far as these authors are aware there are no previous studies testing and comparing both models using data from all of the Nordic countries, and earlier attempts to replicate these investment strategies in one of the Nordic countries have faced the problem of having small sample sizes and have thus been forced to either adjust the original models or to settle with potentially skewed results. When investigating whether any of the investment strategies do beat the market when applied in the Nordic region the return of the portfolios will be benchmarked against the MSCI Nordic, and afterwards, adjusting for risk, any return will be tested using the Sharpe-ratio, Jensen's Alpha and Fama & French´s (2012) three factor model (Sharpe 1966, Jensen 1978, Fama, French 2012). In this thesis the term excess return is defined as the return of the portfolio being tested in excess of the market, while abnormal return is defined as the return that cannot be explained by any of the capital asset pricing models. As there is no previous data readily available on the three component factor portfolios in a Nordic stock market context this thesis will estimate the return of the so called SMB and HML factor portfolios. This opens up for a discussion about the whether the size and value effect persists in the Nordic region.

2. Theoretical framework, empirical research and previous studies

2.1 Theory

2.1.1 Efficient market hypothesis

As previously mentioned the efficient market hypothesis states that prices should reflect all available information and that it should be impossible to generate abnormal returns. Investors claiming to beat the market by showing excess returns would according to this theory then only have taken on more risk. When defined by Roberts (1967) three degrees of the efficient market hypotheses (EMH) were outlined; strong, semi-strong and weak form of efficiency. In the weak form of efficiency past prices cannot be used to determine future price movements, rendering technical analysis useless. The semi-strong form of efficiency states that all publicly available information is incorporated into prices, implying that fundamental analysis is useless in predicting stock returns. The strong form of efficiency claims that all information, both public and private, is incorporated into the price of a security. In this strong form of efficiency even monopolistic information commonly regarded as inside information would not render any success in generating abnormal returns.

In his research Fama (1970) conducted a large empirical study of the EMH and found evidence suggesting markets are in a semi-strong form of efficiency. Various academics has since supported the EMH and verified the findings of Fama, including Burton (1973), Samuelson (1973) and Jensen (1978) amongst others.

2.2 Market anomalies and empirical contradictions of EMH

Many value investors have however been using fundamental analysis and knowledge about market anomalies to systematically beat the market year by year (Mihaljevic 2013). Their success have generated significant interest in investment strategies based on fundamental accounting signals, both amongst academics and practitioners. To help grasp the strategies of Piotroski and Greenblatt the following sections will cover some of the major inefficiencies found in the market, especially those which are considered relevant for the further development of this thesis.

2.2.1 Fundamental analysis of accounting information

Many argue that fundamental analysis is the cornerstone of investing. Contributing to that statement is the fact that a large part of all investment strategies are based upon the concept, which in essence involves applying quantitative analysis on a firm's financial statements in order to gain insight into the future performance of the firm. The idea has in research been validated by numerous academics, including Ou & Penman (1989), Lev & Thiagarajan (1993) and Abarbanell & Bushee (1998).

In 1989 the two academics Ou & Penman demonstrated that information contained in financial statements could be used to estimate future earnings. In their study several accounting measures that were found to be positively correlated with stock prices were consolidated into an aggregated measure called "Pr". As this measure was supposed to capture value relevant information about how the stock price is likely to develop in the future, they went on to constructed a portfolio with a long position in high-PR firms and a short position in low-PR firms. This investment strategy managed to generate returns above that of the market confirming that investment strategies could be developed out of market anomalies. The authors Lev & Thiagarajan (1993) went on to show that 12 accounting measures believed to be value relevant by analysts are strongly correlated with future earnings growth. Later research by Abarbanelll & Bushee (1998) has documented and confirmed this effect, and yet again proved that it is possible to use knowledge about value relevant accounting measures as an investment strategy. With the conclusion that the market fails to incorporate such information into share prices they formed a portfolio based on their research in 1997 which generated an annualized return of 13.2%, consequently beating the market.

In the light of previous studies, it so appears that fundamental analysis of accounting information can be used to successfully separate high- from low-performing businesses. Following below are several anomalies that together concretizes this finding, and upon which both the MFI and the F-score investment strategies are built.

2.2.2 Size matters

The size effect is built upon the market value of a company's equity. Historically small firms seems to have outperformed their larger counterparts, as demonstrated by Banz (1981), and according to him this holds true even when adjusted for risk. A possible explanation put forward is a lack of information around smaller firms and that subsequently only a subset of investors are willing to invest in such stocks, leading to less competition and higher risk-adjusted returns. The size effect was then incorporated into the three-factor asset pricing model put forward by Fama & French (1992). However, they saw size as a proxy for some sort of risk factor related to earning prospects, as small firms during the 1980's had a long period of systematically lower earnings than larger corporations. This view was also supported by previous work by Chan and Chen (1991) who argued that the relationship between size and average returns depend on smaller firms being less efficiently run, having higher leverage and being more sensitive to economic conditions and that the higher return was merely a compensation for higher risk. Whether the historically higher returns of small firms depend on higher risk or not has continued to be a subject of debate amongst scholars, and no consensus seem to have emerged. Another question is whether the higher returns of such firms have persisted over time, as Fama & French (2012) no longer found any statistically significant size premium in Europe when testing their three-factor model in 2012.

2.2.3 The B/M and value effect

Another market anomaly that has been well documented is the abnormal returns of investing in firms with a high book-to-market value, which is a measure of how the market values the equity found in the financial statements. One of the earliest studies published by Rosenberg, Reid, and Lanstein (1985) showed that it is possible to generate abnormal returns by going long in the companies with the highest B/M-ratio whilst going short in the companies with the lowest B/M-ratio. Just like the size effect this phenomenon was incorporated by Fama-French (1992) in their three-factor model, and considered a risk factor as high book-to-market companies were found to have a persistently weak profitability, whilst those with a low book-to-market ratio were found to have consistently strong profitability (Fama, French 1992). But Lakonishok, Shleifer, and Vishny (1994) argued that value stocks are not riskier than their more expensive counterparts, and the abnormal returns can rather be explained by investors extrapolating past performance to long into the future despite that future performance and growth were found to be highly mean reverting. They show that value stocks rarely underperform compared to growth stocks, and suggests that the market inefficiency is due to the incentives and shorter time horizons of mainstream investors. The value premium seem to have persisted over time, as Fama & French (2012) found excess returns of value stocks to be on average 5.5% per annum.

2.2.4 Mean reversion

Mean reversion of earnings, returns and growth in sales has been documented by a variety of researchers when studying accounting based information contained in financial statements. Haugen (1995) concluded that abnormal profits could be earned in the short run, but that positive abnormal profits seems to revert to normalized levels over longer time periods due to increased competition. And the opposite goes with abnormally low profits that also follows the principle of mean reversion when they increase towards medium levels where they are stabilized. Empirically the researcher also found that market expectations for the over-performing companies are very high whereas that of the unsuccessful companies are very low, and he concludes by saying that the market as a whole overreacts to information. When the high (low) expectations of the outperforming (underperforming) companies are not met anymore due to the mean reversion phenomena and due to the market having overreacted to the previous good (bad) news their share prices will decrease (increase). The best performing companies can hence be considered to be overvalued and the worst performing companies to be undervalued. Goedhart, Wessels and Koller (2010) confirmed Haugen's findings by showing that a high return on invested capital and high revenue growth are not sustainable in the long run.

2.3 Investment strategies

This essay examines two famous value investment strategies that are based on fundamental accounting information and have proven themselves when applied to other stock markets. The concept of value investing is in essence rather simple, it involves buying firms that are valued below their intrinsic value - that is to identify bargains on the stock market. There are numerous ways of engaging in value investing, and during later years several investment strategies has emerged that guides investors in how to succeed in the stock markets (Mihaljevic 2013). Amongst the most famous strategies one find Greenblatt´s (2006) Magic Formula Investing and Piotroski's (2000) the F-Score model.

2.3.1 Piotroski's F-score

Of great influence within the area of value investing is professor Joseph Piotroski who, in his article "*Value Investing: The Use of Historical Financial Statement Information to Separate Winners from Losers*" from the early 2000:s, laid out a technique to score businesses on nine accounting-based criteria in order to find over- and underperformers. The author spent considerable amount of time studying the works of e.g. Rosenberg, Reid, and Lanstein (1985) Fama & French (1992) and Lakonishok, Shleifer, and Vishny (1994), who all discussed the usefulness of accounting fundamentals, in particular the book-to-market ratio, in predicting future stock performance. Piotroski however found that only 44% of the sample firms chosen because of their high book-to-market ratio generated positive excess returns, and that their return were consequently "dragged down" by the underperformers in the portfolio. In his studies he therefore began refining the strategy and after selecting the companies with the 20% highest book-to-market ratio, he added 9 additional accounting fundamentals which he found to be value relevant in predicting future stock performance. The nine accounting ratios were divided into three areas (see appendix 8.1), and his findings resulted in the above mentioned F-score technique that awarded the firm one score if the respective key ratio had improved during the last year. As the maximum score is 9, all firms with a score above 7 are considered strong and believed to outperform the market in the year to come and subsequently all firms with a score below 2 are considered weak and believed to underperform. The F-score strategy then simply states; long all companies with a high F-score and short all companies with a low F-score. When testing this strategy on American data during 1976 to 1996 he managed to achieve an annualized realized return of 23%. A table thoroughly describing the scoring process is available in appendix 8.1.

What could explain the success of the strategy?

