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Master of Science in Finance

The Swedish equity market:
Anomalies and pricing contributions using portfolio sorting techniques

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Abstract

The Capital Asset Pricing Model (CAPM) is a widely used tool to describe the risk-return relationship for stocks. Several studies focusing on asset pricing have during the last decades indicated that the one-factor model CAPM is associated with limitations to explain the cross-sectional and time variation in expected stock returns. Furthermore, the returns of stocks has been suggested to, at least partly, be driven by anomalies. Multi-factor pricing models, such as the Fama French three-factor and the Carhart four-factor models, are therefore considered as suitable alternatives to more accurately capture the risk and return trade-off. This master's thesis used portfolio sorting techniques and statistical analyses to evaluate the importance of a broad suite of explanatory variables related to asset returns. Book value of leverage, size, book-to-market ratio, price-to-earnings ratio, return on asset, return on equity, and the investment-to-asset ratio were used to describe the risk and return trade-off in the Swedish equity market during the sample period 2004-2017. Results from portfolio sorting supported significant positive correlations between stock returns and the book-to-market ratio, return on asset, and return on equity, respectively. Further, a significant negative correlation between price-to-earnings ratio and stock return was observed. Although not statistically significant in the portfolio sorting, investment-to-asset ratio was significantly negatively correlated with stock returns for the value-weighted portfolios after the market factors from the Carhart four-factor model were taken into account. In contrast, the variables leverage and size were not able to predict cross-sectional differences in stock returns on the Swedish market over the period studied.

Keywords: Asset pricing, Anomalies, Portfolio sorting, CAPM, Fama French three-factor model, Carhart four-factor model

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1. Introduction

Theories in asset pricing aim to link the expected return from investments to the risks associated with the investment. By constructing general equilibrium models, the relevant measures of risk can be investigated and the relationships between expected return and risk for assets can be analyzed (Elton et al., 1995). Ever since the Capital Asset Pricing Model (CAPM) was introduced it has been a widely used model to capture the risk and return trade-off for assets. CAPM, progressively developed by Treynor (1961; 1962), Sharpe (1964), Lintner (1965), and Mossin (1966), explains and accounts for risks that should be priced by the market. The CAPM is a one-factor model, i.e. the expected return of assets can be modeled as a linear function of beta, the systematic risk of the investment. The model only includes the return on the market as a factor, which in principle infers that other factors are not pricing relevant and should therefore not be included in the pricing model. However, since the invention of the CAPM, several studies that focus on the pricing of assets have suggested additional factors that may affect the risk and return trade-off for stocks, both in the cross section and over time (e.g. Fama and French, 1996; Hou et al., 2017). Thus, the one-factor model, the CAPM, needs to be revised and extended in order to more accurately model the risk and return trade-off.

Factors that have significant effects on the risk and return trade-off for stocks should be included in the pricing equation. Fama and French (1996) argued that their multi-factor model captured pricing anomalies not successfully described by the CAPM. These authors later demonstrated an international size-effect where small stocks outperformed large stocks in a majority of the markets investigated world-wide (Fama and French, 1998). The study by George and Hwang (2007) exemplifies observations where book value of leverage (D/A) are negatively correlated with stock returns. Fama and French (1996) argued for a negative correlation between the size (market capitalization) of the firm and stock return. Further, Fama and French (1992) concluded a positive correlation between book-to-market ratio and stock returns. In Fun and Basana (2011), the price-to-earnings ratio (P/E) seemed negatively correlated with stock returns. Observations have also indicated positive correlations between both return on assets (ROA) and return on equity (ROE), and stock returns (Chen and Zhang, 2010; Haugen and Baker, 1996). Further, Lyandres et al. (2008) argued for a negative correlation between investment-to-asset-ratio (I/A) and stock returns.

Thus, anomalies such as leverage (D/A), size (market capitalization), price-to-earnings ratio (PE-ratio), book-to-market (B/M), return on assets (ROA), return on equity (ROE) and investment-to-asset ratio (I/A) seem to affect the risk and return trade-off in a variety of equity markets world-wide. Moreover, there are indications that extensions of the one-factor model, the CAPM, into multi-factor models (e.g. Fama French three-factor model and the Carhart four-factor model) improve the capacity to describe cross-sectional and time variations observed in risk and return for equities (e.g. Fama and French, 1996; Carhart, 1997). Based on these findings, this master's thesis investigated whether significant pricing anomalies (relative to the CAPM) could be observed on the Swedish equity market during the sample period 2004-2017. The evaluation was performed using portfolio sorting techniques (e.g. Patton and Timmermann, 2008) both for equally- and value-weighted portfolios to estimate the effects of each variable. The CAPM, the Fama French three-factor model, and the Carhart four-factor model were applied to statistically evaluate the pricing relevance of the anomalies relative to the asset pricing models.

Present day research seems divergent about how different anomalies affect the risk and return trade-off. It is also disputed which anomalies that should be used in extended multi-factor asset pricing models to improve the description and predictive capacity of risk and return trade-off. The overall aim of this thesis was to further investigate the significance and respective relation between book-value of leverage (D/A), size of the firm (market capitalization), book-to-market-ratio (B/M), price-to-earnings-ratio (P/E), return on asset (ROA), return on equity (ROE) and the investment-to-asset-ratio (I/A), and stock return.

2. Literature review and hypotheses

This section briefly highlights a selection of previous research within asset pricing with the main focus to review and exemplify variables (e.g. leverage, size, price-to-earnings ratio, book-to-market, return on asset, return on equity, and investment-to-asset ratio) that may affect the risk and return trade-off for equities. This section also presents the hypotheses that frame this master's thesis.

2.1 Leverage

Financial leverage refers to the investment strategy of using financial instruments (borrowed capital) to increase the potential return of an investment. Alternatively, leverage refers to the amount of debt used to finance assets. High leverage indicates more debt than equity. The study by George and Hwang (2007) found a negative correlation between book leverage and stock returns. Further, Penman et al. (2005) analyzed how the book-to-price ratio (B/P) affects leverage. Their results indicated that leverage was not explained by the returns in the four market factors investigated; market, size, book-to-market, and momentum. Specifically, the book-to-price ratio did not accurately describe the relation between pay-off and leverage. Gomes and Schmid (2010) quantified a complex and multi-dimensional relationship between financial leverage and stock returns. The empirical results of Gomes and Schmid (2010) indicated that high proportions of financial leverage was associated with mature firms, likely because mature firms have relatively higher proportions of safe book assets and fewer risky growth opportunities, compared to newer and more recently started firms. Further, these authors did not find a correlation between the book value of leverage for sorted portfolios and equity return in the cross-section, which can be viewed as an inconclusive result in the empirical literature.

The following hypothesis was framed:

I) Book value of leverage is negatively correlated with stock returns.

2.2 Size

Size is a firm characteristic variable generally measured by the market capitalization of the firm. Banz (1981) was the first study that analyzed the correlation between the size of the firm (market capitalization) and equity returns. This author observed a negative correlation between the size of the firm and equity returns, which is also known as the size-effect. Fama and French (1996) investigated firm characteristic variables, including size among others, and their respective relationship to average returns on common stocks. Their three-factor model was suggested to accurately describe the return for equity of portfolios formed on size and book-to-market value of equity. Thus, the study by Fama and French (1996) provided support that the size-effect should be included in an extended version of the original CAPM model. Malin and Veeraraghavan (2004) investigated the robustness of the Fama-French multi-factor model for equities listed in three European markets. According to their study, there seemed to be a small-size effect associated with the markets in France and Germany. In contrast, the inverse relationship was demonstrated in the market in the United Kingdom. The correlation between size of the firm and equity returns was not only inverse, but was also significantly stronger for the UK market compared to that of the French and German markets.

Since a majority of the reviewed studies found a negative relationship between firm size and average stock returns, the following hypothesis was framed:

II) Size of the firm (market capitalization) is negatively correlated with stock returns.

2.3 Book-to-market ratio

The book-to-market ratio (B/M) can be defined as the book value of equity divided by the market value equity. It is generally acknowledged that stocks with high B/M-ratios (commonly referred to as value stocks) are associated with a higher expected return, as compared to stocks with low B/M-ratios (referred to as growth stocks). This positive relationship between B/M ratios and expected stock returns is commonly referred to as the value effect (Cakici and Topyan, 2014). Several studies have indicated strong correlations between the B/M-ratio and stock performance (e.g. Fama and French, 1992; Lakonishok et al., 1994). While Fama and French (1992) related this effect to unobserved risk factor(s), Lakonishok et al. (1994) attributed the effect to mispricing in the market. Lakonishok et al. (1994) argued that investors were too optimistic of low B/M-stocks and, as a consequence, may have overestimated their potential future growth rates in relation to the value stocks. Further support for the mispricing hypothesis as the underlying source of variation can, for example, be found in the study by Bartov and Kim (2004). These authors observed a stronger B/M-effect when the accounting related fundamentals of low B/M- ratios were considered.

