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In Search of a Leverage Factor in Stock Returns:

An Empirical Evaluation of Asset Pricing Models on Swedish Data

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ABSTRACT

Theoretical finance regards leverage as one of the sources of stock return risk, and thus claims that the more levered a firm is, the higher the risk for equity holders and the higher the required rate of return. As asset pricing has matured into an important area of finance, new factors have been incorporated into the CAPM, following observed anomalies in stock returns. Despite its centrality within finance, the relationship between leverage and returns has not been extensively researched, and the empirical findings on this subject have been mixed and sometimes contradictive. This thesis investigates if leverage can help to explain stock returns based on Swedish data during the period 1990 to 2009 by testing if leverage can be used as an additional asset pricing factor, and attempting to determine its potential effect on returns. In conjunction with this, the performance of three acknowledged asset pricing models – the CAPM, the Fama-French (1992) three-factor model, and the Carhart (1997) four-factor model – are evaluated. The time series regression results we obtain do not support the hypothesis that a leverage factor can help reduce mispricing of these asset pricing models. From our cross-section regression results we cannot make a statement about the effect of leverage on stock returns. Furthermore, none of the acknowledged asset pricing models perform particularly well on our data. We end our thesis with a discussion on why we obtain these results and how certain adjustments might yield different conclusions.

Keywords: Asset pricing, CAPM, Carhart, Fama-French, Leverage factor

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1. Introduction

Ever since Modigliani and Miller published their work on corporate finance theory in 1958, scholars have written hundreds of papers addressing capital structure and the rate of return. Not many years after the introduction of the Modigliani-Miller theorems, the first theories on portfolio theory and asset pricing were developed. Corporate finance theory and asset pricing theory have since been two of the most important subjects in finance academia.

Many theories in finance require strong assumptions that bear little relevance to the real investments taking place in various capital markets. Over the years, the academic world learnt how to deal with the Modigliani-Miller assumptions, and how to adapt the theorem to fit into the real world, taking into account for example transaction costs, agency costs, and taxes. The works of Sharpe (1964), Lintner (1965), and Black et al. (1972) on the capital asset pricing model known as the "CAPM" were groundbreaking when published, but as empirical tests have been undertaken in subsequent years many contradicting results and exceptions to the model have been found. As asset pricing has matured into an important area of finance, new factors have been incorporated into the CAPM, most famously through the three-factor model developed by Fama and French (1992).

However, the empirical data that have been used to give support to these models have predominantly derived from firms in the United States, and in line with Rajan and Zingales (1995), we feel that there is a need to test the robustness of these models outside the environment in which they were discovered. This motivates our reason for testing the models on Swedish data in order to see how they perform in another capital market setting.

According to finance textbooks the link between capital structure and return on equity is very straightforward. Theoretical finance regards leverage as one of the sources of risk, and thus claims that the more levered a firm is, the higher the risk for equity holders. As the risk-averse equity holders are exposed to more uncertain cash flows, they will demand a higher rate of return on their investment (equity). Despite its centrality within finance, the relationship between leverage and returns has not been extensively researched, and the empirical findings on this subject have been mixed and sometimes contradictive (Penman et al. (2007)).

For these reasons, we feel there is room for shedding more light on the topic and contributing to the academic research. Hence, we want to evaluate the performance of three acknowledged asset pricing models – the CAPM, Fama and French (1992)'s three-factor model, and Carhart (1997)'s four-factor model – on Swedish data. Further, we want to look into the ability of leverage to explain stock returns by testing whether it can be used as an additional asset pricing factor. As leverage has gained in significance for equity analysis during the recent volatile market conditions, we feel the topic of incorporating leverage into an asset pricing model is of current interest.

Our main aim is thus to contribute to the discussion regarding asset pricing models on the Swedish market. We are not aware of any other studies that have examined whether a leverage factor can help explain stock returns for Swedish firms, and thus an evaluation of a potential leverage factor can be considered as a contribution to the existing research. Regardless if our results show that the asset pricing models can or cannot explain stock returns for Swedish firms, part of our contribution will be either to confirm the models' validity or add to the discussion as to why they do not work in an environment different to where they were conceived.

1.1 Outline

The outline of this thesis is as follows; in Section 2 we present the theoretical framework that we will use throughout the thesis, and we also present the relevant previous research regarding the areas of asset pricing studied. Thereafter, Section 3 presents definitions of the parameters used in our thesis. In Section 4 we present our hypotheses that form the base of our study. Continuing in Section 5, we describe the data used and what adjustments we have done to the raw dataset. Subsequently, Section 6 describes the methodology used regarding portfolio formation and regression models. Results are presented and interpreted in Section 7. Stemming from this, Section 8 contains our conclusions of the study and discussion of the results, and also provides suggestions for further research. Finally, Section 9 presents a list of references used. All figures and tables (except for summary tables) on data and results are included in the Appendix.

2. Theoretical Framework and Previous Research

2.1 Return and Risk

Investors invest for anticipated future returns, but those returns can rarely be predicted precisely as there will almost always be risk associated with investments. Actual or realized returns will almost always deviate from expected returns anticipated in the beginning of the investment period. It is assumed that investors will prefer investments with the highest expected return suitable to their risk aversion (Bodie et al. (2008)).

Risk in a financial context can be interpreted as the level of uncertainty. Risk per se is a broad concept, and the risk pertaining to an investor is very different to the risks a firm is exposed to. The risk-return tradeoff in financial markets implies that low levels of risk are associated with low returns and that high levels of risk imply high returns. Assuming investors are risk averse, they will require a compensation for bearing risk. This risk compensation takes form in a risk premium, which is defined as the expected return less the risk-free rate (Bodie et al. (2008)).

Financial risk for a firm is commonly associated with the form of financing. The greater the amount of debt a firm uses to finance its operation, the higher the financial risk. The risk stems from the firm not being able to meet its financial obligations. Business risk on the other hand arises from the risk associated with the firm's operations, and deals prominently with the firm's ability to meet its operating expenses (Penman et al. (2007)).

2.2 Capital Structure

The most general definition of capital structure is how the combination of equity and debt finance a firm's assets. The firm's ratio of debt to total financing is referred to as the firm's leverage (see section 3.2). The rate of return that capital is expected to earn on an investment of corresponding risk is known as the cost of capital. For an investor to invest in a project or a firm, the return on capital must be larger than the cost of capital (Brealey and Myers (2003)).

Modigliani and Miller (1958) pioneered the field of corporate finance and the cost of capital. They showed that under perfect market conditions, the value of a firm is independent of its capital structure. In the real world one has to consider deviations derived from factors such as taxes and agency costs. Additionally, Modigliani and Miller's proposition II states that expected stock returns (return on equity capital) should increase with financial leverage.

Schwartz (1959) investigated if there is an optimal capital structure for a firm. As the financing of a firm is a matter of discretion, the general case must consider both ownership capital and borrowings (equity and debt) as variable and substitutable. However, as equity and debt are not perfect substitutes, the choice will affect the market's view on the shares and thereby the required return. Schwartz argued that an optimum capital structure for any widely held firm must be one that maximizes the long run value per share, which is different to a capital structure that maximizes profit per share. The difference lies in the rate at which the earnings are capitalized. Hence the optimal capital structure varies for firms in different industries, depending on the stability of earnings and the need to capitalize assets.

2.3 Factor Analysis and Cross-Sectional Analysis

There are two approaches for identifying common sources of variations in stock returns – factor analysis of time series and cross-sectional analysis. The first method allows for isolation of independent sources of common variation in returns, while the latter defines a set of security characteristics that can be tested to determine if they help explain differences in returns across securities (Kritzman (1993)).

Sources of common risk that contribute to changes in security prices are known as factors. If the factors can be identified, risk can be controlled more efficiently and returns can be improved. Factor analysis reveals covariation in returns and the sources of this covariation. The analysis is based on isolation of factors by observing common variations in the returns of different securities. The next step is to group or form portfolios of stock returns, and see if the returns of these groups can partly be explained by a common factor. Factors derived through factor analysis cannot always be interpreted, for example some factors cannot be assigned a measurable proxy or a factor may reflect a combination of several (perhaps offsetting) influences. So even if nearly all of a sample's variation in returns can be accounted for with independent factors, it can be difficult to assign meaning to these factors (Kritzman (1993)).

