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Performance Evaluation of Small- and Large-cap stocks

The importance of size effects on the Swedish equity market

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By

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Abstract

This Bachelor´s thesis investigated the performance of small-cap stocks and large-cap stocks on the Swedish equity market (NASDAQ OMX) over the years 2011 to 2016.

A number of studies focused on asset pricing have during the last decades indicated that the original Capital Asset Pricing Model (CAPM) is misspecified and has limited power to explain cross-sectional and temporal variations in expected equity returns. Moreover, equity returns have been suggested to, at least partially, be influenced by market anomalies e.g. associated with firm size (the size effect). Multi-factor pricing models such as the Fama-French Three-factor model and the Carhart Four-factor model are financial instruments developed to account for market anomalies such as firm size. In this study, single- and multi-factor pricing models were used to quantitatively evaluate the importance of the size effect for equity returns in two composite portfolios based on market capitalization. When analyzing the equity returns generated by small-cap stocks and large-cap stocks compared to the market benchmark (OMXSGI), on average, the small-cap stock portfolio outperformed both the market benchmark and the large-cap stock portfolio. However, the relative stock performance and relation between the equity returns of the two portfolios and the market benchmark varied significantly with time. Although not statistically significant, Fama-French Three-factor regressions generated alpha-values that indicated equity returns higher than those of the market for the small-cap stock portfolio, and equity returns lower than those of the market for the large-cap stock portfolio. Similar patterns were observed using the Carhart Four-factor model. Further, SMB-values from Fama-French Three-factor and Carhart Four-factor modelling indicated a positive risk-premium for holding small-cap stocks and a negative risk-premium for holding large-cap stocks. The SMB-values were statistically significant, thus, single- and multi-factor regression analyses suggested a size effect for the small-cap and large-cap portfolios. In contrast to indications of a general size effect, however, the predictive ability was not drastically different between the three asset pricing models. Although the present study provided empirical support that suggested a negative correlation between firm size and expected equity return, it also supported that additional factors, perhaps correlated with size, likely were important for the observed stock performance.

Keywords: Performance Evaluation, Asset pricing, Size Effect, Sharpe Ratio, Treynor ratio, Jensen´s alpha, Risk-Adjusted Returns, Fama-French Three-Factor Model, Carhart Four-Factor Model, Multi-factor models, Single-factor model

Abbreviations

CAPM – Capital Asset Pricing Model
SMB – Small-Minus-Big (factor)
HML – High-Minus-Low (factor)
MOM – Momentum (factor)
Market cap – Market Capitalization
EMH - Efficient Market Hypothesis
SR – Sharpe Ratio
TR – Treynor Ratio
NYSE – New York Stock Exchange
NASDAQ - National Association of Securities Dealer Automated Quotation system
OLS – Ordinary Least Squares
STDV – Standard deviation
P/E - Price-to-earning ratio
B/M – Book-to-market ratio

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1. Introduction

Financial investments in general follow either active or passive strategies (Bodie et al., 2014). Actively engaging strategies are based on two main underlying assumptions; i) markets are structurally efficient with stock values representing factors that govern the price of a security, and ii) the development of stock prices is not random but rather evolve in patterns and trends that tend to repeat over time (Chen, 2018). An active investment strategy therefore entails active engagement in buying and selling activities based on technical and/or fundamental analyses. Technical analysis is the trading discipline of evaluating investments and identifying trading opportunities by analyzing statistical trends collected from trading activities (e.g. development of stock price). Important objectives in this strategy are to determine the investment prospects by quantification of basic financial factors that may affect the value of the security, and to utilize analytical charting tools for the evaluation of the relative strength of a particular security (Hull, 2012). Moreover, fundamental analysis focuses on related economic and financial factors which affect the value of the security. Such quantitative indicators can be used to evaluate the current value of the security. In contrast to active trading based on short-term financial information, passive investment strategies aim to build wealth gradually over time. Securities are acquired with the intention to hold long term; buy-and-hold. Underlying assumption of this strategy is that market returns are positive over time whereby passive investment strategies often try to replicate market index by well-diversified portfolios of single stocks (Bodie et al., 2014).

The basic assumptions that underlie and describe the behavior of the market have been theorized, for example by the *Efficient Market Hypothesis,* in which the stock performance is assumed to change randomly over time and asset prices are considered to fully reflect all available information (Fama, 1969). According to these assumptions, in principle, it would not be possible to outperform the market on a risk-adjusted basis since market prices solely react to new information. In contrast to the *Efficient Market Hypothesis,* firms with a small market capitalization were observed to outperform firms with a large market capitalization in terms of average equity returns (Banz, 1981; Fama and French, 1992). A wide-spread size effect challenges the *Efficient Market Hypothesis* and the assumption that the only ways of earning excess returns are by chance or to acquire riskier assets (Bodie et al., 2014).

1.1. Objectives and rationale

The overall aim of this Bachelor´s Thesis was to:

- quantitatively evaluate the importance of the size effect for equity returns

Specific objectives were to:

- quantitatively evaluate the performance of small-cap stocks and large-cap stocks on the Swedish equity market, NASDAQ OMX, during the time-period 2011-2016

Two composite portfolios based on market capitalization were constructed, one portfolio containing stocks from large-cap firms and one containing stocks from small-cap firms listed on NASDAQ OMX. The stock portfolios were assessed based on equity returns, risk-adjusted returns, and statistically evaluated using one- (CAPM; Sharpe, 1964; Lintner, 1965; Mossin, 1966) and multi-factor pricing (the Fama-French Three-factor model; Fama and French, 1992; and Carhart Four-factor model; Carhart, 1997) models. These multi-factor models facilitated detailed studies on the importance of firm size, book-to-market ratio and momentum as additional factors in the pricing equation. In addition to the econometric analyses, Sharpe ratios (Sharpe, 1994), Treynor ratios (Treynor, 1961) and Jensen´s alpha (Jensen, 1967) were used to evaluate the risk-adjusted performance of the two stock portfolios.

Previous research and quantitative analyses related to the size effect and equity returns have predominantely focused on stock markets in larger OECD countries (e.g. Banz, 1981; Fama and French, 1992, Crain, 2011). For example, in the original paper introducing the size effect Banz (1981) analyzed the rate of equity returns on the New York Stock Exchange (NYSE). As a consequence, there are fewer studies that focus on the importance of the size effect for equity returns in smaller markets, such as the Swedish equity market. Moreover, during the last decade several studies focused on the performance of the Swedish equity market have emphasized the subprime mortgage crisis (2007-2009) and the equity performance of funds with different market capitalizations before and during the crisis. The time-period of interest in this thesis (2011-2016) is part of the the post-crisis period which has been covered less exhaustively. Additionally, the growth rate during the time-period succeeding the subprime crisis has been comparably high (NASDAQ Inc., 2018). It was considered interesting to in detail investigate the importance of the size effect for rates of equity returns in a bull market.

2 Literature review

Banz (1981) was the first study to suggest firm size (market capitilization) as an important financial factor for equity returns. Observations supported a negative correlation between market capitalization and equity return on the New York Stock Exchange (NYSE). Thus, on average, smaller firms were associated with higher risk-adjusted returns than larger firms. This so called “size effect” implied that CAPM, the single-factor instrument for financial evaluations, did not accurately account for size as an explanatory variable during modelling of equity returns. Since the introduction of the CAPM (Sharpe, 1964; Lintner, 1965; Mossin, 1966), several studies focused on asset pricing have suggested additional factors that may affect the risk and return trade-off for stocks, both in cross-section and over time. In addition to size (market capitilization; Banz, 1981; Fama and French, 1992) and value (book-to-market ratio, B/M; Fama and French, 1992; Cakici and Topyan, 2014), market anomalies that have been suggested to affect rates of equity return include e.g. liquidity (e.g. Amihud and Mendelson, 1986; Hou et al., 2015), momentum (e.g. Jegadeesh and Titman, 1993; Low and Tan, 2016; Carhart, 1997), price-to-earning ratio (P/E; Anderson and Brooks, 2006) and financial leverage (Fama and French 1992; Gomes and Schmid 2010). Furthermore, temporal effects within and between years have also been acknowledged as important anomalies for equity returns (e.g. Keim, 1983). Thus, the single-factor model, CAPM, seemingly needs to be complemented with extended multi-factor models to more accurately describe and predict the relation between risk exposure and equity return.

In addition to critique related to methodological considerations and data interferences (e.g. Lo and MacKinlay, 1990), there are contrasting observations on the mechanisms (Lustig and Leinbach, 1983) as well as on the importance of firm size for the performance in different markets (e.g Hull, 2012), in different market sectors (e.g. Bodie et al., 2014), and during different time periods (e.g. Keim, 1983; Crain, 2011).