In a wider context, studies such as Fama and French (1992) not only suggested that stocks with high B/M-ratios have significantly higher average returns compared with low B/M stocks, but also investigated the importance of value premiums for international markets. They suggested a small difference in value premiums between small and large stocks in an international context. More recently, Asness et al. (2013) showed that the value effect is present in various equity markets, including those of the US, UK, continental Europe, and Japan.

The following hypothesis was framed:

III) Book-to-market ratio is positively correlated with stock returns.

2.4 PE-ratio

According to several studies during the last decade there seems to be a relation between the earning multiple, price-to-earning (P/E-ratio), and stock returns. Basu (1977) provided the first study that investigated the theoretical relationship between price-to-earnings and equity performance. The efficient market hypothesis disclaimed the possibility of earning abnormal returns. However, the P/E-ratio hypothesis infers that due to expectations by the investors there is a possibility to earn abnormal returns in the aggregate. Between 1957 and 1971, portfolios of stocks with low P/E-ratios seemed to earn higher absolute and risk-adjusted returns compared to portfolios of stocks with high P/E-ratios (Basu, 1977).

Basu (1983) examined the empirical relationship between yield of earnings, firm size, and returns for NYSE stocks. Common stocks with low P/E ratios earned higher risk-adjusted excess returns than stocks with high P/E ratios. However, the results were not completely independent of firm size, which suggested complex effects from individual variables in isolation on expected stock returns (Basu, 1983).

Fun and Basana (2011) observed a significantly higher return for stocks with low P/E ratios compared to those with high P/E ratios for a relatively short holding period of six months in the Indonesian stock exchange. For longer holding periods (from one to four years), however, there was no significant difference between the returns for stocks with low and high P/E-ratios, respectively. In the short time frame, the market price for stocks with low P/E-ratios was assumed to be under-valued and expected to increase with time, thereby generating higher returns compared to stocks with high P/E-ratios (Fun and Basana, 2011).

Mukherji and Lee (2013) investigated how fundamental factors for the largest firms, i.e. those included in the Standard and Poor's 100-index, were related to efficient pricing of stocks. Fundamental factors explained almost all of the variation in price-to-book (P/B) and price-to-sales (P/S) multiples. In their study, returns were significantly negatively correlated to forward P/E-multiples.

The following hypothesis was framed:

IV) P/E-ratio is negatively correlated with stock returns.

2.5 ROA, ROE and investment-to-asset-ratio

A positive correlation between expected return on asset (ROA) and stock return was presented in the study by Chen and Zhang (2010). These authors used current ROA as a proxy for the expected ROA, based on the Fama and French (2006) assumption that ROA is a reliable tool to forecast also future profitability. Haugen and Baker (1996), on the other hand, found that during the sample period 1985-1993, return on equity (ROE) was positively correlated with stock return in the world's five largest markets (US, Germany, France, UK and Japan). When these authors ranked the Russel 3000 stocks into portfolios after their expected stock return, the expected stock return increased progressively with increasing mean ROE. Hou et al. (2015) observed a positive correlation between ROE and stock returns. At the same time, Hou et al. (2015) also found that the investment-to-asset ratio (investment calculated as the difference between the total assets from one year to another) was negatively related to stock returns. This investment-factor was earlier described by Lyandres et al. (2008), who also showed that companies with low investment-to-asset ratio were associated with higher stock returns compared to companies with high ratios.

The following hypotheses were framed:

V) *Return on asset (ROA) is positively correlated with stock returns.*

VI) *Return on equity (ROE) is positively correlated with stock returns*.

VII) *Investment-to-asset-ratio is negatively correlated with stock returns.*

3. Theory and theoretical models

This section aims to describe theories and theoretical models related to risk and return as well as basic principles for commonly used asset pricing models. Examples are provided based on the one-factor model (CAPM) as well as multi-factor pricing models.

3.1 Risk and return

The risk and return trade-off in financial markets implies that low levels of risk are associated with low levels of expected returns, and that high levels of risk imply higher expected returns (Markowitz, 1952). Assuming that investors are risk averse, compensation for bearing risky investments is required. This risk compensation entails a risk premium, which can be defined as the expected return minus the risk-free rate (Bodie et al., 2008). The financial risk of a firm is commonly attributed to a market risk and a firm-specific risk. The market risk is non-diversifiable for the marginal investor and should therefore be priced by the market, e.g. according to the CAPM (Treynor, 1961, 1962; Sharpe, 1964; Lintner, 1965; Mossin, 1966). In contrast, the firm-specific risk should not be priced by the market according to the CAPM as the marginal investor is able to diversify in the market and thereby significantly reduce the risk (Markowitz, 1952). If the firm and its form of financing are analyzed in detail, the greater amount of debt financing the firm takes on in its operations, the higher the systematic risk, as evidenced e.g. by an increased beta (Damodaran, 2012). Hence, it is important to understand the fundamental drivers behind the risk and return trade-off in order to acknowledge anomalies that have pricing power in the market and therefore should be included in the pricing model.

Asset pricing anomalies refer to financial characteristics that cause stock returns to deviate from expected returns implied by the CAPM (Fama and French, 1996). Research on asset pricing and anomalies seems divergent to what extent different anomalies affect the risk and return trade-off (e.g. Treynor, 1961, 1962; Sharpe, 1964; Lintner, 1965; Mossin, 1966; Ferson and Harvey, 1994; Fama and French, 1996; Hou et al, 2017). It is thus unclear which anomalies that are pricing relevant and therefore should be used in extended multi-factor asset pricing models to more accurately describe the relationship between risk and return. Hou et al. (2017), for example, investigated more than 400 anomalies in finance and accounting of which more than 150 were found significant for stock returns. However, this study also suggested that effects from the anomalies observed were significantly lower compared to what several other investigations have reported. After including anomalies in a multi-factor model, Hou et al. (2017) concluded that capital markets seemed more efficient than previously assumed.

In another study, Hou et al. (2015) investigated about 100 anomalies including momentum, value versus growth, investments, profitability, intangibles and trading friction categories. The largest causality was observed for liquidity and the authors suggested microcaps as the main reason for the observed deviations. While microcaps account for approximately 60 % of the stocks included in the NYSE-Amex-NASDAQ, they only serve 3 % of the total market capitalization (Fama and French, 2008). According to Hou et al. (2015) it was important to consider that microcaps both have the highest equally-weighted returns, the largest standard deviations in theses returns, and largest number of variables that described anomalies in the cross-section.

3.2. Asset pricing models

The general aim of this section is to introduce the asset pricing models considered in this thesis to describe the risk-return trade-off. These models include the CAPM, which is a one-factor asset pricing model, and the multi-factor models of Fama and French (1993) and Carhart (1997).

3.2.1 CAPM

The capital asset pricing model (CAPM), developed by Treynor (1961; 1962), Sharpe (1964), Lintner (1965), and Mossin (1966), has become a widely used model to capture the risk and return trade-off for stocks. The model is based on the classical work by Markowitz on diversification and modern portfolio theory (Markowitz, 1952). The general idea behind the CAPM is that investors need to be compensated in two ways, the time value of money and the risk associated with the particular investment. The time value of money is represented by the risk-free security, which is a security without reinvestment, and the default risk (Damodaran, 2012). Most often the risk-free security refers to the government bond, with a maturity that fits the analysis. Investors also need to be compensated for the exposure to a systematic risk. Using the CAPM, it is possible to estimate the level of compensation investors require in order to take on additional risks. The systematic or market risk in the model is represented by beta, a measure of the risk exposure for a company in relation to the market portfolio.

In general terms, the CAPM is formulated in the following way:

$$E(R_i) = R_f + \beta_i\left[E(R_m) - R_f\right], \tag{1}$$

where

$E(R_i)$ *is the expected return on asset or portfolio i,*

R_f *is the risk − free rate,*

β_i *is the systematic risk of asset or portfolio i, and*

$E(R_m) - R_f$ *is the market risk premium.*

The risk measure β_i is estimated as the slope coefficient from the univariate regression where the time series of excess asset returns is regressed on the excess market return series, i.e,

$$R_{it}^e = \alpha_i + \beta_i R_{mt}^e + \varepsilon_{it}, \tag{2}$$

where R_{it}^e is the excess (in excess of the risk-free rate) return on asset or portfolio i, and R_{mt}^e is the market excess return.

