Cross-section of Stock Returns:
Conditional vs. Unconditional and Single Factor vs. Multifactor Models

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Abstract

The cross-sectional variation of stock returns used to be described by the Capital Asset Pricing Model until the early 90’s. Anomalies, such as, book-to-market effect and small firm effect undermined CAPM’s ability to explain stock returns and Fama & French (1992) have shown that simple firm attributes, like, firm size and book-to-market value can explain the returns far better than Beta. Following Fama & French many other researchers examine the explanatory powers of CAPM and other asset pricing models. However, most of those studies use US data. There are some researches done in different countries than US, however more out-of-sample studies need to be conducted.

To our knowledge there are very few studies using the Swedish data and this thesis contributes to that small pool of studies. Moreover, the studies testing the CAPM use the unconditional version of the model. There are some papers suggesting the use of a conditional CAPM that would exhibit better explanatory powers than the unconditional CAPM. Different ways of conditioning the CAPM have been proposed, but one that we think is the least complex and possible to make use of in the business world is the dual-beta model. This conditional CAPM assumes a different relationship between beta and stock returns during the up markets and down markets. Furthermore, the model has not thoroughly been tested outside the US. Our study is the first to use the dual-beta model in Sweden. In addition, the momentum effect has lately been given some attention and Fama & French’s (1993) three factor model has not been able to explain the abnormal returns related to that anomaly. We test the Fama & French three factor model, CAPM and Carhart’s four factor model’s explanatory abilities of the momentum effect using Swedish stock returns. Ultimately, our aim is to find the best model that describes stock return cross-section on the Stockholm Stock Exchange.

We use returns of all the non-financial firms listed on Stockholm Stock Exchange between September, 1997 and April, 2010. The number of companies included in our time sample is 366. The results of our tests indicate that the small firm effect, book-to-market effect and the momentum effect are not present on the Stockholm Stock Exchange. Consequently, the CAPM emerges as the one model that explains stock return cross-section better than the other models suggesting that Beta is still a proper measure of risk. Furthermore, the conditional version of CAPM describes the stock return variation far better than the unconditional CAPM. This implies using different Betas to estimate risk during up market conditions and down market conditions.

Keywords:

Cross-section of stock returns, asset-pricing model empirical tests, CAPM, Fama-French, conditional asset-pricing models, time-varying beta, time-varying risk, conditional beta, cross-sectional regression, time series regression, financial market anomalies, value premium, size premium, momentum effect
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1. Introduction

The Introduction to our thesis consists of the problem background briefly reviewing previous researches conducted in the area of interest, problematisation and the research questions that we will be answering along with the purpose of this study. This will conclude with a disposition of the thesis.

1.1. Problem Background

Why does a return on one stock differ from another? No, seriously, why? It is a perfectly legitimate question and, moreover, it has been in the focus of finance and economics researchers since finance and economics researchers ever existed. So, is there an explanation to the variation of returns across different stocks at any point in time? “Pfft!!!” – you might think. Any student at any university around the globe that has ever taken a course in foundations of finance, when presented with this question has one acronym that instantaneously goes through her mind – CAPM. Do we have to spell it out for you? We will do it anyway. CAPM, which stands for Capital Asset Pricing Model, has long been seen as a magic (almost!) formula that explains the cross-sectional differences of stock returns with only a single factor – Beta (β), the covariance of the stock return and the market return. Provided the market is efficient and the equilibrium model (CAPM) is correct, any stock return behavior that cannot be explained by CAPM is considered an anomaly. Throughout the history of stock markets, there have been many anomalies spotted by Wall Street and rigorously researched by the academic world. Keim (2008) distinguishes between two general types of anomalies: time-series anomalies (all calendar related anomalies, such as the January effect, the weekend effect and etc. are an example of that) and cross-sectional anomalies (value premium, size premium, momentum effect and etc.). Keim (2008) further argues that even if some of the anomalies are likely to disperse once they are discovered, some of them tend to persevere over time and do not disappear. Cross-sectional anomalies are of a particular importance, because they present a challenge to traditional asset-pricing models (Keim, 2008).

Cross-section of stock returns has been a hot subject among the financial researches for a long time and there is no doubt that it will remain so in the future. Since Sharpe (1964), Lintner (1965) and Black (1972) have introduced the Capital Asset Pricing Model (CAPM) there have been many studies conducted on cross-sectional variation of stock returns. Numerous studies have tested the empirical validity of CAPM using different approaches; though, the vast majority of these studies were conducted in the US using US stock exchange data. However, about 20 years ago Fama & French (1992, 1993, 1996) have, in their research, found proof that β (beta) alone fails to explain cross-sectional stock return differences in the US, as well as, internationally (1998); and instead found that a combination of the following three variables can better explain much of the cross-sectional variation among average stock returns:

- the ratio of Book equity to Market equity (BE/ME), and
- Market Capitalization (firm size), in addition to
- The market factor (excess market return).
This model incorporates a market portfolio’s excess return, a portfolio that is long in high BE/ME stocks and short in low BE/ME stocks, as well as a portfolio long in stocks of small market capitalization companies and short in stocks of companies with large market capitalization. The findings of Fama & French are very controversial. To begin with, they conclude that Beta we all know and love cannot explain the cross-section of average returns on stocks. Then, they find that simple variables as Book-to-Market equity and Market Capitalization can strongly capture the cross-section of returns far better than Beta. What is controversial is why those two factors can predict stock returns. Fama & French (1995) argue that, with rational stock pricing, the two variables function as proxy for exposure to risk. Others argue that the size and Book-to-Market equity are able to explain stock return cross-section because of survivor bias or data snooping (see, for example, Kothari, Shanken & Sloan, 1995). Lakonishok, Shleifer & Vishny (1994) argue that the effects of Book-to-Market equity and size on cross-section of returns are not due to risk compensation but rather the investors’ over extrapolation. It is apparent that Fama & French’s landmark discovery that Beta might not be a measure of risk sure did stir things around; soon enough and sure enough other studies started coming up, both, confirming and refuting the findings of Fama & French (1992). The CAPM and the Fama & French (1993) three-factor model are, of course, not the only pricing models that there are. There is the very attractive alternative to the mean-variance CAPM - Arbitrage Pricing Theory developed by Ross (1976), which is a multi-factor model with each factor having a beta coefficient that represents the stock returns sensitivity to that specific factor. Subrahmanyam (2010) writes that for the last 25 years or so there have been about 50 cross-sectional predictors of stock returns analyzed by the academic world. Subrahmanyam (2010) manages to categorize the origins of the explanatory factors and models that various researches, up to this moment, have tested:

- Asset-pricing models based on simple informal wisdom from Wall Street;
- Various theoretically motivated risk-return models;
- Cross-sectional predictors originated from behavioral biases of investors; and
- Models that include market frictions as return predictors.

At times some of the findings fail to be confirmed when a different approach (methodwise) or a different timeframe is used to test the same underlying model. There seems to be no consensus over the “how’s”, “what’s” and “when’s”. However, lately there is an apparent tendency to use the Fama & French (1993) three-factor model as a starting point and build upon it.

Fama & French controversially claim that beta is dead; however, their tests on CAPM were done using an unconditional (static) beta. The CAPM assumes a static beta, which is only true for a single period hypothetical world. Conversely, in the real world, which, unlike the hypothetical one, is very dynamic, the beta has been proven to be non-constant, time-varying (see Gregory-Allen, Impson & Karafiath, 1994; see Wells 1994 for varying betas in Stockholm Stock Exchange), and there have been numerous studies (Bundoo, 2008; Bali, Cakici & Tang 2009) showing that when a time-varying beta is used, CAPM does well in explaining cross-sectional stock return variations. Since beta is a relative measure of systematic risk and systematic risk varies across time, using a static beta for empirical tests will result in, to say the least, not accurate conclusions.
being derived from the tests. Most of the studies that test CAPM with time-varying Betas make use of one or another complex way of modeling the Beta (for instance using different forms of Generalized Autoregressive Conditional Heteroskedasticity [GARCH] models). However, Howton & Peterson (1998) show that “it may be too early to label beta as unimportant” (p. 211) (let alone dead) by using a rather simple time-varying risk model to estimate beta. They allow beta to vary depending on the market condition – a beta during the bull market and, another beta during the bear market. Cooper, Gutierrez & Hameed (2004, p. 923) “… find very strong evidence that betas in ‘bull’ and ‘bear’ markets differ”. Interestingly enough, there are some studies that found that even when the beta is allowed to vary over time the CAPM (conditional CAPM) fails to explain the asset-pricing anomalies, such as Book-to-Market equity and momentum effects on cross-section of stock returns (see Lewellen & Nagel, 2006).

Many studies testing CAPM and Fama-French three-factor model have been conducted in the US and internationally, though, not as much internationally as in the US, showing varying results. Fama & French (1998) have also found evidence in support of their model in the international markets; however, till this moment their model has not been able to explain the momentum (past stock returns) effect on stock returns. Jegadeesh & Titman (1993) find evidence of the existence of a momentum effect on variation of returns across stocks. They conclude that buying past winners and selling past losers earns significant abnormal returns. Nartea, Ward & Djajadikerta (2009), Hong, Lim & Stein (2000), as well as, Avramov, Chordia, Jostova & Philipov (2007) also prove the significance of the momentum effect and show various reasons for the existence of that effect.

1.2. Problematization and Research Question

Till this moment not many studies have tested Fama and French’s three-factor model in Sweden and no study has been done to test Carhart’s (1997) four-factor model in Sweden. Asgharian & Hansson (2000) have conducted a cross-sectional analysis of stock returns with a conditional CAPM (using a time-varying Beta) and Fama and French’s three-factor model using Swedish stock returns in the period from 1983 to 1996. However, they do not test the models’ explanatory abilities of the momentum effect. Since Carhart’s four-factor model, which includes the momentum effect, was developed in the US using US data, it is important that it is tested for robustness using non-US data. However, to our knowledge Carhart’s four-factor model has not yet been tested in Sweden. Moreover, conditional versions of CAPM are often found to perform better than unconditional ones.

To this extent, we formulate the following research question:

*Do CAPM, Fama & French’s three-factor model and Carhart’s four-factor model capture the cross-sectional variation of stock returns better with a conditional beta?*

As a prelude we will also address the following question:

*Does firm size, Book-to-Market equity ratio or short run past returns affect the cross-sectional variation of stock returns?*
1.3. Research Purpose

We intend to, first, check for the presence of size, Book-to-Market and momentum effects on cross-section of stock returns on the Stockholm Stock Exchange, and then test the CAPM, Fama-French three-factor model and Carhart’s four-factor model by analyzing the Swedish stock returns from a different period (1997 to 2010 inclusive) than that used by Asgharian & Hansson (2000), as well as, by using different methods than those used by Asgharian & Hansson (2000). In testing the aforementioned models we use a slightly augmented version of Pettengill, Sundaram & Mathur’s (1995) dual-beta model based on assumptions of systematic risk being different during different market conditions. This takes form in conditioning each of the three asset-pricing models on “up” and “down” market states. This method of conditioning the asset-pricing models is different than the method used by Asgharian & Hansson (2000) in a way that it is easier to construct and understand in practice. This convenience is attractive to market professionals, as well as, to the academic world. Our research serves as an out-of-sample robustness test of the Fama & French’s three-factor model and, more importantly, Carhart’s four-factor model, since an overwhelming majority of empirical tests of asset-pricing models are performed in the US.

1.4. Delimitations

Only stock returns of non-financial firms will be included in our sample. Financial firms are excluded because of their peculiar capital structure that is different from that of non-financial firms. Firms in the financial sector tend to have a higher leverage and are exposed to a higher financial risk, however, if firms in the non-financial sector had the same leverage it would be interpreted differently – as a possible financial distress. This practice of excluding financial firms is common in many studies. The time period in consideration will be 12.5 years – from September 1997 to March 2010 inclusive, 150 months in total. Asgharian & Hansson (2000) have used 14 years of data, however, at a different period - between 1983 and 1996. We intend to use a more recent period of time and include the data available up till April 2010. The lower limit of 1997 was chosen because the number of stocks traded on Stockholm Stock Exchange before the 1997 was not possible to get hold of. The data obtained from NASDAQ OMX itself was only from 1997, which subsequently limited the period span of our research.

Moreover, some Swedish firms have two different classes of shares: A and B. B-shares usually have lower voting rights than A-shares – 1/10 as opposed to 1. Both of the shares are usually noted on the Stock Exchange, but B-shares are usually more widely held and traded. For those companies that have two share classes, only the most traded shares will be used. For the majority of companies it is B-shares, but for a few of them it is A-shares.
1.5. Definitions

Cross-sectional stock return variation:

An observation of varying returns across different stocks at one point in time.

Bull (Bear) market:

A concrete and generally accepted definition of bull and bear markets does not exist in the literature and many studies usually define the bull and bear conditions of the stock market differently. Most of the researchers assign a certain threshold that divides the market returns into two opposite camps and, in addition, the markets are assumed to go from one state to the other quite abruptly – the market could be in an “up” state one month and in “down” state in the next month and then move into “up” state again the following month. The thresholds tend to be set arbitrarily, usually some sort of a mean or median return (see for instance Bhardwaj & Brooks, 1993; Howton & Peterson, 1998; and Cooper, Gutierrez & Hameed, 2004). The problem with assigning a mean or a median market return as a threshold is that the threshold would vary depending on what period of time is used to calculate the mean or the median. There is a slightly better way of distinguishing between up and down markets. Pettengill, Sundaram & Mathur (1995), for example, in their study distinguish between an “up” (bull) markets and “down” (bear) markets when the monthly market return exceeds the risk free rate of return. On the other hand, some studies try to implement complex models for distinguishing between market states and let the data itself dictate the threshold (see, for instance, Woodward & Anderson, 2009). However, Woodward & Anderson (2009) find that the transition from bear to bull (or visa-versa) states is not gradual for most industries, but rather abrupt, thus, justifying the abrupt-up-down-movement model for market conditions. In this study we will be using the up-down model similar to that of Pettengill et al. (1995). Hence, the stock market will be considered to be in a bull (bear) market condition during a certain month if the market return for that month is above (below) the risk-free rate of return.
1.6. Disposition

- **Introduction**

The Introduction to our thesis consists of the problem background briefly reviewing previous researches conducted in the area of interest, Problematization and the research questions that we will be answering along with the purpose of this study. This will conclude with a disposition of the thesis.

- **Theoretical Framework**

This chapter will present the reader to the relevant theoretical framework of our study. It will exhibit a smooth transition from theoretical framework containing grand theories, such as the efficient market hypothesis and modern portfolio theory, into literature review, which goes through previous academic studies that have been done in the area of cross-sectional stock return and other connected areas of finance relevant to our study.

- **Method**

The Method chapter contains the theoretical method, where we discuss our scientific approach to the issue in hand, coupled with the practical method where we thoroughly describe the methods and processes applied in this study to obtain the results that are presented later in Chapter 4. This chapter will also present some descriptive statistics of the data used.

- **Results and Analysis**

This part of our study will present the reader to the empirical findings together with the analysis and implications of those findings. The statistical tests conducted on the data and their results will be illustrated. The structure of the chapter closely follows that of the Theoretical Framework Chapter – the hypothesis derived in Theoretical Framework Chapter will be addressed here one after another.

- **Conclusion**

This is the final chapter of our study where the research questions will be answered following the brief summary of this paper. Moreover, further research suggestions will be put forward in the end of the chapter.
2. Theoretical Framework

This chapter will present the reader to the relevant theoretical framework of our study. It will exhibit a smooth transition from theoretical framework containing grand theories, such as the efficient market hypothesis and modern portfolio theory, into literature review, which goes through previous academic studies that have been done in the area of cross-sectional stock return and other connected areas of finance relevant to our study.

2.1. Theories of Efficient Markets

This thesis consists of asset-pricing models and theories connected to them which all somehow relate to the assumption of efficient financial market. In fact, the core of this thesis rests upon an efficient financial market as the models which are tested are done so on assumptions of this theoretical position. Efficient market theories all imply that investors cannot expect more return on their investments than what can be expected considering the risk factors of these investments. All information that is available in the market will be incorporated in the stock prices and, hence, there will be no obvious arbitrage opportunities through over- or undervalued securities. Since there will be no inefficient security valuation, at least not for long time periods, the market will be in equilibrium and anomalies will be nearly impossible to discover. Accordingly, supporters of efficient market theories argue that one cannot outperform the market.

For a more detailed explanation of market efficiency, we turn to Fama (1965, p. 76) who report that a market is efficient when a significant amount of rational, profit maximizing investors with access to relevant information at extremely low costs, attempt to predict the future value of market securities. This phenomenon will cause security prices to shift to a level where available information is reflected through price forecasts made by the investors, hence the intrinsic value. However, investors do not always agree on the price that would truly reflect the securities intrinsic value causing a situation where prices fluctuate randomly around various forecasted prices. Nevertheless, it can be stated that different types of available market information is what drives the market efficiency theory. There are two popular theories explaining the market efficiency and how security prices move according to different variables, where one of them is the Random Walk Theory and the other one, the Efficient Market Hypothesis (EMH).

2.1.1. The Random Walk Theory

Kendall (1953, p. 11), one of the pioneers of the random walk theory, conclude that there is little correlation in stock markets, both historical correlation of individual stocks and between different stocks. A conclusion which is supported by Fama (1965, p. 76) saying that according to the random walk hypothesis movements in stock price have no memory and one cannot predict future prices based on historical prices. Therefore, it is equally possible to forecast the path of stock prices as for a large amount of cumulative random numbers, hence, there is an identification of a random walk in future stock prices. Knowing these facts one might ask why the stock prices cannot be predicted sufficiently to exploit the knowledge and, thereby, make continuous profits.

Some randomness in stock prices can be explained by the inconsistency between different investors and their price estimates, but information is a major part in
explaining the random walk. New available information, which, as will be shown later, can be interpreted differently, will cause stock prices to change as re-estimations of the intrinsic values will be done, as described above by Fama (1965, p. 76). Samuelson (1965, p. 41) explains that in a market where buyers and sellers are sure that the price will rise in the future, it would already be reflected in the price today. By analyzing and reflecting upon this statement one can conclude that future information is unpredictable. If the market already knew about the information that will be uncovered in the future, say t+1, it would already today at t, be reflected in the security prices as known information. This is the core of the random walk theory – since future information, which causes changes in security prices, is unpredictable the future prices must themselves be unpredictable and random.

Further developing the random walk, Fama (1965, p. 76) mentions the implications new information will have on the intrinsic value estimates and, therefore, also the actual prices. Since there is an uncertainty about the new information, it will cause under-adjustments, as many times as it will cause over-adjustments, of the stock price. This will create a delay for the actual security price to reach its intrinsic value, either the price will adjust before the time of the actual event or after, which in itself can be seen as a random and independent variable. When summarizing the random walk theory it means that the all available information is reflected in the stock price and that changes are not possible to predict, thus, security prices will follow a random walk. Even though the random walks of stock prices are accepted by many, there are some that argue against the theory, for instance Lo & MacKinlay (1988) who reject the random walk hypothesis.

2.1.2. The Efficient Market Hypothesis

From the knowledge in the random walk on financial markets we arrive at the Efficient Market Hypothesis where market stock prices, like the random walk theory, reflect all available information. The hypothesis can, however, be divided into three different subgroups of which the efficiency of the markets can be tested. These three are: The weak-form test, the semi-strong-form test and the strong-form test (Fama, 1970, p. 383). It will become clear that the understanding of available information is interpreted differently within these subgroups.

The weak-form test refers to available information as the historical prices and returns. Thus, this form of market efficiency implies that the stock market prices reflect all information that can be obtained when examining historical prices and returns. Fama (1970, p. 414) confirms this weak form of efficient market as he concludes that market prices are a reflection of historical prices and returns.