One explanation put forward is that people simply seem to be too pessimistic about the prospects of high B/M firms. Fama & French (1992) found that high B/M firms showed more signs of financial distress than low B/M firms while McNichols & O'Brien (1997) showed that such firms with poor prospects tend to render less analyst coverage. The low interest in value stocks and subsequently less competition could explain why value stocks seem to have generated better returns than the market. Piotroski's model is as previously mentioned intended to select the best of the high B/M firms, and is based upon the assumption that such firms do have a greater risk of financial distress. Therefore his key ratios have been chosen to capture a change in economic conditions, and focuses on three different areas. The *Profitability* measures are intended to capture the improved ability of financially distressed firms of generating internal funds through operating activities. The key ratios used to measure change in *Leverage, liquidity and source of funds* are related to a firm's capacity to meet its future debt obligations and any deterioration is considered a bad signal about financial risk. The *Operating efficiency* measures are designed to capture the trend in operating performance of the high B/M firms, both in terms of margins and asset turnover. Combined these key ratios have proven to be able to single out both the winners and losers amongst the high B/M firms. But the model is also closely related to the mean reversion phenomenon described above. As shown by Lakonishok, Shleifer, and Vishny (1994) investors tend to extend past performance too long into the future while in reality the profitability of most firms display a tendency of mean reversion. Adding to this theory Haugen (1995) uncovered that expectations for previously poorly performing firms tend to be very low and that the market is overreacting to new information, both good and bad. When the low expectations of the underperforming companies are not met anymore due to the mean reversion phenomena their share prices will increase, leading to abnormal returns.

2.3.2 Greenblatt´s Magic Formula

In 2006 the successful hedge fund manager and professor Joel Greenblatt released the book "*The Little Book That Beats the Market*". Because the investment formula, in his empirical tests, performed well compared to the market index it earned a considerable amount of attention amongst all kinds of investors (Mihaljevic 2013). His idea was to invest in businesses that are valued substantially below their intrinsic value, and to identify such businesses using a simple ranking system, using accounting fundamentals. By first only selecting firms that exceeded a certain market capitalization threshold he argued that investors could sort out the risky dogs from the potential cash cows. Subsequently, to find which of these firms that were trading at a bargain he began ranking them based on their earnings yield, defined as EBIT/EV, and their return on capital, defined in the book as EBIT/(Net working capital + Net tangible assets).The two factors are then weighted equally to arrive at a combined rank for each company and mechanically, without any further analysis, he invested in the 20-30 firms with the best combined rank. As the undervaluation, i.e. mispricing, will vanish over time the portfolio is rebalanced annually. According to Greenblatt it is desirable to have an investment horizon of at least 5 years, and as the technique is proven to perform better during longer time periods his investment lasted for 17 years achieving an annualized return of 30.8%, comparable with the market which had a corresponding return of 12.4% (Greenblatt 2006).

What could explain the success of the strategy?

There are several factors that might explain why this framework seem to work over time. The formula builds on the notion that the market is in a weak form of efficiency, i.e. that the market fails to incorporate all publicly available information into the price of the asset, which is supported by the above documented market anomalies. The two fundamental accounting measures earnings-yield and return on capital are said to be value relevant and capable of identifying future over-performing companies when combined. This extends on the findings of Lev & Thiagarajan (1993) and Abarbanell & Bushee (1997) who, as mentioned in section 2.2.1, found fundamental analysis using accounting measures to be successful in generating abnormal returns. Often businesses with a high return on capital are traded at a premium in the marketplace, putting their expected stock return in parity with less profitable businesses. Greenblatt developed a workaround by using the earnings yield, i.e. operating income to the enterprise value, as a determinant of price which combined with the business quality measure - return on capital - sorts out firms that are cheap in relation to their quality. Investors following the formula are thus able to invest in securities that ought to trade at premium valuations, yet because of mispricing are cheap.

In his book Greenblatt provides two potential answers to why high quality businesses could end up mispriced. The first being the fact that investors are neurotic and consequently overreact to both good and bad information, which also is in line with Haugen’s (1995) findings discussed earlier in 2.2.4. The author also argue that many of the top 20 firms identified by the formula often have something making them unattractive to the ordinary investor, for example businesses with serious company-specific issues such as regulatory scrutiny, excessive employee turnover or accounting problems to name a few. But as investors on average tend to overestimate both the speed and the magnitude with which these negative factors will erode profitability the users of the MFI will manage to gain excess returns. Additionally, as the strategy actually underperformed compared to the index during three consecutive years throughout his 17 year test period many institutional investors are reluctant to stick with the strategy. The author stresses that professional investors hence will struggle to make an institutional product of the formula, as they simply cannot afford to follow a winning strategy if it involves enduring long periods of underperformance.

2.4 Previous studies

A number of previous studies on Piotroski's F-score and Greenblatt's Magic formula have been identified. The F-score investment strategy has been tested and several different adjustments have been proposed for the Swedish and the U.S. stock markets. One example is Rados & Lovric (2009) who, in their bachelor thesis, further developed the F-score by instead of simply using binary measures assign each key ratio a weighting based on the correlation coefficients for the different key ratios to the return, called the A-score. The authors also proposed a B-score which used the relative performance of the company against the market to decide whether to assign the company a point or not, and finally combined both to a C-score. This model was tested in the US market and seemed to improve upon the results obtained by the F-score, and has later been replicated in Sweden as well (Engström, Fors & Waldemarsson 2015).Other proposed modifications of the F-score is to incorporate negative signals (Andersson, Draskovic 2011) or to use the P/E-ratio instead of the B/M-ratio when selecting the portfolio companies (Gudrais, Arvidsson 2013). However the studies testing the F-score in the Swedish stock market have had a problem with data-selection, and despite adjusting the original model and cut-off points they had very few companies in their sample and investment portfolios. For example did Andersson & Draskovic (2011) not have a single company in their short portfolio during nine out of ten years rendering this thesis to question whether the results obtained by previous studies can be considered valid. By testing the F-score model on all of the Nordic countries combined, which has not been done before, this thesis will have a broader data sample and thus potentially render more valid conclusions. The results will also be more relevant to investors as very few are believed to be comfortable putting all of their savings into just a few stocks, leaving them very exposed to idiosyncratic risk (Mihaljevic 2013).

Greenblatt's Magic Formula has also captured the interest of several academics who have back-tested its performance in other markets than the U.S. When exploring earlier research in the Nordic region you may find that some authors have dedicated their study of MFI to a single country, whereas others have attempted their studies using data from several Nordic countries. Some of the researchers that have used data from the entire Nordic region are Persson & Selander (2009) and Kuznecov & Fredriksson (2013). The former author-duo wrote a master thesis examining the effectiveness of MFI taking risk into account, and even though they found the strategy to generate 7.91 % annualized excess return, this later proved to not be statistically significant when benchmarked towards Fama & French's three-factor model. Furthermore they managed to enhance the formula by including intangible assets in the capital base when calculating the earnings yield which generated 19.32% annualized excess return. Kuznecov & Fredriksson (2013), also writing their master's thesis, compared the strategy of Greenblatt with that of Benjamin Graham, and concluded that although positive excess return could be generated it was not statistically significant. One further example of a MFI-study in the Nordic region is Goumas and Källström (2010) who back-tested the formula on the Swedish stock market which in their tests generated an annualized abnormal return of 14.1% when benchmarked with Fama & French's three-factor model.

This thesis will make several contributions relevant to a Nordic investor. First, Piotroski's F-score will be tested on the entire Nordic region which has not been done before. And secondly the results of the F-score will be compared with the Magic Formula using the same time horizon and sample-data, rendering an adequate comparison of the models that never has been done before.

3. Method

This thesis will stay as true to the methodology proposed by Piotroski and Greenblatt as possible. In the section below follows a discussion regarding the choice of data and the required actions needed to replicate the strategies in the Nordic region.

3.1 Portfolio Evaluation

To evaluate whether the strategies are capable of generating excess returns there is a need to select an appropriate benchmark to which the performance can be compared. Both Joseph Piotroski and Joel Greenblatt measured the performance of their respective portfolios compared to the market index, and to be able to compare the results to the original studies the same practice will be applied in this thesis. However, as described above, whether the high returns generated by value investing is indeed abnormal returns or merely a compensation for risk is still debated amongst scholars.Therefore it is deemed suitable to also perform a sensitivity analysis where the returns generated by the strategies will be put in relation to the risk taken. When doing so there are a number of different asset pricing models to choose between. Jensen´s alpha (Jensen 1968) is based upon the CAPM and uses the correlation with the market as a measure of risk, while Fama & French's (1992) three-factor model also considers the B/M-ratio and size as risk factors.

The CAPM and subsequently Jensen´s Alpha have faced some critique over the years, such as Grinblatt (1992) who claimed that the CAPM suffers from dividend yield and size biases, while Ferson & Schadt (1996) questioned the validity of both models by arguing that it is unreasonable that most mutual funds display negative alphas when tested using CAPM and Jensen´s alpha. He argued that the alpha generated by a market should on average be zero as some investors gain and others lose. Despite the critique CAPM is still widely used as a benchmark for evaluating portfolio performance (Brown, Walter 2013). The alternative proposed by Fama & French (1992) incorporates B/M and size as additional risk factors. The reason for using these key ratios as risk measures are that they managed to capture the variation in the return of various listed securities when applied to their sample. Furthermore, during most of the 1980´s small companies had systematically lower earnings than larger corporations, while Fama & French also found that high book-to-market firms seem to have persistently lower earnings than their low book-to-market counterparts, providing a fundamental economic explanation to why these key ratios manages to capture additional risk (Fama, French 1992).

Even though the three-factor model has been shown to better explain the past returns than the CAPM it has rendered some critique of its own. Banz (1981) argued that any size effect would simply depend upon that only a subset of investors are willing to invest in smaller stocks, leading to less competition and higher risk-adjusted returns. As described above, Lakonishok, Shleifer, & Vishny (1994) also argued that value stocks are not riskier than their more expensive counterparts, and that the B/M anomaly can be explained by investors extrapolating past performance too long into the future despite that future performance and growth is found to be highly mean reverting. Nevertheless the additional explanatory power of Fama & French's three-factor model over the CAPM has led to a widespread adoption amongst both practitioners and academics (Foye 2016).