According to Lustig and Leinbach (1983), CAPM constitutes an appropriate analytical tool to evaluate the performance of large-cap firms. However, the single-factor model was suggested to fail in the ability to reflect the performance of small-cap firms. As a consequence, the excess returns shown by small-cap stocks were in Lustig and Leinbach (1983) mainly suggested to be caused by a market compensation for efforts to obtain adequate and sufficient information. Overall, small firms were neglected by large trading institutions. Accurate and up-to-date financial information about smaller firms was therefore less available. This information defiency made smaller firms riskier investments that in general commanded higher returns. As a consequence, investors were compensated for this cost, often by a higher return. Also, large firms are normally subject to considerable monitoring from institutional investors. Such external control of financial information ensures timely and high-quality information on prospects and future scenarios of the large firms. The investment decision in stocks of large firms is due to this structured information flow normally less risky.

Studies have demonstrated a time-dependent size effect where equity returns were most pronounced during the first two weeks of January (e.g. Keim, 1983; Reinganum, 1983; Blume and Stambaugh, 1983). During the period 1963-1979, for example, approximately 50 % of the average size effect observed on the New York Stock Exchange (NYSE) was due to abnormal returns in January (Keim, 1983). In addition, more than 50 % of the January premium was found attributed to large returns during the first week of trading in the year. Effects were particularly obvious during the first trading day. Thus, the correlation between firm size and abnormal returns seemed to be most pronounced in January than in any other month. Arbel and Strebel (1983) coupled the concentration of the size effect in January to the market structure in information flow and the tendency for small firms to be neglected by large institutional traders, i.e. a neglected-firm effect. Neglected firms are expected to earn higher equilibrium returns as compensation for the risk associated with a restricted information flow, i.e. similar to a risk premium (Merton, 1987).

Although a general size effect has been observed in several international stock markets, such effect seemed primarily important over long time horizons (Crain, 2011). According to this author, a size effect has not been observed in the United States since the early 1980s, or in the United Kingdom since the late 1980s. This time period correlates rather well with the initial observations of the size effect (Banz, 1981) and the general increase in small-cap funds during the 1980s. Furthermore, the size effect seemed restricted and only significant for listed firms with less than 5 million USD in market capitalization (Crain, 2011).

The observations by Banz (1981) of negative correlations between the size (market capitalization) of the firm and stock return were further confirmed and strengtened in the study by Fama and French (1996). Firm characteristic variables such as market capitalization, earnings-to-price and cash-flow to price ratios, book-to-market equity and past sales growth, were investigated together with their respective relation to average stock returns. In addition to market capitalization there was a tendency for value stocks (often defined by low P/E ratio and high book-to-market ratio) to provide higher average returns than growth stocks (Bodie et al., 2014). Hence, Fama and French (1996) developed an extention of the original CAPM and included size (Small-Minus-Big; SMB) and value (High-Minus-Low; HML) as two additional factors and introduced the Fama-French Three-factor model for equity returns. The three-factor model was demonstrated to accurately describe the return for equity portfolios formed on size and book-to-market value of equity (Fama and French, 1996). Malin and Veeraraghavan (2004) investigated the robustness of the Fama-French Three-factor model for equities listed in three European markets and observed a small size effect in the markets in Germany and France. In contrast, however, the inverse relation was found in the market in the United Kingdom. The correlation between size of the firm and equity returns was not only inverse, but also statistically more significant for the market in the United Kingdom compared to the German and French markets. These latter observations suggest that the importance of size for equity returns was closely associated with meta-structures and financial anomalies related to the composition of individual stock markets.

Jegadeesh and Titman (1993) acknowledged momentum as an important factor to explain expected rate of return on equity. Momentum of stocks is the empirically observed tendency for stock prices to remain increasing (or decreasing) following a period of increase (or decrease) (Low and Tan, 2016). It provides a viable indicator of strength or weakness in stock price. The study by Jegadeesh and Titman (1993) was further refined and formed the base for the later introduction of the Carhart Four-factor model (Carhart, 1997), an extention of the Fama-French Three-factor model (Fama and French, 1996) including momentum as an additional factor for asset pricing of stocks.

Also, liquidity of an asset has been emphasized as a factor that may regulate expected returns and therefore should be included in the pricing equation (e.g. Amihud and Mendelson, 1986; Amihud et al., 2013). Liquidity refers to the ease and speed with which assets can be sold at a fair market value. Amihud and Mendelson (1986) suggested that liquidity was linked to the size effect and the neglected-firm effect in that investors would require a premium to invest in less-liquid stocks due to the enhanced risk and higher trading costs. Because small and less-analyzed stocks tend to be less liquid, the liquidity effect was suggested to at least partially explain the abnormal returns observed for small-cap stocks (e.g. Amihud and Mendelson, 1986).

Hou et al. (2015) investigated the importance of about 100 market anomalies for equity returns. Overall, using a Q-factor model capital markets seemed more efficient and the importance of the anomalies was significantly lower compared to what several other studies previously reported. The largest causality was observed for liquidity and the authors suggested that the development of micro-caps were the most important factor for the deviations from asset pricing. While micro-caps account for approximately 60 % of the stocks included in the NYSE-Amex-NASDAQ, they only serve less than 5 % of the total market capitalization (Fama and French, 2008).

3. Theory review

3.1. Risk exposure and equity return

One of the fundamentals in financial theory is the link between risk exposure of investments and expected returns. This trade-off between risk exposure and return infers that low levels of risk are associated with low levels of expected returns. Inversely, high levels of risk imply higher expected returns (Markowitz, 1952). Thus, the expected rate of return is assumed to increase by increasing the risk exposure of the investment (Hull, 2012). However, captured returns are often found to deviate from the expected returns due to risk factors and market anomalies associated with the investment (Bodie et al., 2014).

The average investor is often assumed to be risk averse and select investments based on the highest expected return in relation to the individual risk preference (Bodie et al., 2014). An underlying assumption in financial theory is that risk aversion requires financial compensation for bearing risky investments and that each opportunity for investment is evaluated on the risk and return trade-off provided (Markowitz, 1952). The financial compensation for risky investments entails a risk premium, which can be defined as the return in excess of the risk-free rate of return (Kenton, 2018).

Market (systematic) risk and firm-specific (unsystematic) risk are two forms of risk that may affect assets of a firm (Hull, 2012). While market risk is normally considered to be systematic and affect in principle all asset classes, the unsystematic risk is firm-specific and solely affect the particular firm (Bodie et al., 2014). Market risk cannot be mitigated through portfolio diversification as macroeconomic shocks are economy-wide. According to the original CAPM (Sharpe, 1964; Lintner, 1965; Mossin, 1966) such risks should be priced by the market. In contrast, the firm-specific risk can be diversified to arbitrarily low levels by investing in a variety of diverse assets. The specific risk should therefore not be priced by the market (Markowitz, 1952).

3.2 The Efficient Market Hypothesis

According to the *Efficient Market Hypothesis* prices of assets reflect all available information. Consequently, it is theoretically not possible to consistently outperform the market on a risk-adjusted basis (Fama, 1969). Investment strategies such as technical and fundamental analyses are in accordance assumed to be ineffective in identifying mispriced securities since securities are assumed to, on average, be traded at their fair value. When information that indicates a mispriced security reaches the market, trading activities rapidly exploit such profit opportunities. Undervalued securities are purchased and overvalued securities are sold to reach market equilibrium where the rate of returns commensurates with the risk of the stock (Patell and Wolfson, 1984; Busse and Green, 2002; Bodie et al., 2014). However, the efficiency in the response to relevant and accurate information varies between markets. For example, emerging and less analyzed markets seem less efficient compared to more well-analyzed markets (Grossman and Stiglitz, 1980). Moreover, studies have indicated that small-cap stocks are less exhaustively analyzed compared to large- cap stocks, whereby small-cap stocks may be less efficiently priced relative to large-cap stocks (Bodie et al, 2014).

3.3 Asset pricing models

This section aims to introduce the theory underlying the asset pricing models utilized to describe the risk-return trade-off. The pricing models include the single-factor CAPM (Sharpe, 1964; Lintner, 1965; Mossin, 1966) as well as the multi-factor models Fama French Three-factor model (Fama and French, 1992; 1996) and the Carhart Four-factor model (Carhart, 1997).

3.3.1 The Capital Asset Pricing Model

Basic principles of the Capital Asset Pricing Model were first described by Sharpe (1964), Lintner (1965) and Mossin (1966). The theoretical model of CAPM is widely recognized and used to capture the risk and return trade-off for securities, in particular stocks (Fama and French, 2004).

Overall, investors need to be compensated for the time value of money and the risk associated with the particular investment. The time value of money is represented by the risk-free security, a security without reinvestment and default risk (Damodaran, 2012). Investors also need to be compensated for the exposure to market risk (Hull, 2012). The level of compensation required to bear additional risk can be estimated using the framwork of CAPM. In the asset pricing equation (Eq. 1) the sensitivity to market risk is represented by beta, a measure of the contribution of the security/portfolio to the variance of the market portfolio as a fraction of the total variance of the market portfolio.