3.2.2 Multi-factor models

Multi-factor asset pricing models include more than one risk factor that should be priced. Several empirical studies have indicated that some anomalies are not efficiently priced by the CAPM (e.g. Fama and French, 1993). Multi-factor models have therefore been developed to more accurately describe and predict expected returns for stocks. For example, Ferson and Harvey (1994) suggested that multi-factor asset pricing models including several betas provide an improved explanation of equity returns in the cross section.

This thesis uses two multi-factor models to capture effects from several anomalies associated with firm-fundamentals to describe and predict the risk and return trade-off. Similarly, Hou et al (2017) replicated and tested the statistical significance of more than 400 anomalies for the expected stock returns.

The Fama-French three-factor model (Fama and French, 1993) is the first multi-factor model used in this thesis to describe and predict the risk and return trade-off for stocks. The model is a great advancement compared to the CAPM as it, in addition to the market factor, adds size (Small-Minus-Big; SMB) and value (High-Minus-Low; HML) as two additional factors. The Fama French three-factor model can be written as:

$$E(R_i) = R_f + \beta_i\left[E(R_m) - R_f\right] + \beta_{iSMB}E(SMB) + \beta_{iHML}E(HML)\,, \tag{3}$$

where

$E(R_i)$ is the $expected\ \ return\ for\ asset\ or\ portfolio\ i,$

R_f $is\ the\ risk\text{-}free\ rate$,

β_i $is\ the\ market\ risk\ of\ asset\ or\ portfolio\ i,$

$E(R_m) - R_f$ $is\ the\ market\ risk\ premium,$

β_{iSMB} and β_{iHML} $are\ the\ sensitivities\ of\ asset\ or\ portfolio\ i\ to\ SMB\ and\ HML,$

$E(SMB)$ $is\ the\ size\ premium,$ $\quad and$

$E(HML)$ $is\ the\ value\ premium.$

The β_i, β_{iSMB}, and β_{iHML} risk measures are estimated as the slope coefficient from the multivariate regression where the time series of asset returns is regressed on the market return and the *SMB* and *HML* factors, i.e,

$$R_{it}^e = \alpha_i + \beta_i R_{mt}^e + \beta_{iSMB}SMB_t + \beta_{iHML}HML_t + \varepsilon_{it}\,. \tag{4}$$

The Fama-French three-factor model includes two additional factors compared to the original CAPM-model, Small-Minus-Big (SMB) and High-Minus-Low (HML), to explain portfolio returns (Fama and French, 1993). The Small-Minus-Big factor refers to the market capitalization of the firm and the High-Minus-Low factor is associated with the book-to-market value. While "High" refers to companies with a high book-value to market-value ratio, "Low"' refers to companies with low book-to-market ratios. The High-Minus-Low factor is also known as the "value factor" or the "value versus growth factor" because companies with a high book to market ratio are generally considered as "value stocks". Companies with a low book-to-market-ratio are typically associated with stocks with a future potential for growth (growth stocks). Several studies have demonstrated that value stocks outperform growth stocks over time (Cakici and Topyan, 2014).

The second multi-factor model used in this thesis is the Carhart four-factor model (Carhart, 1997). This model is an extended version of the Fama–French three-factor model (Fama and French, 1993) which, in addition, includes a momentum factor for asset pricing of stocks. The momentum effect is generally described as the tendency for the stock price to continue rising (or to continue declining), following a period of increase (or decrease). Stock momentum measures the rate of rise or fall in stock prices and thereby provides a useful indicator of strength or weakness in stock price. The monthly momentum factor can be constructed by subtracting the equally-weighted average of the lowest performing firms from the equally-weighted average of the highest performing firms, lagged one month (Carhart 1997). A momentum effect has occurred if the average return is positive during a 12-month period. Momentum strategies continue to be popular and financial analysts often incorporate the 52-week price high/low in their buy or sell recommendations. The Carhart four-factor model can be expressed as:

$$\mathrm{E(R_i) = R_f + \beta_i[E(R_m) - R_f] + \beta_{iSMB}E(SMB) + \beta_{iHML}E(HML) + \beta_{iMOM}E(MOM)} \qquad (5)$$

where

$E(R_i)$ *is* the *expected return for asset or portfolio i,*

R_f *is the risk-free rate*,

β_i *is the market risk of asset or portfolio i,*

$E(R_m) - R_f$ *is the market risk premium,*

β_{iSMB}, β_{iHML} β_{iMOM} *are the sensitivities of asset or portfolio i to SMB, HML and MOM,*

$E(SMB)$ *is the size premium,*

$E(HML)$ *is the value premium, and*

$E(MOM)$ *is the momentum premium*

The β_i, β_{iSMB}, β_{iHML} and β_{iMOM} risk measures are estimated as the slope coefficient from the multivariate regression where the time series of asset returns is regressed on the market return and the *SMB*, *HML* and *MOM* factors, i.e,

$$R_{it}^e = \alpha_i + \beta_i R_{mt}^e + \beta_{iSMB} SMB_t + \beta_{iHML} HML_t + \beta_{iMOM} MOM_t + \varepsilon_{it}\,. \qquad (6)$$

4. Data and methods

This section contains general information about the data presented and used during the empirical analysis in this thesis. A detailed description about the portfolio-sorting procedure as well as the statistical evaluation-methods used can also be found.

4.1 Data and data handling

In this thesis we analyze data for Swedish equities traded on the Stockholm stock exchange during the sample period 2004-2017. This relatively long sample period was chosen to provide a large number of observations and to include several business cycles. Stock price data as well as book- and market value of equity were collected from the database FinBas (The Swedish House of Finance (TSHoF), 2018) and downloaded on both monthly and yearly basis. Fundamental information of the companies was collected from Eikon (Thomson Reuters, 2018), including information from the balance sheet (total assets, total liabilities and total equity) and income statement (net income), all on a yearly basis. The fundamental information from Eikon was used to calculate the variables ROA, ROE, P/E-ratio, leverage (D/A) and investment-to-asset-ratio (I/A). These variables were used in a subsequent portfolio-sorting exercise.

Return on asset (ROA) was calculated by dividing the Net income (Thomson Reuters, 2018) with the Total assets (Thomson Reuters, 2018), which is in line with (Chen and Zhang, 2010)

$$\text{Return on Assets} = \frac{\text{Net income}}{\text{Total Assets}} . \tag{7}$$

Return on equity (ROE) was estimated from the Net income (Thomson Reuters, 2018) divided by the Total Equity (Thomson Reuters, 2018), which is in line with (Haugen and Baker, 1996).

$$\text{Return on Equity} = \frac{\text{Net income}}{\text{Total Equity}} . \tag{8}$$

Leverage was defined from the ratio between total liabilities and total assets of the firm:

$$\text{Leverage} = \frac{\text{Total Liabilities}}{\text{Total Assets}} . \tag{9}$$

The book-to-market-ratio was calculated according to:

$$\text{Book} - \text{to} - \text{market} - \text{ratio} = \frac{\text{Book value}}{\text{Market value}} \tag{10}$$

The Price-to-earnings-ratio (P/E-ratio) was calculated from:

$$\text{Price Earnings} - \text{ratio} = \frac{\text{Market value}}{\text{Net income}} . \tag{11}$$

The investment-to-asset-ratio (I/A) was calculated using the asset data obtained from Eikon (Thomson Reuters, 2018).

$$\text{Investment} - \text{to} - \text{asset} - \text{ratio} = \frac{\text{Total Asset}_{\text{t}}}{\text{Total Asset}_{\text{t}-1}} - 1 . \tag{12}$$

Al the above accounting variables were calculated on a yearly basis. Stock returns, on the other hand, were calculated using the pricing data (using the last closing price of the month) in FinBas (TSHoF, 2018). If individual data was occasionally missing, the average of the closing ask- and bid-prices was used. Returns were calculated using the following formula:

$$\text{Return}_{\text{t}} = \frac{\text{Price}_{\text{t}}}{\text{Price}_{\text{t}-1}} - 1 . \tag{13}$$

To be able to use the raw data provided by FinBas (TSHoF, 2018) and Eikon (Thomson Reuters, 2018) in model calculations, the companies were matched between the two databases using their respective International Securities Identification Number (ISIN). ISIN was available as company identification in both databases. The number of companies each month varied between the anomalies mainly due to data handling procedures and if calculations required information from both databases or not. For example, information was only required from FinBas to calculate the anomalies size and book-to-market ratio. Portfolios sorted according to these anomalies were based on between 175 and 286 companies per month. In comparison, portfolios sorted according to anomalies that also needed information from Eikon were based on between 128 and 259 companies per month (Figure. 1). Eventual missing fundamental information for individual companies was also searched for in Bloomberg (Bloomberg, 2018) and, if found, this information was added manually to the data sheet.