The semi-strong-form test suggests that the information that is made public and can easily be accessed is reflected in the market prices. Here the public information, not excluding the weak-form information, is events as earnings-, split-, stock issue announcements (Fama, 1970, p. 415). As the weak-form market efficiency the semi-strong-form is confirmed. Fama, Fisher, Jensen, & Roll (1969, p. 25-26) state that stock prices do in fact react quickly to new information and that no excess return above the expected can be anticipated unless the investors have inside information.

The strong-form test considers the market efficiency issue in terms of insider information and whether insiders and investors, having access to this information, can
earn abnormal profits relative to “outsiders” (Fama, 1970, p. 409). The strong-form of market efficiency is rejected by Fama (1970, p. 409-410) and Seyhun (1986, p. 211). They conclude that insiders can make abnormal profits on their information which is not publically available. Consequently, the market is not efficient in its strong-form. However, Rozeff & Zaman (1988, p. 43) have another point of view by presenting their results that insiders do not earn significant abnormal profits on trading and, thereby, they should not hold more information than the market. The fact that insiders do not earn significant abnormal returns can, however, be due to the strong US Securities and Exchange Commission (SEC) regulations concerning insider trading (Rozeff & Zaman, 1988, p. 43). Nevertheless, the studies by Seyhun (1986, p. 211) and Rozeff & Zaman (1988, p. 43) confirm the semi-strong hypothesis of market efficiency. They conclude that outsiders cannot earn abnormal returns trading on insider information when this has gone public which means that the public information is reflected in the stock price.

The assumptions of an efficient market will, as stated in the beginning of this chapter, be of vast importance throughout the thesis. The market efficiency is fundamental for asset-pricing models and anomalies that are found can indicate an inefficient market since abnormal returns are not supposed to appear in an efficient market. More discussions on asset-pricing models and anomalies are to follow as the chapter unfolds.

2.2. Modern Portfolio Theory

Modern Portfolio Theory (MPT) was first introduced in 1952 in the article Portfolio Selection by Nobel Prize winning Harry Markowitz. Since then his research has been fundamental for all kinds of investment topics as it involves the importance of diversification to maximize return and minimize the variance (risk) of a portfolio – the mean-variance model. MPT will, thereby, also be fundamental for this particular thesis as much of the concepts and models used are related to and requires a basic knowledge in the area. Initially, Markowitz presents an investment rule which is reasonable as investors want to maximize their wealth and obtain an as high utility as possible. The rule states that, an investor should diversify his or her portfolio among the securities which are expected to generate the greatest return (Markowitz, 1952, p. 79). As will be shown later, this rule is not fully supported by Markowitz’s diversification theory since investors are also risk averse and do not only consider return on their investments, but also the variance. Investors that are risk averse consider expected return as a positive feature and variance as negative one (Markowitz, 1952, p. 77).

Continuing, in Modern Portfolio Theory, the number of securities in a portfolio plays an important role because the more securities included the closer will the expected return be to the actual return (Markowitz, 1952, p. 79). Not only is the number significant to create an optimal portfolio, but also the covariance of the stocks, which should be as low as possible (Markowitz, 1952, p. 89). Consequently, more securities that offset each other by a low correlation will bring the expected and actual return closer and thus reduce deviations from the expected return. Following the previous argument it is also possible to conclude that the risk will be reduced by including more securities in the portfolio since the variance of expected and actual return will be smaller. A portfolio should, therefore, include a variation of securities that are not correlated in terms of reacting to various economic events.
The previous statements are, however, somewhat limited considering the reduction of risk as the number of securities in a portfolio and the low covariance between them cannot eliminate all risk. Elton & Gruber (1977, p. 425) illustrates through a table that the risk reduction by increasing the number of stocks is relatively vast in the beginning, starting from one stock. The core message can be illustrated in Figure 1 with numbers derived from Statman (1987, p. 355). Elton & Gruber (1977, p. 425) as well as Statman (1987, p. 355) argue, through the use of the figure and its data that as the number of stocks get larger the remaining risk of that portfolio will be reduced less and less. In connection to these findings, Statman (1987, p. 362) concludes that 30 stocks are the lowest number to include in a portfolio for it to be “well-diversified” and reduce the majority of the risk that can be eliminated.

The fact that not the entire risk of a portfolio can be diversified against, no matter how many securities are included, makes it possible to divide the risk factors into two groups – Systematic and Non-systematic risk. The risk which is not possible to reduce through efficient diversification is systematic and this type of risk is influenced by overall market conditions, such as macro economic fluctuations (Sharpe, 1964, p. 441). As the systematic risk is connected to the overall risk in the economy and it is also called market risk and nondiversifiable risk. The other type of risk is the non-systematic, also called firm-specific risk or unique risk, which involves the risk factors connected to a specific company. This can for example be risks due to a lost contract that will influence the company’s future revenues. The non-systematic risk is, therefore, not affecting any other company except maybe its associates. Hence, by including more securities in a portfolio than only securities from one company this firm-specific risk will be reduced.

In Figure 1 it is shown that the non-systematic risk of a portfolio can be reduced quickly when adding more securities, but that independent of how many securities are included the systematic risk will remain.

![Figure 1: The effect on portfolio risk by increasing the number of stocks. Source: Statman, M (1987, p. 355). How many stocks make a diversified portfolio? Journal of Financial and Quantitative analysis. 22 (3), 353-363. (Drawn with data from the source by authors)](image-url)
2.2.1. The Optimal Portfolio Selection of Risky Assets

When choosing a portfolio the investor has to decide a preferable expected return or variance. This is because the portfolio yielding the highest return is probably not the one with the lowest variance. There is a tradeoff between the return and the variance as it is possible to increase the expected return by allowing for more variance and decrease the variance by reducing the expected return. This connection is called the Expected returns – Variance of returns rule, E,V (Markowitz, 1952, p. 79). Now necessary calculations for the understanding of this thesis will be introduced. New per chapter variables will be defined for each equation, other variables have the same meaning as the prior equations in that chapter.

The expected return of a portfolio can be calculated accordingly:

\[ E(r_p) = \sum_{i=1}^{N} W_i E(r_i) \]  

(1)

Where

\[ E(r_p) = \text{Expected return of the portfolio} \]

\[ W_i = \text{Weight percentage of the } i^{th} \text{ security} \]

\[ E(r_i) = \text{Expected return of the } i^{th} \text{ security.} \]

The variance of a portfolio can be measured with the following formula, note that \(i \neq j\):

\[ \sigma_p^2 = \sum_i W_i^2 \sigma_i^2 + \sum_i \sum_j W_i W_j \sigma_i \sigma_j \rho_{ij} \]  

(2)

Where

\[ \sigma_p^2 = \text{Variance of portfolio} \]

\[ W_i^2 = \text{Weight percentage of the } i^{th} \text{ security, squared} \]

\[ \sigma_i^2 = \text{Variance of the } i^{th} \text{ security} \]

\[ W_i = \text{Weight percentage of the } i^{th} \text{ security} \]

\[ W_j = \text{Weight percentage of the } j^{th} \text{ security} \]

\[ \sigma_i = \text{Standard deviation of the } i^{th} \text{ security} \]

\[ \sigma_j = \text{Standard deviation of the } j^{th} \text{ security} \]
\[ \rho_{ij} = \text{Correlation between the } i^{th} \text{ security and the } j^{th} \text{ security} \]

The correlation coefficient \( \sigma_i \sigma_j \rho_{ij} \) is equal to the covariance between the two securities \( \text{Cov}(r_i, r_j) \). Covariance which is:

\[
\text{Cov}(r_i, r_j) = E \left[ \left( (r_i - E(r_i)) (r_j - E(r_j)) \right) \right]
\]

(3)

Where

\[ E \] = The expected value of the deviation of \( r_i \) from its mean multiplied with the deviation of \( r_j \) from its mean.

\[ r_i \] = The actual return of the \( i^{th} \) security

\[ r_j \] = The actual return of the \( j^{th} \) security

Thus,

\[
\sigma_p^2 = \sum_i w_i^2 \sigma_i^2 + \sum_i \sum_j w_i w_j \text{Cov}(r_i, r_j)
\]

(4)

Further, to obtain the standard deviation of a portfolio, which is commonly used when assessing a portfolio’s risk, the following formula is applied:

\[
\sigma_p = \sqrt{\sigma_p^2}
\]

(5)

An investor can by these techniques calculate a number of possible portfolio selections, choosing different weights of the various securities to be included in the portfolio. The calculations will provide a variety of choices in terms of return and risk (variance). By drawing these possibilities in a graph it is possible to identify efficient E,V combinations, also referred to as the efficient frontier, see Figure 2. As it can be seen in Figure 2 the thicker area of the graph are portfolio selections which are efficient as investors want to have as low variance (V) as possible for a chosen expected return (E) or as high E as possible for a chosen V (Markowitz, 1952, p. 82). An investor will now be able to, depending on individual risk aversion, make an optimal portfolio selection. Figure 2 also shows that if an investor selects a portfolio not lying on the efficient E,V combination there will be less return for the same risk or more risk for the same return compared to a selection along the efficient frontier. Note that the variance can be exchanged for standard deviation if preferred as it will be on forthcoming figures through equation 5.
Sharpe (1964, p. 430) shows how the efficient frontier will be differently shaped depending on what the type of correlation securities in a portfolio have, see Figure 3. Assuming two securities to be part of a portfolio, if they are perfectly correlated (=1) then the efficient frontier will be a straight line (AB). Still assuming two securities, but with no correlation (=0) the efficient frontier will be U shaped (AZB) implying that you can obtain an equal return for less risk with that kind of combination compared to the first one. The efficient frontier will be even more U shaped as the securities included in the portfolio will be negatively correlated (<0) (Sharpe, 1964, p. 431). In terms of Figure 3 the latter frontier would be even more U shaped towards the southeast corner than the frontier implying no correlation (AZB).
2.2.2. The Optimal Portfolio Selection With Risk-Free Assets

The possible portfolio selections presented above have been based on risky assets exclusively. However, by constructing a portfolio including both risky and risk-free assets an investor will get superior mean-variance combinations compared to one with only risky assets. The Sharpe Ratio, also called reward to variability ratio, provides a measure for which will provide an investment opportunity set between risky assets and risk-free assets. When applied in the same context as the mean variance model presented by Markowitz (1952) it can be shown that it is preferable to combine risk-free and risky assets. Risk free-assets, usually T-bills, will have a standard deviation of 0 since it is risk-free and the line will, therefore, start from the point of their interest rate return and a standard deviation of 0. By combining these risk-free assets with risky assets from the efficient frontier there will be a straight line from 100 percent of the funds invested in risk-free assets and 100 percent invested in risky assets. The optimal set of choices will be along that line, which somewhere will be tangent to the efficient frontier of risky assets. The line to the tangency point is called the lending portfolio since it is the optimal portfolio which can be obtained when funds are combined between risk free assets and risky assets. The line can also be extended if the investor chooses to borrow funds at the risk-free rate and invest even more in the risky assets of the tangency point, called the borrowing portfolio. This will, in the same manner as
when lending funds, provide a superior portfolio choice compared to the efficient frontier with no lending or borrowing as it will prove a higher expected return compared to the risk undertaken (Sharpe, 1963, p. 286-287).

This is all illustrated in Figure 4, which contains examples with two different risk-free rates of return. The lending portfolio will be along point A and point B with the example of lower risk-free rate of return and the borrowing portfolio will be along point C and point D with the example of higher risk-free rate of return. The efficient frontier of risky assets will be FZBCG. The line from the risk-free return to point Z indicates a portfolio choice which is not efficient but obtainable through choosing the combination of risky assets on the efficient frontier corresponding to point Z.

![Figure 4: Optimal portfolio selections with risk-free assets.](source)

The line provided by the Sharpe ratio is called the Capital Allocation Line, CAL. It is possible to conclude through Figure 4 that all efficient portfolios with the best expected return compared to risk contains of both risk-free assets and risky assets. There are assumptions accompanied with this theory which will result in market equilibrium. The first assumption is that investors agree on the expected returns and, therefore, they all use the same input in their forecasting models. Secondly, lending and borrowing can be done at risk-free rate by all investors, independent of the amount. With this in mind all rational investors will derive the same opportunity set of efficient portfolios, including a combination of risk-free and risky securities. Further, since all investors see the same
efficient investment opportunities they will as a result invest in different combinations along the same CAL depending on their risk aversion. The different investors’ portfolios will, however, be perfectly correlated since different asset combinations on the CAL lie on a straight line (Sharpe, 1964, p. 433-436). Due to that all investors see the same investment opportunities through the CAL they must all hold a part of the market portfolio. The investors’ allocation to risky assets combined is equal to the total market portfolio. From here it is also possible to calculate the weight of each asset accompanied with risk in the market portfolio by dividing the total market value of one risky asset by the total market value of all risky assets (Fama & French, 2004, p. 26-28). Hence, the CAL is equal to the Capital Market Line, CML, which will be of importance to the CAPM discussed in following sections.

The Sharpe Ratio is obtained through the following equation:

\[ S = \frac{E(r_p) - r_f}{\sigma_p} \]  

Where

- \( S \) = The slope of the Capital Allocation Line
- \( E(r_p) \) = Expected return of the portfolio
- \( r_f \) = Risk-free rate of return
- \( \sigma_p \) = The standard deviation of the portfolio

As mentioned, the Sharpe ratio results in a line tangent to the efficient frontier, but it does not say anything about the amount to be invested in risky and risk-free assets depending on the investor’s risk aversion. There are ways of calculating the optimal portfolio for investors with different risk aversion levels which will show how much of the funds to invest in risky assets and how much to be invested in risk-free assets to match that investors preferences. This will, however, not be discussed in this thesis, since it will go slightly outside the scope of the study and is not a necessary knowledge for the overall understanding of the thesis. One can, however, conclude that the optimal portfolio choice, independent of risk aversion, is along the CAL due to the discussion above.

2.3. Asset-pricing Theories

There are a variety of different asset-pricing models and extensions of existing models in the field of finance. Perhaps the most common and well-known is the CAPM, but there are other models that are argued to capture the expected return of securities better than the CAPM. The CAPM is usually the starting point of where anomalies are discovered, which will be shown in this and following chapters.
2.3.1. Capital Asset Pricing Model

The Capital Asset Pricing Model (CAPM) is a model measuring a single asset's return and risk and the model is used frequently when assessing assets in a portfolio (Fama & French, 2004, p. 25). This is to compare with the CAL and CML which measures the return and risk of combinations of assets along the line of possible efficient portfolios.

Before starting to explain the CAPM concept it is useful to present the assumptions that are needed to be made when applying the CAPM. Consequently, (1) there is a common interest rate at which investors can lend and borrow. (2) Investors have the same expectations and homogeneous views regarding an asset's variables, such as expected return, standard deviation and correlation with other assets (Sharpe, 1964, p. 433-434). (3) Investors are risk-averse wealth maximizers. (4) Investors choose their portfolios based on return and risk over a single period. Finally, (5) it is assumed that there are no transaction costs or taxes (Black, Jensen, & Scholes, 1972, p. 79-80). Some of the assumptions presented are equal to the assumptions made for market efficiency, CAL and market equilibrium. Since these assumptions are widely included in many theories they are somewhat validated and consequently applied even though they seem unrealistic (Sharpe, 1964, p. 434).

Single assets are to plot above the CML which indicate their limitations in terms of return and risk compared to an optimal portfolio set on the efficient frontier which provide better return and risk values. The plots will be within the graph for E,V combinations (see the chapter for Modern Portfolio Theory) and will not show any sign of steady relationship concerning return and total risk. Nevertheless, it is possible to identify a consistent relationship between returns and systematic risk (market risk) for single assets (Sharpe, 1964, p. 437). An asset's covariance with the variance and changes of an efficient risky portfolio (i.e. the market portfolio) reveals this systematic risk, measured as the asset's beta (Fama & French, 2004, p. 28; Sharpe, 1964, p. 437). Beta is calculated as:

\[
\beta_i = \frac{Cov(r_i, r_m)}{\sigma_m^2}
\]

(7)

Where

\[Cov(r_i, r_m)\] = Covariance between the \(i^{th}\) security and the market

\[\sigma_m^2\] = The variance of the market

When doing the same variance test for all efficient E,V combinations and the assets that are included they will show the same relationship. Since this correlation is how a security correlates to an efficient combination of risky assets, of which it is a part, suggestively the market portfolio, it is not possible to eliminate through diversification, hence, it is the systematic risk. The beta obtained is further related to the asset's expected return and the prices will adjust so that the ones more correlated to the efficient combination will have a higher expected return and vice versa. With the price adjustments there will be a linear relationship between the beta and the expected return of a security, stating with a beta equal to zero for the assets not being correlated to the
market, thus, not carrying any systematic risk. These assets will be the risk-free assets. Thereby, the beta of a stock or other type of security will be a reflection of the expected return in market equilibrium (Sharpe, 1964, p. 438-442). The fact that beta is only reflecting the systematic risk is because, in the CAPM investors are assumed to hold diversified portfolios, eliminating all non-systematic risk. Even if beta is the essential variable in the CAPM formula it includes more variables than the beta, as it also include rates of returns which can be seen in equation (8). As indicated the CAPM formula will result in a linear relationship between the expected return of a stock and its risk in terms of beta value. The expected return is the risk-free rate plus the stocks risk premium, a risk premium which is the company's beta value multiplied with the expected return of the market minus the risk-free rate of return. The line that is derived through the CAPM formula is called the Security Market Line, SML. According to market efficiency, securities not lying on that line will quickly adjust through the transactions made by investors as they are either over- or undervalued (Mullins, 1982, p. 108). The concept of the SML and the CAPM is illustrated in Figure 5.

Figure 5: SML, the relationship between expected (average) return and beta.

The CAPM formula is the following:

$$E(r_i) = r_f + \beta_i(E(r_m) - r_f)$$

(8)
Where

\[ r_f = \text{Risk-free rate of return} \]
\[ \beta_i = \text{Beta coefficient of the } i\text{th security} \]
\[ E(r_m) = \text{Expected market return} \]
\[ E(r_m) - r_f = \text{Market premium} \]

In spite of its popularity and wide use, the CAPM is a theory exposed to much criticism. Berk (1995) and Fama & French (2004) are skeptical of the CAPM model, along with a number of other authors, as they argue that it does not hold in reality. The weakness of the model is claimed to be either because of flaws in the model itself or applications of the model in empirical tests (Berk, 1995, p. 282; Fama & French, 2004, p. 25). Berk (1995, p. 282) mention that the problems in empirical tests is that an efficient mean-variance portfolio is not used, causing the CAPM to fail. Fama & French (2004, p. 25) further report that unrealistic assumptions, such as unlimited borrowing and lending, are significant parts of the criticism directed towards the CAPM.

Fama & French (1992, p. 428) argues that the CAPM and its beta measure does not sufficiently capture the expected return of a security since market anomalies such as firm size and Book-to-Market ratios are not accounted for. Thereby, there are robust evidences showing that other variables do a better job in capturing the variations in expected return of securities than CAPM beta does. Consequently, if the beta does not capture the expected return of securities it would imply that the market is not efficient in the sense that CAPM suggests and, thereby, it would not hold as an asset-pricing model (Fama & French, 2004, p. 36). Evidence shows that the relationship between beta and the expected return is flatter than what is suggested by the CAPM, saying that low beta assets in reality have a higher return than what the CAPM suggest and vice versa (Black, Jensen, & Scholes, 1972, p. 44; Fama & French, 1992, p. 438). Further criticism towards the beta variable is presented by Jagannathan & Wang (1996, p. 4-5) who claim that the constant beta used by the CAPM is an unrealistic position since companies’ risks varies through business cycles. More detailed critical views of the CAPM and its beta measure is presented below, as both alternative asset-pricing models and market anomalies imply some sort of misspecification in the CAPM described above.