The relation between beta and expected equity return can be formulated:

$$E(r_i) = r_f + \beta_i\left[E(r_m) - r_f\right] \tag{1}$$

$E(r_i)$ = The expected rate of return of security/portfolio i.
r_f = The risk-free rate of return
β_i = The contribution of the security/portfolio to the variance of the market portfolio as a fraction of the total variance of the market portfolio (the sensitivity of the security to market volatility)
$E(r_m)$ = The expected rate of return of the market portfolio
$E(r_m) - r_f$ = The market risk premium

where:

$$\beta_i = \frac{Cov(r_i,r_m)}{var(r_m)} \tag{2}$$

According to CAPM and the asset pricing equation (Eq 1), market risk is the main factor that controls expected rate of returns on securities. Consequently, the sensitivity to market risk governs the price of a security.

3.3.2 Multi-factor asset pricing models

Multi-factor asset pricing models are extensions of CAPM and include more than one risk factor that should be priced by the market. Several empirical studies have indicated that market anomalies, e.g. the size effect, are not efficiently priced by the original CAPM (e.g. Banz, 1981; Fama and French, 1992). As a consequence, multi-factor models have been developed to more accurately describe and predict the expected rate of returns for stocks. For example, Ferson and Harvey (1994) argued that multi-factor asset pricing models including several risk factors provide an improved explanation of equity returns in the cross-section.

The Fama-French Three-factor model is a widely recognized multi-factor model empirically used to describe and estimate the risk and return trade-off for stocks (Bodie et al., 2014). Small-cap stocks were observed to outperform large-cap stocks, and value stocks outperformed growth stocks (Fama and French, 1996). Similar observations have been made in other studies world-wide (e.g. Cakici and Topyan, 2014). In addition to the market factor, the Fama-French Three-factor model accounts for size (Small-Minus-Big; SMB) and value (High-Minus-Low; HML).

The Fama-French Three-factor model is formulated:

$$E(r_i) = r_f + \beta_i\left[E(r_m) - r_f\right] + \beta_{iSMB}E(SMB) + \beta_{iHML}E(HML) \qquad (3)$$

$E(r_i)$ = The expected rate of return of security/portfolio i.
r_f = The risk-free rate of return
β_i = The contribution of the security/portfolio to the variance of the market portfolio as a fraction of the total variance of the market portfolio (the sensitivity of a security to market volatility)
$E(r_m)$ = The expected rate of return of the market portfolio
$E(r_m) - r_f$ = The market risk premium
β_{iSMB} and β_{iHML} = The sensivity of the security/portfolio to SMB and HML respectively
$E(SMB)$ = The size premium
$E(HML)$ = The value premium

Small-Minus-Big (SMB) refers to the market capitalization of the firm and High-Minus-Low (HML) is associated with the book-to-market value (Bodie et al., 2014). “High” refers to firms with a high book-to-market ratio, while “Low” refers to firms with a low book-to-market ratio. The HML factor is often refered to as the “value factor” because firms with a high book-to-market ratio are generally considered as “value stocks”. Firms with a low book-to-market ratio are typically associated with stocks with a future potential for growth; “growth stocks” (Fama and French, 1993).

The Carhart Four-factor model (Carhart, 1997) is an extention of the Fama-French Three-factor model. In addition to size and value, the Carhart Four-factor model includes a momentum factor in the pricing equation (Carhart, 1997). Stock prices often exhibit a momentum, i.e. a tendency for the stock price to continue rising (or continue declining), following a period of increase (or decrease) (e.g. Jegadeesh and Titman, 1993; 1999). Stock momentum indicates the rate of rise or fall in stock prices and, as a consequence, the strength or weakness in assets.

The Carhart Four-factor model is formulated:

$$E(r_i) = r_f + \beta_i\left[E(r_m) - r_f\right] + \beta_{iSMB}E(SMB) + \beta_{iHML}E(HML) + \beta_{iMOM}E(MOM) \qquad (4)$$

$E(r_i)$ = The expected rate of return of security/portfolio i.

r_f = The risk-free rate of return

β_i = The contribution of the security/portfolio to the variance of the market portfolio as a fraction of the total variance of the market portfolio (the security´s sensitivity to market volatility)

$E(r_m)$ = The expected rate of return of the market portfolio

$E(r_m) - r_f$ = The market risk premium

β_{iSMB}, β_{iHML} and β_{iMOM} = The sensivity of the security/portfolio to SMB, HML and MOM respectively

$E(SMB)$ = The size premium

$E(HML)$ = The value premium

$E(MOM)$ = The momentum premium

In this thesis, the Fama-French (Fama and French, 1992) and the Carhart (Carhart, 1997) multi-factor pricing models were used to investigate if significant pricing anomalies relative to CAPM were observed on the Swedish equity market during the period 2011-2016.

4. Data handling and general methodology

4.1. Data collection and market index

Pricing data for equities traded on the Swedish equity market (NASDAQ OMX) over the time period January 2011 to December 2016 was collected on a monthly basis from NASDAQ Inc. (NASDAQ Inc., 2018) and Eikon (Thomson Reuters, 2018). Fundamental information of firms was collected from Eikon (Thomson Reuters, 2018) and included the balance sheets with total assets, total liabilities and total equity as well as income statements (net income). The Swedish risk-free rate ("statsobligationsräntan") was collected from the Swedish Riksbank (Sveriges Riksbank, 2018). Model factors for the computation of the single- and multi-factor models (Eq1 – Eq4) were collected from Swedish House of Finance (SHoF, 2018).

Firms with stock price data for the entire time period were selected for the analyses. When analyzing for the size effect it is common practice to categorize and differentiate between portfolios based on market capitalization (Bodie et al., 2014). In this thesis, the categorization between firms of different market capitalizations (small-cap and large-cap stocks) was made according to the definition provided by NASDAQ Inc. (NASDAQ Inc., 2018):

Small-cap firms = firms with a market value below 150 million euro
Large-cap firms = firms with a market value over one billion euro

This delineation was used to sort stocks into two portfolios representing large-cap and small-cap stocks, respectively. The small-cap and the large-cap stock portfolios were used for model evaluations. In total, 223 firms were included in evaluations. Of these, 123 firms were included in the large-cap portfolio and 100 in the small-cap portfolio (Appendix A).

The market index, OMXSGI (GI - gross index), was used as a market benchmark when the performance of small-cap stocks and large-cap stocks was compared. OMXSGI was used as benchmark for the development of stocks on the Swedish equity market since total returns included share price development and share dividends.

4.2. Calculations and computations

4.2.1 Rate of return

The rate of return is defined from the net gain or loss on an investment over a specified time period, t. Normally, return is expressed in relation to (%) the initial cost of the investment (Bodie et al, 2014). Rates of return (r_t at time t) for the two stock portfolios were calculated according to:

$$r_t = \frac{P_t}{P_{t-1}} - 1 \tag{5}$$

P_t = The security price (time t)
P_{t-1} = The security price (time t-1)

The total rate of return from stocks was estimated monthly from the last closing price of the month (NASDAQ Inc, 2018). In accordance to the use of OMXSGI as a return index for the development of stocks on the Swedish equity market, the price of stocks included share price developments and share dividends.

4.2.2 Book-to-market ratio

The book-to-market ratio (B/M) is defined as the book value of equity divided by the market value of equity. Eventual effects from B/M on stock portfolios are often referred to as value effects (Cakici and Topyan, 2014). The book-to-market-ratio is calculated from:

$$Book\ to\ market\ ratio = \frac{Book\ value_i}{Market\ value_i} \qquad (6)$$

$Book\ value_i$ = The original cost of the asset reduced by any depreciation, amortization or impairment costs made against the asset

$Market\ value_t$ = The market capitalization (obtained by multiplying the number of outstanding shares by the current share price)

The High-Minus-Low (HML) factor is associated with the book-to-market values. In this thesis, values representing the HML-factor were collected from Swedish House of Finance (SHoF, 2018).

4.2.3 Small-Minus-Big

The Small-Minus-Big (SMB) model factor is used in the Fama-French Three-factor model and the Carhart Four-factor model to account for the discrepancy in return between small- and large firms, where size is determined by market capitalization. Once SMB is estimated from the returns, the associated beta coefficient (β_{SMB}) can be determined through regression. A positive beta coefficient for the SMB factor suggests that the portfolio is skewed towards small-cap stocks (small cap stocks > large cap stocks). It also suggests that holding small-cap stocks inherits a positive risk premium which, in turn, has a positive effect on equity returns. Similarly, a negative beta coefficient for the SMB factor suggests that the portfolio is skewed towards large-cap stocks (small cap stocks < large cap stocks). Consequently, this also suggests that holding large-cap stocks provides a negative effect on equity returns. The values constituting the SMB factor was collected from Swedish House of Finance (SHoF, 2018).

4.2.4 Momentum

The momentum-factor (MOM) is used in the Carhart Four-factor model (Carhart, 1997) to quantify the tendency for stock prices to continue increasing (or continue decreasing), subsequent to a period of increase (or decrease) (e.g. Jegadeesh and Titman, 1993). The momentum-factor isolates this short-term momentum effect that securities or assets may experience in the market. In principle, the monthly momentum is calculated by subtracting the value-weighted average of the lowest performing firms from the value-weighted average of the highest performing firms, with one month time-lag (Carhart, 1997). A momentum effect has occurred if the average return is positive during a 12-month period. The values constituting the MOM factor was in this study collected from Swedish House of Finance (SHoF, 2018).