To match the accounting measures to stock returns, the following procedure was used: accounting data from fiscal year *t* (which typically is published during the spring of year *t+1*) were matched to monthly stock returns from July in year *t*+1 to June in year *t+2*. For example, fundamental information from the fiscal year 2003 was matched to stock returns from July 2004 to June 2005, and so on. This procedure ensures that the information used in the subsequent portfolio sorting exercise was actually available at the time of sorting.

Further, market factors (market return in excess of the risk free rate (RM_RF), small-minus-big- (SMB), high-minus-low- (HML) and momentum-factor (MOM)) for the equally- and the value-weighted portfolios were downloaded from FinBas (TSHoF, 2018) to analyze if patterns in average returns of the portfolios were controlled by cross- sectional variations in portfolios sensitive to risk factors. The database provided market factors calculated for Swedish stocks on a monthly basis during the sample period.

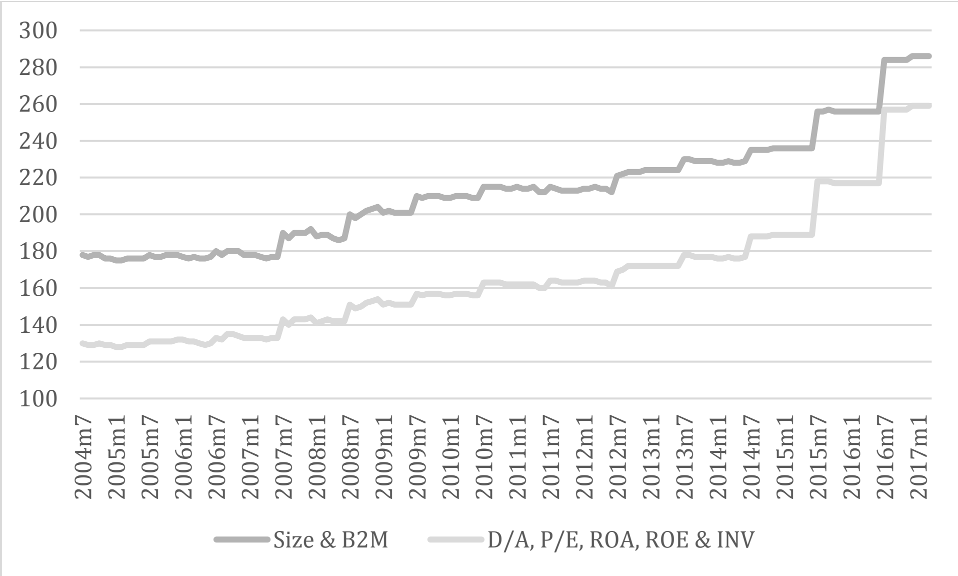

Figure 1: Number of companies used during the portfolio sorting approach (Patton and Timmermann, 2008). Stock portfolios were based on the anomalies size (market value) and book-to-market ratio (B2M; dark grey) as well as leverage (D/A), P/E-ratio, return on asset (ROA), return on equity (ROE) and investment-to-asset-ratio (INV; light grey). The sample period was July 2004 to March 2017.

4.2 Portfolio sorting techniques

Portfolio sorting is an extensively used method within empirical finance to describe the relationship between specific characteristics of the economic unit (e.g. a firm) and expected return (Patton and Timmermann, 2008). Specific characteristics include, for instance, the size of the firm and other fundamental firm information like the accounting variables described above. The main idea behind the portfolio sorting approach is to sort companies into portfolios based on some underlying characteristics and analyze the portfolios rather than the firm in isolation. Specific sorting is done to capture systematic cross-sectional pattern in e.g. equity returns and analyze the effect of each anomaly for stock return. Although portfolio sorting is widely used within empirical finance, the explicit sorting criteria are not well described. The standard approach is to sort stocks into multiple portfolios associated with a particular formation date and study patterns in average return across some holding period of time (Patton and Timmermann, 2008).

According to Patton and Timmermann (2008) portfolio sorting implies testing of correlations between expected stock returns and the variables used to rank stocks. In principle, portfolio sorting is similar to individually analyzing the firms, but has several advantages over the latter method. Patton and Timmermann (2008) argued that portfolio sorting was less affected by outliers and noise compared to when individual stocks were analyzed separately. Another advantage with portfolio sorting is that stocks are combined into portfolios, which circumvents the problems arising from periods with missing data for individual stocks.

In order to test the statistical significance of the framed hypotheses in this master's thesis, each anomaly formed the base for portfolio sorting (Figure 2). Companies in the sample were sorted into portfolios based on the underlying variables; leverage (D/A), size (market value), book-to-market-ratio, P/E-ratio, return on asset (ROA), return on equity (ROE) and investment-to-asset-ratio (I/A), using the portfolio sorting techniques described by Patton and Timmermann (2008). Four portfolios were generated, using STATA14 (Stata Corp, 2015), based on the calculated value of each company. The four groups represented each quartile (0-25%, 25-50%, 50-75% and 75-100%) in company value calculated from the underlying sorting variable. These portfolios were reshuffled each year (in July) to obtain four portfolios structured in accordance to their value (quartile) at the end of each fiscal year (Figure. 2). Each portfolio was analyzed on a monthly basis, both for the equally- and value-weighted portfolios. In the value-weighted portfolios, each firm was given a weight proportional to their market value (market capitalization). This procedure yielded a monthly time-series of portfolio returns for the four equally-weighted and four value-weighted portfolios, respectively, for each anomaly variable. The mean return for each portfolio was used to analyze eventual effects on the stock return from the anomalies included in the model (Figure 2).

The statistical significance of the main hypotheses framed in this master´s thesis was tested by comparing average monthly return of the portfolio with the highest values for the sorting variable (portfolio four; 75-100 %) with the return from the portfolio with the lowest values (portfolio one; 0-25 %). This procedure is equivalent to testing whether the average monthly return on the strategy that buys portfolio four and sells portfolio one is statistically significantly different from zero. Statistical significance was assessed using a standard t-test procedure. This testing procedure is referred to as the four-minus-one (FMO) approach, and the return on the corresponding long-short portfolio as the FMO return.