2.3.2. Alternative Capital Asset Pricing Models

The conditional CAPM is an alternative version of the unconditional and “original” CAPM, as it allows for the beta measure to vary across time and business cycles. Companies are exposed to changes in the market, as well as, whole business sectors are. As business sectors’ market share vary due to new market information, so will the betas and expected returns of corporations included in that sector will change. Thus, the beta measure of the CAPM should change to better explain the reality (Jagannathan & Wang, 1996, p. 5). Accordingly, Jagannathan & Wang (1996, p. 5) find that the conditional CAPM performs better in capturing the variations of average returns in a cross-sectional study. This is concluded when 30 percent of the variations in returns are explained by the conditional CAPM compared to merely one percent with the traditional CAPM. In a
more recent study, Lewellen & Nagel (2006) argue that the conditional CAPM does not capture variations in expected returns better than the unconditional version. The variations in the beta values are not sufficient to actually explain the anomalies which are missed by the unconditional CAPM (Lewellen & Nagel, 2006, p. 291-292). According to this finding neither the unconditional CAPM nor the conditional CAPM explain the variations in expected returns.

Another well-known version of the CAPM is the intertemporal modification (ICAPM) of the model. The basic version of CAPM assumes a single-period investment horizon, which will imply a constant opportunity set for portfolio maximization. ICAPM, on the other hand, does not assume the constant opportunity set for wealth maximizing investors but varying opportunity sets of a portfolio. As a consequence, the intertemporal investor will choose portfolios differently compared to the investor facing a constant opportunity set (Merton, 1973, p. 868). An intertemporal investor will have to consider a longer time horizon than a single period, which means the investor will have to take into account events in terms of returns in the current period and the forthcoming period and how they are to affect each other (Merton, 1973, p. 870). A single-period investor with no intention to change portfolio during that time would not have to make any portfolio decisions over that period. An intertemporal investor on the other hand will have to, except for this period, choose another portfolio set for the next period, since there are new events and returns to consider.

2.3.3. Arbitrage Pricing Theory

An alternative asset-pricing model to the CAPM is the Arbitrage Pricing Theory (APT) which, among other issues, eases on the assumptions made compared to the CAPM. For instance, the APT is valid as an asset-pricing model even though the market is not in equilibrium and the market portfolio is not an important cornerstone (Ross, 1976, p. 343). Unlike the CAPM with its single measure of systematic risk, the APT identifies several types of systematic risk that all affect a security’s return (Shanken, 1982, p. 1130). The systematic factors in the APT are found by Roll & Ross (1984, p. 123) to be unpredictable changes in inflation rate, overall production for a specific industry, risk premiums and the term structure of interest rates.

Since the APT model consists of more than just one factor for systematic risk it is necessary to evaluate the securities’ sensitivity to each of these four-factors. How this is done is not going to be discussed here, see Roll & Ross (1984) for explanation of sensitivity. However, as the sensitivity (factor beta) is higher the asset will go through greater price fluctuations along with the systematic factors, compared to those assets that have a low sensitivity. The main concept of the sensitivity is the same as the beta under the CAPM, except here the sensitivity is measured and considered on four levels of systematic risk, in contrast to one. As a security’s factor beta is one its return will change in the same extent as the systematic factor and if the beta is 0,5 the return will change less. If the factor beta is shown to be 0, the asset will be independent of that particular systematic factor and so on. This is valid for both downturns and upturns for the systematic factors (Roll & Ross, 1984, p. 127). Resembling the CAPM, there will be a linear relationship between expected return and the sensitivity of an asset and investors can expect higher return by taking on more risk. Due to efficient markets under- and overpriced assets will adjust to equilibrium and investors can, thereby, not
expect arbitrage opportunities and more return than what is reflected in their willingness to take on risk (Roll & Ross, 1984, p. 124-125).

Comparing different systematic risks of a security to each other in the APT will give the possibility to see which risk is affecting that particular security. As an example, an asset may have a high beta value concerning inflation but low beta value on production. Assets with different combinations of sensitivity to systematic factors in the APT may have equal CAPM betas. However, the APT shows that they are not related to systematic changes in the same manner and can, therefore, not be seen as equally risky, except possibly in the long run when the systematic changes plausibly offset each other. The assets are, however, exposed to different types of risk when one of them might be considerably less affected by inflation than the other. The knowledge provided by the APT and the variety of sensitivity to systematic changes for a group of assets can be used to build hedging strategies in a portfolio (Roll & Ross, 1984, p. 128-130). Since the APT is not going to fit directly in to the scope of this thesis it will not be discussed further into detail, however, for more details concerning the APT, see for instance Ross (1976), Shanken (1982) and Roll & Ross (1984).

2.4. Stock Market Anomalies

Berk (1995, p. 284) define an anomaly as: “An ‘empirical anomaly’ is, by definition, an empirical fact that cannot be supported by prevailing theory”. Schwert (2002) also defines an anomaly as an empirical finding which is not possible to explain with available and maintained theories within the asset-pricing academia. Further, market anomalies either uncover market inefficiency or misspecifications in the asset-pricing models which are used to calculate the expected return of an asset. A discovery of an anomaly, indicating an inefficient market, will also stress the reliability of the asset-pricing models assuming an efficient market. However, for an anomaly to indicate an inefficient market it must be profitable for investors to trade on it, otherwise it is not “economically significant” and would not imply an inefficient market. As the anomalies are discovered they tend to disappear. The anomaly can disappear when traders take advantage of the anomaly to earn arbitrage profits and, therefore, adjust prices to a level where the anomaly disappears. Sample bias, where the researchers sample is the only sample indicating an anomaly can also be an explanation of why anomalies disappear since they in this case do not exist outside the researchers selected sample (Schwert, 2002, p. 1-3). In other words, in theory, investors cannot know about the presence of anomalies or the anomalies are specific to the research uncovering it, indicating data snooping (Lakonishok, Shleifer, & Vishny, 1994).

Marquering, Nisser & Valla (2006) continue to take a critical stand towards the anomalies that reappear time after time in one scientific article after another. They claim that either the anomalies exist because of data snooping or that all studies are done with the same data, generating the same results. To avoid this problem new data must be the base for anomaly testing. An anomaly should disappear with the new data since there is no longer a case of data snooping and the anomalies that have been discovered historically should have disappeared as investors have been taking advantage of it (Marquering, Nisser & Valla, 2006, p. 291-292).
2.4.1. Small Firm Effect

Banz (1981) finds that firm size, measured as the market capitalization, is an explanatory variable to abnormal return that asset-pricing models, suggestively the CAPM, do not capture. The smallest firms account for the largest abnormal returns but there can, however, not be any linear relationship identified where unexplained returns decrease as the market capitalization of companies increases. Continuously, this firm size effect, also referred to as the small firm effect, is not stable over time as the degree of abnormal returns yielded by small firms is subject to variations (Banz, 1981, p. 11). Berk (1995) also find that the market capitalization of companies has an explanatory power of the returns that are not captured by the CAPM and can, therefore, be used as a variable in an asset-pricing model to capture the return not originally explained (Berk, 1995, 275; 280). Consequently, as the firm size variable is accounted for in an asset-pricing model there should be no more abnormal returns which can be traced to the firm size (Berk, 1995, p. 285). Fama & French (1992, p. 452) also find the size anomaly and state that it is present as a proxy for risk and should be considered in asset-pricing, indicating that small firms are riskier than large firms. The firm size anomaly appears to be more obvious in the month of January as small firms have a considerably higher risk adjusted return in this month compared to other months of the year (Rogalski & Tinic, 1986; Keim, 1983). Keim (1983, p. 31) concludes that half of the abnormal returns in January can be traced to the first week of January. Rogalski & Tinic (1986) studies the January effect to find that it is not only firms with low market capitalization that have higher returns during January, but it is more evident for small firms (Rogalski & Tinic, 1986, p. 69).

Excluding the fact that the small firm effect appears to be more evident in the month of January there are several explanations for its existence. In Banz (1981, p. 16-17) it is speculated that the lacking information available about small firms causes them to have fewer investors than firms with a wider range of information and, thereby, a better possibility to take informed investment decisions about. The consequence of a relatively low investor base explains the firm size effect as these companies have higher return. Now, including the January factor, herein associated with the small firm effect, there is an additional motivation for its existence. The January effect is said by Schwert (2002, p. 5) to be a result of the high volatility that is usual for small firm stocks. As the volatility is higher for small firms, the chance for shareholders to have an investment loss by the end of a year on these stocks is higher, encouraging investors to sell them at this time to realize the losses in their income taxes. Prices of small company stocks will fall at the end of the year, to then at the beginning of next year increase in price since investors repurchase these stocks to again add balance and diversification to their portfolios. This trading due to tax reasons will increase the expected return of small firm stocks since their prices are to rise at the month of January.

Even though there is evidence showing that small firms have higher abnormal returns than larger firms, there are a number of critical opinions arguing that this size effect is not an anomaly. Rogalski & Tinic (1986, p. 69) claim that the small firm effect in January is not a market anomaly since it can be explained by using the varying form of beta measure. Small firms have according to Rogalski & Tinic (1986) considerably higher beta in the month of January. Along with that the expected return of the market as a whole increase in January, but the risk-free rate is not subject to any similar changes resulting in an increased market premium. Thereby, the, by other authors,
suggested anomaly can be explained due to the changing variables in the CAPM formula in January. Further, Berk (1995, p. 284) concludes that returns not captured by the CAPM can be explained by the characteristics of firm and that it should not be seen as an anomaly. The reasoning behind this position is that Berk (1995) shows theoretically, that there is an inverse relationship between firm size in terms of market capitalization and return and with a theoretical motivation for the phenomenon it cannot be regarded as an anomaly.

Chan & Chen (1988) criticize the suggested firm size anomaly as they find that, the firm size’s explanatory power of returns not captured by the CAPM can, instead, be explained by the unconditional beta measure and a larger data sample. Chan & Chen (1988, p. 323) use the unconditional beta for five and 34 years to measure the abnormal returns of small company stocks. The findings are that, the small firm effect disappears as 34 years are used to assess the unconditional beta, whereas the effect does not disappear with a five year sample. The sample size used is, therefore, highly relevant when applied to unconditional CAPM to eliminate the firm size’s explanatory power of returns that CAPM fails to measure.

Further, Stoll & Whaley (1983, p. 74) state that there is no small firm effect if transaction cost is considered, in fact, they find a reversed relationship between small and large firms, where the large firms outperform small firms, taking into account the transaction cost. What Stoll & Whaley (1983) imply is, therefore, that the firm size effect still exists, but that it has a reversed effect where large firms, not the smaller ones, show positive excess returns. These results are based on a one month holding period and transaction costs thereafter, since returns are examined every month. As the holding period is increased the small firm effect seems to recover, but not to an extent which makes it statistically significant (Stoll & Whaley, 1983, p. 77-78). Schultz (1983) reproduces the study made by Stoll & Whaley (1983) but reduces the firm size of the companies included and increases the transaction costs. Schultz (1983, p. 87) concludes that the transaction cost cannot motivate the abolishment of the small firm anomaly as he found that small firms have an abnormal return even in the period of one month, when a January month is included. Thus, a counter argument is put forward concerning the transaction cost’s abolishment of the small firm effect and an additional confirmation of the January effect is provided.

In a more recent study Marquering, Nisser & Valla (2006) find by examining other research done in the field of the small firm effect that, the anomaly is not a consistent one over time making it risky to speculate on. The firm size anomaly seems to appear and then disappear causing no particular explanation for its existence or pattern. This particular anomaly has even been shown to reverse at times. A study done by Schwert in 2003 even suggests that the size anomaly is no longer identifiable, and, thereby, gone, since it was first uncovered in 1981 by Banz. An explanation for this might be that the investors have become aware of the anomaly and, thereby, eliminated it by trading or the results in previous research have been similar due to data snooping (Marquering, Nisser & Valla, 2006, p. 299-300). All the results presented have been conducted with data from either the US, another single country, multiple countries or on an international basis. To our knowledge there is no strong and scientifically valid research documenting the small firm anomaly in Sweden which leaves this topic highly suitable for further investigation and research.
2.4.2. Book-to-Market

Fama & French (1992), Lakonishok, Shleifer, & Vishny (1994), Kothari & Shanken (1997), La Porta, Lakonishok, Shleifer, & Vishny (1997), Lewellen (1999) and Ali, Hwang, & Trombley (2003), among others, find that there is a strong relationship between stock performance and the Book-to-Market ratio of a company. However, there is not any consistency between researchers in the explanation of why this anomaly appears in the market, as there are two different arguments. One side suggesting that it exists because of risk compensation; indicating that firms with a high BE/ME (Book Equity/Market Equity) ratio are riskier and should, therefore, compensate investors with higher return. The other side is stating that the anomaly appears due to over- and undervaluation of future earnings (Ali et al., 2003, p. 356).

According to Fama & French (1992), the companies with a high BE/ME ratio have substantially higher average return than those with a low BE/ME ratio. Continuously, they connect these findings to be a compensation for risk as companies with a high BE/ME ratio, probably, have met a decrease in stock price and indicating poor earnings and distress (Fama & French, 1992, 441; 452). This argument is also presented in other studies, such as Fama (1998). Fama (1998, p. 286), further argues that ratios capturing stock prices, such as the BE/ME ratio, is a measure of past performance. Companies with a high BE/ME ratio are those who have had a poor historical performance and are accordingly considered as riskier.

The other argued explanation of why the Book-to-Market anomaly exists is expectational errors made by investors in terms of over- and undervaluation of stocks, not underlying risk per se. Arguments on this side is presented through the terms value and glamour stocks, where a high BE/ME ratio is value stocks and vice versa. Lakonishok et al. (1994) argue that value stocks have higher return than glamour stocks because of investment behavior, not because of underlying risk. There is a trend indicating that investors overrate information and, thereby, prefer to invest in companies that have a good past performance causing the prices to increase, making them glamour stocks. However, the investors with a strategy of investing in value stocks are shown to outperform the glamour investors simply because the investors choosing glamour stocks hold them too long until their prices eventually decrease. Hence, inconsistent with the argument of Fama & French (1992) and others, Lakonishok et al. (1994) claim that value stocks are not carrying any more risk than glamour stocks, signifying that the risk reward concept cannot explain the Book-to-Market anomaly (Lakonishok et al., 1994, 1542; 1574). An overdue long holding period is not the only explanation of the Book-to-Market anomaly by this group explaining it through behavioral finance. Thus, it is shown that earnings announcements affect value and glamour stocks differently. After an earnings announcement the value stocks show a higher return compared to the glamour stocks. Further, the explanation for this is motivated to be expectational errors made by investors, causing a stock price overvaluation on basis of a high BE/ME company’s earnings announcement. Hence, there will be systematic errors in pricing (La Porta et al., 1997, p. 860; 863; 873). A systematic error in pricing is relatively easy to identify and, therefore, arbitrage opportunities should disappear.

Ali et al. (2003) discover a connection between both of these two arguments, volatility and investor behavior. Professional arbitragers are risk averse which forces them to avoid high BE/ME stocks with have high volatility. The anomaly is, thereby, found to be more apparent for stocks held by less sophisticated owners as they do not discover
the anomaly and take advantage of it. There is also a connection to high transaction cost as non-professional investors are more sensitive to the transaction costs. Accordingly, as the owners of high BE/ME ratio stocks are not big, professional investors the anomalies will be left undiscovered or not exploited due to high transaction costs. Consequently, the anomaly will exist as there are no price adjustments due to arbitrage actions which is an effect caused by a risk averse profession and volatility (Ali et al., 2003, p. 355-356). In contrast, Gaunt (2004) study the Australian stock market where there seems to be no indication of the Book-to-Market anomaly as the BE/ME ratio appears to have no explanatory effect on abnormal returns (Gaunt, 2004, p. 40).

As with the small firm effect the anomaly concerning the Book-to-Market ratio of companies has sparse scientific base concerning the Swedish stock market which also leaves this possible anomaly open for a thorough investigation.

2.4.3. Momentum

With portfolios constructed on previous returns over three to five years it is reported that previous long-term losers outperform long-term winners with a holding period of the same time span, three to five year. Hence, the losers generate a return higher than the market while this is not done by the winners (De Bondt & Thaler, 1984, p. 799). A few years after this finding by De Bondt & Thaler (1984), Jegadeesh (1990) reports the opposite situation when portfolios are formed on the basis of only one month lagged returns. The findings support a predictive ability of future stock returns based on one month historical returns. The stocks considered to be winners, with high returns the previous month, generate abnormal returns the coming month, whereas the losers continue to perform poorly, indicating a momentum effect (Jegadeesh, 1990, p. 889-891). Jegadeesh & Titman (1993) further investigates the momentum effect over a longer time horizon compared to the study made in 1990. The time horizon used here is a spectrum of 3 to 12 months, medium-term, concerning both portfolio holding period and past performance evaluation. All combinations of holding periods and historical evaluation horizon will result in an excess return as the investors sell past losers and buy past winners. The past winners are thereby, again, proven to outperform the losers, strengthening the theory of momentum in financial markets (Jegadeesh & Titman, 1993, p. 70). Jegadeesh & Titman (2001) strengthen their findings in 1993 by conducting an out of sample study eight years later and find the same results. Similar results, suggesting that medium-term winners outperform medium-term losers with abnormal returns, are found by Chan (1996), Rouwenhorst (1998), Maskowitz & Grinblatt (1999), among others. Rouwenhorst (1998, p. 268) also find that this momentum effect lasts for about a year and is not at all related to size and firms with different sizes show nearly equal momentum effects.

Many studies turn to behavioral finance and market underreactions on new information instead of a risk return relationship as they attempt to explain the momentum phenomenon. Jegadeesh & Titman (1993, p. 89-90) conclude that the momentum effect is not due to risk factors but to underreaction on earnings announcements by investors causing a gradual price adjustment. Moreover, Chan, Jegadeesh, & Lakonishok (1996) examine whether market underreactions on earnings and earnings announcements are behind the momentum effect. The reason doing this is because it is shown that stocks of companies that are delivering an earnings announcement better than what is expected outperform those companies that announce insufficient earnings in comparison to what
is expected from them. This advantage in return is consistent for six months, reflecting an underreaction since the information provided is not directly reflected in the stock prices, but is instead gradually incorporated (Chan et al., 1996, p. 1682). Along with this explanation, there is the price momentum that is built on previous stock returns where winners continue to report abnormal returns in the future. Chan et al. (1996, p. 1683-1684) find that both of these momentum strategies described are valid and can be used to predict future abnormal returns over a time horizon of three to twelve months. Additionally, these two methods of forecasting returns are not mutually exclusive indicating that both momentum strategies can be used in prediction. Nevertheless, the price momentum has been shown to have stronger explanatory power and be more robust over longer periods compared to the earnings momentum (Chan et al., 1996, p. 1693).

Hong & Stein (1999) take another path to explain the momentum effect and focus on the interaction between different kinds of investors, those that are referred to as “news watchers” and “momentum traders”. The news watchers base their price forecasts on observed fundamental information but do not incorporate historical stock prices in their predictions. The momentum traders do the opposite, as they look solely on price levels to make their predictions. The fundamentals, which news watchers base their forecasts on, are gradually spread over their area causing an underreaction and stock prices slowly adjust to their intrinsic value. The momentum traders look only at historical prices and, thereby, do not know the intrinsic value of the stock, then enhance the gradual price adjustments made by news watchers. Since the momentum traders, by definition, do not base their forecasts on intrinsic values based on fundamentals they do not know what the right price is, which can cause an overreaction to the available price increasing information. In this sense, the stocks will become overpriced and the momentum anomaly a fact (Hong & Stein, 1999, p. 2144-2145).