4.2.5 Risk and risk-adjusted performance of portfolios

The risk or volatility of the portfolios was calculated by the the standard deviation of the rate of returns (Bodie et al, 2014):

$$\widehat{\sigma_p} = \sqrt{\frac{1}{n-1}\sum_{s=1}^{n}[r(s) - \bar{r}]^2} \tag{7}$$

$\widehat{\sigma_p}$ = The estimated standard deviation of the rate of returns (portfolio risk)
$r(s)$ = The realized rate of return in each scenario
$\bar{r}$ = Deviations from the sample arithmetic average

However, in principle, the standard deviation can only be used as an appropriate measure of portfolio risk if the distribution of data approximately follows a normal probability distribution (Bodie et al, 2014). The underlying probability distribution of the rates of returns for the two composite portfolios were evaluated by histograms (Field, 2014; Appendix B).

Sharpe Ratio (Sharpe, 1994), *Treynor Ratio* (Treynor, 1961) and *Jensen´s alpha* (Jensen, 1967) are measures commonly used to evaluate the risk-adjusted performance of stock portfolios (Bodie et al., 2014). The *Sharpe Ratio* or the reward-to-volatility ratio is one of the most widely used methods for calculating risk-adjusted returns (Hull, 2012). It is the average return earned in excess of the risk-free rate normalized to volatility or total risk of the stock portfolio. Subtracting the risk-free rate of return from the mean return characterizes the profits associated with risk-taking exposure (Hull, 2012).

The Sharpe ratio (SR) was calculated according to Sharpe (1994):

$$SR = \frac{r_p - r_f}{\sigma_p} \tag{8}$$

r_p = The portfolio rate of return
r_f = The risk-free rate of return
σ_p = The total volatility of the portfolio´s rate of returns

The Treynor ratio indicates excess return per unit of risk taken on by a portfolio. Excess return refers to the return earned in excess of the return that could have been earned in a hypothetical risk-free investment (Bodie et al., 2014). Risk refers to market risk as defined by beta, a measure of the tendency for the return of a portfolio to change in response to changes in return for the overall market.

Treynors ratio (TR) was calculated from Bodie et al. (2014):

$$TR = \frac{r_p - r_f}{\beta_p} \tag{9}$$

r_p = The portfolio rate of return
r_f = The risk-free rate of return
β_p = The portfolio beta (sensitivity to market volatility)

Jensen's alpha is a measure of the risk-adjusted performance and represents the average return from an investment, above or below that predicted by CAPM (Bodie et al., 2014):

$$\alpha_p = r_p - \left[r_f + \beta_p\left(r_m - r_f\right)\right] \tag{10}$$

r_p = The portfolio rate of return
r_f = The risk-free rate of return
β_p = The portfolio beta (sensitivity to market volatility)
r_m = The rate of return of the market index

4.2.6 Econometric approach

The single-factor model, CAPM (Sharpe, 1964; Lintner, 1965; Mossin, 1966) and the multi-factor pricing models Fama-French Three-factor model (Fama and French, 1992) and the Carhart Four-factor model (Carhart, 1997) were used to quantitatively evaluate the importance of the size effect for equity returns. Model regressions were computed from equations 1, 3 and 4 and statistically tested in Stata (Stata V14, 2015). The regression model for CAPM was:

$$r_{i,t} - r_{f,t} = \alpha_i + \beta_{mkt,i}\left(r_{m,t} - r_{f,t}\right) + \varepsilon_{i,t} \tag{11}$$

$r_{i,t}$ = The rate of return on the individual security/portfolio i at time t

$r_{f,t}$ = The risk-free rate of return at time t

α_i = The CAPM alpha – the risk-adjusted return for portfolio i

$r_{m,t} - r_{f,t}$ = The excess return of the market at time t

$\varepsilon_{i,t}$ = The error term for security/portfolio i at time t

The regression model for Fama-French Three-factor model was:

$$r_{i,t} - r_{f,t} = \alpha_i + \beta_{mkt,i}(r_{m,t} - r_{f,t}) + \beta_{size,i}(SMB_t) + \beta_{value,i}(HML_t) + \varepsilon_{i,t} \quad (12)$$

$r_{i,t}$ = The rate of return on the individual security/portfolio i at time t

$r_{f,t}$ = The risk-free rate of return at time t

α_i = The Three-factor alpha – the risk-adjusted return for portfolio i

$r_{m,t} - r_{f,t}$ = The excess return of the market at time t

$\beta_{size,i}$ = The risk premium capturing size effects at time t

$\beta_{value,i}$ = The risk premium capturing value-/book-to-market effects at time t

$\varepsilon_{i,t}$ = The error term for security/portfolio i at time t

The regression model for Carhart Four-factor model was:

$$r_{i,t} - r_{f,t} = \alpha_i + \beta_{mkt,i}(r_{m,t} - r_{f,t}) + \beta_{size,i}(SMB_t) + \beta_{value,i}(HML_t) + \beta_{mom,i}(MOM_t) + \varepsilon_{i,t} \quad (13)$$

$r_{i,t}$ = The rate of return on the individual security/portfolio i at time t

$r_{f,t}$ = The risk-free rate of return at time t

α_i = The Four-factor alpha – the risk-adjusted return for portfolio i

$r_{m,t} - r_{f,t}$ = The excess return of the market at time t

$\beta_{size,i}$ = The risk premium capturing size effects at time t

$\beta_{value,i}$ = The risk premium capturing value-/book-to-market effects at time t.

$\beta_{mom,i}$ = The risk premium capturing momentum effects at time t

$\varepsilon_{i,t}$ = The error term for security/portfolio i at time t

Homogeneity of variance, serial correlation and multicollinearity were statistically evaluated to ensure the validity and relevance of Ordinary Least Squares (OLS) regressions. Homogeneity of variance, or homoscedasticity, entails that the conditional variance of the error term is constant (Field, 2014):

$$E[\varepsilon^2 | X_1, \dots, X_k] = \sigma^2 \quad (14)$$

X = Independent variable

σ^2 = The variance

ε^2 = The variability of the error term

ε = The error term

Homoscedasticity was evaluated using the Breusch-Pagan and White tests (Appendix C). Further, serial correlations (or autocorrelations) provide a measure of the correlations between an error term from one time period and an error term for a subsequent time period (Field, 2014). The Breusch-Godfrey test was used to evaluate serial correlations (Appendix C).

Multicollinearity is the existence of high intercorrelation among independent variables in multiple regression models. The degree of multicollinearity was tested by generating a correlation matrix for the independent variables (Appendix C).

5. Results

The distribution of pricing data for the small- and large-cap stock portfolios approximately followed a normal distribution as evidenced by the skewness and kurtosis of the distributions (Table I, Appendix B). Since the assumptions of standard deviation as the appropriate measure of portfolio risk is relatively robust against small violations, the use of standard deviation as a measure of risk was motivated (Field, 2014).

5.1. Equity returns of portfolios and model evaluations

The importance of the size effect for equity returns was evaluated for two composite portfolios based on market capitalization during the time-period Jan 2011-Dec 2016. A summary of the rate of equity returns for the two portfolios is presented in Table I.

Table I. Summary of the monthly equity return (%) for the portfolios sorted by market capitilization (firm size) during the time period Jan 2011- Dec 2016. Positive values indicate an increased return and negative values indicate a decreased return at the end compared to the value of the portfolio at the beginning of each month. Statistic evaluation includes mean, median, standard deviation (STDV) as well as minimum and maximum values of equity return for the large and small stock portfolios. The market index (OMXSGI) is shown for comparison. Statistics for Small-Minus-Big effects (SMB), High-Minus-Low effects (HML) and Momentum effects (MOM) were included as coefficients in the multi-factor models. Skewness was used to quantify the extent to which a probability distribution differs from a normal distribution. Kurtosis is a measure of the "tailedness" of the probability distribution. In total, 223 firms were evaluated.

Variables	Small	Large	Market	SMB	HML	MOM
Mean	1,19	0,82	0,87	0,74	-0,01	0,45
Median	1,59	1,57	1,45	0,32	-0,36	0,07
Variance	0,20	0,15	0,15	0,13	0,06	0,10
STDV	4,42	3,93	3,93	3,54	2,53	3,16
Min	-10,08	-10,63	-10,51	-7,43	-5,59	-9,20
Max	9,91	8,82	8,84	10,59	6,03	9,75
Skeweness	-0,28	-0,47	-0,44	0,72	0,46	0,17
Kurtosis	2,80	3,11	3,07	3,71	2,95	3,59

Average monthly equity return was higher for the small-cap portfolio (1.19 %) compared to the average return in the large-cap portfolio (0.82 %). It also seemed as the risk (STDV) was higher for the small-cap (4.42 %) relative to the large-cap portfolio (3.93 %) and the market index (OMXSGI; 3.93 %). Furthermore, the average monthly return seemed higher in the small-cap portfolio compared to OMXSGI (0.87 %). In contrast, the average monthly equity return in the large-cap portfolio was slightly lower than OMXSGI (Table I).