A further extension of the model has been proposed by Carhart and includes a momentum portfolio as an additional risk factor. However, when tested by Fama & French (2012) the four factor model did not add any explanatory power in the European region, as it failed to generate a higher value of R-squared. The table 1 below presents a number of previous studies also measuring portfolio return and their choice of method:

TABLE 1

Literature review: Evaluating portfolio returns

Author:	Portfolio:	Region:	Horizon:	Measure of risk:	Type of regression:	Additional tests:
You, Huang & Huang 2017	Value investing: Testing dividend-yield strategies	Taiwan	2001 - 2010	CAPM, FF3F, EPS	Time series OLS	No robustness tests
Nelson, Lacey and Bu, Qiang 2016	Evaluating fund managers	U.S.	1998 - 2012	CAPM, FF3F, portfolio of random funds	Time series OLS. Rolling 3Y window to estimate yearly alpha.	Autocorrelation claimed to be captured by bootstrapping technique
Yu, Susana 2009	Reinganum's trading strategy	North America	1970 - 2006	CAPM, FF3F and FFC4F	Time series OLS	No robustness tests
Arshanapalli, Coggin & Doukas 1998	Value investing: Testing industry portfolios	18 equity markets outside the U.S.	1975 - 1995	CAPM, FF3F, Sharpe	Time series OLS	No robustness tests
Brzeszczynski, McIntosh 2014	British socially responsible investments (SRI) stocks	UK	2000 - 2010	Sharpe, FF3F, FFC4F, CEQ	Time series OLS	Tests for autocorrelation and heteroscedacity

FF3F=Fama & French's three- factor model. FFC4F=Fama, French & Carhart's four-factor model. CEQ=Certainty equivalent returns

To achieve comparability with previous work and to assess whether the return generated by the investment strategies MFI and F-score respectively is due to any specific factor loading or risk exposure both CAPM, Fama & French's three-factor model and the Sharpe-ratio will be used in this thesis.

3.2 Portfolio creation and rebalancing

When creating his hedge-portfolio of under- and over-performing companies Piotroski rebalanced his portfolio once every year, at the beginning of the fifth month after the fiscal year end. As this thesis tests whether his model works in the Nordic region the same procedures will be used. All of the firms with adequate financial data will be ranked based upon the B/M key ratio on the first of May and the top 20% will be selected for further analysis in accordance with the original study. The nine key ratios which compose the F-score will be calculated for each of the high B/M firms. Then, for each measure proposed by Piotroski a company will be awarded one point if it fulfills the criteria and zero otherwise. The total number of criterias fulfilled for each firm will finally be summarized into the F-score ranging from 0 to 9. If a company obtains a F-score of 0 or 1 it is expected to have the worst subsequent performance and will be sold short, while if a firm receives a F-score of 8 or 9 it is expected to perform very well in the future and generate high returns and will subsequently be bought. Amongst the firms assumed to be financially distressed it tries to identify the companies which will survive and prosper while going short in those who will not. As in the original study the number of firms included in the portfolio will not be restricted to any specific number, but rather be based solely on the financial development and subsequently the F-score of the firms in the sample.

When selecting which companies to include in the portfolio created by the Magic Formula this thesis will apply the same practices as Joel Greenblatt. First, the earnings yield and return on capital will be calculated for all of the companies included in the sample using data from the latest fiscal year. The earnings yield will be defined as EBIT to Enterprise Value (EV) in agreement with the definition advocated for by Greenblatt. The choice of EBIT/EV rather than the more commonly used P/E multiple is motivated by the fact that EBIT/EV takes into account differences in capital structure amongst sample firms, allowing a more fair comparison of firms with different amounts of debt. Meanwhile, return on capital is defined as EBIT to the sum of net working capital and net tangible assets. Greenblatt motivates his choice of EBIT by stating that it allows you to compare the operating profit of various companies without getting skewed results due to different interest payments and tax rates, while he argues that goodwill should be excluded from the capital base as it will not have to be constantly replaced or renewed for the company to be able to run its future business. All of the sample firms will subsequently be ranked based upon the earnings yield and return on capital respectively. The company with the highest earnings yield will be awarded rank number one, the company with the second highest earnings yield will be awarded rank number two etcetera. The same methodology applies for return on capital. When all companies included in the sample have been ranked based upon both the earnings yield and return on capital, the sum of both ranks will be calculated and the firm with the overall best rank will be the first one to be bought. Unlike Piotroski the Magic Formula then states that you should buy the 20-30 companies with the best combined rank, and this thesis will subsequently only include 25 companies in the portfolio each placement year. The portfolio will be rebalanced on the first of May each year.

3.3 Calculation of returns, volatility and beta

3.3.1 Calculation of returns

As the strategies are back-tested in the entire Nordic region, there is a need to address any currency effects. If left unadjusted they would distort both the sorts and return calculations. To adjust for such translation differences this thesis will therefore convert all prices into a common currency as in Fama & French (2012). As Sweden is the largest stock market both in terms of the number of companies as well as market capitalization the currency selected is the Swedish SEK. Consequently, all prices are adjusted using historical FX spot rates, obtained from the Swedish Riksbank.

Each year in May four portfolios (pos) are formed;

(1) MFI - a portfolio tailored according to the MFI-strategy that every period holds 25 equal weighted long positions in the firms with the best combined rank of earnings yield and return on capital.

(2) F-Score_High - a portfolio that every period holds equal weighted long positions in the firms classified as strong by Piotroski's F-Score strategy.

(3) F-Score_Low - a portfolio that every period holds equal weighted short positions in the firms classified as weak by Piotroski's F-Score strategy.

(4) F-Score_Hedge - a portfolio that every period places an equal amount in F-Score_High and F-Score_Low

All portfolios are held for one year at a time, and later rebalanced according to the respective strategy. This procedure is repeated for 11 consecutive placement years.

Berk & DeMarzo’s definition of the total annual return for a stock will be used when calculating the return for each portfolio company. The formula measures the percentage price, P_i, change (R_i) of a stock between two points in time including any funds distributed to the owners (D_i): (Berk, DeMarzo, *Corporate Finance*)

$$R_{i,12} = \frac{(P_{i,12} - P_{i,0}) + D_i}{P_{i,0}}$$

The accumulated annual return for the portfolio, pos, during placement year, py, is calculated as:

$$R_{(py),(pos),12} = \left(w_{(py),(pos),12} - w_{(py),(pos),0}\right) / w_{(py),(pos),0} =$$

$$= \left(1/N_{(py),(pos)}\right) \times \sum_{i(py)=1}^{N_{(py),(pos)}} \left[\prod_{t(py)=1}^{12} (1 + R_{i(py),t(py)})\right] - 1$$

Where:

$R_{(py),(pos),12} = accumulated\ return\ on\ portfolio, pos, for\ the\ placement\ year, py$

$w_{(py),(pos),0} = the\ amount\ invested\ in\ the\ portfolio, pos, at\ time\ zero$

$w_{(py),(pos),12} =$

$The\ amount\ received\ from\ divesting\ the\ portfolio, pos, 12\ months\ after\ the\ initial\ investment$

$N_{(py),(pos)} =$

$The\ number\ of\ stocks\ included\ in\ the\ portfolio, pos, in\ placemt\ year, py$

$R_{i(py),t,(py)} = Return\ of\ stock\ i\ during\ month\ t\ for\ placement\ year, py$

In accordance with the F-Score strategy the amount generated by taking short positions in the F-Score_Low portfolio, $w_{(py),(F-Score\_Low),0}$, will be used to finance the long positions in the F-Score_High portfolio, $w_{(py),(F-Score\_High),0}$, and by investing the same amount into both portfolios, i.e. $w_{(py),(F-Score\_Low),0} = w_{(py),(F-Score\_High),0}$, this procedure effectively creates a self-financing hedge position later referred to as F-Score_Hedge. The annual net return of the F-Score_Hedge can be calculated as the difference between the accumulated annual return of F-Score_High and the accumulated annual return of F-Score_Low:
(Skogsvik 2002)

$$R_{(py),(F-Score\_Hedge),12} = R_{(py),(F-Score\_High),12} - R_{(py),(F-Score\_Low),12}$$

No adjustment for tax, courtage or any other transaction costs will neither be made. The reason being both that the portfolios are rebalanced only once a year and hence the rebalancing will not result in any significant transaction costs, and as such adjustments lies outside the primary purpose of this thesis.

3.3.2 Abnormal return test; CAPM and Jensen’s alpha

Jensen´s alpha is based upon the Capital Asset Pricing Model. CAPM was independently derived by Sharpe, Lintner and Treynor (Sharpe 1966). The underlying assumptions of the CAPM are: (Skogsvik 2002)

I. All investors are utility maximizing and risk averse
II. All investors have common expectations
III. All investors have a common one-period horizon
IV. All investors chooses their portfolio according to mean-variance preference
V. Unlimited lending and borrowing is possible at the risk-free rate

VI. Perfect capital markets i.e. all assets are possible to invest in and are perfectly divisible, all information is public, no single investor can affect prices and there are no taxes or transaction costs.

The model expresses the expected return of an asset in terms of the risk-free rate and a risk premium proportional to the beta of the asset. The market risk premium is equal to the expected return of the market less the risk-free rate. The beta of an asset represents the systematic risk of that asset which, unlike idiosyncratic risk, cannot be eliminated by holding a diversified portfolio and which investors according to the CAPM therefore require to be compensated for. Algebraically the model can be expressed as:

$$CAPM = E(R_i) = R_f + B_{im}\big(E(R_m) - R_f\big)$$

Where

$E(R_i) = Expected\ return\ on\ asset\ i$

$R_f = One\ period\ risk\ free\ rate$

$B_{im} = Cov(R_i, R_m)/Var(R_m)$

$E(R_m) = Expected\ return\ of\ holding\ a\ well\ diversified\ market\ portfolio$

The CAPM is expressed in terms of expected return while Jensen (1968) showed that assuming the model is valid the realized return of an asset is a linear function of the risk-free rate, the systematic risk in terms of beta, the realized return of the market and a random error with an expected value of zero. Jensen's formula can then be extended by allowing a non-zero constant in the regression analysis, which can be used to determine whether a portfolio or asset generated any abnormal return (also known as alpha). The beta values for the various portfolios and the abnormal return, alpha, are estimated simultaneously, in accordance with Jensen (1968), Greig (1992) and Skogsvik (2002). By doing so one successfully eliminates the problem associated with time-series variations in the beta estimates for the stocks selected by the MFI and F-score strategy respectively. Following the procedure of Greig (1992), also implemented in Skogsvik (2008), the monthly return for the portfolio in excess of the risk-free rate is regressed against the market risk premium in the following way:

$$R_{(MFI),t} - R_{f,t} = \alpha_{(MFI)} + B_{(MFI)} \times \big(R_{m,t} - R_{f,t}\big) + \varepsilon_{(MFI),t}$$

$$R_{(F-Score\_Hedge),t} = \alpha_{(F-Score\_Hedge)} + B_{(F-Score\_Hedge)} \times \big(R_{m,t} - R_{f,t}\big) + \varepsilon_{(F-Score\_Hedge),t}$$

$$R_{(F-Score\_High),t} - R_{f,t} = \alpha_{(F-Score\_High)} + B_{(F-Score\_High)} \times \left(R_{m,t} - R_{f,t}\right) + \varepsilon_{(F-Score\_High),t}$$

$$R_{(F-Score\_Low),t} - R_{f,t} = \alpha_{(F-Score\_Low)} + B_{(F-Score\_Low)} \times \left(R_{m,t} - R_{f,t}\right) + \varepsilon_{(F-Score\_Low),t}$$