When simplifying Johnson’s (2002, p. 585-586) arguments, the momentum anomaly is connected to risk and not behavioral factors. Johnson (2002) reports that risk is associated with the abnormal returns as the firms that are in an upwards momentum experience higher growth rates. The growth rates are, by definition, a measure of risk indicating that a positive momentum is connected to an increased risk due to growth. In contrast, measuring risk with company beta, Rouwenhorst (1998, p. 277-278) finds that risk provides no explanation for the momentum effect since the betas between winners and losers are not very different from each other.

Another point of view on the momentum effect is presented by Maskowitz & Grinblatt (1999) as they argue that the momentum effect is more evident and more profitable when examining industries instead of individual stocks. A connection between industry momentum and individual stocks momentum is also found where the individual winners are usually from the same industry. Considering this, an investment strategy built on momentum is not a good strategy in terms of diversification, since many of the winner stocks belong to the same industry. The industry momentum is also shown to be strongest over a very short time horizon, suggestively one month (Maskowitz & Grinblatt, 1999, 1250; 1286).

Contradictory to all the research presented above, there are studies reporting findings that are evidence against the arbitrage possibility through momentum investment strategies. Among them are Lesmond, Schill, & Zhou (2004) who report that the
momentum effect over a six month period is not a profitable trading strategy for investors because of the transaction costs that are associated with it. The trading costs are significantly higher than what have been found to be earlier. Connected to this there is a study implying that momentum strategies is not always delivering excess returns as they tend to disappears when amounts between $4.5 to $5 billion are investment in such a strategy (Korajczyk & Sadka, 2004, p. 1040).

Parmler & Gonzalez (2007) study the momentum anomaly both on the Swedish stock market and the US stock market to find that both these markets carry a momentum factor. The study contained all Swedish stocks on the Stockholm Stock Exchange between 1979 and 2003, and all stock on NYSE, AMEX and NASDAQ between 1963 and 2004 for the US sample. The ranking period of this study is 6 and 12 months and the hold period is between 3 and 12 months. A momentum investment strategy of individual stocks is concluded to provide the investor with significant profits. However, when Parmler & Gonzalez form portfolios with a range of stocks based on size, Book-to-Market and industry the momentum factor becomes weak or inexistent. Nevertheless, sorting portfolios by industry appears to be the best way to use the portfolio momentum strategy since they provide the investor with the highest profit of the sorting alternatives. Size formed portfolios show an increasing return for losers and a decreasing return for winners as time pass, but the momentum spread is still evident even 12 months after portfolio formation (Parmler & Gonzalez, 2007, p. 310; 314).

The anomalies mentioned above are denoted as such, because the equilibrium asset-pricing model cannot explain them. This has two possible alternative implications: one, that the market is inefficient or, two, that the underlying equilibrium model is incorrect. The equilibrium model we are referring to is, of course, the CAPM; and it has been that for a long time. This study intends to find which of the three (CAPM, Fama-French or Carhart) asset-pricing models captures most of the cross-sectional variation in stock returns and explains the market anomalies such as, size, Book-to-Market equity and momentum. On that account, the presence of the anomalies in question has to be observed first before going into asset-pricing model tests. With this in mind, we formulate the following hypotheses that will be tested later in this study:

Hypothesis 1: A firm's market capitalization (size) has no impact on its stock returns.

Hypothesis 2: The ratio of a firm's Book Equity to Market Equity has no impact on its stock returns.

Hypothesis 3: The stock returns of a firm are not affected by short-term past returns.

2.5. **CAPM vs. Fama & French three-factor model**

CAPM is notoriously known to be unable to explain the size and Book-to-Market ratio effects on stock returns, along with other anomalies. That is actually why they are called anomalies – because CAPM cannot explain them. Fama and French's (1992) magnum opus put beta on shame, showing that beta on its own does not explain cross-sectional variation of average stock returns. Taking into account the well-known anomalies of stock returns being related to firm characteristics, such as, size, leverage, Book-to-
Market equity ratio and E/P ratio, Fama & French (1992) test whether the cross-section of stock returns can be explained given those firm characteristics are accounted for in the asset-pricing model. They find that size and Book-to-Market equity ratio capture the cross-sectional differences between stock returns. The effects of leverage and E/P ratio on average stock returns are also absorbed by the two aforementioned factors. However, they find no significant relation between average returns on US stocks and their betas during the period from 1963 to 1990. Similar to Fama & French (1992), Lam (2002) finds evidence against beta on Hong Kong Stock Exchange. Lam (2002) comes to conclusion, that size, Book-to-Market and E/P ratio combined together capture the cross-sectional of average stock returns in Hong Kong. Fama & French (1992) conclude that Book-to-Market and E/P ratios of US stocks are related, which is the same conclusion that Asgharian & Hansson (2000) reach for the Swedish stocks, and including the E/P factor in the model is redundant. Backed by their findings in 1992, Fama & French (1993) form a three-factor asset-pricing model, which includes not only the size factor and Book-to-Market factor, but also the market factor, which is represented by the excess return on market portfolio over the risk free rate. Fama & French (1993, p. 38) state that

the size and Book-to-Market factors can explain the differences in average returns across stocks, but the market factor is needed to explain why stock returns are on average above the one-month bill rate.

So, the market factor, familiar to us from the CAPM, still remains significantly relevant. However, on its own, the market factor does not fully capture the return variation across stocks and that variation is well captured when the size and Book-to-Market factors are added (Fama & French, 1993, p. 19-21)

The three-factor model proposed by Fama & French (1993) is displayed below:

\[ E(R_i) - R_f = b_1[E(R_M) - R_f] + s_iE(SMB) + h_iE(HML) \]  

(9)

\( E(R_i) \) is the expected return on stock \( i \), \( R_f \) is the return on risk free asset, \( E(R_M) \) is the expected return on market portfolio, \( E(SMB) \) is the difference between expected returns on portfolios of small stocks and expected returns on portfolios of big stocks (SMB stands for Small Minus Big) and \( E(HML) \) is the difference between expected returns on portfolios of High Book-to-Market ratio stocks and Low Book-to-Market ratio stocks.

The results of their empirical tests lead them to a conclusion that CAPM outperforms the Fama & French (1993) three-factor model. Although, one has to keep in mind that other researchers have also used the three-factor model to explain the cross-section of average stock returns in different countries and arrived at varying conclusions. Connor & Sehgal (2001) confirm the findings of Fama & French (1993) that CAPM does not capture cross-section of stock returns, but the three-factor model does. Connor & Sehgal (2001, p. 9) test the models on the Indian stock market and, interestingly enough, find a negative size premium. Misirli & Alper (2009) compare CAPM, Fama & French (1993) three-factor model and several other versions of asset-pricing models built upon the Fama & French (1993) three-factor model using data from the Istanbul Stock Exchange. The results of their empirical tests lead them to a conclusion that CAPM outperforms the Fama & French (1993) three-factor model. Although, one has to keep in mind that
the Istanbul Stock Exchange is a developing market and might differ from that of
developed countries and, in addition, the time period analyzed is a rather short one,
1996-2005. Nevertheless, their results cannot be disregarded. Another study, conducted
in New Zealand by Nartea et al. (2009), finds that, even though the addition of the size
and Book-to-Market factors to the CAPM increases the descriptive powers of the
model, the magnitude is lower than expected when compared to the findings of Fama &
that the three-factor model does not capture the cross-section of all the European stocks.
They use stocks listed on 16 European countries, including Sweden. However, their
tests are not done country by country but by combining all countries into one European
market. To our knowledge, there are very few studies that focus specifically on the
Swedish market. Fama & French (1998) include Swedish stocks when they test the
applicability of the three-factor model in the international market. Though, the data they
use includes only large Swedish stocks and, again, the tests are done for the entire
international market rather than focusing on testing the model country by country.
A study done in Europe, by Bauer, Cosemans & Schotman (2010) finds
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applicability of the three-factor model in the international market. Though, the data they
use includes only large Swedish stocks and, again, the tests are done for the entire
international market rather than focusing on testing the model country by country.

In order to find which of the two asset-pricing models captures the cross-section of
stock returns related to the size and Book-to-Market effects better we formulate the
following hypothesis:

Hypothesis 4: CAPM can explain the cross-sectional stock return variation
caused by size and Book-to-Market effects better than the Fama &

2.6. Carhart’s Four-factor Model

Fama & French (1996) further test whether the three-factor model can explain the
relationship between average stock returns and E/P ratio, Cash Flow/Price ratio, sales
growth, the long term past returns and short term past returns. The three-factor model
performs well in all cases except when it comes to the short term past returns
(momentum effect). Nartea et al. (2009) also find similar results when they test whether
Fama & French (1993) three-factor model can capture the continuation of short-run past
return patterns. The three-factor model cannot describe stock return variation related to
the continuation of short run return patterns in the future. Bauer et al. (2010) confirm
these findings in their pan-European study, where they find that Fama & French (1993)
model cannot explain the momentum effect that is present in Europe.

Granted the momentum effect is robust across different stock exchanges and different
time periods, that is, it is not just a result of spurious data-snooping, the failure of the
three-factor model to explain this anomaly can be alleviated by adding another factor, as
suggested by Fama & French (1996). A factor which would engross the momentum
effect. Carhart (1997) modifies the three-factor model by including an additional factor
that embraces one year momentum effect on stock returns. The four-factor model does a
good job in explaining the cross-sectional variation of average stock returns as it
“substantially improves the average pricing errors of the CAPM and the 3-factor model” (Carhart, 1997, p. 62). Carhart’s (1997) four-factor model is presented below:

\[
E(R_i) - R_f = \beta_1[E(R_M) - R_f] + \beta_2E(SMB) + \beta_3E(HML) + \beta_4E(WML)
\]  
(10)

Where, \( E(WML) \) is the difference between expected returns on the winner portfolio and the loser portfolio. The winner portfolio consists of top 30% of stocks ranked on past one year performance, while the loser portfolio contains the bottom 30% (See Method chapter for further details). It should be noted, however, that the momentum factor is purely empirically based. It is not a risk factor and there is no theoretical explanation or motivation behind it. On the other hand, the size and Book-to-Market factors can be considered as risk factors, as Fama & French (1993) stipulate. However, it is not the scope of this thesis to investigate why certain factors explain stock return cross-section.

Adding a momentum factor in hopes of it explaining the past return effects on stock return cross-section has shown varying results among different researches. Avramov & Chordia (2006, p. 1026-1027) conclude that the momentum factor does not help in explaining the effects of neither past three, six nor 12 month returns on the cross-sectional variation of NYSE stocks and NYSE-AMEX-NASDAQ stocks. It is worth noting, however, that their study is done on individual stocks, unlike many other studies that conduct tests on portfolios of stocks. Nartea et al. (2009, p. 195), on the other hand, show that adding the momentum factor into Fama-French three-factor model does, in fact, capture the past returns effect on the New Zealand Stock Exchange. They show this by using portfolios of stocks.

To test the ability of the asset-pricing models to explain the momentum effect we formulate the following hypotheses:

**Hypothesis 5:** CAPM can explain the cross-sectional stock return variation caused by short-run past returns better than the Fama & French (1993) three-factor model and Carhart’s (1997) four-factor model.

**Hypothesis 6:** Fama & French (1993) three-factor model can explain the cross-sectional stock return variation caused by short-run past returns better than CAPM and Carhart’s (1997) four-factor model.

**Hypothesis 7:** Carhart’s (1997) four-factor model can explain the cross-sectional stock return variation caused by short run past returns better than CAPM and the Fama & French (1993) three-factor model.

### 2.7. Conditional Asset-pricing Models

The failure of the asset-pricing models could well be due to their assumptions of a static nature of risk. Conditional asset-pricing models are found to perform better than their unconditional counterparts. Bauer et al. (2010) conclude that the conditional version of Fama & French (1993) three-factor model does a better job in capturing the Book-to-Market, size, as well as, momentum related cross-section of European stock returns.
The success or failure of a conditional asset-pricing model, of course, depends on what
the model is conditional on. For instance, Avramov & Chordia (2006) test CAPM, first,
with a static beta, then, with a conditional beta to check whether CAPM’s explanatory
ability increases if beta is conditional. They find that CAPM fails in both cases.
Although, they use individual stocks instead of forming portfolios; and the conditioning
method used is not a time-varying conditioning per se, but one that considers the effects
of firm size and Book-to-Market equity ratio in combination with the default spread,
beta by estimating it through time series regressions, where a firm’s beta is dependent on
i) size and Book-to-Market ratio of a firm; ii) the default spread; and iii) size, Book-to-
Market ratio and the default spread. Thus, they have three model specifications for a
conditional beta and none of them succeeds in saving CAPM from failing to explain the
market anomalies like, size, Book-to-Market, momentum and turnover effects. In
contrast to Avramov & Chordia (2006), Bali et al. (2009) estimate conditional betas by
using three different conditioning methods: autoregressive (AR), moving average (MA)
and generalized autoregressive conditional heteroskedasticity (GARCH) models. Their
empirical findings show that each of the three alternative conditional betas can explain
cross-sectional differences in stock returns even after controlling for size, Book-to-
Market and momentum effects. One issue, as we see it, with the approach used by Bali
et al. (2009) is that they estimate betas from daily stock returns. This practice would
significantly impact the estimated beta values, because of high levels of noise in daily
price movements. It is rather problematic, and especially so for illiquid stocks, to
correctly estimate the covariance of a daily stock return with that of the market. That is
why most of the studies use monthly data, so as to avoid some of the issues related to
market microstructure.

There are other approaches to conditioning the asset-pricing models that are more
practically convenient. One of them is the “up” and “down” market approach. It implies
that the asset-pricing model, be it CAPM or any other model, should account for the
positive and negative risk-return relationship. Pettengill et al. (1995) introduced the
conditional relationship between beta and stock returns by conditioning the beta on
excess market return. Pettengill et al. (1995) argue that there is an inverse relationship
between beta and stock returns when the market return is below the risk-free rate and
the omission of this relationship by static version of CAPM would result in wrong
conclusions, that CAPM cannot explain cross-section of stock returns. Indeed, when \( r_m \)
is less than \( r_f \), then \( \beta^*(r_m - r_f) \) is a negative value, which means that the higher the beta,
the lower the stock return (\( R_i \)), since

\[
R_i = R_f + \beta^*(R_m - R_f)
\]  

(11)

So, assuming a positive relationship between beta and returns at all times is not valid.
Pettengill et al. (1995) reason that, the CAPM describes relationship between expected
return and beta, however, all the empirical tests of asset-pricing models are done using
realized returns. It is known that an expected return is a sum of possible return outcomes multiplied by their probabilities:

\[
E(R) = \sum_{i=1}^{n} r_i \times p_i
\]  

(12)
CAPM implies a positive relationship between beta and expected returns. Moreover, it implies expected market return $E(R_M)$ to be higher than the risk-free rate of return. This means that there should be a possible market return outcome which is lower than the risk-free rate $r_m < r_f$ with a probability $p_i > 0$. Thus, when using realized returns one needs to take into account events when the realized market return is lower than the risk-free rate of return. This leads to inferences that beta is conditional on market states. Fletcher (2000) tests the up-down market approach of Pettengill et al. (1995) on an international market using 18 different countries, including Sweden. He uses the return on MSCI World Index as the market return and finds that there is a significant positive relationship between beta and return during up market and a significant negative relationship during the down market conditions. Fraser, Hamelink, Hoesli & Macgregor (2004) test the same approach in the UK and find a rather weak support for the cross-sectional relationship between beta and return. Crombez & Vander Vennet (2000), on the other hand, conclude that the CAPM conditional on market states does perform better than the unconditional CAPM in the Brussels Stock Exchange during the period of 1990-1996. They find that the unconditional CAPM cannot account for the cross-sectional differences among stock returns, however, this changes when they implement the conditioning approach proposed by Pettengill et al. (1995).

The Pettengill et al. (1995) approach has not yet been tested in Sweden. This thesis intends to accomplish that. For that purpose the conditional Capital Asset Pricing Model has to be specified as shown below:

$$E(R_i) - R_f = \beta_{up} (R_M - R_f) + (\beta_{down} - \beta_{up}) (R_M - R_f) \times D$$

Where,

$D$ is a dummy which equals to one when $(r_m - r_f) < 0$; and equals to zero when $(r_m - r_f) > 0$.

The above stated dual-beta model is an adaptation of Bhardwaj & Brooks (1993) dual-beta model. We augment their model by defining the up and down markets to correspond to the Pettengill et al. (1995) approach. Bhardwaj & Brooks (1993) use a different specification for the up (bull) and down (bear) markets. They consider a market to be in up or down state when the market return is above or below the median market return for a certain period. However, this approach would give different results if different periods are used, since the median would change as the time frame changes. Thus, we choose Bhardwaj & Brooks (1993) dual-beta model specifications and define the dual betas according to Pettengill et al. (1995).

CAPM conditioned on market states should now be able to capture the cross-section of stock returns. Thus, we formulate and test the following hypothesis:

**Hypothesis 8:** Conditional CAPM captures the cross-sectional stock return variation caused by size, Book-to-Market and momentum effects better than the unconditional CAPM.

It would also be of interest to observe the performance of the other asset-pricing models when the excess market return is conditional on the market state. Of course, the most parsimonious model is to be preferred. Consequently, the Conditional Fama & French (1993) three-factor and Carhart (1997) four-factor models are specified as shown below:
Conditional three-factor model:

\[
E(R_i) - R_f = b_{up}(R_M - R_f) + (b_{down} - b_{up}) \times (R_M - R_f) \times D + s_iSMB + h_iHML
\]  

(14)

Conditional four-factor model:

\[
E(R_i) - R_f = b_{up}(R_M - R_f) + (b_{down} - b_{up})(R_M - R_f) \times D + s_iSMB + h_iHML + w_iWML
\]  

(15)
3. Method

The Method chapter contains the discussion about our scientific approach to the issue in hand, coupled with the practical method where we thoroughly describe the methods and processes applied in this study to obtain the results that are presented later in Chapter 4. This chapter will also present some descriptive statistics of the data used.

3.1. Preconceptions

Both of the authors have studied Finance at the Master’s, as well as, Bachelor’s level and have received the fundamental knowledge of financial theories, such as, the efficient market hypothesis, the financial market anomalies, modern portfolio theory and the CAPM. Neither of the authors has any professional experience related to financial theories used in this thesis, thus, the knowledge is only theoretical. The results and conclusions that we arrive at in this paper are in no way affected by our preconceptions. This is largely due to the nature of the scientific approach adopted in this thesis. Quantitative methods rely heavily on objective and hard evidence.

Since both of us have studied various finance related courses we have encountered the Capital Asset Pricing Model quite often and there was very little focus on alternative asset pricing models. The weaknesses of the CAPM have been taught during the finance classes, however, no alternative models have been presented. The interest in doing a research on cross-section of stock returns was strengthened after having read a couple of articles presenting evidence that undermines the CAPM’s validity. We were curious to find out whether the cross-section of stock returns could still be explained by the CAPM or was the CAPM really dead. If CAPM were no longer viable, then which models could take its place?