A common method to test if an additional factor can improve an existing factor model is to run OLS (Ordinary Least Squares) time series regressions. If the factors are excess returns then one can test to see if the additional factor helps to reduce the number of regression intercepts that are different from zero. These regressions intercepts are equivalent to pricing errors (Cochrane (2005). A time series regression model for several assets or portfolios can be tested for if all intercepts (alphas) are jointly zero (null hypothesis). The test can be performed by the Gibbons, Ross, and Shanken (1989) ("GRS") test statistic. (See Formula 1 in the Appendix.) By testing joint significance of alpha, the results do not depend on the portfolio formation (Sangiorgi (2009)).

An alternative to factor analysis is cross-sectional analysis which specifies the sources of return covariation. The first step is to hypothesize characteristics that are believed to correspond to differences in stock returns. Cross-sectional analysis thus defines a characteristic – not a factor. Once a characteristic that likely measures sensitivity to the common sources of risk, for example leverage, is specified, the returns across a large sample are regressed during a period with the characteristic's values for each firm (as of the beginning of that period). Next, this regression is repeated over many periods (Kritzman (1993)).

If the coefficients of the characteristic values are different from zero and are significant it is possible to conclude that differences in returns across stocks relate to differences in their characteristic values. The average value of the coefficient over many regressions may be zero, but the characteristic may still be important if the coefficient is different from zero in a large number of the regressions. Whether the coefficient is significant or not can be measured by its t-statistic; the value of the coefficient divided by its standard error (Kritzman (1993)).

2.3.1 Fama-MacBeth Procedure

Fama and MacBeth (1973) ("FM") developed a two-step procedure for analysis of the cross-section of stock returns, and the method is used for estimation of betas and risk premia for factors (characteristics) in the analysis of linear factor models. The first step is to run time series regressions for estimating the regressors (factor loadings, for example betas) of each stock or portfolio. Second, a cross-sectional regression is run for each time period including either the time series betas, actual stock characteristics, or both. By this approach, estimates for the parameters and standard errors are obtained so that t-statistics can be computed, and one can test if mispricing (here in the form of residuals) is zero. It is assumed that the factor loadings are time-invariant or in other words constant over time. Essentially, the FM procedure is another way of calculating the standard errors, corrected for cross-sectional correlation. The FM procedure is often used when one wants to determine risk premiums and the effect of stock characteristics (Cochrane (2005)). (See Formula 2 in the Appendix.)

2.3.2 Testing Regression Models

A simple time series regression can be used to see if the variables (factors) are priced and to examine if any factor is redundant with respect to the other factors. The intercept of the time series regression of one factor onto the other factors provides information regarding the potential additional explanatory power of the factor. If the alpha in this regression is not significantly different from zero, then the factor is redundant (Sangiorgi (2009)).

2.4 Asset Pricing

2.4.1 CAPM

Sharpe (1964), Lintner (1965), and Black et al. (1972) developed the Capital Asset Pricing Model ("CAPM"), which would become the benchmark asset pricing model used by practitioners and academics. The CAPM implies that the appropriate risk premium on an asset will be determined by its contribution to the risk of investors' overall portfolios. The one-factor model provides a prediction of the relationship between the risk of an asset and its expected return, given the return for a theoretical risk-free asset, market portfolio return, and the stock's sensitivity to the market portfolio. Non-diversifiable market risk is the only risk factor used, and according to the model should be sufficient for explaining the risk-return tradeoff (Bodie et al. (2008)). Further, there is a linear relationship between expected returns and their market betas, where the relation between stocks' systematic risk ("market beta") and the expected market risk premium ("ERM"), which is the expected return on the market portfolio less the risk-free rate, suffice for explaining the cross-section of expected returns (Bodie et al. (2008)). "ER" is here the stock return in excess of the risk-free rate.

$$ER_{it} = \alpha_i + \beta_{i,ERM}ERM_t + \varepsilon_{it} \qquad (1)$$

According to the CAPM specification above, the intercept alpha ("α") should be zero and the beta ("β"), the coefficient for a given stock *i,* should capture the cross-sectional variation of expected returns. Market beta is thus the only explanatory factor.

Although based on several strong assumptions that ignore real world complexities, the CAPM proved to work empirically during some periods of the twentieth century, predominantly in the pre-1969 period (Bodie et al. (2008)).

2.4.2 Anomalies and Multifactor Models

As the CAPM is a fundamentally simple model, academics have found several empirical contradictions of the model over the years and developed it for more accurate predictions of expected returns. Users of the CAPM have also assessed anomalies related to the model. An anomaly in this context refers to a characteristic that causes a stock's return to deviate from the expected value obtained by the CAPM. Multifactor asset pricing models use more than one risk factor for explaining expected returns, and incorporate one or several anomalies.

Banz (1981) documented that market betas do not suffice for describing expected returns. Banz found that size (shares outstanding times share price; market equity, "ME") helps to explain returns. Banz's findings have been known as the "size effect," as Banz found that small firms (low ME) yield higher average returns given their beta estimates.

According to the CAPM, leverage risk should, ceteris paribus, be captured by the market beta as shown in Formula 3 in the Appendix. Bhandari (1988) documented a positive relation between returns and leverage, which is in line with Modigliani and Miller (1958)'s proposition II. Bhandari used a firm's debt-to-equity ratio to proxy for the risk of common equity, and proposed leverage as an additional variable to explain expected returns. As a proxy was used for the market portfolio and market betas were based on a calculation period that did not overlap the test period (neglecting possible changes of market beta over time) there were reasons for including an additional variable. Bhandari tested all stocks on the New York Stock Exchange for both size (ME) and market beta in a cross-sectional analysis and concluded that leverage helped explain cross-section of average returns.

Fama and French (1992) investigated empirical contradictions to the CAPM and developed the research on the area. Following the research on the size effect (Banz (1981)) and leverage (Bhandari (1988)), Fama and French also included the observed positive relation between average stock returns and the ratio of a firm's book value of its common equity to its market value ("BE/ME"). Furthermore, Fama and French included the earnings-to-price ratio ("E/P") that had been shown to help explain cross-section of average returns. E/P was likely to be higher for stocks with higher risks and expected returns. According to Ball (1978), E/P could act as a "catch-all proxy" for unnamed factors in expected returns.

As the above variables could be regarded as different ways to scale stock prices, Fama and French expected that some of them would be redundant for describing average returns. They thus evaluated the joint roles of market beta, ME, BE/ME, E/P, and leverage in a cross-section of average returns on U.S. stocks. They found that the relation between average stock returns and market beta was weak during 1941-1990, and even disappeared during the 1963-1990 period when market beta was used alone. They discovered that the univariate relations between average returns and ME, BE/ME, E/P, and leverage were strong. In multivariate tests, the relations between average returns and ME and BE/ME respectively were robust in competition with other variables. The study concluded that the combination of ME and BE/ME absorbed the roles of E/P and leverage in average stock returns. (The matching factors "SMB" and "HML" are described in detail in section 6.1.) The model constructed by Fama and French is known as the "Fama-French three-factor model" ("FF 3-factor model"), specified below:

$$ER_{it} = \alpha_i + \beta_{i,ERM}ERM_t + \beta_{i,SMB}SMB_t + \beta_{i,HML}HML_t + \varepsilon_{it} \qquad (2)$$

Carhart (1997) developed the observed momentum effect in stock returns (a tendency for rising prices during a period to continue to rise in the subsequent period) by constructing a four-factor model ("Carhart 4-factor model") that expanded the FF 3-factor model by a momentum factor ("PR1YR", described in further in section 6.1), specified below:

$$ER_{it} = \alpha_i + \beta_{i,ERM}ERM_t + \beta_{i,SMB}SMB_t + \beta_{i,HML}HML_t + \beta_{i,PR1YR}PR1YR_t + \varepsilon_{it} \qquad (3)$$

Carhart argued that the FF 3-factor model was unable to explain cross-sectional variation in momentum sorted portfolio returns, and tested the Carhart 4-factor model on U.S. stock portfolio returns. Carhart found that the Carhart 4-factor model could explain considerable time series variations in returns. The results also suggested that the factors ME, BE/ME, and PR1YR accounted for significant cross-sectional variation in the mean return on stock portfolios. Carhart concluded that the Carhart 4-factor model substantially reduces the average pricing errors relative to both the CAPM and the FF 3-factor model, indicating that it is better in describing the cross-sectional variation in average stock returns. The Carhart 4-factor model has been tested in Sweden by Emtemark and Liu (2009), but they primarily used it for examining the performance persistence of mutual funds.