Where

$R_{(MFI),t} = The\ return\ on\ the\ MFI\ portfolio\ for\ month\ t$

$R_{(F-Score\_Hedge),t} = R_{(F-Score\_High),t} - R_{(F-Score\_Low),t},$

$i.e. the\ return\ on\ the\ hedge\ position\ for\ month\ t$

$R_{(F-Score\_High),t} = The\ return\ on\ the\ F - Score\_High\ portfoliofor\ month\ t$

$R_{(F-Score\_Low),t} = The\ return\ on\ the\ F - Score\_Low\ portfoliofor\ month\ t$

$R_{f,t} = One\ period\ risk\ free\ rate\ at\ the\ beginning\ of\ the\ month\ t$

$R_{m,t} = The\ return\ of\ the\ market\ index\ for\ month\ t$

$\alpha_{(.)} = The\ monthly\ abnormal\ return\ of\ the\ portfolio$

$B_{(.)} = Cov\left(R_{(.)}, R_m\right)/Var(R_m), i.e. the\ beta\ value\ of\ the\ portfolio$

$\varepsilon_{(.),t} = An\ error\ term$

Due to how the regression model is specified the intercept of the resulting regressions equals an average monthly alpha. The results from this test can be examined in table 5.

3.3.3 Sharpe ratio

When investigating the performance of mutual funds, William Sharpe (1966) built upon previous work done by Jack Treynor to develop what has later been known as the Sharpe ratio. The idea was to evaluate which mutual fund that had managed to select the most efficient portfolio, i.e. to generate the highest return in excess of the risk-free rate for any given level of risk. The Sharpe ratio uses the volatility of a portfolio or asset as a measure of its risk. The ratio is a relatively simple measure that unlike the Capital Asset Pricing Model does not rely heavily on multiple assumptions (Sharpe 1966). The ratio simply puts the average annual return in excess of the risk-free rate generated by a portfolio in relation to the amount of volatility experienced by the portfolio. As such the ratio becomes an easy way to compare the performance of one portfolio with another. The ratio is calculated as:

$$Sharpe\ ratio_{(pos)} = \left(\frac{\sum_{(py)=1}^{11} R_{(py),(pos),12}}{PY} - \frac{\sum_{(py)=1}^{11} R_{(py),f}}{PY}\right)/\sigma_{(pos)}$$

Where

$R_{(py),(pos),12} =$

$Accumulated\ return\ on\ portfolio, pos, for\ placement\ year, py, defined\ in\ section$ 3.3.1

$R_{(py),f} = One\ period\ risk -$

$free\ rate\ measured\ at\ the\ beginning\ of\ the\ placement\ year, py$

$PY = The\ total\ number\ of\ placement\ years, py, included\ in\ the\ test\ period$

$\sigma_{(pos)} = The\ standard\ deviation\ of\ R_{(py),(pos),12}$

As this ratio is a relative measure whose main purpose is to relate an asset’s return to the variability incurred to achieve those returns Sharpe highlights that the calculation and deduction of the risk free rate can be done in several ways without undermining the efficiency of the ratio as long as this is done consistently for all portfolios. These results will be presented in table 3.

3.3.4 Fama & French’s 3 factor model

In addition to the market factor, Fama & French's (1992) three-factor model uses size and book-to-market as additional risk measures. The choice of these specific key ratios does not rely on any economic theory, but rather their empirical ability to explain the variation in stock returns. Fama & French (1992) also found that the combination of B/M and size manages to absorb the effect of other risk measures such as earnings-to-price and leverage.

The expected return of an asset according to the three-factor model consist of the risk-free rate, a market risk premium proportional to the market-beta of the portfolio, a risk premium for any exposure towards small stocks proportional to the portfolio beta on the SMB factor as well as a risk premium for any exposure towards high book-to-market companies proportional to the portfolio beta on the HML factor.

To calculate the HML and SMB factors all of the companies in the market portfolio are divided into portfolios based on certain B/M and size cutoffs. The return from these portfolios are subsequently used in a regression to determine the coefficients on the risk factors. In their earlier study Fama & French (1992) uses size and B/M cutoffs based on the NYSE median to form their portfolios. However, this thesis follows their slightly modified approach from 2012 to determine the cutoff values. This involves using a percentage of accumulated market cap instead of the median market cap to determine the size cutoff, to avoid an excessive weight on very small stocks. Of the same reason the book-to-market cutoffs are then calculated based on the large stock portfolio (Fama, French 2012).

The sorts based on market cap and the book-to-market ratio are conducted at the end of June each year. The sorts uses the market cap from December 31:st the previous calendar year and the book value of equity from the previous fiscal year ending. The companies belonging to the top 90% of the accumulated market cap are classified as big stocks (B), while the companies belonging to the bottom 10 % of the accumulated market cap are classified as small stocks (S). To divide the companies into the high, neutral or low B/M category the 30th and 70th percentile values for the B/M ratio amongst the large corporations are used as cutoffs values, and subsequently applied to the small stock portfolio as well. Companies with a B/M ratio in excess of the 70th percentile cutoff value are considered value stocks (H), while companies with a B/M ratio below the 30th percentile cutoff value are considered growth stocks (G), and those in between are classified as neutral stocks (N). The result is six different size and value portfolios; SmallValue, SmallNeutral, SmallGrowth, LargeValue, LargeNeutral and LargeGrowth, hereafter denominated as SV, SN, SG, BV, BN and BG. The return from the six size and value portfolios are used to calculate the return of the SMB and HML portfolios in the following way:

$$SMB = \frac{SV+SN+SG}{3} - \frac{BV+BN+BG}{3}$$

$$HML = \frac{HML_S+HML_B}{2} = \frac{(SV-SG)+(BV-BG)}{2}$$

The returns for SMB and HML together with the return of the market in excess of the risk-free rate are used in a linear regression against the portfolio return less the risk-free rate. The three factor model used in this thesis is expressed algebraically below:

$$E(R_i) = R_f + B_{i,m}\left(E(R_m) - R_f\right) + B_{i,SMB}(SMB) + B_{i,HML}(HML)$$

Where:

$E(R_i) = Expected\ return\ on\ asset\ i$

$E(R_m) = Expected\ return\ of\ holding\ a\ well\ diversified\ market\ portfolio$

$R_f = One\ period\ risk - free\ rate$

$$B_{i,m} = \frac{Covariance(R_i,R_m)}{Variance(R_m)}$$

$$B_{i,SMB} = \frac{Covariance(R_i,SMB)}{Variance(SMB)}$$

$$B_{i,HML} = \frac{Covariance(R_i,HML)}{Variance(HML)}$$

$$SMB = \frac{SV+SN+SG}{3} - \frac{BV+BN+BG}{3}$$

$$HML = \frac{HML_S+HML_B}{2} = \frac{(SV-SG)+(BV-BG)}{2}$$

In order to use the model in a regression to test the return of the MFI and the F-Score_Hedge portfolio it has been rearranged in the following way:

$$R_{(MFI),t} - R_{f,t} = \alpha_{(MFI)} + B_{(MFI),m} \times (R_{m,t} - R_{f,t}) + B_{(MFI),SMB}(SMB) + B_{(MFI),HML}(HML) + \varepsilon_{(MFI),t}$$

$$R_{(F-Score\_High),t} - R_{f,t} = \alpha_{(F-Score\_High)} + B_{(F-Score\_High),m} \times (R_{m,t} - R_{f,t}) + B_{(F-Score\_High),SMB}(SMB) + B_{(F-Score\_High),HML}(HML) + \varepsilon_{(F-Score\_High),t}$$

$$R_{(F-Score\_Low),t} - R_{f,t} = \alpha_{(F-Score\_Low)} + B_{(F-Score\_Low),m} \times (R_{m,t} - R_{f,t}) + B_{(F-Score\_Low),SMB}(SMB) + B_{(F-Score\_Low),HML}(HML) + \varepsilon_{(F-Score\_Low),t}$$

$$R_{(F-Score\_Hedge),t} = \alpha_{(F-Score\_Hedge)} + B_{(F-Score\_Hedge),m} \times (R_{m,t} - R_{f,t}) + B_{(F-Score\_Hedge),SMB}(SMB) + B_{(F-Score\_Hedge),HML}(HML) + \varepsilon_{(F-Score\_Hedge),t}$$

Where

$R_{(MFI),t} = The\ return\ on\ the\ MFI\ portfolio\ for\ month\ t$

$R_{(F-Score\_Hedge),t} = R_{(F-Score\_High),t} - R_{(F-Score\_Low),t},$

$i.e. the\ return\ on\ the\ hedge\ position\ for\ month\ t$

$R_{(F-Score\_High),t} = The\ return\ on\ the\ F-Score\_High\ portfoliofor\ month\ t$

$R_{(F-Score\_Low),t} = The\ return\ on\ the\ F-Score\_Low\ portfoliofor\ month\ t$

$R_{f,t} = One\ period\ risk\ free\ rate\ at\ the\ beginning\ of\ the\ month\ t$

$R_{m,t} = The\ return\ of\ the\ market\ index\ for\ month\ t$

$\alpha_{(.)} = The\ monthly\ abnormal\ return\ of\ the\ portfolio$

3.4 Hypotheses

According to Greenblatt and Piotroski the strategies are successful when applied in the U.S. stock market. This thesis aims to find out whether this is also the case in the Nordic region, and which of the models that seems to outperform the other. The monthly returns generated by the investment strategies will also be regressed using Jensen’s alpha and Fama & French’s three-factor model. Furthermore the accumulated annual return will be analyzed and compared to the market index using the Sharpe ratio. As such the following hypotheses have been formulated:

1. Can the MFI beat the market in the Nordic region?

(a) **$H_{0,(1a)}$:** *MFI cannot be used to generate positive abnormal returns according to Jensen's alpha*
$H_{1,(1a)}$: *MFI can be used to generate positive abnormal returns according to Jensen's alpha*

(b) **$H_{0,(1b)}$:** *MFI cannot be used to generate positive abnormal returns according to Fama & French's three-factor model*
$H_{1,(1b)}$: *MFI can be used to generate positive abnormal returns according to Fama & French's three-factor model*

2. Can the F-score strategy beat the market in the Nordics?

(a) **$H_{0,(2a)}$:** *The F-Score strategy cannot be used to generate positive abnormal returns according to Jensen's alpha*
$H_{1,(2a)}$: *The F-Score strategy can be used to generate positive abnormal returns according to Jensen's alpha*

(b) **$H_{0,(2b)}$:** *The F-Score strategy cannot be used to generate positive abnormal returns according to Fama & French's three-factor model*
$H_{1,(2b)}$: *The F-Score strategy can be used to generate positive abnormal returns according to Fama & French's three-factor model*

3.5 Potential biases

There are two potential biases which may arise when back-testing an investment strategy using historical data (Andreu, Ferruz & Vicente 2010). The look-ahead bias relates to the fact that the strategy may act upon information not available at the time of the portfolio formation. As the data used in this thesis almost solely is gathered from annual reports and firms release their reports at different points in time this could be a potential problem. But as the date of the portfolio formation is set to the first of May as described above, a large majority of the firms will have been able to release their annual reports for the investors to act upon, thus mitigating the problem. Secondly, if firms that are delisted in the placement year either were to be excluded beforehand or if they were excluded when calculating the return of the portfolios the study would suffer from a survivorship bias. However as Datastream includes firms that delist during the year the ranking on the first of May will include such firms, and if the strategies invest in such firms their delisting returns are assumed to be zero, which is in accordance with how Piotroski handled the problem. As firms could delist because of two reasons, either they are bought at a premium and taken private or they go bankrupt and become liquidated, these two effects are likely to offset each other looking at a large data sample. Piotroski (2000) also found that the average delisting return of low F-score firms was only -0.87% while the average delisting return of high F-score firms was merely 2.2%, suggesting that the reason for the delisting have already been incorporated in the share price at the date when the stock is removed from the market. The proceeds will then be reinvested in the market index until the next portfolio formation date.

4. Empirical data and results

4.1 Data collection

4.1.1 Region and time span

The Nordic stock market comprises of all the stocks listed in Sweden, Denmark, Finland, Norway and Iceland. Data from all companies listed in any of those markets will be used to render such a large sample as possible. Both strategies will be back-tested over a period of eleven years with the first investment made in 2005 and the last in 2015. This time span is well within the recommendation of Greenblatt (2006) who, after his study, stated that it was desirable to stick with the formula for at least five years, and also well aligned with Piotroski who stated that the results of the F-score is robust across time. Furthermore the period neither begins nor ends in a period of economic crisis. To gather the data necessary to conduct the study Thomson Reuters Datastream will be used. Since 1988 it has carried extensive information on trends, stock prices and accounting data of listed European companies.

4.1.2 Market and choice of risk-free rate

When selecting which benchmark to use for evaluating the performance of the MFI and F-score strategies a number of considerations have been made. First of all, the index selected needs to have sufficient data covering the entire sample period. Secondly, the index need to cover the entire Nordic region to be able to serve as a proxy for the market portfolio in the CAPM. Third, the index needs to be adjusted and include events such as dividends, share repurchases and stocks splits. A number of indices have been considered, but rejected either due to a lack of time series data (e.g. SIX Nordic) or due to incomplete coverage (e.g. OMX Nordic which do not include the Norwegian stock exchange as it is operated by another exchange provider). The best proxy for the market portfolio is the broad MSCI Nordic total return index, which constituents represents 85% of the total market cap in the Nordic Region. The return index is adjusted for all capital actions, such as dividends and stock splits. The index is originally quoted in USD, and each price quotation has been translated into the Swedish SEK to match the individual stock price quotations. When selecting which risk-free rate to use the main considerations are the duration and currency. As previously mentioned in 3.3.1. all prices have been adjusted to a common currency to account for translation differences and just as in Fama & French (2012) the risk-free rate of the country to which all prices are adjusted have been selected. Furthermore, the duration of the risk-free rate should have a maturity matching the monthly portfolio returns used in the regression analysis (Skogsvik 2002). Of the reasons mentioned above the rate on a 1-month Swedish treasury bill, made available on Riksbanken's website, has been selected as the risk-free rate.

4.1.3 Sample selection

The aim is to be as true to the methodology of the original authors as possible in the data selection process. Starting with the selection process needed to back-test Piotroski's F-Score he only included firms where sufficient data on the stock price and book value could be found. Following this practice all Nordic firms with sufficient data available in Datastream will be included when calculating the result of the F-score, consequently firms lacking sufficient data in order to calculate the B/M-ratio and the 9 accounting key ratios needed for the ranking process will be excluded. Greenblatt, on the other hand, had a more extensive approach when selecting which firms to include. In addition to excluding firms without sufficient data he also choose not to include stocks from the financial sector. The industry classification used for this purpose is based upon the INDM code in Thomson Reuters Datastream. The reason for excluding firms classified as banks, asset managers, clearing houses, brokerage firms and insurance companies is that they have financial statements that differ significantly from the rest rendering the accounting fundamentals used for ranking less value relevant. Lastly he also eliminated firms with limited liquidity by setting a market capitalization threshold of 50 million USD, arguing that no individual investor then should be able to push the price higher. This threshold effectively excluded 21.5% of the combined number of shares listed on the U.S. stock markets NYSE and NASDAQ. In order to exclude the same proportion of shares in the Nordic stock market context the threshold has been adjusted to 500 MSEK. Table 2 below illustrates the number of firms both in the original and final sample.

TABLE 2
Data collection

The Magic Formula		The F-Score	
Original number of firms		**Original number of firms**	
Total number of firms*	2934	Total number of firms*	2934
Adjustments		**Adjustments**	
Excluding firms lacking sufficient accounting data, redemption rights and A-shares	-1519	Excluding firms lacking sufficient accounting data, redemption rights and A-shares	-1461
Removing firms not listed on the main exchanges	-444	Removing firms not listed on the main exchanges	-492
Excluding firms classified as financial	-36		
Final sample		**Final sample**	
Total number of firms	**935**	Total number of firms	**981**

Source Datastream.* Total number of firms includes various classes of securities

4.2 Results

4.2.1 Accumulated annual returns

The formula defined in section 3.3.1 has been used to calculate table 3.

TABLE 3
Annual returns

Placement year	Market index	MFI	*N firms*	F-Score_Hedge	F-Score_High	*N firms*	F-Score_Low	*N firms*
2005	39.38%	56.32%	*25*	-16.52%	71.26%	*47*	87.78%	*15*
2006	44.97%	57.38%	*25*	16.79%	41.62%	*19*	24.83%	*6*
2007	13.35%	-6.91%	*25*	6.42%	-8.76%	*18*	-15.18%	*12*
2008	-59.49%	-39.49%	*25*	8.05%	-37.36%	*11*	-45.41%	*10*
2009	61.07%	65.48%	*25*	14.59%	34.63%	*9*	20.04%	*19*
2010	60.60%	23.94%	*25*	15.48%	6.14%	*8*	-9.34%	*17*
2011	-26.59%	-6.61%	*25*	4.70%	-20.33%	*22*	-25.03%	*5*
2012	22.06%	6.17%	*25*	4.94%	0.28%	*15*	-4.65%	*11*
2013	22.53%	10.93%	*25*	-32.28%	17.68%	*14*	49.96%	*7*
2014	-21.50%	12.39%	*25*	23.58%	16.95%	*15*	-6.64%	*10*
2015	-2.87%	-1.69%	*25*	16.26%	5.73%	*27*	-10.53%	*10*
Std. Dev.	38.37%	32.27%		16.35%	30.13%		37.43%	
Sharpe ratio	0.33	0.46		0.26	0.34		0.12	
Accumulated return during HP	100.92%	245.38%			130.26%		5.76%	
CAGR	6.55%	11.93%			7.88%		0.51%	

The magic formula managed to generate annual returns above that of the market for seven out of the eleven placement years, compared with the F-Score_Hedge portfolio that only managed to perform better than the market index in four of the placement years. With compounding effects an investment in the MFI-portfolio generated an accumulated return of 245.38% throughout the 11 placement years, which is higher than an equivalent investment in the market index that would have rendered 100.92%. These results suggests that the MFI-strategy could be used to generate excess returns when applied in the Nordic region. Also worth highlighting is the fact that this study, unlike previous tests of the F-Score strategy in a single Nordic country, have a number of firms in both the F-Score_High and F-Score_Low portfolio throughout the entire test period. Consequently, by including firms from all of the Nordic countries, the F-Score_Hedge portfolio can realistically be constructed as self-financing; the amount generated by taking short positions can be used to finance the long positions.

Both MFI and the F-Score seems to be less affected by the financial crisis in 2008 than the market in general. Furthermore, the F-Score_High (F-Score_Low) portfolio only manage to outperform (underperform) the market in 5 (6) out of the 11 placement years. The F-Score_High still manages to generate 29.34% excess return, while the accumulated return of the F-Score_Low portfolio is somewhat positive. This means that even though the companies with an F-Score below 2 underperforms compared to the market, you would still lose some money by holding the short portfolio throughout the entire period.

The table above also shows that both the MFI and the F-Score_High portfolio have a cumulative average growth rate in excess of the market, while the F-Score_Low portfolio have a cumulative average growth rate below the market, as expected according to the respective strategy. During the tested period the MFI portfolio managed to generate the highest returns in excess of the risk-free rate and in relation to the standard deviation (i.e. volatility) of returns experienced by the portfolio, which is why its Sharpe ratio is the highest amongst the five tested portfolios. According to the same ratio an investor would also receive a higher compensation for the risk incurred, in terms of volatility, by investing in the F-Score_High or market portfolio rather than the F-Score_Hedge or F-Score_Low portfolio in the Nordic region.