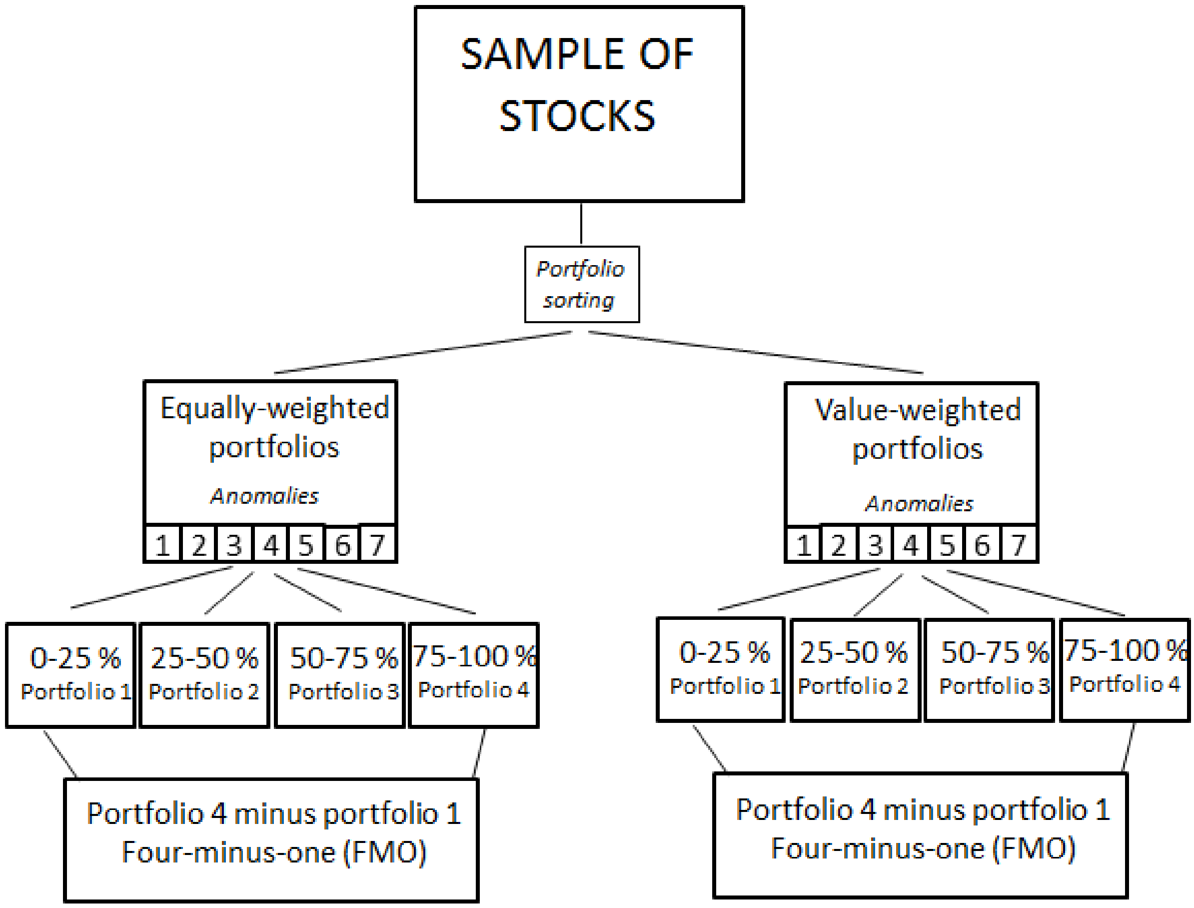

Figure 2: An overview of the principles for the portfolio-sorting-process (Patton and Timmermann, 2008) and the "four-minus-one" (FMO)-approach.

Additional analyses are often performed to evaluate patterns in average returns of the sorted portfolios. It is important to understand whether the patterns are controlled by cross-sectional variations in portfolios sensitive to risk factors, and whether these patterns in average returns remain after normalizing for sensitivity to systematic risk factors (Bali et al. 2016). The CAPM, Fama French three-factor- and Carhart four-factor models are three main models of risk-adjustment (ibid.). The portfolio sorting approach was therefore complemented, and the calculated portfolio returns were evaluated using these models. Each of the three models was used to risk-adjust the portfolio returns in a time-series regression analysis. In particular, the same regressions as in equations (2), (4), and (6) were estimated using the FMO returns from the portfolio sorting exercise as dependent variables. These regressions result in a set of coefficients (intercepts and slopes) and T-statistics corresponding to each coefficient. The model intercept (α) can be interpreted as the average excess return of the portfolio not caused by sensitivity to any of the factors included in the factor model. This value is normally referred to as the alpha, Jensen (1968)'s alpha, of the portfolio and constitutes the difference in return not explained by the regressed market factors.

5. Results

5.1 Portfolio sorting

The sample of companies was sorted into equally-weighted and value-weighted portfolios based on the underlying explanatory variables (leverage (D/A), size (MV), book-to-market-ratio (B2M), P/E, ROA, ROE and investment-to-asset-ratio (INV), using portfolio sorting techniques (Patton and Timmermann, 2008; Figure. 2). A summary of the monthly return for the eight groups of portfolios investigated is provided in Table 1.

Table 1: Summary of the average (Mean) monthly return (%) for the eight subgroups of portfolios sorted by leverage (D/A-ratio), size (market value of equity -MV), book-to-market value (B2M), PE-ratio, ROA, ROE and Investment-to-asset-ratio (INV). Portfolios were compared using the "four-minus-one" (FMO)-approach where the estimated return of portfolio 1 (0-25 %) was subtracted from the estimated return of portfolio 4 (75-100 %). Positive values indicate an increased return and negative values indicate a decreased return at the end compared to the value of the portfolio at the beginning of each month. Statistical T-value for each coefficient is presented within brackets. *=10 % significance level **=5 % significance level ***=1 % significance level

		Equally-weighted portfolios					Value-weighted portfolios				
		(0-25%) 1	(25-50%) 2	(50-75%) 3	(75-100%) 4	Four-minus-one FMO	(0-25%) 1	(25-50%) 2	(50-75%) 3	(75-100%) 4	Four-minus-one FMO
Leverage	Mean	1.52	1.16	1.24	1.37	-0.16	1.46	0.79	1.00	1.21	-0.25
	(T-statistics)					(-0.53)					(-0.81)
Size	Mean	1.37	1.26	1.66	1.28	-0.09	1.28	1.08	1.43	1.02	-0.26
	(T-statistics)					(-0.25)					(-0.69)
B2M	Mean	1.24	1.39	1.49	1.46	0.23	0.96	0.98	1.28	1.58	**0.62** **
	(T-statistics)					(0.93)					(2.11)
P/E	Mean	1.08	1.53	1.38	1.31	0.22	1.52	1.34	0.92	0.78	**-0.74** **
	(T-statistics)					(0.78)					(-2.03)
ROA	Mean	0.93	1.47	1.47	1.43	**0.50** **	1.03	1.07	1.41	0.85	-0.18
	(T-statistics)					(1.99)					(-0.40)
ROE	Mean	0.94	1.57	1.33	1.45	**0.51** *	1.05	1.06	0.93	1.10	0.05
	(T-statistics)					(1.94)					0.13
INV	Mean	1.31	1.38	1.27	1.34	0.03	1.62	0.89	0.99	1.20	-0.42
	(T-statistics)					(0.13)					(-1.33)

Using the “four-minus-one” (FMO)-approach, a negative correlation was observed between leverage and stock returns. This means portfolio one (the portfolio containing low leverage stocks) earned a higher average return than portfolio four (the portfolio containing high leverage stocks) for the equally- and value-weighted portfolios. As a consequence, the FMO portfolio earned a negative average monthly return throughout our sample period both in case of the equally-weighted (FMO=-0.16) and the value-weighted (FMO=-0.25) portfolios sorted on leverage. These negative correlations were, however, not statistically significant.

Similarly, a negative correlation was observed between firm size and stock returns. That is, portfolios sorted by size (market value of equity) supported a small-size effect both for the equally- (FMO=-0.09) and value- (FMO=-0.26) weighted portfolios. However, the size-effect was also not statistically significant.

There was a positive correlation between book-to-market and stock returns, which is in line with the value-effect (FMO=0.23 for the equally-weighted and FMO=0.62 for the value-weighted portfolios). The average monthly return for the value-weighed FMO portfolio was statistically significant at 5% significance level. The economic magnitude is also considerable: the value-weighted long-short portfolio earned a monthly return of 0.62% on average.

Although not statistically significant, there was a positive correlation between price-to-earnings ratio (P/E) and stock returns for the equally-weighted portfolios (FMO=0.22) In contrast, there was a negative correlation between P/E and stock returns for the value-weighted portfolios. The average monthly return on the value-weighted FMO portfolio was statistically significant at 5 % significance level. This result is also economically meaningful, as the value-weighted FMO portfolio earned an average return of -0.74% per month. The large discrepancy between the equal-weighted and value-weighted results indicated that small stocks behave differently from large stocks. Further, the P/E effect is more relevant for large stocks.

Return on assets (ROA) and return on equity (ROE) were positively correlated with stock returns for the equally-weighted portfolios (FMO=0.50 and FMO=0.51, respectively). Both correlations were statistically significant at 5% and 10% significance level, respectively. In contrast, there seemed to be a negative correlation between ROA and stock returns (FMO=-0.18) in case of the value-weighted portfolios. However, this result was not statistically significant. Also, there seemed to be only a small positive (FMO=0.05) and not significant correlation between ROE and portfolio return for the value-weighted portfolio. The difference between the results of the equally-weighted and value-weighted portfolios suggested that the ROA- and ROE- effects were more relevant for small stocks in the sample.

Finally, there were contrasting FMO-values for investment-to-asset-ratio (INV) when comparing the equally-weighted (FMO=0.03) and value-weighted (FMO=-0.42) portfolios. Neither of the correlations were statistically significant at 5 % significance level (T-values: -0.13 and -1.33, respectively). However, the average monthly return on the value-weighted FMO portfolio was -0.42%, which is considerable in magnitude. That is, there seemed to be an economically meaningful negative correlation between the investment-to-asset ratio and stock returns, when value-weighted portfolios were considered.