Ferguson and Shockley (2003) showed that loadings on portfolios formed on leverage and distress subsume the powers of the Fama and French (1992) factors SMB and HML in explaining cross-sectional returns. Ferguson and Shockley stated that many empirical anomalies are actually consistent with the CAPM if an equity-only proxy for the true market portfolio is used. Their model implied that that "if the single-factor CAPM holds, then factors formed on relative leverage and relative distress should provide the best compliments to the equity market index for explaining the cross-section of returns."

Korteweg (2004) tested the relation of expected returns and leverage with a time series approach by studying exchange offers. Korteweg argued that a time series analysis allowed for better control of the firms unlevered (business) risk, asset betas, and the study used time varying, non-zero, debt betas. Korteweg advocated that Modigliani and Miller (1958)'s proposition II does not imply that leverage should be a separate risk factor. Cross-sectional studies assume constant asset betas within industries, and the above logic was extended to assume that all factor loadings in multifactor models should increase with leverage. Korteweg concluded that equity betas of highly levered firms are too low to support the statement that expected returns increase with leverage.

George and Hwang (2007) examined how financial distress and leverage affect stock returns. They constructed a regression model that expanded the FF 3-factor model with factors for leverage, momentum (different to the factor used by Carhart (1997)), and default risk prediction, and tested U.S. stock returns between 1963 and 2003. Their paper documented that average returns on stocks are negatively related to book leverage, and the leverage factor explained a significant component of time series variations in returns in contradiction to Fama and French (1992). George and Hwang concluded that BE/ME measures sensitivity to operating distress risk, while leverage measures sensitivity to financial distress risk, and that both are priced in equity markets. Their interpretation was that leverage and BE/ME factors appear to capture different return premiums.

Penman et al. (2007) further investigated the ratio book to price ("B/P"), which is identical to the ratio denoted BE/ME used by Fama and French (1992). Penman et al. decomposed the B/P into an enterprise B/P (pertaining to the operations) and a leverage component (reflecting financial risk). They found a negative correlation between market leverage and future returns, and advocated that this relationship is not absorbed by the BE/ME factor as stated by Fama and French (1992). They further found that their enterprise B/P ratio as a risk factor is positively related to returns, and thus concluded that the puzzling issue of how operating and financing components of B/P relate to stock returns cannot be sorted out without a well specified asset pricing model. An asset pricing model including B/P or BE/ME without a leverage premium cannot explain if the variation in returns is due to reward for risk or mispricing of market leverage. A replication of this study on Swedish data has been done by Kidane et al. (2009).

Gomes and Schmid (2008) sought to provide a new view of levered returns due to the mixed and contradicting findings on how returns relate to varying capital structures. They investigated the effects of leverage in the context of capital spending and investments, as an increase in the value of assets changes the underlying business risk and thus the risk to equity holders. Gomes and Schmid constructed an option model that showed how the link between expected returns and leverage arises endogenously as a result of investment and financing policies. They then constructed a quantitative model to test the empirical implications and reached several conclusions. They confirmed both the positive relation between leverage and firm size (large firms have a higher level of leverage) and the correlation between leverage and investments. Secondly, they found that equity returns were positively related to market leverage, but insensitive to book leverage, even after controlling for firm size. However, market leverage was only weakly linked to returns after controlling for book-to-market. The interpretation of these findings was that market leverage, containing market capitalization (ME) in the denominator was mechanically positively related to returns.

Sivaprasad and Muradoglu (2008) tested whether leverage was an asset pricing factor on firms listed on the London Stock Exchange from 1965 to 2004. They formed leverage mimicking factor portfolios to explain the returns in different risk classes. Sivaprasad and Muradoglu used the Carhart 4-factor model and extended it with a leverage factor. They found that leverage mimicking portfolios strongly captured time series variation in returns, and that the leverage factor seemed to explain stock variations in the various risk classes. Their interpretation was that leverage is a risk which is priced and with a return premium to stocks of companies with high leverage.

2.4.3 Summary of Previous Studies

To summarize the previous literature, there is evidence that equity returns:

- rise with market leverage (Bhandari (1988), Fama and French (1992), and Gomes and Schmid (2008)),
- are insensitive or even decline with book leverage (Fama and French (1992), George and Hwang (2007), and Gomes and Schmid (2008)),
- decline with market leverage after controlling for the book-to-market factor (Penman et al. (2007)),
- cannot be better explained by leverage (Korteweg (2004)),
- can be better explained by leverage (Ferguson and Shockley (2003) and Sivaprasad and Muradoglu (2008)).

From the above one can see that the results of previous studies are very mixed. There are several other studies addressing the issue, but in our research the studies mentioned above are the most cited studies that we have come across.

The study by Sivaprasad and Muradoglu (2008) bears some resemblance to our thesis. We felt that their approach to a (potential) leverage factor was interesting, and therefore we decided to follow a similar methodology. We will also extend the Carhart 4-factor model with a leverage factor, but we use another dataset (Sweden as opposed to the U.K. and another time period), a different measure of leverage, additional portfolio formations, and we will further try to answer whether leverage has a positive effect on stock returns (see Hypothesis 2, section 4.2).

3. Definitions

3.1 Returns

Our general definition of returns has to be considered in a wider context for analysis of the asset pricing models. Considerations have to be made regarding dividends, stock splits, and share issues as these affect returns in numerous ways. Lintner (1965) defined the return on any common stock as the sum of the cash dividend received plus the change in its market price. This definition will be used throughout this thesis, unless otherwise specified.

When examining returns over a longer time period, one also has to consider the use of real or nominal returns. The use of real returns seems preferable if the rate of inflation has varied considerably during the period, but following Bhandari (1988) we will use nominal returns. Bhandari (1988) concluded that the results were virtually identical when using nominal returns instead of real returns, and that the preference for either method only alters the estimated intercept term in the cross-sectional equation by the average amount of inflation.

Returns in an asset pricing context refers to expected returns. A careful reader might notice that returns have been described as both “expected returns” and “average returns.” This is explained by the fact that when regressions are performed on historical returns, in order to determine the components of the relevant asset pricing models, one has to proxy expected returns with average returns as an unbiased estimator.

3.2 Measures of Leverage

When starting to consider what kind of measure for leverage is appropriate for a study, one should first think of what the objective of the study is (Rajan and Zingales (1995)). As our objective is not to examine leverage as a mechanism to transfer control in case of financial distress or investigate liquidity problems, we are solely interested in the amount of debt in relation to firm value. Total liabilities to total assets is the broadest definition of leverage, but this, as Rajan and Zingales (1995) argue, is not a good proxy for financial risk, since many balance sheet items included in total liabilities are used for transaction purposes rather than financing. Therefore, debt will be regarded as interest-bearing liabilities throughout this thesis, and leverage defined as the ratio between debt and total assets (see section 5.1).

The next step after providing a definition of leverage is to decide on an appropriate measure. The previous papers written on this subject have a mixed attitude to the use of book value or market value. The use of either book or market value of leverage can yield different conclusions, for example as presented by Gomes and Schmid (2008). Titman and Wessels (1988) argued that the coefficients in the factor model may vary depending on whether book or market values are used. As we will use market values of equity for estimating ME, one might argue that markets values of debt would be better for any comparison. Although the use of market values of debt can have its advantages over book value, we have to consider what measures of debt are available. As book values are more readily available as opposed to market values, we are inclined to use the former.

3.3 Industry Classification

Since the optimum capital structure of a firm varies depending on which industry it operates in, it is preferable to classify firms by industry when examining their capital structure (Schwartz (1959)). Titman and Wessels (1988) argued that the capital structure choice of firms is largely dependent on what type of assets they own, and thus concluded that firms with assets that can be used as collateral will be more levered. Furthermore, Harris and Raviv (1991) claimed that leverage increases with larger fixed assets, investment opportunities, and firm size, but decreases with for instance volatility and profitability. As risk can be divided into financial and business risk (see section 2.1), firms can be classified according to different risk classes. We believe industry classification is a good proxy for estimating financial risk across firms. Industry classification will hence be one of the firm characteristics used for forming portfolios (section 6.2).

4. Hypotheses

4.1 Hypothesis 1

We hypothesize that capital structure as an independent variable in a multifactor asset model is priced and can explain variations in stock returns. We therefore believe leverage as an additional factor will help reduce pricing errors.