3.2. Literature Search

The search for relevant literature was conducted mainly through databases that are available at the Umeå University Library. These include: Business Source Premier (EBSCO), which is a full text business database that covers areas, such as, management, economics, finance, accounting and international business; Emerald Fulltext – a research database with over 35 000 peer-reviewed articles in all fields of business administration and economics; EconLit (EBSCO), which provides comprehensive information on subjects, such as, accounting, capital markets, econometrics and economic forecasting; as well as other all-inclusive reference databases like, Web of Science (ISI), Academic Search Elite (EBSCO) and SCIRUS (Elsevier). We searched for peer reviewed articles, so all of the articles referred in this thesis are peer reviewed scientific articles. When searching for relevant articles we not only used keywords and key phrases to search in the databases, but we also used the references provided in the articles to find further relevant articles. The citations were also made use of to find other relevant articles that referred to the articles we initially found. The keywords and key phrases that we used include, but are not limited to the following list:

Cross-section of stock returns, asset-pricing model empirical tests, CAPM, Fama-French, conditional asset-pricing models, time-varying beta, time-varying risk,
conditional beta, cross-sectional regression, time series regression, financial market anomalies, value premium, size premium, momentum effect and etc…

3.2. Scientific Approach

The choices of methods that we make in this thesis are directly affected by how we look upon the problem in hand. However, more importantly, our choices depend on the assumptions that we have about the nature of science and the nature of the society, that is, which of the four sociological paradigms we adopt. That being said, our epistemological and ontological standpoints put us in the functionalist category of researchers, not unlike many other finance researches, as Ardalan (2003) argues. As adopters of the functionalist paradigm we believe in positivistic methods and, thus, think that the validity of asset-pricing models such as, CAPM, Fama & French’s three-factor model or Carhart’s four-factor model, should be (and can be) tested empirically. Hence, in accordance with the positivistic doctrine (Bryman & Bell 2007, p. 16), the aim of our research is to test the hypotheses derived from theories pertaining to models that capture cross-sectional stock variation and give our contribution to finding the true knowledge that explains the reality, that is, the one model that captures variation of returns across different stocks. Since our stance is that only what can be proved empirically can be thought of as the true knowledge, we will test the validity of the aforementioned asset-pricing models by analyzing their ability to explain the cross-section of historical stock returns. Moreover, since the true knowledge (i.e. that any of the asset-pricing models being tested in this study does in fact explain the cross-section of stock returns), as we perceive it, is for, and applies to, all places and times, our research conducted in Sweden using Swedish stock returns for the chosen period should come to similar conclusions about the ability of the models to capture cross-section of returns as previous researches that were done in other countries and using different time periods. With the above discussion in mind, we undertake a quantitative strategy to carry out our research. Accordingly, the hypotheses derived from the theory review are tested using methods described later in this chapter.

3.2.1. Epistemological Foundations

As we mentioned earlier, we categorize ourselves as functionalist researchers, which is derived from our opinions of what knowledge is, what acceptable knowledge is, and how social entities are to be seen. Epistemology is the concept describing what knowledge is and what can be considered as valid knowledge and it has the natural science as foundation. In social science one can identify two major perspectives – positivism and interpretivism.

The positivistic view characterizes this thesis and the research accompanied with it as it can be identifiable to the below described criteria. Positivism is a perspective which origins from natural science and can basically be described and identifiable with five cornerstones. Firstly, (1) only phenomenon which can be validated by the human senses can be considered as knowledge. Further, (2) the purpose of theory in the positivistic view is to generate hypotheses that can be tested with observations and collected data, (3) collected data and observations which are by the positivists seen as knowledge. Finally, (4) positivists believe that objective research is possible to conduct and, therefore, research should be absent of opinions and (5) only scientific statements can be considered as science, not normative statements. Even though the suitability of the
five cornerstones can be discussed and criticized within the field of social science they are in general applicable and accepted positivistic views (Bryman & Bell, 2003, p. 26-29).

The other epistemological perspective in social science is interpretivism which is the result of critical views of how well positivism fits into the social research and the characteristics of the social context. In this perspective interpretation is vital, something that is not seen as suitable in the scientific context according to positivists. For this perspective interpretation is essential because there is believed to be a considerable difference between natural science and social science that makes interpretations necessary. Different from natural science, social science studies human beings and the context of which they exist and operate. This, by the interpretivists, requires another view on the research process which is applicable to humans and their behavior. Rather than just explain human behavior and actions interpretivists want to understand and interpret them (Bryman & Bell, 2003, p. 29-33). There are many subcategories within interpretivism but they cannot all be discussed within the scope of this thesis. However, it is important to know that there are alternative epistemological perspectives with different views on what good knowledge is.

3.2.2. Ontological Foundations
Ontology concerns social entities’ characteristics in terms of organization as well as culture, and whether they should be considered as objective entities not possible to be affected by social observers or entities that the observers influence and create with their actions and opinions. The first description being the objectivism and the latter being constructionism. In this field we consider ourselves as objectivists. Thereby, we consider an organization as a tangible entity, separated from the individuals in it, where rules and standards are being developed and applied. The individuals within the organizations have defined roles, follow the rules that have been set up and tell others to do the same. As a consequence the organization works as a forcing power making the people within it to act and think in a certain way (Bryman & Bell, 2003, p. 33-35). The stock markets and asset-pricing models can be identifiable to this description. On the stock markets there are certain orders that the players have to follow, for example the way of trading and the method of valuing stocks. This allows for the existence of one true asset-pricing model that explains the stock returns’ cross-sectional variation. As objectivists we attempt to find these rules that explain the cross-section of stock returns and, thereby, which asset-pricing model explains them the best. Constructionism, on the other hand, suggests that the individuals within an organization are able to affect the organization as well as its culture and that these are continuously in a state of change (Bryman & Bell, 2003, p. 33-35). We cannot identify our research to this perspective as the one asset-pricing model we find to explain the cross-section of stock returns better cannot be affected by the investors on the market, but are affected by the stock market as a whole and its rules and orders.

3.2.3. Relationship Between Theory And Empirical Observations
In social science there are two types of approaches that can be taken considering the relationship between theory and what can be found by conducting empirical studies. One of these approaches is the deductive one where the researcher from prior knowledge and the prevailing theory forms hypotheses that will be tested against empirical observations. When the hypotheses have been tested, and either been rejected
or confirmed, the basis for new and revised theory has been created. In a less detailed description of deductive research it is possible to describe it as, the approach where existing theory is the starting point for further tests and validations through empirical research (Bryman & Bell, 2003, p. 23-25).

The inductive approach is basically the opposite of the deductive one. With the inductive approach another point of view towards the scientific research is taken as empirical studies are the base for new theory, instead of tests of the already existing theory. Even though the processes of these two approaches can seem straightforward and hierarchical it is not unlikely that researcher encounters complications that force him or her to go backwards in the process. This is mostly a phenomenon seen in the deductive approach as new theories can have been unveiled during the research period or that the data collected is unable to be tested against the hypotheses or that it is of poor quality. Deduction and induction can also be mixed to create a unique approach named as the iterative approach. Here collected data could need further analysis with more theory or data than that has already been considered, resulting in a mixed approach (Bryman & Bell, 2003, p. 23-25). As for this specific thesis a deductive approach has been applied, meaning that existing asset-pricing theories have been studied to be the foundation of the hypotheses. Hypotheses, which later in the results section of the thesis are either rejected or confirmed as the data has been collected and processed.

3.2.4. Research Strategies

As stated, we are applying a quantitative research strategy. This strategy is in general related to all the scientific approaches and perspectives that have been described above to fit our research – positivism, objectivism and a deductive view on the relationship between theory and empirical findings. Qualitative research strategies are in contrast usually connected to interpretivism, constructivism and an inductive point of view on the connection between theory and empirical observations. However, the most basic way to distinguish between the two strategies is that the quantitative method measures different phenomenon while the qualitative does not measure anything in the way it is done in the quantitative strategy (Bryman & Bell, 2003, p. 39-41). Testing asset-pricing models with stock returns from a variety of companies on the Stockholm Stock Exchange during a considerable time period is figure intense and it is impossible to employ other techniques than the quantitative research strategy which is applied in this research.

3.2.5. Reliability and Validity

In research connected to business administration there are three basic criteria that are of vast importance when assessing the quality of the research. These three factors are reliability, validity and replication or reproducibility. To be able to assess scientific research, especially quantitative studies, one must have an understanding of their fundamental meanings. The subcategories within these factors are many, but are subordinated to the general meanings, why we only take a general approach to these concepts here. Replication is closely related to reliability and deals with the possibility for other researchers to replicate a study done by others based on the methodological description provided in the scientific documentation of that study (Bryman & Bell, 2003, p. 48). As will be seen below we have provided the reader with a thorough description of practical method, which will make the study possible to reproduce if desired, providing the thesis with a high value of reproducibility.
Reliability, closely connected to the reproducibility, concerns the issue whether the result(s) from a study will be the same when reproduced or if the original result have been subject of random events or variables. Reliability, thereby, indicates how stable the measures are and is in general more interesting in quantitative studies than in qualitative studies, because if replicating studies obtain different result it is possible to question the used measures’ reliability. The reliability can, then, be questioned since it is possible to criticize the trustworthiness of the measures and whether they are measuring what they aim to measure (Bryman & Bell, 2003, p. 48). The reliability of this thesis’ results and measures are considered to be high. If the study were to be conducted again, in the same manner and over the same time period as done here the same results would be required. However, if an equal study will be conducted in the far future and over another time period than the one chosen here, the characteristics of the Stockholm Stock Exchange might have changed. As a result the outcome of the study could be different, considering the behavior of the stock market anomalies and etcetera.

When discussing the validity of a study it concerns whether indicators that have been created measure what they are intended to measure. Reliability and validity is, thereby, closely related since the validity of a study is dependent on the reliability of the same study. Building on this, if the measure is not stable over time (reliability) it will not give information about what is intended to measure since the measure itself will not be stable and constant. If the measure itself is not stable the possibility of it not to measure what is intended to measure is high when the same study is conducted in another point of time from the original study (Bryman & Bell, 2003, p. 95-99). As we consider our study strong in reliability we also consider the research to have a strong validity. The asset-pricing models used here have been tested in many scientific articles and studies and are, in the majority of cases, said to measure intrinsic stock values, meaning they are measuring what is expected from them.

3.3. Practical Method

The data used in this thesis are monthly stock returns for the OMX All Share constituents, excluding the shares of financial companies, the book value of equity and the market value of equity. Our sample covers the period from 1997 through 2010 inclusive. The stock returns and accounting data were obtained from the DataStream Advance database of Thomson Financials. The database was accessed through one of the computer labs at the Umeå University Library. DataStream Advance provides historical and current financial, as well as economic, data on equities, indexes, bonds, exchange rates and other financial and economic information.

To calculate the stock returns we obtain monthly adjusted stock prices and dividends per share for each company via DataStream Advance and use a simple return formula demonstrated below:

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

(16)

Where,

\( R_{i,t} \) – return on stock \( i \) for month \( t \);
\[ P_{i,t} \] – adjusted price of stock \( i \) at the end of month \( t \);

\[ D_{i,t} \] – dividend per share of stock \( i \) for month \( t \);

\[ P_{i,t-1} \] – adjusted price of stock \( i \) at the end of month \( t-1 \)

In order to test the ability of the asset-pricing models to explain cross-sectional variation of stock returns, we employ the so called time series regression tests (see Fama & French, 1993). There are two methods of testing the asset-pricing models. One of them is the two-pass cross-sectional regression method of Fama and Macbeth (1973) and the other is multivariate time series regression method originated initially by Black, Jensen and Scholes (1972). Both of the approaches use portfolio returns for the tests as opposed to using individual stock returns, because the beta estimates are generally considered to be more precise for portfolios than the beta estimates for stocks. The cross-sectional regression approach consists of two stages, where the first stage involves calculating estimates of factors one is interested in (beta, size, momentum factors and etc.) for each individual stock and for each month. Then, in the second stage, the time series averages of the estimates are calculated and these are used as the final estimates to conduct the statistical tests – Ordinary Least Squares, t-statistics and R^2 values, and make inferences about the explanatory ability of the model in question. The multivariate time series regression method, on the other hand, has only one stage where the dependent variable is regressed on the explanatory factor premiums. This is a form of a multivariate test and it implies that, the intercepts of the time-series regressions, that is, the \( \alpha \)'s in the asset-pricing models presented below, also known as the Jensen’s \( \alpha \), should be equal to zero if the independent variables (the excess returns or premiums) in the model explain the cross-section of returns. A more detailed explanation of the time series regression approach is provided below.

3.3.1. **Multivariate Time-Series Regression Inputs**

Unlike the two-pass cross-sectional regression method utilized by Fama & French (1992), the multivariate time series regression method of Black, Jensen & Scholes (Scholes, 1972) is somewhat simpler, but, more importantly, more appropriate for comparing different model specifications, because it tests how well various combinations of factors can manage to explain the cross-section of average stock returns (Fama & French, 1993, p. 5). For the time series approach we will need two types of variables - independent (explanatory) and dependent (explained) variables, to put into the regressions.

3.3.1.1. **Explanatory Variables**

The explanatory variables are the three-factor mimicking market excess return, Size, Book-to-Market equity ratio and Momentum effects on the cross-section of stock returns. The three unconditional model specifications using these factors are shown below.

**Unconditional models:**

CAPM:
\[ RP_t - RF_t = \alpha + \beta(RM_t - RF_t) + e_t \]  

Fama-French three-factor model:

\[ RP_t - RF_t = \alpha + \beta(RM_t - RF_t) + sSMB_t + hHML_t + wWML_t + e_t \]  

Carhart’s four-factor model:

Where,

\( RP_t - RF_t \) - Excess return of the Portfolio over the risk-free rate (RF); we use the Swedish one month T-bill (Statsskuldväxel SSX - 30 dagar) rate as a proxy for the risk-free rate RF.

\( RM_t - RF_t \) - Excess return on Market portfolio over the risk-free rate; as a proxy for our market portfolio we use the All Share Index. Thus, \( RM_t \) is a value-weighted return on the market portfolio.

\( SMB_t \) - (Small minus Big) Average returns of the portfolios S-L, S-M and S-H minus the average returns of the portfolios B-L, B-M and B-H (See further in this Chapter for details on portfolio formation). SMB is a zero-investment portfolio that mimics a strategy of going long in small stocks and short in big stocks;

\( HML_t \) - (High minus Low) Average returns of the portfolios S-H and B-H minus the average returns of the portfolios S-L and B-L. HML is a zero-investment portfolio mimicking a strategy that goes long on stocks with high Book-to-Market equity ratio and goes short on low Book-to-Market equity ratio stocks;

\( WML_t \) - (Winners minus Losers) Difference between the average returns of portfolios S-W plus B-W and S-L plus W-L. WML is a zero-investment portfolio meant to mimic a strategy of going long in stocks with good past performance and going short in stocks that performed poorly in the past;

\( e_t \) - the error term.

The explanatory variables, that is, the SMB, HML and WML factors in the models specified above, are created following Fama & French (1993, 1995), Lam & Li (2009) and L’Her, Masmoudi & Suret (2004). First, we rank the stocks according to their size (measured by Market Capitalization) from small up to big. The ranking is done on September of year \( t \). Then, stocks below the median Market Capitalization form the “Small” portfolio and stocks above the median Market Capitalization, accordingly, form the “Big” portfolio.

Stocks are also independently ranked according to their Book-to-Market equity ratios and three Book-to-Market equity ratio sorted portfolios are formed – Low, Medium and High. “Low Book-to-Market” portfolio consists of the bottom 30%, “Medium Book-to-Market” portfolio consisting of middle 40% and “High Book-to-Market” portfolio
contains the top 30% of the Book-to-Market equity ratio ranked stocks. Following Fama & French (1993), Book-to-Market equity ratios are calculated as follows: Book equity for the company fiscal year that ends in calendar year \( t - 1 \) is divided by the Market equity (Market Capitalization) at the end of calendar year (end of December) \( t - 1 \). Six portfolios are formed at the intersection of the above explained Size and Book-to-Market equity ratio sorted portfolios. As a result, we have the following portfolios in hand:

- Portfolio “S-L”: Small stocks – Low B/M stocks
- Portfolio “S-M”: Small stocks – Medium B/M stocks
- Portfolio “S-H”: Small stocks – High B/M stocks
- Portfolio “B-L”: Big stocks – Low B/M stocks
- Portfolio “B-M”: Big stocks – Medium B/M stocks
- Portfolio “B-H”: Big stocks – High B/M stocks

The average annual number of companies in each portfolio can be found in Table 1. Portfolio B-L, for instance, holds the stocks in the size sorted portfolio “Big” that are also in the “Low Book-to-Market” portfolio. The value-weighted returns for each of the above six portfolios are calculated on a monthly interval. The portfolios are reformed at the beginning of September of each year \( t+1 \). Some of the companies on the Stockholm Stock Exchange have April as the fiscal year end, so to be sure that we have the book equity of all the companies for the year \( t-1 \) we calculate the portfolio returns starting from September year \( t \), assuming that the necessary accounting data would be available within four months after the fiscal year end as the Finansinspektionen, the Swedish Financial Supervisory Authority, requires (2007:528, Securities Market Act). Thus, the value weighted returns of the portfolios are calculated monthly from September year \( t \) to August year \( t+1 \). Consequently, the very first portfolio returns would be calculated starting from September 1997.

In addition to the six portfolios listed above we form further three past performance sorted portfolios in order to test the explanatory powers of the asset-pricing models on the momentum effect. At the beginning of September year \( t \) the stocks are ranked according to their 12 month past returns and the following three portfolios are formed:

- Portfolio “Winners”: the top 1/3 stocks
- Portfolio “Losers”: the bottom 1/3 of the stocks
- Portfolio “Neutral”: the stocks that were neither Winners nor Losers

While all the studies we have seen use the size-neutral Book-to-Market portfolios (by sorting stocks into portfolios at the intersection of Book-to-Market and size deciles as we explained above), some of the studies (Carhart, 1997; Nartea et al., 2009) do not use size-neutral portfolios for momentum. L’Her et al. (2004) and Lam & Li (2008) on the other hand, form six portfolios at the intersection of two size and three momentum portfolios. We will also be using six momentum portfolios formed in a same manner as the Book-to-Market portfolios, that is two by three size and momentum sorted portfolios:

- Portfolio “S-L”: Small – Losers
- Portfolio “S-N”: Small – Neutral
• Portfolio “S-W”: Small – Winners
• Portfolio “B-L”: Big – Losers
• Portfolio “B-N”: Big – Neutral
• Portfolio “B-W”: Big – Winners

The average annual number of stocks in each of the above portfolios, except the Neutral portfolios, is displayed in Table 4. The equal-weighted portfolio returns are calculated monthly and all six portfolios are reformed on a yearly basis. The portfolio returns are lagged one month to avoid any effects from the bid-ask bounce. Thus, the first three portfolios will be formed as follows: On September 1997 all the stocks are ranked according to their performance over the period September 1996 through August 1997, leaving out September 1997 returns to avoid distortions from the bid-ask bounce. The effect of bid-ask bounce is especially dangerous for small stocks. Since small stocks have a relatively large bid-ask spread as a proportion of the stock price itself, a change in price due to the bid-ask bouncing may tempt the observer to make wrong conclusions about the stock return.

As a result of the procedures described above we have the following independent (explanatory) variables: the excess market return and returns on our zero-investment portfolios SMB, HML and WML.

3.3.1.2. Dependent Variables

In order to create the dependent variables Fama & French (1993) form 25 portfolios the same way the six portfolios were formed above – they form 25 portfolios on the intersection of the five Size and Book-to-Market equity ratio sorted portfolios. However, considering the relatively smaller amount of company shares traded on the Stockholm Stock Exchange, if we were to use the abovementioned procedure in this study, it would result in some of the portfolios consisting of only a few stocks in them. Nartea, Ward & Djajadikerta (2009) use only six (two size by three Book-to-Market portfolios) portfolios’ excess returns as their dependent variables, but, since it is preferable to have a range of dependent variables that is wide enough so the differences are observable more clearly, we find it more suitable to divide the stocks into only four size and Book-to-Market equity ratio groups. The data quartiles are used to divide the Market Capitalization ranked stocks into four portfolios, where the stocks below the 1st quartile are allocated into the first portfolio, stocks above the first and below the second quartile are allocated into the next portfolio, stocks above the second quartile and below the third quartile are in the third portfolio and stocks above the third quartile are in the fourth portfolio. Thus, these portfolios are size sorted, so that the stocks with smallest Market Capitalization are in the first portfolio and the largest Market Capitalization stocks are, accordingly, in the fourth portfolio. The ranking of stocks is done in September of each year t and the four size portfolios are then annually reformed.