To summarize, there were statistically significant correlations between book-to-market (value-weighted portfolios; FMO = 0.62; T-value = 2.11), price-to-earnings ratio (P/E; value-weighted portfolios; FMO = -0.74; T-value = -2.03), return on assets (ROA; equally-weighted portfolios; FMO = 0.50; T-value = 1.99) and return on equity (ROE; equally-weighted portfolios; FMO = 0.51; T-value = 1.94), and stock returns. These four correlations, along with the correlation between investment-to-asset ratio and stock return for the value-weighted portfolios (FMO = -0.42; T-value = -1.33) were selected for further in-depth analysis.

5.1.1 Cumulative returns on the FMO portfolios

The temporal development in cumulative return following portfolio sorting for equally-weighted portfolios sorted according to return on asset (ROA) and return on equity (ROE), and value-weighted portfolios sorted by book-to-market (B/M) , price to earnings ratio (P/E) and investment-to-asset ratio (I/A) during the period July 2004 to March 2017 is illustrated in Figure 3. The cumulative return was estimated using the FMO (four-minus-one) – approach for ROA, ROE and B2M, and the inverse (OMF - one-minus-four) approach for the anomalies P/E and investment- to asset ratio (due to their negative FMO-values).

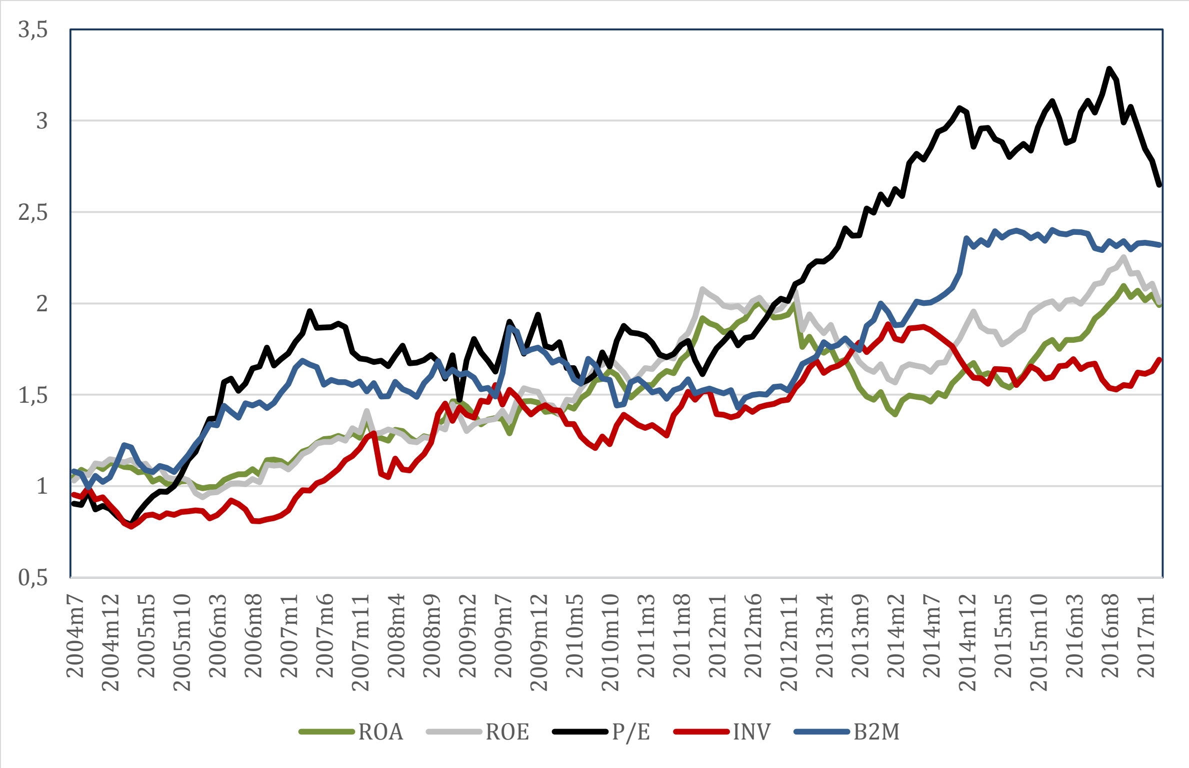

Figure 3: Cumulative return from July 2004 to March 2017 for the anomalies ROA, ROE, P/E, INV and B2M

The largest difference in return between portfolio four and one (FMO) was observed for P/E (Figure. 3). For each SEK invested in portfolio one in July 2004 an additional 1.5 SEK were generated in return at the end of the sample period (March 2017), compared to if the same amount was invested in portfolio four (i.e. ≈ 150 % difference in return). Portfolios sorted according to the anomalies B2M, ROA and ROE generated about 1 additional SEK if 1 SEK was invested in portfolio four compared to in portfolio one during the same time period (i.e. ≈ 100 % difference in return). For comparison, portfolios sorted according to investment-to-asset ratio generated about 0.70 SEK more if the 1 SEK was invested in portfolio one compared to if invested in portfolio four (i.e. ≈ 70 % difference in return).

5.2 CAPM, Fama-French three-factor- and Carhart four-factor model

The aim of this section is to assess whether the significant FMO returns uncovered previously can be explained by popular asset pricing models like the CAPM, the Fama-French three-factor model, or the Carhart four-factor model.

5.2.1 Equally-weighted portfolios

The evaluation of the FMO returns for the equally-weighted portfolios sorted according to the anomalies ROA and ROE is provided in Table 2. Since the FMO returns correspond to the equally-weighted portfolios, the equally-weighted factor returns (SMB, HML, and MOM) were used in the regressions. The calculated FMO returns were regressed on the equally-weighted market factors from CAPM, Fama-French three-factor- and the Carhart four-factor model to investigate if these factors explained the differences in return between portfolio four (75-100 %) and portfolio one (0-25 %).

Table 2: Statistical evaluation (Stata Corp, 2015) of stock returns (FMO) for the equally-weighted portfolios sorted by return on asset (ROA) and return on equity (ROE). CAPM, Fama French 3-factor and Carhart 4-factor models were used to estimate the effects of monthly market risk premium (RM_RF_monthly), equally-weighted small-minus-big factor (SMB_ew), equally-weighted momentum factor (MOM_ew) and equally-weighted high-minus-low factor (HML_ew). In addition, the model intercept (Alpha) is presented together with T-statistics for the coefficients. R^2 is the coefficient of determination. *=10 % significance-level, **=5 % significance level and ***=1 % significance level.

	CAPM		Fama-French 3-factor		Carhart four-factor	
	ROA_ew	ROE_ew	ROA_ew	ROE_ew	ROA_ew	ROE_ew
Alpha T-statistics	0.56** -2.17	0.53* -1.90	0.57** -2.26	0.53** -2.02	0.47* -1.92	0.45* -1.74
RM_RF_monthly T-statistics	-0.05 (-0.93)	0.01 -0.25	-0.07 (-1.39)	-0.02 (-0.43)	-0.04 (-0.72)	0.00 -0.09
SMB_ew T-statistics			-0.16*** (-3.47)	-0.21*** (-4.29)	-0.12** (-2.51)	-0.18*** (-3.49)
HML_ew T-statistics			-0.08 (-1.00)	-0.04 (-0.52)	-0.02 (-0.19)	0.01 -0.11
MOM_ew T-statistics					0.20*** -3.26	0.17** -2.46
Observations (#) R-squared (R^2)	151 0.01	151 0.00	150 0.08	150 0.11	150 0.15	150 0.15

The CAPM model resulted in alpha-values of 0.56 for the ROA-sorted portfolios and 0.53 for the ROE-sorted portfolios. These alpha-values were statistically significant (at the 5% and 10% level, respectively), and similar to the estimated FMO-values (0.50 and 0.51, respectively; Table 1). That is, the difference in return between portfolio four (75-100 %) and portfolio one (0-25 %) was not explained by the CAPM. Also, the market betas were not statistically significant for any of the two regressions. This observation indicated that these long-short portfolios were not exposed to market risk.

When extending the number of explanatory factors and regressing the FMO returns on the factors from the Fama-French three-factor model, the alpha-values were 0.57 for the ROA-sorted portfolio and 0.53 for the ROE-sorted portfolio. Both values were significant at 5 % level and were basically unchanged from the CAPM regressions. This indicated that the SMB-and HML-factors did not further explain the difference in return between portfolio four (75-100 %) and portfolio one (0-25 %). The regressions also indicated a negative and statistically significant correlation with the SMB factor for both FMO portfolios. The sensitivity to the HML-factor was close to zero and insignificant in both cases.