4.2 Hypothesis 2

During the entire test period we believe leverage will have a positive effect on stock returns, implying that the highly levered firms will yield higher (above average) returns.

4.3 Asset Pricing Models Evaluation

In conjunction with testing our hypotheses, we will evaluate the performance of the CAPM, the FF 3-factor model, and the Carhart 4-factor model on our data. These models form the benchmark when testing to see if an additional leverage factor can reduce mispricing.

4.4 Interpretation

The first hypothesis relates to a leverage factor in a multifactor asset pricing model. If a factor is priced, it will help reduce the absolute values of the pricing errors, known as alphas in a times series regression equation. If the leverage factor can explain variations in returns, this would imply that stocks with positive covariance with the leverage factor would yield higher returns. (However, this does not necessarily imply that a firm is highly levered.) For this kind of analysis a time series framework will be used.

The second hypothesis incorporates our belief that highly levered firms will yield higher returns than firms with low leverage, implying that equity investors are compensated for the increased risk associated with leverage. This means that leverage, as a stock characteristic, is positively correlated with returns.

This hypothesis will be analyzed by using cross-section analysis in the form of the Fama-MacBeth procedure.

5. Data

5.1 Type of Data

The dataset used for this thesis consists of total returns during the period 1990 to 2009 for firms currently listed in Sweden, and their corresponding data on market capitalization and relevant balance sheet items. This relatively long time period captures several business cycles and results in a larger number of observations which is desirable from a statistical perspective. All the data were obtained from the Thomson Datastream ("DS") database during April 2010.

To calculate returns, we used a total return index (DS Mnemonic: RI) which we believe gives a fairly accurate representation of the returns to investors. The index shows the theoretical growth in the value of a stock, assuming dividends are reinvested. The index uses adjusted closing prices, which takes dividends, splits, and repurchases into consideration, and thus follows our return definition (section 3.1).

According to the index calculations, the discrete quantity of the dividend paid is added to the price on the ex-date of the payment, where "RI" is the return index, "P" is the share price, "D" the dividend paid, and "t" is the ex-date in equation (4):

$$RI_t = RI_{t-1} \times \frac{P_t + D_t}{P_{t-1}} \qquad (4)$$

For the size (ME) of firms, we used Market Value (DS Mnemonic: MV), which is specified as the number of ordinary shares outstanding per share class in the issue multiplied by the share price (also known as "market capitalization"). In order to calculate the book-to-market ratio (BE/ME) we used Common Equity (DS Mnemonic: WC03501) as a proxy for book value of equity. We wanted to use a measure of leverage consistent with our definition in section 3.2 and hence we used Total Debt-to-Total Assets (DS Mnemonic: WC08236), which is defined as:

$$\text{Leverage [\%]} = \frac{\text{Total Debt}}{\text{Total Assets}} = \frac{\text{(Long Term Debt + Short Term Debt \& Current Portion of Long Term Debt)}}{\text{Total Assets}} \qquad (5)$$

For the market return, we opted to use Affärsvärlden's General Index, "AFGX" (DS Mnemonic: OMXAFGX). This value-weighted index is widely used and encompasses all currently listed Swedish stocks. Datastream was also used for retrieving the risk-free interest rate proxy, which in this case was chosen to be the Swedish 30-day Treasury Bill middle rate (DS Mnemonic: SDTB30D).

5.2 Data Adjustments

5.2.1 Equity Observations

All 490 currently listed firms in Sweden were initially downloaded from Datastream.[1] For firms that have A and B (or C) classes of shares we chose only the major security, thus allowing only one share class per firm.

Firms with fewer than five consecutive years of returns and accounting data observations were omitted, ensuring that all included stocks had at least 60 months of returns. As in Fama and French (1992) we excluded firms with negative book equity values. We also decided to exclude firms with a leverage ratio greater than 100% as this is not particularly realistic given the above leverage definition used in our study. Some of the negative book equity stocks were the ones that had leverage ratios in excess of 100%.

5.2.2 Financials

As certain industries require firms to be more levered, and certain business profiles are based on being highly levered, the question of whether to include or exclude financial firms (Financials) such as banks and insurance companies needs to be addressed. Rajan and Zingales (1995) argue that Financials should be eliminated from a cross-sectional study due to their leverage being strongly influenced by explicit or implicit "investor insurance schemes such as deposit insurance." The main argument presented is that the debt of Financials is not comparable to the debt held by non-Financials. Also, Fama and French (1992) exclude Financials because the normal leverage level for Financials does not have the same meaning for non-Financials, in which high leverage more likely indicates financial distress. We agree with the reasoning in the mentioned studies, and hence excluded all Financials. Specifically, we chose to omit all firms under the industry group 4300 (Financials) in Datastream (DS Mnemonic: WC06011). We deleted a further seven firms[2] that are not classified under 4300 but that, after consulting their respective websites, were deemed to be Financials.

[1] We define currently listed as being labeled as "active" in the Datastream database. There is one active firm (Ekomarine, first trading day on 27 April 2010) which was not included in the initial dataset as it was not listed when the data was gathered.
[2] Bure, Latour, Lundbergs, Kinnevik, Ledstiernan, Scribona, and Traction.

5.2.3 Survivorship bias

The data obtained from Datastream are subject to some survivorship bias as a number of firms have been delisted during our 19-year test period. This might cause our results to be biased towards firms with higher returns, as firms that have been delisted in some cases plausibly have had lower than average stock returns prior to their delisting (especially during bankruptcy filings). Thus, average returns on our data are most likely higher than the actual returns for all firms (listed and delisted) due to the survivorship bias. As leverage increases the financial risk of firms, it is possible that many highly levered firms have been delisted due to financial distress and subsequent bankruptcy. This would effectively cause the leverage factor to not represent the true (and possibly lower) returns associated with highly levered firms. Further, the exclusion of delisted firms might bias the momentum factor in particular since including them would reasonably increase the spread in the HML factor (section 6.1).

Some studies on U.S. data (for example Gomes and Schmid (2008)) use a bias correction for delisted firms. However, we were not aware of any equivalent correction factor for the Swedish market, and thus no such correction was made.

5.3 Final dataset

After the removal of firms from the raw sample according to the above described procedure, our sample used for estimating regression variables consisted of 201 firms, as presented in Table 40 (Section 10.4 of the Appendix). The number of firms included in any given year varies considerably and is basically an increasing function of time. The yearly average number of firms over the 19-year period is 127 and the lowest recorded amount is 45 (1990). We are aware that the implications of our data adjustments may result in our estimated variables not necessarily reflecting the “true” independent factors representative for the Swedish market, but we feel that these adjustments are necessary in order to improve our statistical estimates and limit the number of potential biases.

6. Methodology

6.1 Factor Portfolios

The CAPM, which is the building block for most asset pricing models, only entails the market factor. In our case, this was simply calculated every month by taking our AFGX index return and subtracting the corresponding Swedish Treasury Bill rate, in order to get the market risk premium (“ERM”).

Following the methodology of Fama and French (1993), we continue by calculating the two additional factors needed for the FF 3-factor model. The factors are constructed by using six value weighted portfolios formed on size (ME) and book-to-market (BE/ME). The firms included in our sample are ranked each year at the end of June based on their ME and BE/ME, and then organized into portfolios. If a firm during a given year does not have any ME or BE/ME ranking it is not included in the factor relevant for that year. Similarly, the firm is only included if it has all the 12 monthly returns in the subsequent holding period. The median stock size is used to split the firms into two groups, Small ("S") and Big ("B"). We then split the sample into three groups based on BE/ME, where the bottom percentile is 30% (Low, "L" or Growth), the middle percentile is 40% (Neutral, "M"), and the top percentile is 70% (High, "H" or Value).

The six portfolios that are formed are; S/L, S/M, S/H, B/L, B/M, and B/H (See Figure 1). For example, the portfolio S/L contains firms with small market values and low book-to-market ratios. The BE/ME used to sort the portfolios in June-end year t is calculated by dividing a firm's Common Equity with its Market Value in December t-1. This approach of a six-month gap between actual values and subsequent rankings is conservative and ensures that accounting data (annual reports) are available for the returns during the holding period. We change the portfolios every year at the end of June, and calculate the monthly value weighted returns from July of year t to June-end of year t+1. The size ranking is carried out using an equivalent procedure.