Furthermore, since we want to test the asset-pricing models’ ability to explain the Book-to-Market effect, stocks are independently ranked according to their respective Book-to-Market equity ratios and four Book-to-Market equity ratio sorted portfolios are created in a same manner as the Size sorted portfolios: the first quartile portfolio contains stocks with the lowest Book-to-Market equity ratio and the fourth portfolio contains stocks with the highest Book-to-Market equity ratio.
Sixteen (four times four) size – Book-to-Market portfolios are created at the intersection of the Size and Book-to-Market equity quartiles and the value weighted portfolio returns are calculated each month between September of the year $t$ and August of the year $t + 1$ after which the portfolios are reformed. The excess returns of these sixteen portfolios over the risk free rate ($RP_t - RF_t$) are the dependent variables in the time series regression.

In addition to the 16 size–Book-to-Market equity ratio portfolios, we use excess returns of each of the six past return and size sorted portfolios as dependent variables to test the ability of the asset-pricing models to capture the momentum effect.

If the explanatory variables in the asset-pricing models do in fact explain the cross-sectional variation of average stock returns and absorb that variation, then “the intercepts [$\alpha$] in the time-series regressions should be indistinguishable from 0 [zero]” (Fama & French, 1993, p. 35). The intercept $\alpha$ represents the pricing error, and if the pricing error is not zero, then the variables do not fully capture the cross-sectional variation among stock returns. For instance, if the Fama-French three-factor model explains the variation of average returns across stocks and, thus, absorbs the Size premium (by the SMB factor coefficient) and the value premium (by the HML factor coefficient) then there will be close to none pricing error, that is unexplained return. Naturally, the model with the intercepts closest to zero is seen as superior to the others, since the factor or factors in that model are able to capture most of the variation in the size, Book-to-Market or momentum sorted portfolio returns. To test whether all the intercepts are jointly equal to zero for a model we conduct an F-test suggested by Gibbons, Ross and Shanken (1989). Their F-test is a modified version of a Wald test.

The F-statistics suggested Gibbons, Ross and Shanken (1989) is calculated as follows:

$$F = \frac{(A'\Sigma^{-1}A)(N-K-L+1)}{(L \times (N-K) \times \Omega^{-1})}$$

Where,

- $N$ is the total number of time series observations. In our case $N = 150$ (12.5 years * 12 months);
- $L$ is the number of regressions and equals to 16 in this study – four size sorted portfolios by four Book-to-Market equity ratio sorted portfolios;
- $K$ is the number of explanatory factors in the regression being tested plus one;
- $A$ is a column vector of the intercepts of 16 regressions:

$$A = \begin{bmatrix} \alpha_1 \\ \alpha_2 \\ \alpha_3 \\ \vdots \\ \alpha_{16} \end{bmatrix}$$
\(\omega_{1,1}\) is the diagonal element of \((X'X)^{-1}\) that corresponds to the intercept;

\(\Sigma\) is the variance-covariance matrix of the residuals from the 16 regressions.

Gibbons, Ross and Shanken (1989) show that the above stated F-statistics is F-distributed with \(L\) and \(N - K - L + 1\) degrees of freedom under the assumption that the true intercepts are equal to zero (null hypothesis equals that intercepts are zero) and the variables are normal. The F-test of Gibbons, Ross and Shanken (1989) requires that the data be iid-normal, that is, independent, identical and normally distributed. However, it is widely known that the stock returns are in contradiction with the iid-normality assumption. Groenewold and Fraser (2002) check whether the outcomes of the tests would change if one were to use statistical tests that do not require data to be iid-normal. They use Australian data to test three different asset-pricing models, the unconditional CAPM, conditional CAPM and a multi-factor APT model, with the traditional Wald test and the GRS F-test. To check the robustness of the outcomes of these two tests Groenewold and Fraser (2002) conduct Hansen's J-test associated with the GMM estimator, as well as, a bootstrapping procedure. They conclude that the test outcomes were not affected by the use of different techniques (Groenewold and Fraser, 2002, p. 508). Of course, when the probability values (sig. - values) are very close to the significance level it is advised to use more appropriate tests in addition to the standard tests (Groenewold and Fraser, 2002, p. 508).

In addition to the Gibbons, Ross and Shanken's (1989) F-statistics, the adjusted \(R^2\) will also be used to check for the goodness-of-fit of the models and the individual intercept values from the linear regressions for each portfolio will also be looked on. However, the F-values of the GRS (Gibbons, Ross & Shanken, 1989) tests are given a heavier weight when arriving at conclusions. We employ statistical analysis programs, such as Stata and SPSS, to perform the aforementioned tests. Microsoft Excel will also be used to sort the stocks, form portfolios and calculate the returns.

### 3.3.2. Conditional Models

To test the performance of conditional models we need to, first, specify the conditioning algorithm used to help us differentiate between the up and down market conditions on the Stockholm Stock Exchange. For that purpose we create a binary dummy variable \(D_1\) that is equal to one during the down market and equal to zero during the up market conditions. As we have defined in the Introduction chapter of the thesis, the market is in a down condition during a certain month if the market return for that month is below the risk-free rate of return. The opposite applies to the up market. \(\beta\) will be allowed to vary depending on the market condition, so that we can test whether any of the models perform better if the underlying systematic risk captured by \(\beta\) is assumed to differ between up and down markets. Pettengill et al. (1995) employ Fama & MacBeth (1973) approach to test the relationship between beta and return, however, we will be using the times series regression method throughout the thesis for consistency and ease of comparison between conditional and unconditional models. Consequently, we incorporate the up-down beta proposed by Pettengill et al. (1995) into the time series regressions as shown below:

**Conditional CAPM:**
\[ RP_t - RF_t = \alpha + \beta_{up}(RM_t - RF_t) + (\beta_{down} - \beta_{up})(RM_t - RF_t)D_t + e_t \]  (21)

Conditional Fama-French three-factor model:

\[ RP_t - RF_t = \alpha + \beta_{up}(RM_t - RF_t) + \beta_{down} - \beta_{up} \times (RM_t - RF_t)D_t + sSMB_t + hHML_t + e_t \]  (21)

Conditional Four-factor model:

\[ RP_t - RF_t = \alpha + \beta_{up}(RM_t - RF_t) + (\beta_{down} - \beta_{up}) \times (RM_t - RF_t)D_t + sSMB_t + hHML_t + wWML_t + e_t \]  (22)

As a result, we have six different models in total, three static and three conditional, to be tested using the times series regressions, where we test the regression intercepts against zero. This will give us six time series regressions with size and Book-to-Market equity ratio portfolio excess returns as dependent variables, as well, as six time series regressions where the dependent variables are the momentum portfolios’ excess returns over the risk free rate. However, before we commence the tests of the asset-pricing models we will check for the presence of Book-to-Market equity, Size and Momentum effects on stock returns. This can be directly confirmed by the returns on portfolios HML, SMB and WML – if these portfolios have a statistically significant positive return than each of the anomalies in question are confirmed. For instance, since SMB represents excess average returns of Small stock portfolios over the Big stock portfolios, if the SMB value is positive then the size premium is confirmed. The same logic stands for the value premium and the momentum effect.

3.4. Data Collection and Processing

Collection and the subsequent processing of the data took a substantial amount of time and effort on the authors’ part. Since the research required the use of, both, dead and alive stocks to avoid the survivorship bias, we had to obtain a list of all the companies that have been listed on the Stockholm Stock Exchange. Such a list was nowhere to be found and, thus, had to be manually formed by us. We have managed to get hold of the annual changes to the list of companies traded on the Stockholm Stock Exchange via NASDAQ OMX. The archive stretched only from 1997 till present. Using this archive we created annual lists of companies, which were then combined to form one list of all the companies listed on the Stockholm Stock Exchange from 1997 and onwards, excluding banks, real estate, insurance and other financial companies. The list also excluded companies that were listed for less than one year – this is due to the ranking period of 12 months for the momentum portfolios. Once the list was finalized, portfolios were formed as described earlier in this chapter. Individual regressions for each portfolio were conducted using SPSS, whereas the joint hypothesis test using the GRS F-test was conducted in Stata.
4. Results and Analysis

This part of our study will present the reader to the empirical findings together with the analysis and implications of those findings. The statistical tests conducted on the data and their results will be illustrated. The structure of the chapter closely follows that of the Theoretical Framework Chapter – the hypothesis derived in Theoretical Framework Chapter will be addressed here one after another.

We will start this chapter with some descriptive statistics about our data before we go into presenting and analyzing our findings. The abbreviations used throughout the chapter are defined below:

s1, s2, s3 and s4 represent size ranked portfolios, where s1 is a portfolio consisting of firms with the smallest market value. Table 1 shows average values for the entire period of 150 months of annual average firm sizes in each of the portfolios and one can see the gradual increase in size going from s1 to s4.

b/m1, b/m2, b/m3 b/m4, in their turn, signify Book-to-Market equity ratio ranked portfolios. b/m1 contains lowest Book-to-Market ratio stocks and b/m4 – the highest.

You can observe from Table 1 that the average firm size in any given size category stays within the same range between different Book-to-Market levels. The exception is the s4 – b/m1 portfolio that has a concentration of very large companies – the average firm size for that portfolio is almost four times larger than the average size of s4 – b/m4 portfolio, bearing in mind that they are in the same size category. This gives an implication that most of the companies with the largest market values have low Book-to-Market values. Table 3 shows the average proportion of the market value in each portfolio relative to the sum of all market values. Here, the reader can notice that again the companies in s4 - b/m1 have the highest percentage of the market value.

Our data contains a total of 150 observations, where each observation represents monthly returns. The starting point is October of 1997 and the last observation is March 2010, which gives us 12,5 years or 150 months of returns. Table 2 has the average

<table>
<thead>
<tr>
<th></th>
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<th>b/m2</th>
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<th>b/m4</th>
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<td>192,3</td>
<td>191,1</td>
<td>180,1</td>
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<tr>
<td>s2</td>
<td>555,2</td>
<td>565,1</td>
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<td>1 941,0</td>
<td>1 924,6</td>
<td>1 597,4</td>
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<tr>
<td>s4</td>
<td>82 059,6</td>
<td>30 877,6</td>
<td>26 245,2</td>
<td>21 016,3</td>
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<table>
<thead>
<tr>
<th></th>
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<th>b/m3</th>
<th>b/m4</th>
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<td>6,6</td>
<td>9,4</td>
<td>13,8</td>
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<td>s2</td>
<td>12,7</td>
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<td>s3</td>
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<td>16,7</td>
<td>12,2</td>
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<tr>
<td>s4</td>
<td>18,9</td>
<td>13,5</td>
<td>11,2</td>
<td>9,4</td>
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</table>
number of companies in each of 16 portfolios formed on the intersection of size and Book-to-Market ranks. Some descriptive statistics for the six portfolios formed on size and past performance are displayed in Table 4. From Table 4 we can notice that the number of “loser” companies in large size category is almost half the number of “winner” companies in the same size category. However, the small size category exhibits the opposite picture.

4.1. Testing the Anomalies

As part of our research objective we have tested for the presence of some of the stock market anomalies on Stockholm Stock Exchange. We direct the reader’s attention to Figure 6, which displays the average returns for 16 size and Book-to-Market formed portfolios. The returns on the figure are monthly returns. No apparent pattern can be recognized from the figure, which speaks in favor of the efficient market.

Next we present our findings for each of the three anomalies starting with the most famous Small firm effect.

### Table 3: Average of annual percent of market value in portfolio for 16 portfolios formed on size and Book-to-Market ratio between 1997 and 2010, 150 months.

<table>
<thead>
<tr>
<th></th>
<th>b/m1</th>
<th>b/m2</th>
<th>b/m3</th>
<th>b/m4</th>
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<td>s2</td>
<td>0.28%</td>
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<td>0.33%</td>
<td>0.26%</td>
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<tr>
<td>s3</td>
<td>1.20%</td>
<td>1.29%</td>
<td>0.91%</td>
<td>0.49%</td>
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<td>s4</td>
<td>58.30%</td>
<td>16.49%</td>
<td>11.22%</td>
<td>8.58%</td>
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</table>

Figure 6: Average monthly returns for 16 portfolios formed on size and Book-to-Market, 150 months.
4.1.1. Small Firm Anomaly

The difference between small and large firm’s mean returns was 2.67 percent when converted into annual returns. However, as the results of the test below show, this difference is not statistically significant, and, perhaps, rather low.

We have formulated the following hypothesis for an Independent samples test (the same procedure is used for testing all the anomalies in this paper):

\[ H_0: \mu_s = \mu_b \]

\[ H_1: \mu_s \neq \mu_b \]

Where,

\[ \mu_s \] – Mean monthly return of small firms and,

\[ \mu_b \] – Mean monthly return of big firms.

The results of an Independent Samples test show that the differences in means are not statistically significant (p-value: 0.791; mean difference: 0.0022; t-statistics: 0.265).

To confirm the absence of the size effect even further, we tested the difference of mean returns between the smallest and the largest size categories – s1 and s4. There is still no significant difference between the mean returns of small and large firms as the results of the Independent samples test indicate (t-statistics: 1.379; p-value: 0.17; mean difference: 0.01017). This leads us to a conclusion that the Stockholm Stock Exchange did not exhibit the size effect from 1997 and onwards. Furthermore, we can derive the conclusion that the Stockholm Stock Exchange has been an efficient one over the period of October 1997 to March 2010 in terms of, and considering only the absence of the small firm anomaly.

These findings are contradictory to the majority and most recognized scientific framework on the firm size anomaly, which report a significant difference in returns between small and big companies, for example Banz (1981), Berk (1995), Rogalski & Tinic (1986). The previous research done in this area is, however, divided concerning the explanation of why small firms outperform larger firms. Some claim that it is due to a market anomaly (Banz, 1981), while others have other arguments, for example that small firms are riskier and should, thereby, compensate for this by offering higher

| Table 4: Descriptive statistics for six portfolios formed on size (in million SEK) and past performance: 1997-2010, 150 months. |
|-------------------------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Average of annual averages of firm size         | Losers Neutral  | Winners         |
| Small   | 291,0 376,9 | 422,6           | Small           | 0,50% 0,59% 0,43% |
| Big     | 15 934,4 23 850,9 27 352,9 | Big 12,40% 44,27% 41,81% |
| Average of annual number of firms in portfolio  | Losers Neutral  | Winners         |
| Small   | 39,8 36 | 22 | Big             | 18,2 41 | 34,5 |
returns (Berk, 1995; Fama & French, 1992; Rogalski & Tinic, 1986). Additionally, there is more research focusing on the small firm January effect than the small firm effect alone. This provides a narrower base for analysis, since the January effect is not directly connected to the aim of this study and the research purpose. However, the volatility of small stocks causing them to have a stronger January effect than other stocks can also be used in an analysis of the small firm effect alone.

Marquering, Nisser & Valla (2006) state that the size anomaly is fluctuating in its existence by disappearing and reappearing between different periods; or even being fully undetectable since the groundbreaking result concluding a superiority of small firm stocks by Banz in 1981. The fact that the size anomaly does not exist anymore is either because of data snooping in previous research or investors’ discovery and exploiting of the anomaly causing it to disappear. Since this thesis show no findings of the size anomaly on the Stockholm Stock Exchange (SSE) between late 1997 and early 2010, the findings of Marquering, Nisser & Valla (2006) are highly relevant.

The conflicting results between this research and others are not obviously traced to any specific factors. By building on the findings of Marquering, Nisser & Valla (2006) the investors on the SSE must have been familiar with the small firm effect causing it to disappear as it is traded on until it reaches a point where it is traded on its intrinsic value and, therefore, its “true” price considering the risk. If the previous statement is not true, and instead that the investors on the SSE did not and do not know about the small firm anomaly, then the data used can be a source to explain the results. As we do not use the data which are used by other researchers before us, it eliminates the fact that we get the same result as other researchers because of the data. In fact, there is no, to our knowledge, previous comprehensive research about this specific area on the Swedish stock market. There are, therefore, no possibilities to even compare and evaluate these results to others looking at the same market. An analysis has to be conducted with and upon other stock markets around the world where the small firm effect has been studied, creating few result matches.

Continuously, Banz (1981) provides an explanation of why the firm size anomaly may exist. He claims that it is because of the information shortage around smaller firms compared to the larger ones. One can only speculate why there is no small firm effect on SSE over the 150 months that have been studied, but according to Banz one possible reason can be that investors on the SSE have good access to information. The access to information about and from small firms must, therefore, be as good as for the large firms to make the market indifferent on investing conditions between small and large corporations. Some factors on the SSE can indicate that there should be no considerably big difference between the information provided on small companies and big companies. For example, the SSE is a rather small stock exchange with a limited number of companies, compared to exchanges like LSE and NYSE, and the rules to be listed are the same for all companies, small or large. The rules contain a number of information requirements that have to be met to be able to be and stay listed on the SSE that more or less make sure investors get the information to make informed decisions. Additionally, the listed companies have to follow the Swedish code for corporate governance, which also protects the owners (investors) through regulations of transparency, information distribution and content.
With these information requirements in mind, there is an explanation on the lack of size anomaly in Sweden, based on Banz’s reasoning of its existence. However, the SSE is not unique on having listing requirements and external information regulations for its listed companies. It is not unique in having a corporate governance code to follow either, as the US for example has the Sarbanes Oxley Act, comparable to the Swedish code for corporate governance. Thus, even though the reasoning may be valid it does not explain why the firm size anomaly is found on other stock exchanges around the world, but not Stockholm. This explanatory factor on the lack of size anomaly can, thereby, be dismissed. The only possible justification to still elaborate on this would be if companies listed on the SSE are more willing to provide their investors with information than companies on other stock exchanges. Possibly also that there is a better information coverage on the companies listed in Stockholm making investors indifferent to small and large firms, concerning information. It can also be that the regulations on the SSE are stronger and more “bullet proof” than those of other countries and exchanges. As the purpose of this study is not to investigate this, there will be no effort in doing so, but we find these factors of why there is no size anomaly on the SSE highly unlikely.

Risk is another factor argued to explain the size anomaly, foremost by Fama & French (1992). In general small firms are riskier than big and established firms which then cannot explain why there is no size anomaly on the SSE. Again, it would be naïve to assume that the small firms listed in Stockholm are not riskier than the large firms when, if the risk explanation for the size anomaly is true, it is proven to be so, on other markets around the world.

More or less ruling out the information factor, the risk factor and the fact that we are using the same data as other researchers, there is only one remaining theoretical factor that can explain the lack of small firm effect on the Stockholm Stock Exchange – An efficient market where there is and has been an awareness of the anomaly and, therefore, “arbitraged away”. A condition for this to actually be true is also low transaction costs, otherwise it would be too costly to trade on anomalies and they would still exist. However, Stoll & Whaley (1983) argue that even when transaction costs are accounted for there is no small firm effect, rather the opposite effect. This position is not supported by Schultz (1983) who claims that the small firm anomaly exists even considering the transaction costs. Since we have not included the transaction costs, we cannot say how this would affect our result, but one can assume that the result would not be much different. Thus, the small firm effect being unidentifiable on the SSE between 1997 and 2010 due to being arbitrated away on an efficient market is not unlikely. The small firm effect was first uncovered in 1981 and rational investors should have taken advantage of this anomaly to earn abnormal profits, causing it to disappear. More about the efficiency of the SSE and transaction costs will be discussed after each separate anomaly has been analyzed.

4.1.2. Book-to-Market Anomaly

Even though there is no specific pattern concerning the Book-to-Market ratio and return, there are some tendencies that can be found. Viewing Figure 6 it is possible to identify that small firms with low Book-to-Market earn higher return than those a high ratio. Opposite to what is suggested in research concerning the Book-to-Market anomaly. The reverse can be observed for large stock, yet not as obvious as the
difference on small stocks. Even though the difference in returns for large firms and their Book-to-Market are not as big as for small, its pattern is consistent with the anomaly theory.