TABLE 4

Descriptives

	Market	MFI	F-Score_Hedge	F-Score_High	F-Score_Low
Mean	1.00	0.97	0.98	0.82	-0.16
Median	0.13	1.44	1.15	1.12	-0.47
Standard deviation	9.69	5.81	5.34	5.63	8.42
Minimum	-31.80	-21.09	-18.01	-17.61	-30.04
Maximum	29.73	13.04	12.43	15.72	25.97

All returns are quoted in basis points. Monthly statistics.

The table presents the monthly descriptive statistics for all five portfolios. The market has the highest mean return, followed by the F-Score_Hedge, MFI, F-Score_High and F-Score_Low portfolios. When looking at the median return instead, the relative performance is somewhat different and the MFI strategy delivers the best performance followed by, in descending order, the F-Score_Hedge-, F-Score_High-, Market- and F-Score_Low portfolio. However the conclusions that can be drawn about the performance of each portfolio from the monthly mean and median returns are limited. As these measures are simply the average and median monthly return of each portfolio over the course of the entire 11 years, they do not account for the compounding effect throughout the year nor the compounding effect over the course of several years. Additionally, the table above presents the standard deviation as well as maximum and minimum values of each portfolio's return. The monthly market returns are the most volatile of the five portfolio returns during the tested period, both in terms of the standard deviation as well as the maximum and minimum value of the return, while the F-Score_Hedge portfolio experience the least amount of volatility.

4.2.2 Abnormal returns according to Jensen's Alpha

TABLE 5

VARIABLES	MFI	F-Score_Hedge	F-Score_High	F-Score_Low
Market	0.427***	-0.171***	0.388***	0.558***
Std. Err.	*0.037*	*0.046*	*0.038*	*0.059*
P>|t|	*0.000*	*0.000*	*0.000*	*0.000*
Constant	0.471*	1.125***	0.356	-0.769*
Std. Err.	*0.361*	*0.445*	*0.370*	*0.568*
P>t	*0.097*	*0.0065*	*0.169*	*0.089*
Observations	132	132	132	132
Adjusted R-squared	0.500	0.089	0.439	0.407

*** p<0.01, ** p<0.05, * p<0.1

The table above presents the output from the regression specified in section 3.3.2. The first row called *Market* presents the market beta of the respective portfolio. The market beta of all four portfolios are statistically different from zero at a significance level of 1%. Both the MFI, F-Score_High and F-Score_Low portfolios have a positive beta on the market, meaning the returns are positively related to the market return, while the F-Score_Hedge portfolio has a negative market beta, meaning that the return of the portfolio is negatively related to the market return. The reason for the negative market beta of the F-Score_Hedge portfolio is that in addition to taking a long position in the F-Score_High portfolio the strategy establishes a short position in the F-Score_Low portfolio, which due to equal weighting of the long- and short portfolio and the higher market beta of the F-Score_Low portfolio results in a slightly negative market beta for the hedge position.

Regarding the performance of the MFI portfolio the constant representing the alpha is only just statistically significant at the 10% level for a one sided test, and hypothesis $H_{0, (1a)}$ that MFI is unable to generate alpha when tested with Jensen's alpha in the Nordic region can therefore only be rejected at the 10% significance level. The statistically significant negative alpha of the F-Score_Low portfolio confirms that these firms on average have negative risk-adjusted returns, which benefits the F-Score_Hedge portfolio as a short position is established in the F-Score_Low portfolio. The results presented above do also suggest that the F-Score_High portfolio on average generate positive abnormal returns which also benefits the F-Score_Hedge portfolio as a long position is established in the F-Score_High portfolio. Subsequently the positive abnormal return generated by the long-short F-Score_Hedge portfolio is statistically significant at the 1% level for a one-sided test, and hypothesis $H_{0, (2a)}$ stating that the F-Score strategy cannot be used to generate abnormal returns when tested with Jensen's alpha, can therefore be rejected at the 1% level.

4.2.3 Fama & French three-factor model

TABLE 6
Descriptives

	Market (MSCI Nordic)	SMB	HML
Mean	1.00	0.32	-0.43
Median	0.13	0.25	-0.57
Standard Deviation	9.69	2.46	2.14
Minimum	-31.80	-7.64	-6.22
Maximum	29.73	7.96	7.27

All returns are quoted in basis points. Monthly statistics. For calculation of SMB and HML returns please review section 3.2.4

The table above presents the descriptive statistics of the market, SMB and HML portfolios. Contrary to the findings of Fama & French (2012), who used European data, there seem to exist a size premium in the Nordic region equal to 0.32% per month on average. However there does not seem to exist any value premium, as the return of the HML portfolio is actually -0.43% per month on average. Furthermore, the volatility of both the SMB and HML portfolios are much smaller than that of the market, which is reflected in both the standard deviation and absolute size of the minimum and maximum one-month returns. The reason might be related to the SMB and HML portfolios only measuring the return difference between small and large stocks, and value and growth stocks respectively.

4.2.4 Abnormal returns according to Fama & French's three-factor model

TABLE 7

VARIABLES	MFI	F-Score_Hedge	F-Score_High	F-Score_Low
Market	0.363***	-0.135***	0.334***	0.469***
Std. Err.	*0.039*	*0.051*	*0.041*	*0.063*
P>|t|	*0.000*	*0.009*	*0.000*	*0.000*
SMB	0.635***	-0.323	0.516***	0.839***
Std. Err.	*0.152*	*0.200*	*0.161*	*0.246*
P>|t|	*0.000*	*0.108*	*0.002*	*0.001*
HML	-0.201	-0.032	-0.105	-0.073
Std. Err.	*0.159*	*0.209*	*0.168*	*0.258*
P>|t|	*0.209*	*0.877*	*0.533*	*0.777*
Constant	0.241	1.182***	0.194	-0.988**
Std. Err.	*0.347*	*0.455*	*0.367*	*0.561*
P>t	*0.2445*	*0.0055*	*0.2990*	*0.041*
Observations	132	132	132	132
Adjusted R-squared	0.561	0.114	0.475	0.449

*** p<0.01, ** p<0.05, * p<0.1

The table above presents the output from the regression specified in section 3.3.4. The market beta of all portfolios are statistically different from zero at a significance level of 1%. The MFI, F-Score_High and F-Score_Low portfolios have a positive beta on the market, meaning the return is positively related to the market return, while the F-Score_Hedge portfolio has a negative market beta, meaning that the return of the portfolio is negatively related to the market return. The row labeled SMB represent the portfolio betas on the SMB factor. Both the MFI, F-Score_High and F-Score_Low portfolios have positive betas on the SMB factor which are statistically different from zero at the 1% significance level, while the F-Score_Hedge portfolio has a slightly negative beta on the SMB factor, although not statistically different from zero. The coefficient on the SMB factor provides a measure of to what extent the return of the tested portfolio varies along with the return difference between small and big stocks, and a lower beta-value can be interpreted as a portfolio having less exposure towards the risk factor.

The row labeled HML presents the coefficients of each tested portfolio towards the return difference between high book-to-market firms and low book-to-market firms. As demonstrated by the negative HML average return found in table 6, there does not seem to exist any value premium in the Nordic region. Neither of the portfolios tested comes close to having a statistically significant beta on the HML portfolio, and the risk factor subsequently fails to explain any significant proportion of the returns generated by the various portfolios.

Regarding the performance of the MFI portfolio the constant representing the alpha is, although positive, not statistically significant at any conventional significance level and hypothesis $H_{0,\,(1b)}$ that the strategy is unsuccessful in creating abnormal returns can therefore not be rejected. The F-Score_Low portfolio have an average negative alpha of 0.988 % per month, which is statistically significant at the 5% level for a one sided test. This benefits the F-Score_Hedge portfolio as a short position is established in the F-Score_Low portfolio. The constant of the F-Score_High portfolio is on the other hand quite close to zero and far from being statistically significant. The average monthly alpha of 1.182% generated by the F-Score_Hedge portfolio is consequently driven mainly by the abnormal return of the short portfolio, and is statistically significant at the 1% level for a one sided test. Hypothesis $H_{0,\,(2b)}$ stating that the F-Score strategy cannot deliver abnormal returns can therefore be rejected at the 1% significance level. Furthermore, the adjusted R-squared values are higher for the Fama & French three-factor model than for Jensen´s alpha (0.561, 0.114, 0.475 and 0.449 compared to 0.500, 0.089, 0.439 and 0.407 respectively), indicating that the inclusion of the risk proxies SMB and HML improve the accuracy of the estimated return.

5. Analysis and discussion

Both strategies in this thesis are built upon economical reasoning backed by several years of research on market anomalies. They are famous for their proven success when used in the U.S. Consequently at first glance they might appeal to the Nordic investor as well, but this thesis shows that there is more to the story than what is being told in the literature by Greenblatt and Piotroski.

5.1 Analysis and discussion

The chosen 132 month test period in this thesis consists of 11 placement years where investments have been made in both bull and bear markets. By testing the strategies through times of financial crisis as well as optimism, several advantages and drawbacks of each strategy can be highlighted. The two strategies have generated two unique return patterns that have characteristics that might appeal to different kinds of investors. MFI on one hand generated the highest excess return but also experienced negative returns in four out of the eleven placement years. The F-Score_Hedge portfolio on the other hand only suffered from negative returns in two out of the eleven placement years. Even though the MFI generated a higher return over the course of the 11 years, this strategy may involve to much risk for those investors who feel they might have to withdraw their money before the end the of the 11 year holding period. For these investors a strategy like the F-Score that only lost money in two out of the 11 years may be more suitable as the risk of having to withdraw their funds and accepting a loss is reduced. Moreover the F-score actually managed to deliver a return of 8.05% during the financial crisis in 2008 in a time when the MFI portfolio and the market index declined by -39.49% and -59.49% respectively.