The Small-minus-Big ("SMB") and High-minus-Low ("HML") factors are then calculated using equations (6) and (7):

$$\mathrm{SMB} = \frac{(\text{Small Value} + \text{Small Neutral} + \text{Small Growth}) - (\text{Big Value} + \text{Big Neutral} + \text{Big Growth})}{3} \tag{6}$$

$$\mathrm{HML} = \frac{(\text{Small Value} + \text{Big Value}) - (\text{Small Growth} + \text{Big Growth})}{2} \tag{7}$$

The portfolio SMB is the difference each month between the simple average of the returns on the three small stock portfolios, S/L, S/M, and S/H, and the simple average of the returns on the three big stock portfolios, B/L, B/M, and B/H. The SMB portfolio, which is meant to mimic the risk factor related to size, is thus the difference between the returns on small and big stock portfolios with about the same weighted average book-to-market ratios. The SMB portfolio can be interpreted as the return an investor would receive from buying a value weighted portfolio containing the 50% smallest stocks by size while at the same time short selling a value weighted portfolio containing the 50% largest stocks (implying a zero investment portfolio).

The portfolio HML is defined similarly and is thus the difference each month between the simple average of the returns on the two high BE/ME portfolios, S/H and B/H, and the simple average of returns on the two low BE/ME portfolios, S/L and B/L. HML is meant to mimic the risk factor in return related to book-to-market equity, and should largely be free of the size factor in returns (Fama and French (1993)).

We continue our portfolio formation by creating portfolios for the additional factors of momentum and leverage. To construct a factor mimicking portfolio for momentum in stock returns, we employ the same method as Carhart (1997). The factor PR1YR is defined as the value weighted average return of firms with the highest 30% eleven month returns lagged one month minus the value weighted average return of firms with the lowest 30% eleven month returns lagged one month. The portfolios are rebalanced at the end of June each year.

For leverage, we form a portfolio to mimic the risk factor related to the leverage of firms. At the end of June each year, all firms are ranked based on their leverage as reported for December t-1. Similar to the above treatment of HML and PR1YR, we group firms based on the breakpoints for the bottom 30% (Low), middle 40% (Neutral), and top 30% (High). The difference each month between the simple average of the highly levered firms' returns and the simple average of the low levered firms' returns is used to create the High-Leverage-minus-Low-Leverage ("HLMLL") portfolio similarly to Sivaprasad and Muradoglu (2008).

During some of the years in our test period, a substantial amount of firms did not have any reported leverage in the Datastream database. As we could not verify if this actually was the case or the result of an error in the data, we constructed a second leverage factor that excluded firms that had zero reported leverage. This entailed making a new ranking for firms with non-zero leverage and followed the same portfolio formation procedure as the leverage factor including all the firms. This modified leverage factor is denoted as "HLMLL_ex."

6.2 Regression Portfolios

In order to produce the empirical results needed to answer our hypotheses, we form regression portfolios of our 201 stocks. The forming of portfolios is desirable as it reduces the residual variance of the estimated betas and produces more stable betas over time. It also avoids the problem of dealing with individual stock returns that can be very volatile and yield results that cannot reject the proposition that all average returns are equivalent (Cochrane (2005)).

We form our stocks into portfolios using three different methods; leverage ranking, 3x3 matrix ranking, and industry sorted portfolios.

6.2.1 Leverage Ranked Portfolios

As our thesis is primarily concerned with finding a potential leverage factor, it is natural to form our stocks into portfolios based on leverage. We do this by ranking the stocks with leverage into 10 deciles portfolios (1 being the lowest and 10 being the highest). We also create one additional portfolio containing the stocks that have zero leverage. Thus, we have a total of 11 leverage portfolios. In addition to answering our first hypothesis, leverage ranked portfolios will also help us to answer our second hypothesis.

6.2.2 3x3 Portfolios

Fama and French (1993) formed 25 portfolios based on a 5x5 matrix with quintiles for both SMB and HML rankings. They formed stocks in this way as they were interested to see if the SMB and HML portfolios could capture common factors in stock returns related to ME and BE/ME. Such portfolios can produce a wide range of average returns (Fama and French (1993)). As we only have 201 stocks, we decide to create a similar 3x3 matrix based on our SMB and HML rankings, according to Figure 2. This gives us 9 portfolios that will help us to determine if the inclusion of a leverage factor can help to improve pricing errors, and also to see how well the SMB and HML factors perform. The portfolios, 1-9, are S/L, S/M, S/H, M/L, M/M, M/H, B/L, B/M and B/H, where breakpoints are 1/3 and 2/3, based on ME and BE/ME rankings for each portfolio.

6.2.3 Industry Sorted Portfolios

In addition to testing returns based on leverage ranking and SMB and HML rankings, it is also interesting to see if industry classification can help to explain differences in returns according to the reasoning in section 3.3. We form our stocks into 23 industry portfolios based on the same industry classification (DS Mnemonic: WC06011) used to exclude financial firms from our data sample. The industry classifications can be seen in Table 3 in the Appendix. It is important to note that these portfolios are very unbalanced compared to our leverage ranked portfolios and 3x3 portfolios.

6.3 Testing Models

6.3.1 Model Specifications

In order to test if the factors added to the original CAPM (1) provide greater explanatory power to returns, we test the models against each other. A factor can be dropped from an asset pricing model if a regression with the factor as the dependent variable against the other factors (independent variables) produces a constant (alpha) that is zero. This is due to the fact that if factors price a certain factor then they can price anything that the factor prices (Sangiorgi (2009)).

The following regressions are conducted to test the models:

$$SMB_t = \alpha_{SMB} + \beta_{ERM}ERM_t + \varepsilon_t \quad (8)$$

$$HML_t = \alpha_{HML} + \beta_{ERM}ERM_t + \beta_{SMB}SMB_t + \varepsilon_t \quad (9)$$

$$PR1YR_t = \alpha_{PR1YR} + \beta_{ERM}ERM_t + \beta_{SMB}SMB_t + \beta_{HML}HML_t + \varepsilon_t \quad (10)$$

$$HLMLL_t = \alpha_{HLMLL} + \beta_{ERM}ERM_t + \beta_{SMB}SMB_t + \beta_{HML}HML_t + \beta_{PR1YR}PR1YR_t + \varepsilon_t \quad (11)$$

$$HLMLL\_ex_t = \alpha_{HLMLL\_ex} + \beta_{ERM}ERM_t + \beta_{SMB}SMB_t + \beta_{HML}HML_t + \beta_{PR1YR}PR1YR_t + \varepsilon_t \quad (12)$$

Where t = 1990-07, 1990-08…2009-06 = T

6.3.2 Model Definitions

Equation (8) tests SMB on CAPM, (9) tests HML on ERM and SMB, (10) tests PR1YR on the FF 3-factor model, and (11) tests our leverage factor (HLMLL) on the Carhart 4-factor model. HLMLL_ex represents the leverage factor which excludes firms with zero leverage and is used in (12) to test if our second leverage factor carries more explanatory power than our original leverage factor.

The factors ERM, SMB, HML, PR1YR, HLMLL, and HLMLL_ex are defined as in section 6.1. Alpha (α) is the intercept and the error term is ε_{it}.

6.4 Time Series Regressions

6.4.1 Model Specifications

We employ different asset pricing models with variable risk factors. All models are regressed according to equation (13) to (19) for our leverage, 3x3, and industry sorted portfolios.

$$ER_{it} = \alpha_i + \beta_{i,ERM}ERM_t + \varepsilon_{it} \quad (13)$$

$$ER_{it} = \alpha_i + \beta_{i,ERM}ERM_t + \beta_{i,SMB}SMB_t + \beta_{i,HML}HML_t + \varepsilon_{it} \quad (14)$$

$$ER_{it} = \alpha_i + \beta_{i,ERM}ERM_t + \beta_{i,SMB}SMB_t + \beta_{i,HML}HML_t + \beta_{i,PR1YR}PR1YR_t + \varepsilon_{it} \quad (15)$$

$$ER_{it} = \alpha_i + \beta_{i,ERM}ERM_t + \beta_{i,SMB}SMB_t + \beta_{i,HML}HML_t + \beta_{i,PR1YR}PR1YR_t + \beta_{i,HLMLL}HLMLL_t + \varepsilon_{it} \quad (16)$$

$$ER_{it} = \alpha_i + \beta_{i,ERM}ERM_t + \beta_{i,SMB}SMB_t + \beta_{i,HML}HML_t + \beta_{i,PR1YR}PR1YR_t + \beta_{i,HLMLL\_ex}HLMLL\_ex_t + \varepsilon_{it} \quad (17)$$

$$ER_{it} = \alpha_i + \beta_{i,ERM}ERM_t + \beta_{i,SMB}SMB_t + \beta_{i,HLMLL}HLMLL_t + \varepsilon_{it} \quad (18)$$

$$ER_{it} = \alpha_i + \beta_{i,ERM}ERM_t + \beta_{i,SMB}SMB_t + \beta_{i,HLMLL\_ex}HLMLL\_ex_t + \varepsilon_{it} \quad (19)$$

Where t = 1990-07, 1990-08…2009-06 = T and i represents portfolios.