To test for the Book-to-Market anomaly we formulated the following hypothesis for an Independent Samples test:

\[ H_0: \mu_h = \mu_l \]
\[ H_1: \mu_h \neq \mu_l \]

Where,

\( \mu_h \) – Mean monthly return of firms with high Book-to-Market equity ratio and,

\( \mu_l \) – Mean monthly return of firms with low Book-to-Market equity ratio.

We could not reject the null hypothesis at a 0.05 significance level (t-statistics: 0.049; p-value: 0.961; mean difference: 0.00041) and can, therefore, not reject that there is no Book-to-Market anomaly on the Stockholm Stock Exchange. The difference in means between high Book-to-Market firms are low Book-to-Market firms are not significant, indicating no anomaly.

Fama & French (1992) argue that the Book-to-Market anomaly is connected to risk, as with the firm size anomaly. Companies with a high BE/ME ratio are riskier, because it indicates historically falling stock prices due to non-satisfactory previous performance. Using this position on the Book-to-Market anomaly to analyze our findings it should indicate that, there is no difference in risk between high and low BE/ME companies at Stockholm Stock Exchange. If there were a risk difference it would lead us to conclude that the anomaly existed on the SSE over the period October 1997 to March 2010, which we cannot do. The high BE/ME ratio stocks would then have systematically generated higher returns than low BE/ME ratio stocks. Trying to use this to explain why there is no Book-to-Market premium on the SSE is, therefore, not a good one, since high BE/ME businesses generally are those with a low return. Consequently, there must be another explanation why the Book-to-Market anomaly is not seen on the SSE.

Over- and undervaluation is another factor for the Book-to-Market anomaly suggested by Lakonishok et al. (1994) and La Porta et al. (1997). Suggesting there is no Book-to-Market anomaly on the SSE over the investigated period, there should be no significant over- or underreactions or valuations either. Also this can seem unrealistic taking into account behavioral factors influencing investors and the different methods of valuing stocks resulting in dissimilar opinions of the intrinsic values for different investors. This leaves us with the reasoning of Ali (2003) who says that this anomaly is not eliminated since professional investors are risk averse and non-professional investors cannot exploit them because of transaction costs. Also this explanation can be considered as unlikely. There are a wide range of professional investors who have different investment strategies and some of them invest in risky assets, while others do not. Furthermore, if a market anomaly were known, all the professionals would likely use this arbitrage opportunity to earn abnormal returns. However, with lacking previous
research on the SSE and the Swedish market concerning this anomaly to compare results with; this is left as only a speculation.

The fact that the Book-to-Market does not exist on the SSE is, however, not surprising, neither is it surprising that the size anomaly does not exist. The anomaly has been publically reported to exist since the beginning of 1992 and because of that, it is more likely that it should be exploited and disappear than still prevail. Furthermore, it can be discussed whether the Book-to-Market ratio is a valid and widely used ratio for risk assessment in Sweden and for investors on the Swedish market. In case the ratio is not used the anomaly would not be relevant since there is no trading based on it. This would mean that investors do not differentiate between companies due to this reason. The Book-to-Market anomaly would be irrelevant and non-existent as firms with low or high BE/ME would not be assessed and traded on the basis requiring higher return on high BE/ME stocks. These two, recently discussed, explanations are alternatives to the ones that are provided by simply reversing the arguments from previous research on the Book-to-Market anomaly. However, there is no possibility for us within the range of this study to find the underlying explanation of the Book-to-Market anomaly’s absence.

4.1.3. Momentum Anomaly

Examining Figure 7 it is not possible to find any specific pattern concerning small firms and some sort of future momentum effect caused by the last 12 months performance. Small winners tend to outperform neutrals and losers, but losers outperform neutrals which should not be the case following theoretical arguments. Nevertheless, when only considering winners and losers there is an expected result, as past winners outperform past losers, even though the difference in returns are small. The reversed effect than what is described in theory can be seen for the big companies. Here the past 12 months losers seem to outperform both neutrals and foremost, winners. However, when testing the momentum anomaly for both small and big firms, by formulating the Independent Samples test hypothesis below, the differences in return are not significant:

\[ H_0: \mu_w = \mu_l \]
\[ H_1: \mu_w \neq \mu_l \]

Where,

\( \mu_w \) – Mean monthly return of winners and,
\( \mu_l \) – Mean monthly return of losers.

There is no significant evidence to reject the null hypothesis that there is no difference in mean returns of losers and winners at a 0.05 significance level (t-statistics: 0.279; p-value: 0.78; mean difference: 0.00266).
Figure 7: Monthly average returns for 6 portfolios formed on size and past performance, 1997 - 2010, 150 months.

Jagadeesh & Titman (1993) found that past winners outperform past losers, where past performance is measured over a 12 month time period, and the holding period for these stocks where 12 months into the future. Same results were found by Jagadeesh & Titman in 2001, as well as by Chan (1996), Rouwenhorst (1998) and Maskowitz & Grinblatt (1999). Parmler & Gonzalez (2007) find the same results as the above mentioned, but on the Swedish market. We did not find any significant difference in results between winners and losers, which is contradictory to the finding just presented. In particular, the difference between our and Parmler & Gonzalez (2007) findings are of interest since the results are different, but the market is the same and our and their studies have somewhat overlapping periods.

As with all anomalies, there are several reported reasons of why they exist. Jegadeesh & Timan (1993) and Chan (1996) explain it with behavioral factors, in terms of underreaction on earnings announcements and a price momentum effect. The results that we have found would then imply that there is no underreaction on earnings announcements and that the momentum of stocks does not affect the investors trading decisions on the Stockholm Stock Exchange. Johnson (2002) on the other hand explains the momentum factor with risk, as he suggests that growth rate is an indicator of risk and, thereby, the winners should generate higher returns. Also when it comes to this risk proxy there must be something with the Swedish market that does not proxy growth as risk. Or, as with all explanations for all anomalies, that the investors are aware of its generation of abnormal returns and, therefore, adjusting the prices to a level where they are no longer abnormal.

Yet another behavioral explanation is the one by Hong & Stein (1999). They point out that there are two kinds of investors, news watchers and momentum traders. The news watchers do their fundamental valuations of companies and trade upon that information, which spread rather slowly between investors and cause a gradually changing stock price. The momentum traders then see a price trend and trade on this, not knowing the intrinsic value suggested by fundamental analyses. Thereby, the momentum traders will continue to move the stock prices in previous directions causing the stock prices to
move over or under the intrinsic threshold. This chain reaction cannot be significant on the SSE, since the momentum anomaly is not statistically significant. The theory in itself can be questioned as the two different types of investors are totally isolated to the other investor type’s method and valuation. Even though there might be a gap between them, an assumption of them being totally isolated to each other is irrational. The absence of the momentum anomaly on the SSE might be because these two investor types do not isolate themselves in an extreme manner as Hong & Stein (1999) suggest and, therefore, price movements are somewhat rational and reflecting the intrinsic values of the stocks. In case this is true, one can ask why this is not valid on all stock markets or why the Swedish investors are different from those on other markets.

Parmler & Gonzalez (2007) find a momentum effect on the Swedish market, contradictory to our findings. Parmler & Gonzalez’s study is more comprehensive as they analyze the anomalies only, not the asset-pricing models. This does, however, not explain the fact why they found a momentum anomaly and we did not. Using different databases should not make the results as different as they in fact are, when both studies consider newly listed companies and dead or delisted companies and respectively include or exclude them. Both studies created portfolios on 12 months past performance and had a holding period of 12 months. Further, both studies use adjusted stock prices, exclude financial firms and use the most traded stock of a company when they have more than one stock listed. This should as a consequence make both studies free from sample bias. This leaves us with two possible factors explaining the difference. First of all, both sample periods used by Parmler & Gonzalez (2007) end earlier than our sample period, as they end 1992 and 2003. Considering the extra years from 2003 to 2010 in our sample there might be a possibility that the momentum anomaly disappears during this time, or get weakened, making it insignificant. Second, and to us, the most likely explanation is the different way we created the portfolios. While we used the top and bottom 30 percent as winners respectively losers, Parmler & Gonzalez (2007) used the 20 to bottom percent. This gives Parmler & Gonzalez (2007) a bigger difference between winners and losers resulting in a wider difference in return between the two categories.

As a final note we would like to point out that the use of different portfolio formation period and holding period (instead of the now used 12 months formation and 12 months holding) would probably give a different outcome. As Parmler & Gonzalez (2007) report the winners minus losers spread get weaker and weaker the longer the holding period is. In other words, if we were to use different or additional holding periods we might have gotten different results and maybe even be able to confirm a momentum effect. This is important to keep in mind when reflecting upon the analysis above. However, since the majority of studies find a momentum effect even after a 12 months holding period, we are able to use our findings and analyze them on the basis of the other results provided by the abovementioned research.

4.1.4. Anomalies Summary

There is no significant evidence saying that there is either a size-, Book-to-Market-, or momentum anomaly on the Stockholm Stock Exchange over the period October 1997 to March 2010. Because of this there have, as seen above, been a lot of speculations around the many explanations of the anomalies existence and why they do not appear on the Stockholm Stock Exchange. There might be specific factors behind the anomalies,
but it is impossible to derive any conclusions about them for us, since we do not intend to dissect the anomalies in themselves. The Swedish stock market may be different in ways causing it to behave differently and because of its uniqueness not contain the specific anomalies. Alternatively, as said many times before, the knowledge about the three anomalies is widespread and taken advantage of, which makes it disappear.

The most logical explanation for their absence is that the Swedish stock market is efficient and the investors are aware of the anomalies and have used them to earn arbitrage profits historically, causing them to disappear. It is the most logical explanation because the fact the Swedish stock market would be significantly different from other stock markets in the world seems unrealistic. Even though there have been no comprehensive study on these anomalies in Sweden, except for the momentum anomaly, investors are probably aware of them from research made outside Sweden. This means, as stated by Schwert (2002), that the CAPM should be a valid pricing model since the market is efficient. The CAPM’s validity will, however, be discussed more thoroughly in the following section.

Worth mentioning, before leaving the analysis of each separate anomaly is our exclusion of transaction costs when calculating the portfolio returns. We did not consider the transaction cost for any portfolio. If this study were to include transaction costs the results might have been different as small firms tend to have a higher transaction cost than big firms, which will result in a lower return for small stocks. In addition, when sorting the portfolios every year it was noticeable that small companies that got listed either delisted due to various reasons or died after a relatively short period on the stock exchange. The companies that got delisted had usually a high Book-to-Market and suffered falling stock prices and, thereby, low returns. A reason why small stocks with high Book-to-Market had a worse return than those with low Book-to-Market, as a reversed effect than suggested in theory, could, therefore, be that investors avoid these stocks as a whole. The stocks might be considered too risky for investors who then sell them leading to a negative price development, until the day they get delisted because of bankruptcy, take-over etc. This risk argument can be linked to Fama & French (1992) that high Book-to-Market stocks indicate distressed companies and should provide higher returns. However, if the stocks are considered too risky, no one would buy them, and the company stays in a distressed state until they have to delist from the stock exchange.
Table 5: Correlations, means and standard deviations of the four explanatory variables.

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<th>WML</th>
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<td>1</td>
<td>0.00339</td>
<td>0.06577</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>0.884</td>
<td>0.074</td>
<td>0.0</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Correlation is significant at the 0.01 level (2-tailed).

4.2. Testing the Asset-pricing Models

The variables used in the, so called, time series regressions and their means and standard deviations are shown in Table 5 and Table 6. The correlations are pretty low, absolute value at around 0.3, even though some of them are statistically significant at 0.01 level.

As we have explained earlier in the Method chapter, the tests of the asset-pricing models in this paper will evolve around the intercepts of the model regressions. First off is the battle between CAPM and the three-factor Fama & French (1993) model. We test the following null hypothesis that we have formulated in the Theory chapter:

Hypothesis 4: CAPM can explain the cross-sectional stock return variation caused by size and Book-to-Market effects better than the Fama & French (1993) three-factor model.

Table 7 presents the regression results for the CAPM. The CAPM is regressed on 16 size and Book-to-Market formed portfolios and, as one can see the alphas display the same lack of any specific pattern in them. All the intercepts are somewhat in the same range and are close to 0, except for some extreme values for s1/bm1, s1/bm2. The mean monthly returns for these two portfolios were the highest among the 16 portfolio returns 1.41% and 2.17% (see Table 6). The high intercepts for these two portfolios indicate the inability of CAPM to explain the mean returns of these to portfolios, which contain small firms with low Book-to-Market ratios. It is also worthy to note that the standard

Table 6: Mean monthly returns and standard deviations of the 22 dependent variables.

<table>
<thead>
<tr>
<th></th>
<th>b/m1</th>
<th>b/m2</th>
<th>b/m3</th>
<th>b/m4</th>
<th>b/m1</th>
<th>b/m2</th>
<th>b/m3</th>
<th>b/m4</th>
<th>Losers</th>
<th>Neutral</th>
<th>Winners</th>
<th>Losers</th>
<th>Neutral</th>
<th>Winners</th>
</tr>
</thead>
<tbody>
<tr>
<td>s1</td>
<td>0.0141</td>
<td>0.0217</td>
<td>0.006</td>
<td>0.0072</td>
<td>0.11819</td>
<td>0.12197</td>
<td>0.08339</td>
<td>0.07762</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>s2</td>
<td>0.0068</td>
<td>0.0051</td>
<td>0.0066</td>
<td>0.0036</td>
<td>0.10149</td>
<td>0.08131</td>
<td>0.05956</td>
<td>0.08756</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>s3</td>
<td>-0.0001</td>
<td>0.0094</td>
<td>0.0074</td>
<td>0.0085</td>
<td>0.09697</td>
<td>0.0776</td>
<td>0.07058</td>
<td>0.10282</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>s4</td>
<td>0.0067</td>
<td>0.0068</td>
<td>0.009</td>
<td>0.0081</td>
<td>0.06949</td>
<td>0.08301</td>
<td>0.06612</td>
<td>0.07461</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Losers</td>
<td>Neutral</td>
<td>Winners</td>
<td>Losers</td>
<td>Neutral</td>
<td>Winners</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small</td>
<td>0.0096</td>
<td>0.0081</td>
<td>0.0126</td>
<td>0.10931</td>
<td>0.06897</td>
<td>0.06608</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Big</td>
<td>0.0098</td>
<td>0.0059</td>
<td>0.0014</td>
<td>0.10429</td>
<td>0.06687</td>
<td>0.06671</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
errors for these two portfolios are also rather high in comparison to the others (see Table 6). If we take a look at Table 8, which displays the regression coefficients for the three-factor model of Fama & French (1993), the intercepts are not so different from the intercepts of the CAPM regressions. The intercepts of s1-b/m1 and s1-b/m2 regressions are still much larger than the rest of the intercepts. CAPM was not able to fully explain the returns of those two portfolios. The three-factor model is not able to explain them either.

The $R^2$ values are interestingly low for CAPM, ranging between 0.25 and 0.713. Here, again, the two of the abovementioned portfolios have the lowest $R^2$ values. Interestingly the $R^2$ values of the Fama-French regressions, adjusted for the degrees of freedom, are overall higher than the CAPM $R^2$.

To test the Hypothesis 4 (and all the others that are to follow) we used GRS F-test to see if the intercepts are jointly equal to zero. Looking at the intercepts of the individual regressions separately and deriving conclusions from that would result in erroneous conclusions. That is because t-tests of individual regressions on each separate portfolio reject the null hypothesis of $\alpha = 0$ if the data is “very surprising”. However, if the data taken separately, is just “pretty surprising”, the individual t-tests would not reject the null hypothesis, implying that that certain intercept ($\alpha$) is not significantly different from zero. This, in its own turn, would mean that the model in question can explain the returns, since there is no significant evidence for a pricing error ($\alpha$) for all or most of the regressions. The problem with looking at each separate intercept test is that, it is “very surprising” to see numerous “pretty surprising” observations and looking at individual regression intercepts misses that. However, a joint hypothesis test will not miss it and will report a statistically significant value rejecting the joint hypothesis. The GRS F-test
does the job well here. We test a joint hypothesis that all 16 intercepts jointly equal to zero. Table 9 shows the results of the GRS F-test. CAPM has a much lower F-statistics compared to the three-factor model (0.898 versus 1.974). The closer to zero is the F-statistics, the closer to zero are the intercepts jointly. CAPM exhibits intercepts closer to zero according to the GRS F-test. Moreover, the F-statistics for CAPM is not significant, implying that the intercepts of all 16 portfolio regressions are not significantly different from zero. On the other hand, the three-factor model of Fama & French (1993) has a p-value of 0.019 and the F-statistics is significant at 0.05 level, meaning that the intercepts are significantly different from zero. This suggests that Fama and French’s (1993) three-factor model cannot explain the return cross-section of the 16 portfolios formed on size and Book-to-

<table>
<thead>
<tr>
<th>Table 8: Three-factor Fama &amp; French (1993) model regressions for simple monthly excess returns on 16 portfolios formed on size and Book-to-Market: 150 months, 1997 - 2010.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Book-to-Market</td>
</tr>
<tr>
<td>Size</td>
</tr>
<tr>
<td>---</td>
</tr>
<tr>
<td><strong>α</strong></td>
</tr>
<tr>
<td>s1</td>
</tr>
<tr>
<td>s2</td>
</tr>
<tr>
<td>s3</td>
</tr>
<tr>
<td>s4</td>
</tr>
<tr>
<td><strong>β</strong></td>
</tr>
<tr>
<td>s1</td>
</tr>
<tr>
<td>s2</td>
</tr>
<tr>
<td>s3</td>
</tr>
<tr>
<td>s4</td>
</tr>
<tr>
<td><strong>s</strong></td>
</tr>
<tr>
<td>s1</td>
</tr>
<tr>
<td>s2</td>
</tr>
<tr>
<td>s3</td>
</tr>
<tr>
<td>s4</td>
</tr>
<tr>
<td><strong>h</strong></td>
</tr>
<tr>
<td>s1</td>
</tr>
<tr>
<td>s2</td>
</tr>
<tr>
<td>s3</td>
</tr>
<tr>
<td>s4</td>
</tr>
<tr>
<td><strong>Adjusted R²</strong></td>
</tr>
<tr>
<td>s1</td>
</tr>
<tr>
<td>s2</td>
</tr>
<tr>
<td>s3</td>
</tr>
<tr>
<td>s4</td>
</tr>
</tbody>
</table>

* significant at 0.05 level
Market. This contradicts with the findings of Fama & French (1993, 1996 and 1998). However, the results of our tests are not totally unanticipated given the absence of size and Book-to-Market anomalies on Stockholm Stock Exchange that we have shown earlier. Hence, CAPM does in fact explain the cross-sectional stock return variation caused by size and Book-to-Market effects better than the Fama & French (1993) three-factor model. Fama & French (1993) get the lowest F-statistics of 1.56 for the three-factor model, whereas the CAPM exhibits an F-value of 2.09 during their tests. This is the opposite of what we obtain in our study. However, it is interesting to note that Fama & French (1993) as well reject the hypothesis that all the intercepts are jointly zero for the three-factor model regression, even though the three-factor model did in fact have the lowest F-statistics.

It is interesting to note that when we conduct the GRS F-test excluding the excess returns of portfolios s1-b/m1 and s1-b/m2, the F-statistics for CAPM decreases down to 0.629 (p-value 0.84). This is an indication to that the pricing error reduces if the CAPM is regressed on all portfolio returns except the returns for portfolios of the smallest stocks with the lowest Book-to-Market ratios.

The next hypothesis that we have derived in the Theory chapter is as follows:

Table 9: Results of the GRS F-test for 16 portfolios formed on size and Book-to-Market, and 6 portfolios formed on size and past 12 month performance.