The Fama-French Three-factor model is designed to also account for size (Small-Minus-Big; SMB) and value (High-Minus-Low; HML) during evaluations of equity returns (Fama and French, 1992). Value stocks (high HML) are often considered to outperform growth stocks (low HML) over time (e.g. Cakici & Topyan, 2014). In the present study, negligible effects on stock return were found using the HML-approach (HML = -0.01 %). In contrast and in accordance with higher equity returns observed for small-cap than large cap portfolios (Table I), Fama French Three-factor modelling supported a small size effect, i.e. an SMB effect (SMB = 0.74 %). Including momentum as a factor using the Carhart Four-factor model indicated that momentum positively affected equity returns (MOM = 0.45 %), although seemingly not to the same extent as firm size (Table I).

5.2 Market capitalization and equity returns

The average monthly equity return for the small-cap portfolio was larger compared to the market index (OMXSGI) and the return for the large-cap portfolio during the time period 2011-2016 (Table I).

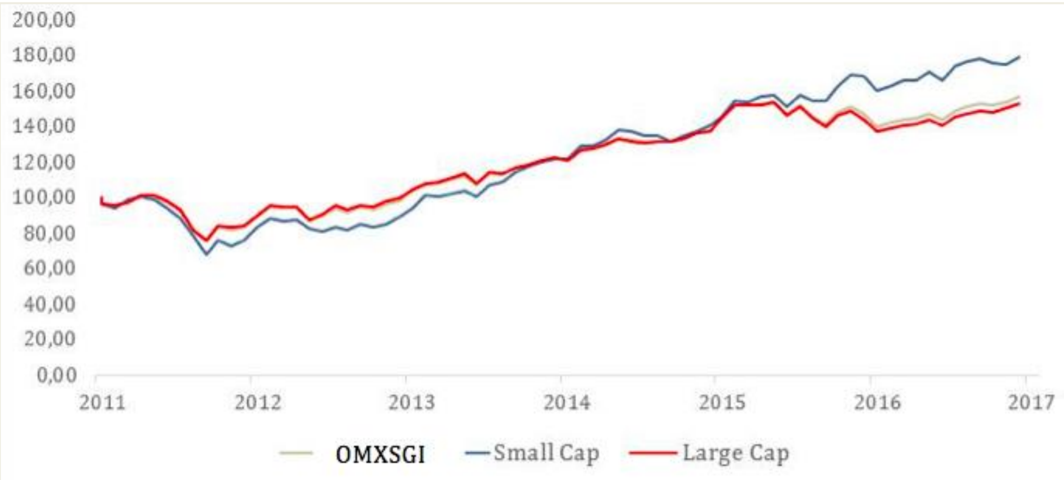

Figure I. Equity return over time for the small-cap (solid blue) and large-cap (solid red) stock portfolios from January 2011 to December 2016. The development of the market index OMXSGI is included for comparison (solid light brown). The equity returns were normalized and compared to the respective starting value (100 % at t=0). Data was collected on a monthly basis from Thomson Reuters (Thomson Reuters, 2018).

Stock performance and the development of equity returns over time (Fig. I) were in good agreement with the descriptive statistics (Table I). Although the small-cap portfolio yielded a higher return compared to the large-cap portfolio and the market index (OMXSGI) during large periods, there were also extended periods where the large-cap portfolio seemed to outperform the small-cap portfolio (Fig. I). From the beginning of 2014 to the end of the sample period (December 2016), the equity return of the small-cap portfolio was similar to or higher than that of the large-cap portfolio. During the period 2011 to 2014, however, the situation was more or less inverse. The temporal development of the large-cap stock portfolio closely followed the performance of the market index (OMXSGI) throughout the study period. Moreover, in accordance with the initial observations presented in Table I, the volatility of the small-cap portfolio was higher for the small-cap stock portfolio compared to the large-cap portfolio (Fig. I and II).

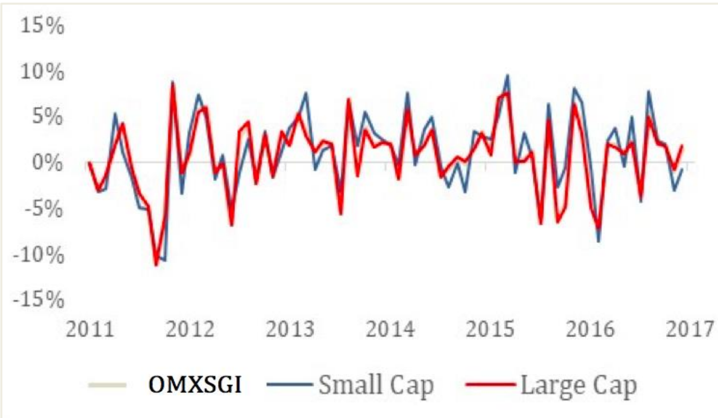

Figure II. Monthly value-weighted portfolio returns over time. The solid blue line represents returns from the small-cap portfolio and the solid red line denotes the large-cap portfoilio returns. The performance of OMXSGI is illustrated by the solid light-brown line.

There was a pronounced market downfall during 2011 (“Black Monday 2011”; Kim, 2016) which not only affected both stock portfolios and NASDAQ-OMX but the global stock market. In accordance with its high volatility, the small-cap porfolio reacted strongly to the downfall and small-cap stocks did not recover for an extended period of time (Fig. I and II).

5.3 Performance of stock portfolios and risk-adjusted returns

Risk-adjusted return characterizes the return from an investment by quantifying the risk associated to the return. As such, the risk-adjusted performance provides a tool to assess the long term viability of investment strategies. Common measures for risk-adjusted performance include Sharpe ratio, Jensen´s alpha and Treynor ratio (Bodie et al., 2014).

Table II. Risk adjusted stock performance for the small-cap and large-cap portfolios evaluated by the Sharpe Ratio, Jensen´s alpha and the Treynor ratio.

Variables	Small-Cap Portfolio	Large-Cap Portfolio
Sharpe Ratio	0,80	0,59
Jensen´s Alpha	3,23	-0,52
Treynor Ratio	0,12	0,08

The small-cap stock portfolio appeared as a more profitable investment in terms of risk-adjusted stock return than the large-cap portfolio (Table II). Effects were particularly evident for Jensen´s alpha ($\alpha_{p,small}$ = 3.23 for small-cap and $\alpha_{p,large}$ =-0.52 for large cap) while the difference was not as pronounced for the Treynor ratio ($TR_{,small}$ = 0.12 for small-cap and $TR_{,large}$ = 0.08 for large cap). A positive value for Jensen´s alpha of the small-cap portfolio ($\alpha_{p,small} > 0$) suggested an equity return higher than the fair value predicted (Bodie et al., 2014). In the same way, a negative value ($\alpha_{p,large} < 0$) indicated a lower predicted return than the fair value predicted for the large-cap stock portfolio. Similar values of the Treynor ratio for the small-cap and large-cap portfolios suggested that the two stock portfolios earned similar returns per unit of systematic risk exposure. Obtained Sharpe ratios ("risk-to-volatility measure") indicated that investments in the small-cap portfolio were more compensated in terms of equity return for a given total risk exposure compared to investments in the large-cap stock portfolio ($SR_{,small}$ = 0.80 compared to $SR_{,large}$ = 0.59). Overall, the Treynor ratio is often considered as the most appropriate measure of risk-adjusted return in well-diversified stock portfolios (Hull, 2012; Bodie et al., 2014).

5.4 Single- and multi-factor regressions and size effects of stock portfolios

The stock portfolios were assessed using single- (CAPM; Sharpe, 1964; Lintner, 1965; Mossin, 1966) and multi-factor pricing models (the Fama-French Three-factor model; Fama and French, 1992 and the Carhart Four-factor model; Carhart, 1997). These models made possible detailed studies of market capitalization (size), book-to-market ratio (value) and momentum. To statistically evaluate stock performance and to quantify the potential importance of the size effect, the small-cap and the large-cap stock portfolios were assessed using three separate OLS regressions related to the single- and multi-factor models (Table III). Overall, model predictions (adjusted R^2) appeared higher for the large-cap compared to the small-cap portfolios in all model regressions.