6.4.2 Model Definitions

Equation (13) is the CAPM, (14) is the FF-3 factor model, (15) is the Carhart 4-factor model, (16) is the Carhart 4-factor model + the leverage factor (HLMLL) ("Our 5-factor model"), (18) is a modified FF 3-factor model ("Modified 3-factor model") that uses HLMLL in place of HML similar to Ferguson and Shockley (2003). Equations (17) and (19) are similar to (16) and (18) respectively, but they employ the modified leverage factor HLMLL_ex instead of HLMLL.

ER_{it} is the monthly stock return in excess of the risk-free rate for portfolio *i* in month *t*. Alpha (α) is the risk-adjusted abnormal return, known as the pricing error. ERM is the excess return on the market portfolio, known as the market risk premium. The other factors SMB, HML, PR1YR, HLMLL, and HLMLL_ex are defined as in section 6.1. The error term is ε_{it}. All the factors are excess returns and hence one can look at the constants (alphas) to determine mispricing.

6.4.3 Model Purposes

Model (13) is designed to see how well the CAPM holds on our Swedish stock market data. (14) serves as a test of the FF 3-factor model on our data. Model (15) encompasses momentum as an explanatory factor and uses (14) as its base of comparison. Model (16) is our 5-factor model that uses (15) as its base of comparison. (18) is our modified FF 3-factor model that uses (14) as its base of comparison. (17) and (19) are modifications of (16) and (18) and have the same purpose.

6.5 Fama-MacBeth Regressions

6.5.1 Model Specifications

We employ five different asset pricing models in our FM procedure with the command "xtfmb" in Stata[3]. The models are regressed according to equation (20) to (26) for our leverage ranked portfolios (section 6.2.1). We chose only to use leverage ranked portfolios as we are primarily interested in our second hypothesis that solely concerns the leverage factor as a stock characteristic. Sorting by leverage helps to increase the dispersion between the portfolios.

$$ER_{it} = \gamma_{it} + \beta_{i,ERM}\lambda_{t,ERM} + \alpha_{it} \quad (20)$$

$$ER_{it} = \gamma_{it} + \beta_{i,ERM}\lambda_{t,ERM} + \ln(ME)_{it}\lambda_{t,ME} + BE/ME_{it}\lambda_{t,BE/ME} + \alpha_{it} \quad (21)$$

$$ER_{it} = \gamma_{it} + \beta_{i,ERM}\lambda_{t,ERM} + \ln(ME)_{it}\lambda_{t,ME} + BE/ME_{it}\lambda_{t,BE/ME} + \beta_{i,PR1YR}\lambda_{t,PR1YR} + \alpha_{it} \quad (22)$$

$$ER_{it} = \gamma_{it} + \beta_{i,ERM}\lambda_{t,ERM} + \ln(ME)_{it}\lambda_{t,ME} + BE/ME_{it}\lambda_{t,BE/ME} + \beta_{i,PR1YR}\lambda_{t,PR1YR} + Lev_{it}\lambda_{t,Lev} + \alpha_{it} \quad (23)$$

$$*ER_{it} = \gamma_{it} + \beta_{i,ERM}\lambda_{t,ERM} + \ln(ME)_{it}\lambda_{t,ME} + BE/ME_{it}\lambda_{t,BE/ME} + \beta_{i,PR1YR}\lambda_{t,PR1YR} + Lev_{it}\lambda_{t,Lev} + \alpha_{it} \quad (24)$$

$$ER_{it} = \gamma_{it} + \beta_{i,ERM}\lambda_{t,ERM} + \ln(ME)_{it}\lambda_{t,ME} + Lev_{it}\lambda_{t,Lev} + \alpha_{it} \quad (25)$$

$$*ER_{it} = \gamma_{it} + \beta_{i,ERM}\lambda_{t,ERM} + \ln(ME)_{it}\lambda_{t,ME} + Lev_{it}\lambda_{t,Lev} + \alpha_{it} \quad (26)$$

Where t = 1990-07, 1990-08…2009-06 = T, where i represents portfolios, and * = exclusion of zero leverage portfolio.

6.5.2 Model Definitions

Equation (20) is a test of the CAPM market beta, (21) is a test of the market beta, firm size (ME), and BE/ME, (22) is a test of the market beta, ME, BE/ME, and PR1YR beta, (23) is a test of the market beta, ME, BE/ME, PR1YR beta, and leverage ("Lev"), and (25) is a test of the market beta, ME, and Lev. Equations (24) and (26) are identical to (23) and (25) respectively, except for the fact that they exclude the zero leverage portfolios.

ER_{it} is the monthly stock return in excess of the risk-free rate for portfolio *i* in month *t*. $\beta_{i,ERM}$ is the market beta received from the time series regression (13). $\ln(ME)_{it}$ is the natural logarithm of the average portfolio size. BE/ME_{it} is the average portfolio book-to-market ratio. $\beta_{i,PR1YR}$ is the momentum beta obtained from a time series regression with the ERM_t and $PR1YR_t$ factors. Lev_{it} is the average portfolio

[3] Intercooled Stata 9.2 for Windows.

leverage (as defined in section 5.1, equation (5)). λ_t is the premium for each respective beta or stock characteristic and will be subsequently averaged for the T periods. Gamma (γ_{it}) is the intercept and alpha (α_{it}) is here the error term.

6.5.3 Model Purposes

Model (20) is designed to find the market risk premium. (21) serves to find the risk premiums related to the stock characteristics of ME and BE/ME. (22) adds the momentum beta in order to find the momentum premium. (23) adds leverage to determine the leverage risk premium and to determine if leverage as a stock characteristic can explain stock returns. (25) replaces BE/ME in (21) with leverage to further test leverage as a stock characteristic. (24) and (26) serve to minimize the potential data error arising from the zero leverage portfolio by simply excluding it from the respective regressions.

7. Empirical Findings and Interpretation

7.1 Average Returns and Correlation

We initially computed average excess returns for each factor during the entire data period, as presented in Table 4. The ERM factor is the only factor that produces positive average excess returns during the period 1990-07 to 2009-06. The returns on all other factor portfolios are negative and some are substantially negative. Had we included delisted firms, there is reason to believe that the average returns would be even lower which make our initial results even more difficult to explain. Regarding momentum, our results are opposite to that of Emtemark and Liu (2009) who investigated the Swedish momentum factor and found indications of a positive average momentum return. This can be explained by our use of another time period (1990-07 to 2009-06 instead of 1997-01 to 2008-12) and a different dataset, since when we compare the same time period we also retrieve a positive average return on momentum.

The standard deviations are relatively similar for all the factors except for the momentum factor PR1YR which has a considerably higher standard deviation. This is reflected in the minimum and maximum monthly return for PR1YR which has a difference in excess of 100 percentage points.

We also examined the excess return correlations between all factors. The correlation matrix is presented in Table 5. Overall, the correlations between the factors are low. The only factors that have high correlation are HLMLL and HLMLL_ex, which should not be surprising given that they are constructed very similarly. ERM correlates negatively with all factors except for the leverage factors, which indicates that the factors SMB, HML, and PR1YR all move in the opposite direction to the market risk premium.

PR1YR is negatively correlated with both leverage factors, showing that the momentum and leverage factors move in the opposite direction.

7.2 Testing Models

We continued our analysis by testing if the additional factors could provide greater explanatory power. Throughout section 7, the 5% p-value level is defined as the statistically significant cut-off point. The results of the five regressions are presented in Table 6 to Table 10 in section 10.3.4.

Equation (8) produces a significant regression (although very low R-square), but the constant is not significantly different from zero. The result indicates that the SMB factor does not improve the explanatory power of the CAPM.