<table>
<thead>
<tr>
<th>Tested Models</th>
<th>16 portfolios formed on size and Book-to-Market</th>
<th>6 portfolios formed on size and past performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAPM</td>
<td>0.898</td>
<td>1.276</td>
</tr>
<tr>
<td>Fama - French</td>
<td>1.974*</td>
<td>2.949*</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sig.</td>
<td>0.5727</td>
<td>0.2721</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.0193</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CAPM</td>
<td></td>
<td>2.945*</td>
</tr>
<tr>
<td>Fama - French</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carhart</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.0097</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.0098</td>
</tr>
</tbody>
</table>

* significant at 0.05 level

Figure 8: OMX All-share index development: September, 1997 - April, 2010.
Hypothesis 5: CAPM can explain the cross-sectional stock return variation caused by short-run past returns better than the Fama & French (1993) three-factor model and Carhart’s (1997) four-factor model.

Along with this hypothesis we test the two hypotheses closely related to it:

Hypothesis 6: Fama & French (1993) three-factor model can explain the cross-sectional stock return variation caused by short-run past returns better than CAPM and Carhart’s (1997) four-factor model.

Hypothesis 7: Carhart’s (1997) four-factor model can explain the cross-sectional stock return variation caused by short-run past returns better than CAPM and the Fama & French (1993) three-factor model.

To test these hypotheses we, first, regress the three models in question on the excess returns of six portfolios formed on size and past performance. The intercepts from the regressions of 6 portfolios formed on size and past performance are all somewhat equally close to zero (see Table 11). Notice that only one of the intercepts for the CAPM regressions is significant, as opposed to the multi-factor models, which have two

Table 10: Results of the GRS F-test for 16 portfolios formed on size and Book-to-Market, and 6 portfolios formed on size and past 12 month performance: Down (69 months) and Up (81) market states.

<table>
<thead>
<tr>
<th>Tested Models</th>
<th>Down market ($r_m &lt; r_f$)</th>
<th>Up market ($r_m &gt; r_f$)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>F</td>
<td>Sig.</td>
</tr>
<tr>
<td>CAPM</td>
<td>0.0059</td>
<td>1</td>
</tr>
<tr>
<td>Fama - French</td>
<td>1.8729*</td>
<td>0.0467</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>6 portfolios formed on size and past performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAPM</td>
<td>0.0017</td>
</tr>
<tr>
<td>Fama - French</td>
<td>0.9435</td>
</tr>
<tr>
<td>Carhart</td>
<td>0.9421</td>
</tr>
</tbody>
</table>

* significant at 0.05 level

Table 11: Intercepts from excess stock return regressions for 6 size and past performance formed portfolios, 150 months, 1997 - 2010.

<table>
<thead>
<tr>
<th>Size</th>
<th>Past Performance</th>
<th>α</th>
<th>t(α)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Losers</td>
<td>Neutral</td>
<td>Winners</td>
</tr>
<tr>
<td>CAPM</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small</td>
<td>0.0062</td>
<td>0.0054</td>
<td>0.0102*</td>
</tr>
<tr>
<td>Big</td>
<td>0.0056</td>
<td>0.0029</td>
<td>-0.0015</td>
</tr>
<tr>
<td>Fama-French</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small</td>
<td>0.0050</td>
<td>0.0048*</td>
<td>0.0099*</td>
</tr>
<tr>
<td>Big</td>
<td>0.0045</td>
<td>0.0023</td>
<td>-0.0015</td>
</tr>
<tr>
<td>Carhart</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small</td>
<td>0.0046</td>
<td>0.0048*</td>
<td>0.0101*</td>
</tr>
<tr>
<td>Big</td>
<td>0.0041</td>
<td>0.0023</td>
<td>-0.0013</td>
</tr>
</tbody>
</table>

*significant at 0.05 level
Since it is not viable to distinguish between the performances of the three models by looking at individual regression intercepts, we turn the reader’s attention to the results of the joint hypothesis tests displayed in Table 9. The lowest F-statistics is, again, achieved by CAPM. The three-factor and four-factor models have F-statistics that are very close to each other and are both statistically significant at the 0,05 level with p-values of ≈0,01. Thus, we reject Hypotheses 6 and 7 in favor of the Hypothesis 5.

Consistent with the results from Avramov & Chordia (2006) adding a momentum factor does not reduce the pricing error. We are inclined to believe that the absence of the significant past performance effect on the Stockholm Stock Exchange during 1997 and

Table 12: Intercepts from excess stock return regressions for 16 size and Book-to-Market portfolios during up market state, 81 months.

<table>
<thead>
<tr>
<th>size</th>
<th>α</th>
<th>t(α)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B/M1</td>
<td>B/M2</td>
</tr>
<tr>
<td>CAPM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>s1</td>
<td>-0,0114</td>
<td>0,0100</td>
</tr>
<tr>
<td>s2</td>
<td>-0,0015</td>
<td>0,0107</td>
</tr>
<tr>
<td>s3</td>
<td>-0,0109</td>
<td>0,004</td>
</tr>
<tr>
<td>s4</td>
<td>0,0013</td>
<td>0,0025</td>
</tr>
<tr>
<td>Fama - French</td>
<td></td>
<td></td>
</tr>
<tr>
<td>s1</td>
<td>-0,0148</td>
<td>0,0032</td>
</tr>
<tr>
<td>s2</td>
<td>-0,0042</td>
<td>0,0059</td>
</tr>
<tr>
<td>s3</td>
<td>-0,0145</td>
<td>0,0007</td>
</tr>
<tr>
<td>s4</td>
<td>0,0034</td>
<td>0,0016</td>
</tr>
</tbody>
</table>

*significant at 0,05 level

Table 13: Intercepts from excess stock return regressions for 16 size and Book-to-Market portfolios during down market state, 69 months.

<table>
<thead>
<tr>
<th>size</th>
<th>α</th>
<th>t(α)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B/M1</td>
<td>B/M2</td>
</tr>
<tr>
<td>CAPM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>s1</td>
<td>0,0278</td>
<td>0,0001</td>
</tr>
<tr>
<td>s2</td>
<td>-0,0034</td>
<td>-0,0031</td>
</tr>
<tr>
<td>s3</td>
<td>-0,0128</td>
<td>0,0124</td>
</tr>
<tr>
<td>s4</td>
<td>0,0049</td>
<td>0,0027</td>
</tr>
<tr>
<td>Fama - French</td>
<td></td>
<td></td>
</tr>
<tr>
<td>s1</td>
<td>0,0345*</td>
<td>0,0065</td>
</tr>
<tr>
<td>s2</td>
<td>0,0047</td>
<td>0,001</td>
</tr>
<tr>
<td>s3</td>
<td>-0,009</td>
<td>0,0146*</td>
</tr>
<tr>
<td>s4</td>
<td>0,0077</td>
<td>-0,0001</td>
</tr>
</tbody>
</table>

*significant at 0,05 level
2010 has an impact on the models’ performance. That is, since there is no anomaly, beta (β) on its own can explain the cross-section of stock returns. Hence, the CAPM has the lowest pricing error among the three asset-pricing models.

The F-statistics from the CAPM regressions of 6 size - past performance formed portfolios is slightly higher than that of 16 size – Book-to-Market formed portfolios. This indicates the presence of a slightly higher pricing error when CAPM is set to explain past performance related cross-section of stock returns. CAPM does a better job explaining Book-to-Market and size related stock return variation. Of course both of these are considerably lower when compared to the other two models’ F-statistics.

4.2.1. Testing the Conditional Models

We have seen, thus far, that CAPM has outperformed the multi-factor models when we regressed 16 portfolios formed on size and Book-to-Market, as well as, 6 portfolios formed on size and 12 months past performance. These results are from the entire period of 150 months between September, 1997 and March, 2010 inclusive. This short period of 12.5 years has seen two major crashes – first the dotcom crash in the early 2000’s, then the financial crisis that started late 2007 (see Figure 8 for the development of the OMX All-share index). One cannot help but wonder whether the results of our tests are affected by the uniqueness of the period. In order to test the explanatory ability of the CAPM during up and down market conditions we have derived the following hypothesis earlier in this thesis:

Hypothesis 8: Conditional CAPM captures the cross-sectional stock return variation caused by size, Book-to-Market and momentum effects better than the unconditional CAPM.

When the period is divided into two different states, using the excess market return over the risk-free rate as described in the Method chapter, we have 69 months of a “down” market state and 81 months of an “up” market state. The intercepts and their t-values for all of the models during the up markets are displayed in Tables 12 and 15, and the results of GRS F-tests can be found in Table 10. The F-statistics for CAPM are

| Table 14: Intercepts from excess stock return regressions for 6 size and past performance portfolios during down market state, 69 months. |
|---|---|---|---|---|---|---|
| Size | Past Performance | α | t(α) |
| | Losers | Neutral | Winners | Small | Neutral | Winners |
| CAPM |  | | | | | |
| Small | 0,0008 | 0,0077 | 0,0029 | 0,074 | 0,945 | 0,371 |
| Big | 0,0056 | 0,0051 | 0,0008 | 0,527 | 0,896 | 0,105 |
| Fama – French |  | | | | | |
| Small | 0,0037 | 0,0105* | 0,0055 | 0,537 | 2,225 | 0,868 |
| Big | 0,0055 | 0,0047 | 0,0032 | 0,661 | 0,958 | 0,423 |
| Carhart |  | | | | | |
| Small | 0,0036 | 0,0105* | 0,0056 | 0,611 | 2,208 | 1,03 |
| Big | 0,0054 | 0,0047 | 0,0033 | 1,105 | 0,954 | 0,597 |

*significant at 0,05 level
extremely close to zero and much lower than the F-statistics of the other models. This tells us that CAPM does a very good job in explaining the stock return variation when the market is divided into two different states. The conditional CAPM by far outperforms the unconditional version of CAPM leading to a conclusion that we do not have enough evidence to reject Hypothesis 8. Our findings are in line with those of Pettengill et al. (1995), Crombez & Vander Vennet (2000) and Bhardwaj & Brooks (1993).

A glance at the F-statistics of the other two models tells us that even they perform slightly better when they are conditioned on market states as opposed to when they are unconditionally tested using the entire period. One exception is Fama and French (1993) three-factor model regressed on up-market excess returns (F-statistics: 2.77 with p-value: 0.0178) – the F-statistics is much larger and statistically significant compared to the F-statistics of the down-market Fama and French (1993) model. This F-statistics is not much different from the unconditional three-factor model’s F-statistics (2.949) implying the three-factor model performs as bad during the up-market condition as the unconditional three-factor model.

Table 15: Intercepts from excess stock return regressions for 6 size and past performance portfolios during up market state, 81 months.

<table>
<thead>
<tr>
<th>Size</th>
<th>α</th>
<th>t(α)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Losers</td>
<td>Neutral</td>
</tr>
<tr>
<td>CAPM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small</td>
<td>-0.0027</td>
<td>0.0122</td>
</tr>
<tr>
<td>Big</td>
<td>-0.0203</td>
<td>0.0030</td>
</tr>
<tr>
<td>Fama-French</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small</td>
<td>-0.0109</td>
<td>0.0082*</td>
</tr>
<tr>
<td>Big</td>
<td>-0.0249</td>
<td>0.0009</td>
</tr>
<tr>
<td>Carhart</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small</td>
<td>0.0212</td>
<td>0.0083*</td>
</tr>
<tr>
<td>Big</td>
<td>-0.0025</td>
<td>0.0025</td>
</tr>
</tbody>
</table>

*significant at 0.05 level
5. Conclusion

This is the final chapter of our study where the research questions will be answered following the brief summary of this paper. Moreover, further research suggestions will be put forward in the end of the chapter.

The research questions that we have established in the beginning of this paper were as follows:

- Do CAPM, Fama & French’s three-factor model and Carhart’s four-factor model capture the cross-sectional variation of stock returns better with a conditional beta?

Before answering the question above we have researched the following question:

- Does firm size, Book-to-Market equity ratio or short run past returns affect the cross-sectional variation of stock returns?

By searching for answers to the aforementioned questions we wished to contribute with further knowledge into the studies of cross-section of stock returns. Specifically, the studies conduct using the Swedish stocks. We have come to find that there is a very scarce pool of researches that have been done in Sweden in this field of research. There are only a few papers that take on testing the asset-pricing models empirically in Sweden. As we have stated in the introduction chapter, our paper is the first to compare a number of models by conditioning them on market states. There have been similar studies done in other countries, of which the vast majority done in the US, and our research is to serve as a robustness test.

In the theoretical chapter of this paper we have arrived at several hypotheses to aid us in finding answers to the research questions. To begin with, we have investigated for the presence of some financial market anomalies, specifically, the size, Book-to-Market and momentum effects. Our findings indicate that there are no such anomalies on the Stockholm Stock Exchange during our test period (1997-2010). So, to answer our secondary research question – we conclude that firm size, Book-to-Market equity ratio or short run past returns do not affect the cross-sectional variation of stock returns.

To answer the primary research question and find the best performing model that can explain the returns of Swedish stocks we have conducted some joint hypothesis tests using the test statistic suggested by Gibbons, Ross and Shanken (1989). Since we believe that there exists one model that best explains the stock return cross-section, we compare various model specifications. First off, unconditional versions of the CAPM and the three-factor model of Fama & French (1993) are compared. Then, using past performance sorted portfolios, the ability to explain stock returns of two models mentioned above and the four-factor model proposed by Carhart (1997) is compared. Out of these three models, the CAPM emerges as the model that can best explain the returns of 22 portfolios. Since, the period we test does not exhibit the financial anomalies, such as size, Book-to-Market and momentum effects, we anticipated the CAPM to capture the cross-section of stock returns better than the other models. This finding is in contradiction with what Fama and French (1993) conclude. We show that their results are not robust to geographical changes, as well as time period changes. CAPM, as our results indicate, still holds.
The conditional CAPM is able to capture the return variation across stocks far better than the unconditional CAPM as the results of our tests point out. There is a drastic reduction in pricing errors when the CAPM is conditioned on market states. This is in line with Pettengill et al. (1995) and Bhardwaj & Brooks (1993). Our results confirm their conclusions that the relationship between beta and returns is conditional on market states. Crombez & Vander Vennet (2000) also come to a conclusion similar to ours when they investigate the performance of conditional and unconditional CAPM Brussels Stock Exchange.

The conditional version of Fama and French (1993) performs better during the down-market state than the unconditional version of it. However, during the up-market states the three-factor model does not perform distinguishably different from the unconditional one. This is an interesting observation that needs some deeper investigation in the future.

Carhart’s four-factor model performs better when it is conditioned on market states in comparison to the unconditional version. However, the conditional CAPM is the ultimate winner here. Table 16 summarizes the hypotheses that we have tested in this thesis in order to arrive at the conclusions presented. All the hypotheses are accepted except Hypotheses 6 and 7.

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Description</th>
<th>Reject</th>
<th>Accept</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypothesis 1</td>
<td>A firm’s market capitalization (size) has no impact on its stock returns.</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Hypothesis 2</td>
<td>The ratio of a firm’s Book Equity to Market Equity has no impact on its stock returns.</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Hypothesis 3</td>
<td>The stock returns of a firm are not affected by short-term past returns.</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Hypothesis 4</td>
<td>CAPM can explain the cross-sectional stock return variation caused by size and Book-to-Market effects better than the Fama &amp; French (1993) three-factor model.</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Hypothesis 5</td>
<td>CAPM can explain the cross-sectional stock return variation caused by short-run past returns better than the Fama &amp; French (1993) three-factor model and Carhart’s (1997) four-factor model.</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Hypothesis 6</td>
<td>Fama &amp; French (1993) three-factor model can explain the cross-sectional stock return variation caused by short-run past returns better than CAPM and Carhart’s (1997) four-factor model.</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Hypothesis 7</td>
<td>Carhart’s (1997) four-factor model can explain the cross-sectional stock return variation caused by short run past returns better than CAPM and the Fama &amp; French (1993) three-factor model.</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Hypothesis 8</td>
<td>Conditional CAPM captures the cross-sectional stock return variation caused by size, Book-to-Market and momentum effects better than the unconditional CAPM.</td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>
5.1. **Theoretical and Practical Contributions**

Our research’s empirical contribution is obvious – we study a field that has not yet been fully explored on the Stockholm Stock Exchange. In addition to restoring the CAPM’s reputation and reinstating beta as the measure of risk, we confirm the suggestion that the condition the market is in does play a role. The investors should indeed use different betas depending on the expectations of how the market is to perform in the future. Furthermore, our paper contributes into the research on the financial market anomalies and the market efficiency studies. We show that the anomalies we chose to investigate are not present during the last twelve years. In addition, we show that the multi-factor models of Fama & French (1993) and Carhart (1997) are not robust when the time and place are changed.

On the theoretical field, we have strengthened the positions of the efficient market hypothesis and the CAPM. Our research functions as a theoretical base for future research on cross-section of stock returns, as well as, financial market anomalies in the Nordic region. We, furthermore, have filled the research gap that existed in the Swedish financial research. Our study is the first to investigate the dual-beta conditional CAPM, as well as, the four-factor model proposed by Carhart (1997). In addition, the period under examination includes data up until April of 2010, whereas, most of previous research is conducted during the 90’s and rather few of them use data from the 2000’s.

5.2. **Further Research**

When we were conducting this study we were surprised by the existence of many gaps concerning the research on stock market anomalies in the Swedish and Nordic marketplace. Not to mention the lack of research on the asset-pricing models in the same context, this probably has its roots in the shortage of scientific research on the anomalies themselves. The consequences have been that the results found in this thesis had to be compared and analyzed on research done on other markets which might not be as applicable to the Stockholm Stock Exchange as the Nordic markets. These subjects, in the markets mentioned above, are in need of further research and as they seem to be two rather unexamined areas. More thorough research on the market anomalies and the asset-pricing models will be of interest for, both, the professional and academic sphere, as it can conclude whether the Swedish or Nordic stock markets are efficient or not.

More specifically we suggest that further research is conducted on the anomalies and whether they exist on the Stockholm Stock Exchange. The research already done is fragile or even nonexistent. Consequently, a more detailed investigation of the anomalies should also include more anomalies than only the three that were discussed in this thesis. For example, one could include the January effect, the weekend effect and etcetera, to make a stable foundation and starting point for subsequent research testing the anomalies. Naturally, when the anomaly research has a sounder base the asset-pricing models should be re-tested considering the new finding on the anomalies on the Stockholm Stock Exchange or other similar stock markets.

The aforementioned are main pillars that need to be done before other research can be conducted in a fruitful manner. Of course, the suggestions that we leave here are mainly focused on the Swedish and Nordic markets, as these are the ones found to have a shortage of research on these subjects. However, much of the revolutionary outcomes
concerning anomalies and the different asset-pricing models tested in this thesis are getting rather old, signifying that new research on the same markets with different time horizons could be healthy. Moreover, as the main pillars are constructed, the asset-pricing models such as, CAPM, Fama-French and Carhart, should be tested and having portfolios formed on the basis of these. Further research should also test the models in different market conditions to see whether any model performs better in a certain market state or if they are insensitive to, for example, macroeconomic variations.

Finally, as a number of other financial phenomena, the research can always be conducted on a wider time period, making it more valid. We have only included those stocks that have been or are listed on the Stockholm Stock Exchange between October 1996 (including one year formation period) and March 2010. Thus, we suggest the use of a bigger sample which could be the whole OMX Nordic Exchange. Moreover, an extension of the studied period could be of interest to see whether the anomalies existed before 1997 and are now gone, or if they have never existed at all on the Stockholm or Nordic Stock Exchanges. To get a clear-cut view of this, subsamples should be used, to then be able to report over which periods the anomalies are more evident and over which periods the asset-pricing models explain the cross-section of stock returns better.
References