According to CAPM, the coefficient (beta) is an indication of the sensitivity to market volatility (Eq. 1). A beta-value equal to one denotes a portfolio with identical sensitivity to market risk as the market index. As a consequence, the expected return ought to be identical to the expected return of the market. A beta-value larger than one implies a portfolio with above-average sensitivity to market swings, i.e. the portfolio is more aggressive (riskier) relative to the market. In the present study, the market coefficient for the the two portfolios was statistically significant at a level of 1 % in all three model evaluations (Table III). The market coefficients for the large-cap portfolio ($Market_{large,CAPM} = 0.997$; $Market_{large,FAMA} = 0.987$; $Market_{large,Carhart} =0.987$) indicated a sensitivity to market volatility similar to or slightly lower than that of the market. Thus, in accordance to the initial indications (Table I; Fig. I) the large-cap portfolio followed the overall patterns of the market rather well throughout the sample period. The market coefficients for the small-cap portfolio were slightly above-average sensitivity ($Market_{small,CAPM} = 1.020$; $Market_{small,FAMA} = 1.062$; $Market_{small,Carhart} = 1.052$) which also supported the results from the initial analysis of a more volatile small-cap portfolio compared to OMXSGI and the large-cap stock portfolio.

The intercepts of model regressions, or alpha coefficients, statistically capture the risk-adjusted return for the stock portfolios. A positive alpha-value indicates that the stock portfolio outperforms the market, while a negative value indicates underperformance relative to the market. The alpha-values for the large-cap portfolio ($\alpha_{large,CAPM} = 0.000$; $\alpha_{large,FAMA} = -0.007$; $\alpha_{large,Carhart} = -0.007$) indicated a stock performance similar to or slightly lower than that of the market. The alpha-values for the small-cap portfolio ($\alpha_{small,CAPM} = 0.003$; $\alpha_{small,FAMA} =0.003$; $\alpha_{small,Carhart} =0.003$) indicated a stock performance slightly higher than that of the market. Although not statistically significant, the results indicated a better performance of the small-cap portfolio compared to the large-cap portfolio on a risk-adjusted basis.

The SMB-coefficient was positive for the small-cap portfolio ($SMB_{small,FAMA}$ = 0.131; level of significance = 0.05) and negative for the large-cap portfolio ($SMB_{large,FAMA}$ = -0.032; level of significance = 0.01) using the Fama-French Three-factor model. Fama-French Three-factor modelling therefore indicated a positive risk-premium for holding small stocks and a negative risk-premium for holding large-cap stocks. The SMB-values were statistically significant, thus, single- and multi-factor regression analyses suggested a size effect for the small-cap and large-cap portfolios. A similar pattern was observed using the Carhart Four-factor model ($SMB_{small,Carhart}$ = 0.098; statistically insignificant; $SMB_{large,Carhart}$ = -0.030; level of significance =0.05), although the Carhart regression of the small-cap portfolio provided a statistically insignificant SMB-factor. Furthermore, including Momentum (MOM) as an additional pricing factor in the Carhart Four-factor regression did not significantly improve the predictive capacity, neither for the small-cap ($R^2_{small,CAPM}$=0.701; $R^2_{small,FAMA}$=0.706; $R^2_{small,Carhart}$=0.707) nor for the large-cap ($R^2_{large,CAPM}$=0.821; $R^2_{large,FAMA}$=0.832; $R^2_{large,Carhart}$=0.833) portfolios.

Table III. Statistical evaluation (Stata V14, 2015) of equity returns for small-cap and large-cap stock portfolios using the Capital Asset Pricing Model (CAPM), the Fama French Three-factor and the Carhart Four-factor models. The variables alpha (model constants), market benchmark (OMXSGI), value-weighted Small-Minus-Big (SMB), value-weighted High-Minus-Low (HML) and value-weighted Momentum (MOM) are presented together with the number of observations and the adjusted coefficient of determination (R-squared) for each of the regressions. Newey-West standard errors are provided within the parentheses. The expected return- beta relation in CAPM was calculated from $r_{i,t} - r_{f,t} = alpha + \beta_i^{mkt}(r_{m,t} - r_{f,t})$, the Fama-French Three-factor regression: $r_{i,t} - r_{f,t} = alpha + \beta_i^{mkt}(r_{m,t} - r_{f,t}) + \beta_i^{size}(SMB_t) + \beta_i^{value}(HML_t)$, and the Carhart Four-factor regression: $r_{i,t} - r_{f,t} = alpha + \beta_i^{mkt}(r_{m,t} - r_{f,t}) + \beta_i^{size}(SMB_t) + \beta_i^{value}(HML_t) + \beta_i^{mom}(MOM_t)$. *** indicates statistical significance at 0.01 level, ** significance at 0.05 level and * significance at 0.10 level, respectively.

	Capital Asset Pricing Model		**Fama-French Three-Factor Model**		**Carhart Four-Factor Model**	
Variables	**Large-Cap Portfolio**	**Small-Cap Portfolio**	**Large-Cap Portfolio**	**Small-Cap Portfolio**	**Large-Cap Portfolio**	**Small-Cap Portfolio**
Alpha	0.000	0.003	-0.007	0.003	-0.007	0.003
	(0.000)	(0.002)	(0.003)	(0.002)	(0.003)	(0.002)
Market	0.997***	1.020***	0.987***	1.062***	0.987***	1.052***
	(0.007)	(0.056)	(0.007)	(0.061)	(0.007)	(0.059)
SMB	-	-	-0.032***	0.131**	-0.030**	0.098
	-	-	(0.008)	(0.063)	(0.010)	(0.072)
HML	-	-	-0.008	0.064	-0.006	0.030
	-	-	(0.012)	(0.098)	(0.013)	(0.100)
MOM	-	-	-	-	0.005	-0.090
	-	-	-	-	(0.009)	(0.069)
Number of observations	72	72	72	72	72	72
R-squared	0.821	0.701	0.832	0.706	0.833	0.707

6. Analysis and discussion

Several studies focused on asset pricing have suggested that single-factor models such as the CAPM (Sharpe, 1964; Lintner, 1965; Mossin, 1966) have limited power to describe and predict variations in expected equity returns. Market capitalization provides an important market anomaly observed to regulate equity returns (Banz, 1981; Fama and French, 1992) but there are contrasting observations on the overall importance (Bodie et al., 2014) and financial mechanisms that regulate size effects (e.g. Lustig and Leinbach, 1983). Single- and multi-factor pricing models were in this study used to quantitatively evaluate the importance of the size effect for equity returns in two composite stock portfolios based on market capitalization.

6.1 Size effects and equity returns

Pricing data from the period 2011 to 2016 indicated that the average monthly return of stocks was higher for the small-cap portfolio than the average return for the large-cap portfolio, as well as compared to the market index (OMXSGI; Table I). It also appeared as the volatility, expressed as STDV of portfolio returns, was higher for the small-cap relative to the large-cap portfolio and the market index (Table I; Fig I and II). These observations are in accordance to basic financial theories that small-cap stock portfolios are associated with enhanced risk exposure (e.g. Hull, 2012), and the presumption that higher risk is accompanied by higher expected returns (e.g. Markowitz, 1952; Bodie et al., 2014). However, although higher average returns were observed for the small-cap portfolio compared to the large-cap portfolio and the market index (OMXSGI), there were extended periods where equity returns for the small-cap portfolio seemed to underperform compared to the returns for the small-cap portfolio and the market benchmark (Fig. I). Significant temporal variations between the equity returns of the two portfolios and the market benchmark directly implied that financial factors other than size were also important for the equity returns observed. Further, the adjusted coefficient of determination (R^2) for model regressions also implied that additional variables are needed to improve model predictions of equity returns (Table III). Potential model deficiencies were more pronounced for models that described the small-cap ($R^2_{small\text{-}cap}$= 0.701 – 0.707) compared to the large-cap portfolios ($R^2_{large\text{-}cap}$= 0.821– 0.833).

The risk-adjusted performance was assesed by the financial indicators Sharpe ratio, Jensen´s alpha and Treynor ratio (Hull, 2012). Overall, all indicators suggested a higher risk-adjusted return for small-cap compared to large-cap stocks (Table II). The higher normalized return observed for the small-cap compared to the large-cap stock portfolio, indicated that small-cap stocks were a more profitable investment than large-cap stocks in terms of the trade-off between risk and return. Effects seemed most pronounced for Jensen´s alpha while the difference between the two portfolios was smaller when the Treynor ratio was used to evaluate the risk-adjusted return of equities. The small- and large-cap portfolios contained stocks from a wide spectrum of different market sectors and industries (Appendix A). Consequently, portfolios could be considered as well-diversified. In such portfolios, the systematic risk (beta) is normally the main concern for investors (Bodie et al., 2014). The Treynor Ratio therefore likely provided the most appropriate risk-adjusted measure of performance for the small-cap and large-cap portfolios in this study. Comparable values of the Treynor ratio for the two stock portfolios suggested similar earnings per unit of systematic risk exposure.

Statistical evaluation using CAPM (Sharpe, 1964; Lintner, 1965; Mossin, 1966), the Fama-French Three-factor model (Fama and French, 1992) and the Carhart Four-factor model (Carhart, 1997) facilitated detailed studies of financial factors that affected asset pricing of the small-cap and large-cap stock portfolios (Table III). Although not statistically significant, Fama-French Three-factor regressions generated alpha-values that indicated equity returns higher than those of the market for the small-cap stock portfolio, and equity returns lower than those of the market for the large-cap stock portfolio. Similar patterns were observed using the Carhart Four-factor model. Further, in agreement with e.g. Banz (1981) and Fama and French (1992), the Fama-French Three-factor regressions provided SMB-values that supported a size effect on equity returns for the small-cap and the large-cap portfolios. Similar patterns were observed using the Carhart Four-factor model (Table III). Thus, single- and multi-factor regression analyses suggested a size effect for the two stock portfolios.