The magic formula was designed by Greenblatt to find firms with a low valuation and a high return on capital, and judging from the results presented in 4.2.1 it seem to perform quite well in the Nordic region, which is in line with what the author found when testing the strategy in the U.S. stock market. The annual return of the portfolio rarely falls more than the market index in pessimistic times and often increases more in optimistic times. According to the Sharpe ratio the MFI also had the best risk adjusted return. Furthermore, when tested using Jensen's alpha the strategy managed to generate a positive abnormal return of 0.471% per month, although only significant at the 10%-level. However, when adding other determinants of risk the abnormal return of the strategy seems to diminish. When testing the return using the Fama & French three-factor model the alpha generated by the portfolio was almost cut in half compared to the result obtained using Jensen's alpha. The coefficient on the SMB factor is larger than the market beta and significant on the 1%-level, implying that the MFI strategy is biased against smaller stocks that also manages to deliver higher returns. Hence, after the size effect has been taken into account the alpha of the strategy is still positive but no longer statistically significant, conveying that the strategy might not be successful in generating abnormal returns. The fact that the strategy is biased towards small stocks is consistent with Greenblatt's findings in the U.S. (Greenblatt 2006).

The F-Score_Hedge portfolio generates the least volatile returns, as expected. Due to a lower beta on both the market, the SMB and HML portfolios the F-Score_Hedge also generated the highest risk-adjusted returns, both when measured using Jensen's alpha and Fama & French three-factor model. Interestingly the F-Score_Low portfolio is more volatile than both the F-Score_High- and the MFI portfolio, which might be due to the fact that it contains fewer stocks than the other portfolios and subsequently is less diversified. Moreover, as a standalone investment the F-Score_Low portfolio actually generated a positive absolute return to the investor who was long the stocks that the F-score strategy had assigned the lowest score. The results, although somewhat unintuitive, are consistent with the results presented by Piotroski (2002) who also found that the average return of the companies assigned a low F-score was positive but below the return of the market. With that being said the strategy clearly has been successful in separating overperforming firms from their underperforming counterparts. As can be seen in table 3 the F-Score_High portfolio outperformed the F-Score_Low portfolio 9 out of the 11 placement years, suggesting that the fundamental signals once employed by Piotroski in the U.S. are also value relevant in the Nordic region.

As mentioned in section 2.3.1 Piotroski's scoring technique was developed to exploit the B/M-anomaly after he found that only 44% of the firms with the 20% highest book-to-market ratio generated positive market adjusted returns. An underlying prerequisite for the F-Score strategy to be as successful in the Nordic region is consequently the existence of a positive value effect, as described in 2.2.3. Having estimated the HML factor used in Fama & French's three factor model this thesis also learned about the value effect in the Nordic region between 2005 and 2015. As seen in appendix 8.2 statistical tests suggests the opposite of what have previously been found by Fama & French (2012); namely that a small negative value effect appears to exist. This might explain why the strategy does not generate the same return when applied to the Nordic region as when previously tested in the US. In a more general sense it can thus be hypothesized that the F-Score strategy will perform worse in a setting where the value-effect is insignificant. Looking at absolute returns the market seems to be unbeaten by the strategy. However, both the CAPM and Fama & French's three-factor model provided evidence that the portfolio in fact generated alpha. As described in 3.3.2 the CAPM states that investors only are compensated for the systematic risk incurred by the portfolio measured by the market beta. By taking both long and short positions the F-Score_Hedge portfolio diminishes the total market exposure, consequently lowering the portfolio's market beta. The market beta of the portfolio tested with CAPM and the three-factor model was, as seen in section 4.2.2 and 4.2.3 respectively, negative which indicates a negative exposure to systematic risk. In efficient markets, where investors only are compensated for their exposure to the risk factors, the expected return of the F-Score_Hedge portfolio would hence be negative. Despite so the results presented in Table 3 demonstrates that F-Score_Hedge generates positive returns in 9 out of 11 years – which explains why the monthly alpha of 1.125% and 1.185% estimated by CAPM and the three-factor model respectively are significant on the 1%-level (one-sided test). Not even including size and value effects as risk proxy variables, as vouched for by Fama & French amongst others, could explain the return of the portfolio. As the R-squared value of the regressions using CAPM and the three factor model have been relatively modest, a sensitivity analysis where the market index MSCI Nordic was replaced with a Nordic hedge index has been conducted. However, the notion that the returns better could be explained by the systematic movements of the hedge index was rejected as both the CAPM and Fama & French three-factor model during this test rendered an even lower R-Squared value, as seen in appendix 8.3.

As described in section 4.2.3. a positive size effect appears to be present in the Nordic region during the time period between 2005-2015. This result is further validated by a t-test showing that the effect is significant on the 10% level (appendix 8.4). The result is in contrast to the findings of Fama & French (2012) who does not manage to uncover any size premium in Europe during the period of 1990-2011. The findings in this thesis are however supported by James Foye (2016) who using data from 1993-2013 concluded that the size premium still exists when breaking down the European data into country specific factors. In addition to using a different time period and region to Fama & French (2012), the reason why this thesis uncovered a size effect becomes understandable when comparing the Nordic market and small cap indices, where the small cap index have outperformed the market index quite remarkably, as seen in appendix 8.5. Furthermore, as described in section 4.2.3., the value effect seems to be slightly negative in the Nordic region which is contrary to what Fama & French have found in the U.S. and Europe using the three-factor model over the period of

1990-2011. However several studies, amongst other Gulen, Huseyin; Xing, Yuhang; Zhang, Lu (2010) have found the value premium to be time varying, and according to data obtained from Kenneth French data library the average monthly return of the HML portfolio in Europe during the time period used in this thesis is -0.11%, providing a possible explanation to why a similar pattern was found in the Nordic region. In fact the level of explained variance, the adjusted R-squared, increases slightly when the HML portfolio is removed from the Fama & French three-factor model. Consequently it is questionable whether HML should still be used as a risk proxy variable, especially in the Nordic region. This is for further research to delve deeper into, as it lies outside the main purpose of this thesis.

5.2 Validity of results

This thesis aims at evaluating the performance of the MFI and F-Score investment strategies when applied to the Nordic region. However, the performance of the respective portfolio may not be attributable to the specific key ratios being used to screen amongst all of the publicly traded corporations, but rather to other accounting metrics and information contained in the financial statements or reports issued to the financial markets. The statistically significant results obtained in most of the regressions do however support the value relevance of the key ratios being used by MFI and F-Score respectively.

Another aspect which may affect the performance of the F-score strategy is whether all of the corporations included in the F-Score_Low portfolio can be sold short in practice. An investor might face restrictions regarding which companies that can be sold short, and thus have to either adjust the original F-Score strategy or abandon it completely. The potential effect of such restrictions have not been taken into account by this thesis, and may be a subject for further investigation.

As the portfolio strategies back-tested in this thesis already have been specified and applied to other markets over time, the key consideration regarding the validity of the results obtained in this thesis is how the returns are evaluated. The choice of regression model and which risk proxy variables that are included could have a substantial impact on the results obtained. This thesis uses four different methods to evaluate the return of the MFI and F-Score portfolios and account for risk. The excess return is defined as the return of the portfolio being tested in excess of the market and is a measure of the absolute return obtained by each strategy compared to the market. The Sharpe ratio puts the excess return of each portfolio in relation to the volatility experienced by that portfolio, and provides a measure of the amount of compensation an investor receive per amount of volatility. The CAPM and Jensen´s alpha uses the beta of the market as a measure of risk while Fama & French's three-factor model also considers size and book-to-market as risk factors. However there may be additional risk factors that could have an impact on the results obtained, and the risk measures considered in this thesis is in no way exhaustive. Nevertheless most of the regressions have resulted in a value of the R-squared statistic in the region of 0.4 to 0.5, supporting the explanatory power of the models employed.

Furthermore, any conclusions regarding the efficient market hypothesis and abnormal return of various market anomalies suffers from the joint hypothesis problem (Fama 1991). When evaluating whether a specific market anomaly or strategy exists and is capable of generating abnormal return there is a need to determine the expected rate of return using a capital asset pricing model. However any deviations from the expected rate of return could also depend on the misspecification of the capital asset pricing model being used. For example, the assumptions outlined in section 3.3.2 on which the CAPM is built are not very likely to be fulfilled in practice. Therefore, it is impossible to tell whether the evidence of market anomalies are due to market inefficiency, miss-specified asset pricing models or both.

To be able to fit a linear regression model the residuals are required to be normally distributed as well as independent and identically distributed (Skogsvik 2002). To examine whether the residuals violates any of these assumptions a number of tests have been performed. First, the assumption of normality was addressed. A Kernel density plot was produced where the residuals appeared to follow a normal distribution. Furthermore a standardized normal probability plot was produced to examine non-normality in the middle of the data range and the quantiles of our return was compared with the quantiles of the normal distribution to test for non-normality in the outer region of the data range, and as both these tests showed no sign of non-normality the assumption about normally distributed residuals cannot be rejected. To test the assumption of homoscedasticity a plot of the residuals versus the fitted value was performed. As a tendency towards heteroscedasticity was detected for the regression models used for the MFI portfolio, both a White test and Breusch-Pagan test were performed. In neither case the null hypothesis of homoscedasticity could be rejected at any conventional significance level. To test for autocorrelation Wald-Wolfowitz runs test were made, whose resulting p-value did not lead to the rejection of the null hypothesis of serially independent residuals for any of the models. Finally, the predicting variables used in the regression analysis were examined for any multicollinearity using the variance inflation factor, and as the highest VIF value was 1.24 it did not even came close to exceeding the critical value of 10, so there does not appear to be any problem regarding multicollinearity.

5.3 Reliability of results

All data is obtained using the widely available Thomson Reuters Datastream, and for each key ratio used in the analysis a number of random samples have been made where the accounting information contained in Datastream have been compared to the numbers reported by the respective firm in their annual report. As no deviations have been recorded the reliability is considered satisfying. Furthermore, the entire sample have been manually checked to ensure that the industry and list on which the share is or has been traded is accurate. To further strengthen the reliability and replicability of this thesis the choices made have been stated throughout. Finally, all calculations have been made using built-in commands in Stata and Excel respectively, which minimizes the risk of human errors. Due to reasons mentioned above the reliability of the results is considered high.