Regressions using the Carhart four-factor model, i.e. adding the momentum-factor to the Fama-French 3-factor model, provided alpha-values that were slightly smaller and closer to zero than the alpha-values from the previous models. That is, the momentum factor was able to explain part of the difference in returns observed for the ROA- and ROE- sorted portfolios. Both long-short portfolios demonstrated a positive and statistically significant sensitivity to the momentum factor. However, the reduction in the alpha-value was small in economic terms. Both alpha-values remained significant at 10 %-level for the Carhart four-factor model. It therefore seemed as the Carhart four-factor model was not able to explain the difference in returns for these portfolios.

5.2.2 Value-weighted portfolios

The FMO returns for the value-weighted portfolios sorted according to book-to-market, P/E and investment-to-asset-ratio is provided in Table 3. The FMO returns were regressed on the factors from CAPM, Fama-French three-factor- and the Carhart four-factor models. The book-to-market FMO portfolio return was only regressed against CAPM as the other two models included the HML-factor, which is an anomaly based on the book-to-market factor.

Table 3: Statistical evaluation (Stata Corp, 2015) of stock returns (FMO) for the value-weighted portfolios sorted by book-to-market (B2M), Price/earnings-ratio (PE) and the investment-to-asset-ratio (INV). CAPM, Fama French 3-factor and Carhart 4-factor models were used to estimate the effects of monthly market risk premium (RM_RF_monthly), value-weighted small-minus-big factor (SMB_vw), value-weighted momentum factor (MOM_vw), value-weighted high-minus-low factor (HML_vw). In addition, the model intercept (Alpha) is presented together with T-statistics for the coefficients. R^2 is the coefficient of determination. *=10 % significance-level, **=5 % significance level and ***=1 % significance level

	CAPM			Fama-French 3-factor		Carhart four-factor	
	B2M_vw	PE_vw	INV_vw	PE_vw	INV_vw	PE_vw	INV_vw
Alpha	0.64**	-0.62*	-0.59*	-0.55	-0.59*	-0.43	-0.64**
T-statistics	-2.13	(-1.66)	(-1.87)	(-1.50)	(-1.85)	(-1.19)	(-2.00)
RM_RF_monthly	-0.02	-0.21***	0.21***	-0.17**	0.21***	-0.21***	0.22***
T-statistics	(-0.29)	(-2.89)	-3.34	(-2.18)	-3.02	(-2.67)	-3.20
SMB_vw				0.10	0.00	0.04	0.03
T-statistics				-1.23	-0.03	-0.42	-0.40
HML_vw				-0.09	0.06	-0.24*	0.12
T-statistics				(-0.76)	-0.57	(-1.81)	-1.04
MOM_vw						-0.25***	0.11
T-statistics						(-2.69)	-1.27
Observations (#)	151	151	151	151	151	151	151
R-squared (R^2)	0.00	0.05	0.07	0.08	0.07	0.12	0.08

The CAPM model resulted in alpha-values of 0.64, -0.62 and -0.59 for portfolios sorted according to book-to-market, P/E, and investment-to-asset-ratio, respectively. The average monthly FMO returns were 0.62 for portfolios sorted according to book-to-market, -0.74 for portfolios sorted based on P/E and -0.42 for portfolios sorted according to the anomaly investment-to-asset-ratio (Table 1).

The alpha of CAPM for portfolios sorted by P/E was slightly closer to zero compared to the average FMO return (-0.62 compared to – 0.74). The alpha was also significant at the 10%-level, which indicated that the difference in stock returns was partly explained by market risk. Also, the FMO returns of portfolios sorted according to P/E were associated with a market beta-value significantly different from zero (Table 2). When evaluating the anomaly returns using the Fama-French three-factor and the Carhart four-factor models, the alpha-values became smaller and statistically insignificant. That is, these two models seemed to explain, at least from a statistical point of view, the anomaly returns of the P/E-sorted portfolios.

Portfolios sorted according to book-to-market resulted in a CAPM-alpha of 0.64 (Table 2). This alpha-value was significant at 5 % significance level. The estimated mean FMO return for the value-weighted portfolios sorted according to book-to-market was 0.62 (Table 1). Thus, the CAPM-alpha was similar to, or slightly larger than, the mean FMO return. This indicated that including the market risk premium by the anomaly book-to-market did not further contribute to an improved model description.

The CAPM-alpha for portfolios sorted by investment-to-asset was -0.59 (T-value = -1.87), i.e. smaller and further away from zero compared to the mean portfolio return estimated using the FMO-approach (FMO = -0.42; Table 1). Also, the alpha-values were further away from zero when regressing against the market factors from the three- and four factor models. This indicated that the differences in return between portfolio four and portfolio one sorted by investment-to-asset were not explained by any of the tested market factors.

6. Discussion

During the last years, several studies have challenged the use of the CAPM to describe the relationship between expected return and risk for stocks (e.g. Fama and French, 1996; Hou et al., 2017). Investigations have demonstrated drawbacks in general principles of CAPM, mainly associated with cross-sectional and time variations in expected stock returns (Fama and French, 1996). Further, while the CAPM includes the market factor as the only explanatory variable for the development of expected return for portfolios, the value of stocks has been demonstrated to be controlled also by additional variables (anomalies) such as leverage (D/A; George and Hwang, 2007), size (market value of equity; Banz, 1981), book-to-market ratio (B/M; Fama and French, 1992), price-to-earnings-ratio (P/E; Fun and Basana, 2011), return on assets (ROA; Chen and Zhang, 2010), return on equity (ROE; Haugen & Baker, 1996), and investment-to-asset ratio (I/A; Lyandres et al., 2008). Multi-factor pricing models such as the Fama-French three-factor- (Fama and French, 1996) and the Carhart four-factor- (Carhart, 1997) models are therefore increasingly used to more accurately describe and predict the trade-off between risk and return for stock portfolios (Hou et al., 2017). The present contribution analyzed 7 different anomalies related to asset pricing and investigated if these anomalies explained the risk and return trade-off in the Swedish equity market during 2004-2017. Table 4 provides a summary of the hypotheses tested in this thesis and the statistical significance of the empirical analysis.

Table 4: A summary of the results from hypotheses tested in comparison to the initial hypotheses. +/- indicates a positive (+) or negative (-) correlation as a result of the various evaluation approaches (portfolio sorting – FMO of equally- and value-weighted portfolios, CAPM - alpha, 3-factor and 4-factor modelling – alpha). Portfolios were sorted according to leverage (D/A), size (market value of equity; MV), book-to-market ratio (B2M), price-to-earnings-ratio (P/E), return on assets (ROA), return on equity (ROE), and investment-to-asset ratio (INV). *=10 % significance-level, **=5 % significance level and ***=1 % significance level.

	Hypothesis	Portfolio sorting		CAPM alpha	3-factor alpha	4-factor alpha
		EW	VW			
D/A	-	-	-			
MV	-	-	-			
B2M	+	+	+**	+**		
P/E	-	+	-**	-*	-	-
ROA	+	+**	-	+**	+**	+*
ROE	+	+*		+*	+**	+*
INV	-	+	-	-*	-*	-**

Financial leverage refers to the strategy of using financial instruments to enhance the return of investments. Based on previous research (e.g. George and Hwang, 2007), this thesis tested the hypothesis that there is a negative relationship between book-value of leverage and stock returns. Based on the portfolio sorting analysis, there was a negative correlation between leverage and stock returns, both for equally-weighted and value-weighted portfolios. However, the magnitude of the return difference between low leverage and high leverage stocks was economically small, and was not statistically significantly different from zero. Therefore, we can conclude that the leverage anomaly was not present on the Swedish equity market over the analyzed period.

The second hypothesis related to firm size. Firm size is generally measured by the firm's market capitalization (market value, MV) and several studies have found a negative relationship between size and stock returns, which is commonly referred to as the size-effect (e.g. Banz, 1981; Fama and French, 1996; Malin and Veeraraghavan, 2004). In the present study, the portfolio sorting approach indicated a negative correlation between size and stock returns both for the equally- and value-weighted portfolios. Thus, in accordance with the literature cited above, the estimated mean return for the smallest stocks was higher than the mean return for the largest stocks, which is in line with the size-effect. However the return differences were small in magnitude and were not statistically significant. Thus, the overall conclusion is that the size-effect was not observable on the Swedish stock market over the studied period.

The third hypothesis was to investigate the relationship between book-to-market ratio (B/M) and stock return. According to Fama and French (1992), book-to-market-ratio was positively correlated with stock return. Consistent with the value-effect, positive correlations were found for both the equally-weighted and value-weighted portfolios using the FMO-approach. The T-statistics demonstrated significant correlations (5 % significance level) for the value-weighted portfolios but not for the equally-weighted portfolios. When regressing the resulting FMO returns against the market factor (CAPM), the significant model alpha was slightly larger than the mean stock return for the FMO portfolio, which indicated that the return difference cannot be explained by the market risk premium. Therefore we can conclude that book-to-market ratio has a significant positive effect on average stock returns on the Swedish stock market during the studied period.