Equation (9) produces a significant regression, but the constant is not significantly different from zero. This suggests that the HML factor cannot add explanatory power to the CAPM + SMB model.

Equation (10) produces a significant regression (although very low R-square), but the constant is not significant. The possibility that the PR1YR factor adds explanatory power to the FF 3-factor model seems to be limited.

Equation (11) produces a significant regression, but the constant is not significant. This indicates that our leverage factor HLMLL cannot add explanatory power to the Carhart 4-factor model.

Equation (12) produces a significant regression, but the constant is not significant as is the case for the regression of equation (11). This indicates that our leverage factor HLMLL_ex cannot add explanatory power to the Carhart 4-factor model.

The results from these tests indicate that the additional factors to the CAPM will most likely not provide any additional explanatory power. The indications of these initial findings will be further tested using time series regressions.

7.3 Time Series Regressions

The second part of our empirical study is to test if the additional factors to the CAPM can create asset pricing models that explain returns better than the CAPM. We are particularly interested in the leverage factor. By running time series regressions we can test if there are fewer pricing errors (fewer constants – alphas – that are statistically different from zero) with our asset pricing models than the CAPM and also answer Hypothesis 1. The time series regressions that follow are the regression models specified in section 6.4.1, presented according to the different regression portfolio formations in section 6.1.

7.3.1 Leverage Ranked Portfolios

Table 11 to Table 17 in section 10.3.5.1 of the Appendix show the time series regression results for the portfolios ranked by leverage. There are in total 11 portfolios as described in section 6.2.1.

In the original CAPM regressions, all ERM betas are significant and positive, and there are five regressions that have constants that are statistically different from zero. Since the market beta should, ceteris paribus, be increasing with leverage (section 2.4), one would reasonably expect that our market betas would increase with the leverage portfolios. However, as can be seen in Table 11, there is no indication that such is the case.

For the FF 3-factor model, all ERM betas are positive and significant, while only three SMB betas and four HML betas (one negative) are significant. There are six regressions that have constants statistically different from zero as opposed to the CAPM regressions which only had five constants statistically different from zero. The discrepancy is due to portfolio 7 having a 5.1% p-value in the CAPM regression and a 4.8% p-value in the FF 3-factor regression. This indicates that the FF 3-factor model is marginally worse in explaining returns than the CAPM; a slightly counterintuitive result.

The Carhart 4-factor model performs better than the FF 3-factor model as only five constants are statistically different from zero. However, this is only due to Portfolio 7 having a constant that is once again statistically not different from zero (6.8% p-value) as in the original CAPM regression. The fourth factor, PR1YR, only has three betas that are significant.

The addition of our HLMLL leverage factor to the Carhart 4-factor model (our 5-factor model) leads to the same pricing errors as in the FF 3-factor model, and thus fares worse than both the CAPM and the Carhart 4-factor model. Six portfolios have a significant beta on the leverage factor, two of which are negative. The leverage factor modification described in section 6.1, which effectively excludes firms with zero book leverage and then ranks the remaining firms, improves the regression results by yielding only five constants that are statistically different from zero, but with only five significant HLMLL_ex betas. The modified 3-factor model which replaces HML with HLMLL performs worse than the CAPM, Carhart 4-factor model, and our 5-factor model (17) with six constants statistically different from zero, both for HLMLL and HLMLL_ex (with the discrepancy due to Portfolio 7 once again).

From Table 14 to Table 17 it can be observed that the beta coefficients of our HLMLL and HLMLL_ex factors have a slight positive correlation with the leverage portfolios. This is to be expected given that the leverage factors are essentially long high leverage and short low leverage. However, the fluctuating nature of the relationship between the beta coefficients of our leverage factors and the leverage portfolios does seem to indicate that there are factors in addition to leverage that are affecting returns.

For all our models we tested to see if the regression alphas are jointly zero by using the GRS test statistic. As can be seen in Table 11 to Table 17, all the GRS tests lead to a clear rejection of the null hypothesis that the alphas are jointly zero. This suggests that none of the models are well-specified in explaining the returns across the portfolios. The R-squares for all our regressions improve as we increase the number of factors, something which is to be expected. However, the simple average across the R-squares (0.4919) in the CAPM regressions is only marginally higher than the corresponding simple average (0.5488) of our 5-factor regression indicating that the multifactor models do not substantially improve the fitting of the leveraged ranked data.

7.3.2 3x3 Portfolios

Table 18 to Table 24 in section 10.3.5.2 of the Appendix show the time series regression results for the portfolios using the 3x3 matrix described in section 6.2 and Figure 2 in the Appendix.

For the original CAPM, all ERM betas are significant and positive. Portfolios 1-3 (small size) and 7-9 (big size) all have constants that are statistically different from zero. The FF 3-factor model has seven SMB betas that are significant (one negative beta) and six HML betas that are significant (also one negative beta). As in the CAPM, the small size and big size portfolios have constants that are statistically different from zero, indicating no improvement in pricing. The Carhart 4-factor model does not have any significant betas on the PR1YR factor and does not improve on the six constants that are statistically different from zero.

Our 5-factor model produces two significant betas (both negative) on HLMLL, but fails as with the previous models to improve on the mispricing (small size and big size portfolios still have constants statistically different from zero). Our 5-factor model with HLMLL_ex yields four significant betas on HLMLL_ex, but does not improve on mispricing compared to the previous models. The modified 3-factor model gives five statistically significant betas on HLMLL as opposed to six statistically significant betas on HML in the original FF 3-factor model, but does not improve on the mispricing of the FF 3-factor model. The modified 3-factor model with HLMLL_ex produces five significant betas on HLMLL_ex, but as the previous models does not improve on mispricing. The same six portfolios have constants that are statistically different from zero. None of the models appear to improve the mispricing in the original CAPM. Furthermore there appears to be no particular relationship between our leverage factors and the 3x3 portfolios formed on ME and BE/ME.

We apply the GRS test statistic on all our models to see if the alphas in our regressions are jointly zero. Table 18 to Table 24 show that all the GRS tests lead to a clear rejection of the null hypothesis that the alphas are jointly zero, lending no support to our models. As expected, the R-squares for our regressions increase with additional factors. The simple average across the R-squares in the CAPM regressions is 0.4996 which increases to an average of 0.6775 for our 5-factor regression showing that although not improving on the pricing errors, our multifactor models fit the 3x3 portfolios better than the CAPM.

7.3.3 Industry Portfolios

Table 25 to Table 31 in section 10.3.5.3 of the Appendix show the time series regression results for the 23 industry portfolios listed in Table 3.

In the original CAPM, 21 portfolio betas are statistically significant and positive. Both Food (10) and Tobacco (20) only have one firm and do not have statistically significant ERM betas. Out of the 23 portfolios, six have constants that are statistically different from zero. In the FF 3-factor model, six portfolios have constants that are statistically different from zero, indicating no improvement in asset pricing over the CAPM. The Carhart 4-factor model produces seven regressions that have constants that are statistically different from zero, which is slightly worse than the CAPM and FF 3-factor model. Our 5-factor model also yields seven regressions that have constants that are statistically different from zero. Our 5-factor model with HLMLL_ex yields the same output regarding mispricing, with seven significant constants. The modified 3-factor model has six portfolios that have constants that are statistically different from zero, in line with the CAPM and FF 3-factor model. However, the modified 3-factor model with HLMLL_ex worsens on the mispricing by producing seven significant constants. Evidently, neither the addition of a momentum factor nor a leverage factor improves the mispricing of the CAPM and FF 3-factor model. The discrepancy in the number of significant alphas for the models is due to Machinery & Equipment's alpha (11) altering between statistical significance and insignificance at the 5% level.

The GRS test statistics for our industry sorted portfolio regressions are included in Table 25 to Table 31. The tests show that we can clearly reject the null hypothesis that the alphas are jointly zero, providing no support for our models. The R-squares for our 3x3 portfolio regressions vary considerably and are very low for some of the regressions. This can in part relate to the fact that the portfolios are very unbalanced and some of the portfolios have very few firms.

7.3.4 Interpretation

The time series regression results show that none of our three portfolio formation methods give support to Hypothesis 1 that the leverage factor can help to reduce mispricing of asset pricing models. This result is in line with our previous results in section 7.1 where we tested the factors against each other. Further, none of the multifactor models are able to improve on the CAPM.