6. Conclusions

This thesis is unique in the sense that it tests and compares the strategies put forward by Joel Greenblatt and Joseph Piotroski in a Nordic stock market context. As there is a modest amount of research within the area of testing stock returns and market anomalies in the Nordic region this thesis contributes with several conclusions about the stock market conditions in the region. The results put forward in the sections above strengthens the findings of Ou & Penman (1989), Lev & Thiagarajan (1993) and Abarnell & Bushee (1998) who amongst others academics found that fundamental accounting measures indeed are value relevant for future stock returns, and that investing strategies successfully can be constructed to exploit such information.

Given that the capital asset pricing models employed to test the strategies holds true, the statistically significant alpha on the 1%-level of the F-Score strategy provides suggestive results that the Nordic stock markets are in a weak-form of efficiency. However, no such conclusions can be drawn from testing the MFI portfolio. As previously described the magic formula was the most successful in generating excess returns while also having the highest Sharpe-ratio. However it fails to generate statistically significant alpha when being tested using the Fama & French three-factor model. In this test it seems as though it is biased towards small stocks and that the higher returns could be due to a larger exposure to these potentially more risky assets. Thus, looking solely at the alpha generated by each strategy, the F-Score_Hedge portfolio outperforms the MFI formula by a significant margin, but considering the lower Sharpe-ratio a rational investor with mean-variance preference might still have an incentive to choose the MFI strategy.

Furthermore the estimation of the SMB and HML factors necessary for the use of Fama & French's three-factor model in the Nordic region contributed with a valuable insight regarding the existence of the size and value effects. In line with early research on the size effect in the U.S., but contrary to what Fama & French (2012) found in Europe, this thesis demonstrated a positive size effect significant on the 10% level in the Nordic region. The value effect was also found to be significant, but contrary to what was found in the U.S. this study provides evidence for that the value effect is slightly negative in the Nordic stock markets, and that it also lacks explanatory power when used as a risk proxy in the three factor regression model. Apart from HML all other factors included in the pricing models seem to contribute in explaining the variance of returns. With adjusted R-squared values in the range of 0.4-0.5 for the buy-and-hold portfolios both the CAPM and the three factor model can hence be deemed to have relatively high explanatory power validating their usefulness in the Nordic region going forward.

Summarizing conclusions are that the success of each strategy is dependent on how you measure risk, and while one strategy managed to generate excess returns and had the highest Sharpe-ratio, the other strategy performed better when tested with any of the asset pricing models. Both MFI and the F-Score generated abnormal returns according to Jensen's alpha, but when put to the test, using HML and SMB as risk factors, only the F-Score produced alpha. The quest for alpha in the Nordic region can thus be deemed partly successful.

7. Further research

Even though both the MFI and F-Score did manage to generate either excess or abnormal returns, the strategies did not manage to perform as well as in previous studies, and a question that can be raised by future research is whether the competition in the Nordic stock markets increases over time. Drawing on the results presented in table 3 it is also apparent that the return of the F-Score_Hedge portfolio is negatively affected by the performance of the companies included in the F-Score_Low portfolio. The return of these companies are on average positive and further research could be concentrated on evaluating the specific characteristics of these firms and whether the F-Score can be further improved to select companies for the short portfolio with negative raw returns.

The results of the F-Score_Hedge portfolio also raises questions about whether the adjustments regarding cutoff values performed in previous research directed towards any of the Nordic countries have skewed the results in favor of the F-score_Hedge portfolio. As far as these authors are aware of all previous studies of the F-score applied in a single country have despite the above mentioned adjustments still suffered from having very few companies in their respective long and short portfolio during a majority of the period investigated. Further research could also focus on evaluating whether any proposed changes to the F-Score, such as those described in section 2.4, can improve upon the performance of the F-Score investment strategy when applied to the entire Nordic region.

Additionally, as a positive size effect was found in the Nordic region it would be interesting to evaluate whether the results could be generalized and if the size effect exists across other regions as well, especially during more recent time periods. Further research could also investigate the value effect in the Nordic region, to conclude whether the HML factor should be disregarded as a proxy for risk when measuring return performance in the region.

8. Appendix

8.1 The scoring process used by Piotroski

Area	Ratio	Formula	Award one point if
Profitability	*Return on assets (ROA)*	$\text{Net income before extraordinary items}_t / \text{Total assets}_{t-1}$	Positive
	Change in ROA	$\text{Return on assets}_t - \text{Return on assets}_{t-1}$	Positive
	CFFO ratio	$\text{Cash flow from operations}_t / \text{Total assets}_{t-1}$	Positive
	Accruals	$(\text{Net income before extraordinary items}_t - \text{CFFO}_t) / \text{Total assets}_{t-1}$	Positive
Leverage, liquidity and source of funds	*Change in leverage ratio*	$\text{Long term debt}_t / \frac{\text{Total assets}_t + \text{Total assets}_{t-1}}{2} - \text{Long term debt}_{t-1} / \frac{\text{Total assets}_{t-1} + \text{Total assets}_{t-2}}{2}$	Unchanged (0) or negative
	Change in current ratio	$\text{Current assets}_t / \text{Current liabilities}_t - \text{Current assets}_{t-1} / \text{Current liabilities}_{t-1}$	Positive
	Change in # shares	$\text{Number of shares}_t - \text{Number of shares}_{t-1}$	Unchanged (0) or negative
Operating efficiency	*Change in gross margin*	$\text{Gross profit}_t / \text{Total sales}_t - \text{Gross profit}_{t-1} / \text{Total sales}_{t-1}$	Positive
	Change in asset turn over	$\text{Total sales}_t / \text{Total assets}_{t-1} - \text{Total sales}_{t-1} / \text{Total assets}_{t-2}$	Positive

Firms are ranked based on the figures that are collected from fiscal year t.The ratios explained in the table are used to score the firms with the 20% highest B/M. The score ranges from 0 to 9. All firms with a score of 7< are longed while all firms with a score <2 are shorted.

8.2 Test of the HML factor estimated in the Nordics

```
One-sample t test

Variable |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
     HML |     132   -.4275861    .1865356    2.143131    -.796598   -.0585741
------------------------------------------------------------------------------
    mean = mean(HML)                                              t =  -2.2922
Ho: mean = 0                                     degrees of freedom =      131

    Ha: mean < 0                 Ha: mean != 0                 Ha: mean > 0
 Pr(T < t) = 0.0117         Pr(|T| > |t|) = 0.0235          Pr(T > t) = 0.9883
```

8.3 Sensitivity analysis; replacing the market index

VARIABLES	CAPM F-Score_HEDGE	Fama French 3 component F-Score_HEDGE
Market (*Nordic Hedge Index*)	-0.751***	-0.429
Std. Err.	*0.284*	*0.331*
P>|t|	*0.009*	*0.197*
SMB		-0.405*
Std. Err.		*0.215*
P>|t|		*0.062*
HML		-0.108
Std. Err.		*0.211*
P>|t|		*0.611*
Constant	1.346***	1.270***
Std. Err.	*0.476*	*0.481*
P>t	*0.0025*	*0.0045*
Observations	132	132
Adjusted R-squared	0.044	0.057

*** p<0.01, ** p<0.05, * p<0.1

Source: Nordic Hedge Index (NHX Equities) made available at http://nhx.hedgenordic.com/

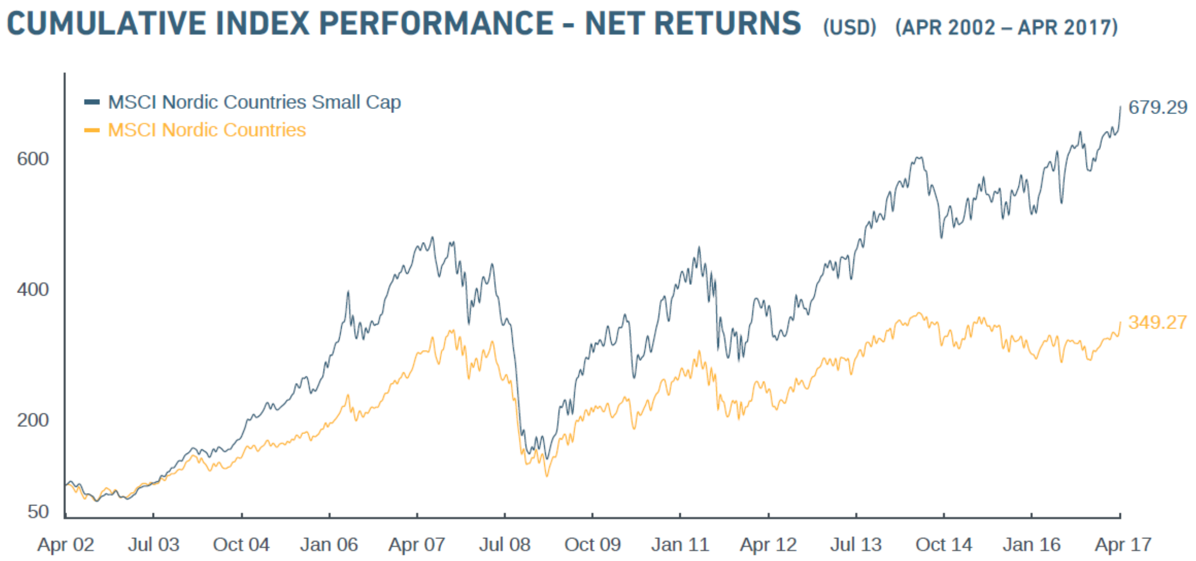
8.4 Test of the SMB factor estimated in the Nordics

```
One-sample t test

Variable |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
     SMB |     132    .3175776     .214514    2.464578   -.1067822    .7419374
------------------------------------------------------------------------------
    mean = mean(SMB)                                              t =   1.4805
Ho: mean = 0                                     degrees of freedom =      131

    Ha: mean < 0                 Ha: mean != 0                 Ha: mean > 0
 Pr(T < t) = 0.9294         Pr(|T| > |t|) = 0.1412          Pr(T > t) = 0.0706
```

8.5 The outperformance of small cap stocks in the Nordics



(The MSCI Nordic Countries Small Cap Index made available at https://www.msci.com)

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