Several studies have indicated a negative correlation between the earning multiple, price-to-earning (P/E-ratio), and stock returns (e.g. Basu, 1977; 1983; Fun and Basana, 2011). In this thesis contrasting results were observed using the FMO-approach, positive correlation for the equally-weighted and negative correlation for the value-weighted (FMO_{EW} = 0.22 and FMO_{VW} = - 0.74). However, the result for the value-weighted portfolios was statistically significant at 5% level while the result for the equally-weighted sorting had a low T-value and thus no significance. When regressing the value-weighted FMO returns against the market factor (CAPM), the alpha indicated that a small part of the variation found was explained by the market risk premium. Additional statistical evaluation using the Fama-French three-factor model and the Carhart four-factor model did not confirm a statistically significant alpha and could therefore explain the return difference from a statistical point of view. As neither of the market factor models were significantly able to explain the full difference in return between portfolio one and four, can we conclude that P/E has a negative effect on stock return in our sample.

The fifth hypothesis focused on the relationship between the profitability anomaly, ROA, and stock returns. Results from the portfolio sorting indicated that ROA was positively correlated with stock return for the equally-weighted portfolios, and the FMO return ($FMO_{ROA,EW}$ = 0.50) was significant at the 5 % significance level. However, an inverse relationship was observed for the value-weighted portfolios ($FMO_{ROA,VW}$ =-0.18) but with a low T-value. This observation for the value-weighted portfolios is in contrast to e.g. Chen and Zhang (2010) but due to the low T-value this was not given a significant weight in the final conclusion. When the equally-weighted FMO return was regressed against the market factor (CAPM) an alpha similar to the estimated FMO-value was obtained, which indicated that the differences in portfolio return was not further explained by the market risk premium. Extending the number of explanatory factors using the Fama-French three-factor model, supported the observation that the factors did not explain the difference in return. However, adding the momentum-factor to the model (i.e. using the Carhart four-factor model), seemed to at least partly explain the difference in stock return for the ROA-sorted portfolios. As none of the factor-models were able to fully explain the difference in returns between portfolio four and one, the conclusion drawn is that there is a positive relationship between ROA and stock returns on the Swedish stock market during the investigated period. The hypothesis is therefore accepted.

Hypothesis six related to the correlation between return on equity (ROE) and stock returns. Similarly to observations made for ROA, ROE was positively correlated with stock returns for the equally-weighted portfolios, with the FMO return ($FMO_{ROE, EW}$=0.51) being significant at the 10% level. There also seemed to be a small positive correlation between ROE and portfolio return for the value-weighted portfolio, but this correlation was not significant. The alpha when regressing the FMO return against the market factor (CAPM) was similar to the return calculated from the FMO approach. This suggested that the difference in portfolio return was not further explained by the market risk premium. The Fama-French three-factor model supported the observation that the size- and value- factors did not further explain the difference in portfolio return. However, as was also observed for ROA, including the momentum-factor via the Carhart four-factor model seemed to explain a small part of the difference in stock return for the ROE-sorted portfolios. As all empirical tests performed in this thesis (Table 4) support the findings by Haugen and Baker (1996) and with statistical significance for all except the value-weighted portfolio sorting, the conclusion drawn is that ROE and stock return are positively correlated in the studied sample.

The last hypothesis investigated in this thesis was to study the correlation between the investment-to-asset ratio and stock returns. The expectations from previous research were to find a negative correlation between these two variables (Lyandres et al., 2007). From Table 4 it can be concluded that this hypothesis seems to hold for all empirical tests except for the equally-weighted portfolio sorting, where a minimal positive effect was observed. The value-weighted FMO return indicated an economically important negative effect ($FMO_{INV, VW}$=-0.42) but this result was not statistically significant (T=1.33). Then the value-weighted FMO returns were regressed on the different factors using our factor-models, and the results showed that the alphas were in the range between -0.59 and -0.64 and all at least significant on a 10 %-level.

This was interpreted as the difference in return between portfolio one and four were even larger after the market factors were taken into account. These results are strong enough for us to conclude that there is a negative relationship between investment-to-asset-ratio and stock returns on the Swedish stock market over the studied period.

7. Conclusions

This master's thesis used portfolio sorting techniques and statistical analyses (single- and multi-factor models) to investigate the effects from seven pricing anomalies on asset returns. Book value of leverage, size, book-to-market ratio, price-to-earnings ratio, return on asset, return on equity and the investment-to-asset ratio were used to describe the risk and return trade-off in the Swedish equity market during the sample period 2004-2017. Portfolio sorting techniques (FMO) supported statistically significant (at least 10 % level) correlations between book-to-market-ratio, price-to-earnings ratio, return on asset and return on equity, and stock returns. Further, after accounting for the market factors, including the SMB-, HML- and the momentum-factor, in the Fama French three-factor- and Carhart four-factor models, there was a significant correlation between the investment-to-asset ratio and stock return for the value-weighted portfolios. Therefore, the results in this master thesis suggest that investing in long-short trading strategies based on stocks' book-to-market ratios, return on assets, return on equity, price-to earnings ratios, and investment-to-asset ratios has generated abnormal returns (relative to commonly used asset pricing models) during the period investigated and might potentially become profitable investment selection advices in the Swedish equity market also in the future.

8. Suggestions for further research

Observations on the importance of a wide spectrum of financial anomalies on stock return provide critical information for the development of basic investment strategies. There are several areas where our findings can be further developed and practically applied. One example is to include anomalies significant for the development of stock return in trading strategies and aim towards a factor-based investing approach. To apply and compare a factor-based investment approach on Swedish and international equity markets would be interesting.

To apply the same methodology on a broader market context would be a step forward. One example of a future study would be to use the European market as benchmark and compare the findings with those made in this master's thesis. The other way around would be to narrow down the study and investigate some of the emerging markets. These markets may not be efficiently priced and more significant anomalies may be expected. Comparing trading strategies from mature compared to emerging markets would provide important insights to the controls of various anomalies with time.

9. References

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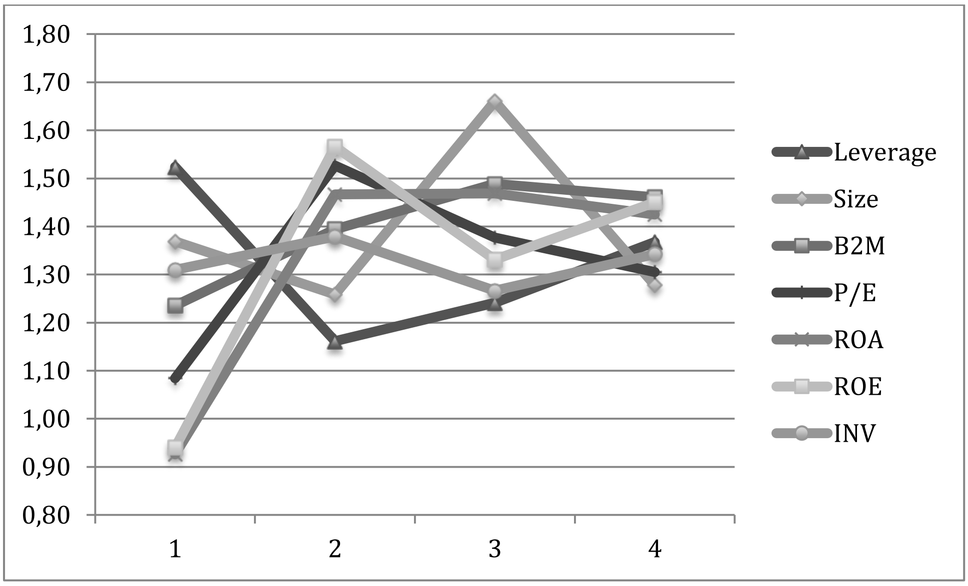
10. Appendix

A1: Summary results for the four the four equally-portfolios and the trends for our anomalies sorted by (leverage (D/A), size (MV), book-to-market (B2M), P/E-ratio, ROA, ROE and investment (INV))



A2: Summary results for the four value-weighted portfolios and the trends for our anomalies sorted by (leverage (D/A), size (MV), book-to-market (B2M), P/E-ratio, ROA, ROE and investment (INV))