Furthermore, the ability to predict equity returns, as evidenced by the adjusted coefficient of determination (R^2), was not drastically different between the three asset pricing models. As the multi-factor pricing models included the SMB- (size) and the HML- (value) factors to compensate for effects asssociated with size and value, model outputs and the predictive capacity of the models were expected to improve provided size and value were important factor for stock performance (Ferson and Harvey, 1994). Furthermore, all model predictions provided statistically insignificant Momentum-factors (Table III).

In contrast to indications from model correlations of a general size effect, however, the predictive ability did not seem to improve for the multi-factor models. Thus, the present study provided empirical support that confirmed a negative correlation between firm size and expected equity return. It also provided indications that additional factors, perhaps correlated with size, likely were important for the observed stock performance.

6.2 Additional market anomalies and equity returns

6.2.1 Market sectors

The performance of assets is often closely linked to cyclical factors associated with the status of economy, including e.g. corporate earnings, interest rates, and inflation. Long-term fluctuations in an economy therefore normally affect equity returns and the performance of market sectors, where the market performance is often sector dependent (e.g. Bodie et al., 2014). An underlying assumption behind the potential inability of multi-factor models to sufficiently compensate for the trade-off between risk and equity returns across market sectors is sector-unique fundamental characteristics that control long-term returns. Furthermore, these characteristics may not only be sector-dependent but also rely on the contemporary market status. For example, the consumer discretionary sector (e.g. entertainment, leisure, cars and motorbikes) tends to outperform during bull markets as consumers allocate more disposable income to discretionary expenses (e.g. Gottfries, 2013).

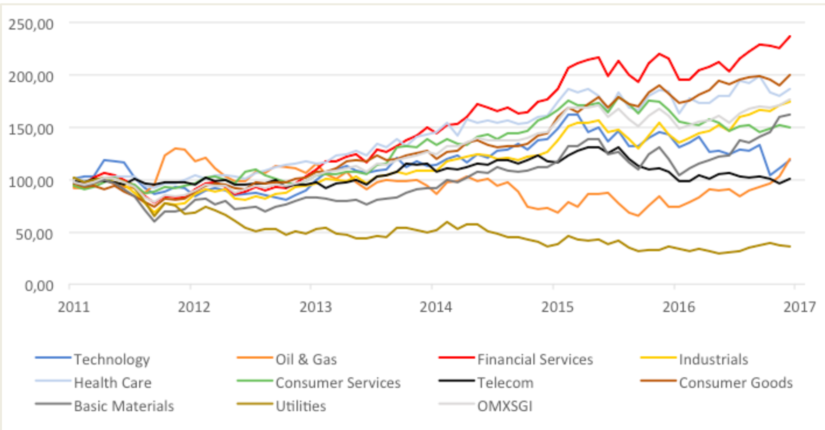

Figure III. Sector dependent value-weighted equity returns over time for individual market sectors. The development of the market index OMXSGI is included for comparison. The equity returns were normalized and compared to the respective starting value (100 % at t=0). Data was collected on a monthly basis from Thomson Reuters (Thomson Reuters, 2018).

The development of equity return for a wide spectra of individual market sectors is illustrated in Fig. III. During the period January 2011 to December 2016 the development of equity returns were significantly different between market sectors. Overall, market sectors such as financial services, consumer goods and health care seemed to perform particularly well. In contrast, firms related to the utilities and oil & gas sectors have experienced an overall negative development since 2011 (Fig. III). A significant difference in the performance of equity returns between market sectors with sector-unique characteristics may have influenced model evaluations of the size effect. It was, however, considered outside the scope of the present study to provide detailed model evaluations for the eventual sector-specific importance of firm size for the observed patterns in equity returns between the small-cap and large-cap portfolios.

6.2.2 Temporal effects

In accordance to observations that long-term and large-scale fluctuations in an economy are important for large scale inter-annual variations in equity returns (Emsbo-Mattingly et al., 2017), there are studies that indicate short-term and intra-annual variations in equity returns related to market capitilization. The negative correlation between firm size and equity returns seemed most pronounced in January than in any other month (e.g. Keim, 1983). In fact, effects were most pronounced during the first two weeks of January (e.g. Keim, 1983; Reinganum; 1983; Blume and Stambaugh, 1983). Arbel and Strebel (1983) attributed the January size effect to the restricted information flow for small firms. Neglected firms were suggested to earn higher equilibrium returns as compensation for the lack of accurate and timely information, i.e. similar to a risk premium (Merton, 1987).

Although the equity return for the small-cap and the large-cap stock portfolio in the present study varied within and between years, as well as in comparison to the market index (OMXSGI) (Fig. I), there was no obvious correlation for the intra-annual variation in equity returns between years (Fig. IV). In general, the difference in monthly equity returns between the small-cap and the large-cap stock portfolios was largest in December, August and February. In contrast to observations of a January size effect (e.g. Keim, 1983), the difference in equity returns between the two portfolios was close to zero in January, July, March and April (Fig. IV).

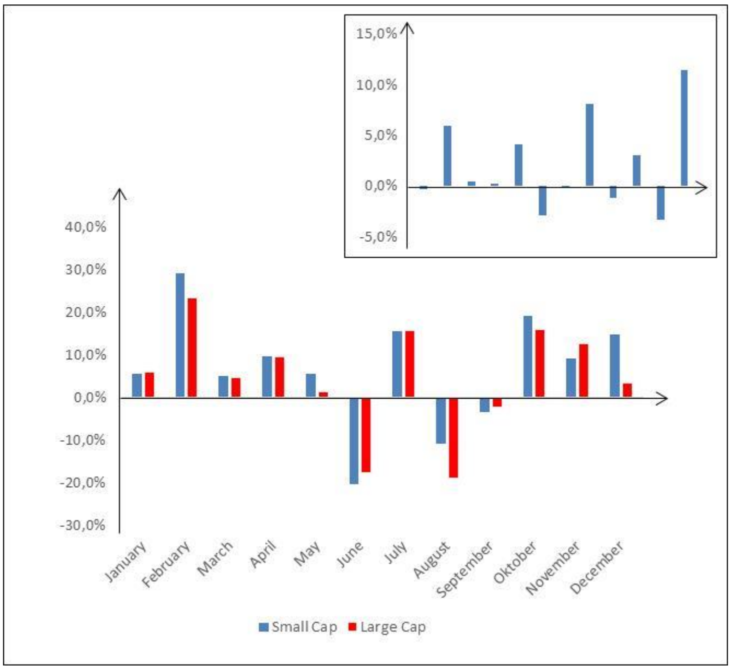

Figure IV. Monthly equity returns for the small-cap (solid blue) and the large-cap (solid red) portfolios during January 2011 to December 2016. The difference between the two portfolios (small-cap minus large-cap) is illustrated separately for comparison (insert top right) .

Although there are several studies that have indicated a general time-dependent size effect in a multitude of international stock markets, effects seem primarily of a decadal time character (Crain, 2011). The sample period investigated in this thesis (2011-2016, i.e. 6 years) is comparably short and, in a general sense, characterized by high overall growth in the economy (bull market). Due to the restricted time available for a Bachelor´s thesis it was considered beyond the scope of the present study to also evaluate temporal effects associated with a significantly extended time period. Such extension could also have included more detailed model evaluations of the market performance and the importance of market capitalization for equity returns during natural fluctuation of the economy between periods of expansion (growth) and contraction (recession).

7. Conclusions and future perspectives

The overall aim of this Bachelor´s Thesis was to quantitatively evaluate the importance of the size effect for equity returns. Specific objectives were to quantitatively evaluate the equity performance of small-cap stocks and large-cap stocks on the Swedish equity market, NASDAQ OMX, during the time-period 2011-2016. The approach was to use single- (CAPM) and multi-factor (the Fama-French Three-factor model and the Cahart Four-factor model) pricing models in two composite portfolios based on market capitalization.

- On average, small-cap stock portfolios outperformed both the market benchmark (OMXSGI) and the large-cap stock portfolio. However, the relative stock performance and relation between the equity returns of the two portfolios and the market benchmark varied within and between years.
- Indicators for risk-adjusted performance (Sharpe Ratio, Jensen´s alpha and Treynor Ratio) suggested a higher risk-adjusted return for small-cap compared to large-cap stocks which indicated that small-cap stocks were more profitable than large-cap stocks in terms of the risk and return trade-off.
- The Fama-French Three-factor regressions provided SMB values that supported a size effect on equity returns for the small-cap and the large-cap portfolios. Similar patterns were observed using the Carhart Four-factor model. Thus, single- and multi-factor regression analyses suggested a size effect for the small-cap and large-cap portfolios.
- The ability to predict equity returns was not drastically different between the three asset pricing models which implied that the financial factors SMB (Small-Minus-Big), HML (High-Minus-Low) and MOM (Momentum) were not significant for the ability to predict the equity returns of the two stock portfolios.
- Model evaluations indicated that additional factors, perhaps correlated with size, were important for the observed stock performance.

Results obtained within the framework of this thesis have opened several new perspectives that would have been interesting to pursue. Such perspectives include e.g. to quantitatively evaluate the sector-specific importance of the size effect for equity returns, as well as to perform detailed investigations on the importance of market capitalization for equity returns during natural fluctuation of the economy.

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9. Appendices

9.1 Appendix A

Table A1. Firms included in the large-cap stock portfolio.

AAK	ABB Ltd	ÅF B	Ahlsell	Alfa Laval
Autoliv SDB	Ahlstrom-Munksjö Oyj	Arion Banki SDB	Arjo B	ASSA ABLOY B
Atlas Copco A	Atlas Copco B	Atrium Ljungberg B	Attendo	Axfood
Avanza Bank Holding	AstraZeneca	Fast. Balder B	Betsson B	BillerudKorsnäs
Boliden	Bonava A	Bonava B	Bravida Holding	Castellum
Collector	Dometic Group	Elekta B	Electrolux A	Electrolux B
Epiroc A	Epiroc B	Ericsson A	Klövern B	Essity A
Essity B	Evolution Gaming Group	Fabege	Fingerprint Cards B	Getinge B
Hemfosa Fastigheter	Hexagon B	Hennes & Mauritz B	Holmen A	Husqvarna B
HEXPOL B	Hufvudstaden A	Hufvudstaden C	Husqvarna A	Intrum
ICA Gruppen	Indutrade	Industrivärden A	Industrivärden C	Kinnevik A
Investor A	Investor B	JM	Kindred Group	Latour B
Kinnevik B	Kungsleden	Klövern A	Ericsson B	Lundbergföretagen B
LeoVegas	Lifco B	Loomis B	Lundin Mining Corporation	Munters Group
Lundin Petroleum	Millicom Int. Cellular SDB	Modern Times Group A	Modern Times Group B	NIBE Industrier B
NCC A	NCC B	Nordea Bank Abp	NetEnt B	Pandox B
Nobia	Nyfosa	Oriflame Holding	Tele2 B	Sagax A
Ratos A	Ratos B	Resurs Holding	SAAB B	SCA B
Sagax B	Sagax D	Sandvik	SCA A	Sv. Handelsbanken B
SEB A	SEB C	Securitas B	Sv. Handelsbanken A	SSAB A
Skanska B	SKF A	SKF B	Swedish Orphan Biovitrum	SWECO B
SSAB B	Stora Enso A	Stora Enso R	SWECO A	Telia Company
Swedbank A	Swedish Match	Tele2 A	Peab B	Volvo A
Thule Group	Tieto Oyj	Trelleborg B	Veoneer SDB	-
Volvo B	Wallenstam B	Wihlborgs Fastigheter	Holmen B	-

Table A2. Firms included in the small-cap stock portfolio.

Active Biotech	Agromino	Anoto Group	Arise	Arctic Paper
Actic Group	Alligator Bioscience	A3 Allmänna IT- och Telekom.	B3 Consulting Group	Bactiguard Holding B
Balco Group	BE Group	Beijer Electronics Group	BioInvent International	BONESUPPORT HOLDING
Bong	Björn Borg	Boule Diagnostics	Bergs Timber B	Brinova Fastigheter B
BTS Group B	Cantargia	Christian Berner Tech Trade B	Concordia Maritime B	Consilium B
C-RAD B	CTT Systems	Dedicare B	DORO	Duroc B
Edgeware	Electra Gruppen	Elos Medtech B	Empir Group B	Endomines
Enea	Eniro	Eolus Vind B	Episurf B	Etrion
eWork Group	Feelgood Svenska	FM Mattsson Mora Group B	FormPipe Software	GHP Specialty Care
ICTA	Immunicum	Image Systems	Karolinska Development B	Lammhults Design Group B
Lime Technologies	MedCap	Malmbergs Elektriska B	Midway A	Midway B
Mips	Moberg Pharma	Moment Group	MQ Holding	Micro Systemation B
MultiQ International	NCAB Group	NGS Group	Nilörngruppen B	NOTE
NOVOTEK B	Nuevolution	NeuroVive Pharmaceutical	Oasmia Pharmaceutical	Odd Molly International
Ortivus A	Ortivus B	Proact IT Group	Projektengagemang Sweden B	Poolia B
Precise Biometrics	Prevas B	Pricer B	Profilgruppen B	Railcare Group
Rejlers B	RNB RETAIL AND BRANDS	Rottneros	Saniona	Semcon
Sensys Gatso Group	SinterCast	Softronic B	Sportamore	Strax
Stockwik Förvaltning	Svedbergs B	Studsvik	TradeDoubler	Trention
Venue Retail Group B	Viking Supply Ships B	Wise Group	XANO Industri B	ZetaDisplay

9.2 Appendix B

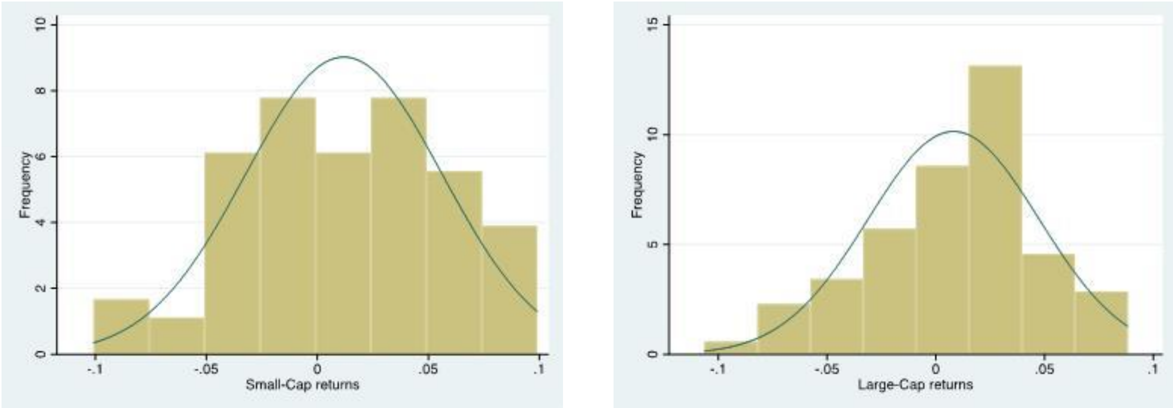

Figure B1. Distribution of data for equity returns of the small-cap (left panel) and large-cap (right panel) stock portfolios. Data was fitted against a normal distribution of data for comparison (Stata V14, 2015).

9.3 Appendix C
Statistical tests of the OLS Assumptions

Table C1. Statistical evaluation of heteroscedasticity for the small- and large-cap portfolios using the White test and the Breusch-Pagan test (Field, 2014). According to the null hypothesis, the variance of the error term is constant. The values denote p-values.

Variables	Small-cap	Large-cap
White Test	0.065	0.074
Breusch-Pagan	0.052	0.098

Obtained p-values from the statistical tests (Table C1) indicated that the null hypothesis was rejected on a 10 % level of significance (p-values < 0.1) for both stock portfolios. Newey-West standard errors were therefore used in the statistical analyses of the two stock portfolios to account for a heteroscedastic error term (Field, 2014).

Table C2. Statistical evaluation of serial correlation for the small- and large-cap portfolios using the Breusch-Godfrey test (Field, 2014). According to the null hypothesis, there are no serial correlations in the dataset. The values represent p-values. The described Breusch-Godfrey test has a lag of 1 in the residuals (prediction errors).

Variables	Small-cap	Large-cap
Breusch-Godfrey	0.002	0.001

Obtained p-values from the Breusch-Godfrey test (Table C2) suggested that the null hypothesis was rejected on a 1 % level of significance (p-values < 0.01). Newey-West standard errors were therefore used in the statistical analyses of the two stock portfolios to account for serial-correlations. Additional tests with higher levels of lag in the residuals confirmed serial correlations in the dataset.

Table C3: Statistical evaluation of multicollinearity for the small- and large-cap portfolios using a correlation matrix that describes the correlation between the variables SMB (Small-Minus-Big), HML (High-Minus-Low) and MOM (Momentum). The underlying assumption of no-multicollinearity is often considered to be violated if the correlation between two independent variables is larger than 0.9 (or smaller than -0.9)(Field, 2014).

Variables	Market	SMB	HML	MOM
Market	1			
SMB	-0.3939	1		
HML	0.1053	-0.3523	1	
MOM	-0.0062	-0.2474	-0.1742	1

The correlation matrix (Table C3) suggested that the assumption of no-multicollinearity was not violated (|correlation values| < 0.9) (Field, 2014). No adjustments for multicollinearity was therefore made in the present study.