7.4 Fama-MacBeth Regressions

7.4.1 Results

Table 32 to Table 38 in section 10.3.6.1 of the Appendix present the FM regression results for our asset pricing models based on leverage ranked portfolios. The coefficients in the FM tables represent the risk premium on the relevant factor and can therefore answer Hypothesis 2.

The CAPM does not produce a statistically significant FM regression and the coefficient representing the market risk premium is statistically insignificant. This seems slightly counterintuitive in light of the strongly significant market betas in the time series regressions. However, the average R-square of the regression is only 0.1151. The result is the same for the FF 3-factor model which does not produce a statistically significant FM regression and has no coefficients that are significant. The average R-square is considerably higher than the CAPM at 0.4014. Just as the previous two models, the Carhart 4-factor model does not produce a statistically significant FM regression and none of the coefficients are significant. The average R-square is only slightly higher than the FF 3-factor model at 0.4941.

Our 5-factor model does not produce a statistically significant FM regression and none of the coefficients are significant. The average R-square is 0.5721. Our leverage factor has a p-value of 97.5% implying that we cannot make any statement about the risk premium and thus the effect of leverage on stock returns. Similarly, our modified 5-factor model does not produce a statistically significant FM regression and none of the coefficients are significant. The average R-square is slightly higher at 0.6202 and the p-value for our leverage factor is substantially lower at 27.9%. However, this is not adequate in order to be able to make a statement regarding the risk premium associated with leverage as a stock characteristic.

Our modified 3-factor models using both HLMLL and HLMLL_ex do not produce statistically significant regressions and have no coefficients that are statistically significant and thus do not provide any insight into the leverage risk premium. The respective average R-squares are 0.3705 and 0.3835, both of which are lower than the original FF 3-factor model which we use as a comparison.

7.4.2 Interpretation

Evidently, none of the seven asset pricing models (including two with the modified HLMLL factor) produce statistically significant coefficients (premiums). This implies that we cannot validate Hypothesis 2 and make a statement about the effect of leverage as a stock characteristic on stock returns. We can in fact not make any statement about any of our factors' and characteristics' risk premiums.

8. Conclusion and Discussion

8.1 Results Summary

In order to be able to easily compare the results of our various models in our time series regressions, we have summarized the results in Table 1. Additionally, our cross-section regressions for our leverage ranked portfolios are summarized in Table 2.

Table 1: Summary of Time Series Regressions from section 7.3.

The table shows the number of constants that are statistically different from zero per time series regression model for the different portfolio formations. Also included are the corresponding GRS test statistics and their p-values.

Model		Portfolio Formation	Number of Significant Constants	GRS	p-value
CAPM	(13)	Leverage Ranked Portfolios	5 out of (11)	5.428	1.290e-07
FF 3-factor model	(14)		6 out of (11)	5.429	1.310e-07
Carhart 4-factor model	(15)		5 out of (11)	5.433	1.306e-07
Our 5-factor model	(16)		6 out of (11)	5.408	1.443e-07
Our 5-factor model with HLMLL_ex	(17)		5 out of (11)	5.390	1.545e-07
Modifed 3-factor model	(18)		6 out of (11)	5.426	1.324e-07
Modified 3-factor model with HLMLL_ex	(19)		6 out of (11)	5.424	1.335e-07
CAPM	(13)	3x3 Portfolios	6 out of (9)	6.714	1.754e-08
FF 3-factor model	(14)		6 out of (9)	6.872	1.094e-08
Carhart 4-factor model	(15)		6 out of (9)	6.763	1.555e-08
Our 5-factor model	(16)		6 out of (9)	6.783	1.476e-08
Our 5-factor model with HLMLL_ex	(17)		6 out of (9)	6.690	1.973e-08
Modifed 3-factor model	(18)		6 out of (9)	6.868	1.107e-08
Modified 3-factor model with HLMLL_ex	(19)		6 out of (9)	6.770	1.500e-08
CAPM	(13)	Industry Sorted Portfolios	6 out of (23)	14.329	1.110e-16
FF 3-factor model	(14)		6 out of (23)	14.188	1.110e-16
Carhart 4-factor model	(15)		7 out of (23)	13.680	1.110e-16
Our 5-factor model	(16)		7 out of (23)	17.121	1.110e-16
Our 5-factor model with HLMLL_ex	(17)		7 out of (23)	17.076	1.110e-16
Modifed 3-factor model	(18)		6 out of (23)	17.769	1.110e-16
Modified 3-factor model with HLMLL_ex	(19)		7 out of (23)	17.782	1.110e-16

Table 2: Summary of the FM cross-section regression models from section 7.4.

The table shows the F-statistics, average R-squares and the risk premiums for each model used in the FM cross-section regressions.

Cross Section Regression Model		F	Average R^2	Beta_ERM Risk Premium		Ln(ME) Risk Premium		BE/ME Risk Premium		Beta_PR1YR Premium		Leverage Risk Premium	
				Coef.	p-value	Coef.	p-value	Coef.	p-value	Coef.	p-value	Coef.	p-value
CAPM	(20)	0.3565	0.1151	-1.084985	0.357								
FF 3-factor model	(21)	0.5702	0.4014	-1.454864	0.214	.0700237	0.526	.3236088	0.529				
Carhart 4-factor model	(22)	0.7765	0.4941	-.9236848	0.437	.0312228	0.785	.1827297	0.734	1.781077	0.278		
Our 5-factor model	(23)	0.7997	0.5721	-.9856105	0.405	.0288726	0.816	.3855802	0.500	2.007868	0.288	.0002747	0.975
Our 5-factor model*	(24)	0.1932	0.6202	-1.121742	0.486	-.1669369	0.321	.9036451	0.166	1.947934	0.367	-.012037	0.279
Modifed 3-factor model	(25)	0.4426	0.3705	-1.433142	0.219	.1042161	0.348					-.00305	0.704
Modified 3-factor model*	(26)	0.3503	0.3835	-1.836279	0.151	-.0445537	0.740					-.0094123	0.258

*Excluding zero leverage portfolio

8.2 Conclusion from Results

8.2.1 Hypothesis 1

Our first hypothesis was that capital structure (in the form of leverage) could be an independent variable in a multifactor asset model and that it could explain the variation in stock returns. Since there is no indication that our leverage factor helps reduce the pricing errors present in the time series regressions of the other asset pricing models, we find no support for this hypothesis.

8.2.2 Hypothesis 2

Our second hypothesis was that leverage would have a positive effect on stock returns during our test period due to the higher risk generally associated with a more levered firm. We find no evidence that leverage as a stock characteristic can explain returns in cross-sectional regressions and thus find no support for this hypothesis.

8.2.3 Asset Pricing Models Evaluation

In testing our leverage factor and leverage as a stock characteristic we also test three widely acknowledged asset pricing models; the CAPM, the FF 3-factor model, and the Carhart 4-factor model. The CAPM clearly finds support in the fact that practically all its betas are statistically significant. However, it has a substantial amount of pricing errors and therefore can by no means be categorized as a sufficient model for explaining the stock returns of our data. The FF 3-factor model does not seem to be able to describe the stock returns any better than the CAPM, which is contrary to the original findings on US data (Fama and French (1992)). Similarly, the Carhart 4-factor model does not improve on the pricing errors, which is contrary to the original findings on US data (Carhart (1997)).

The cross-sectional regression results do not provide any information with regards to the relevant risk premiums for the CAPM, the FF 3-factor model, or the Carhart 4-factor model, which is also contrary to previous studies on other datasets.

8.3 Discussion of Results

Our inconclusive results lend to a discussion regarding why we obtain these results and how certain adjustments might yield different conclusions.

8.3.1 Data Issues

The data adjustments (section 5.2) that were made to our raw dataset were designed to improve the quality of our results at the cost of fewer firms in our regressions. In particular, we were concerned that including firms with insufficient and unrealistic data might bias our results without our knowledge. This led to a final dataset of 201 firms from an original of 490. From an ex-ante perspective this made sense, but in retrospect this prudent approach might have led to a dataset with too few firms and one can speculate that a larger dataset might have yielded more significant results.

The test period of 1990 to 2009 that we chose was deliberately quite long in order to increase the likelihood of achieving significant results. Although this is desirable from an econometric perspective, it resulted in the number of firms at the beginning of the test period being considerably lower than at the end of the test period. This implies that both the factors and the portfolios had constituents that were changing on a yearly basis, something which could potentially have affected our results in an adverse manner.

A data issue that was beyond our control was the reliability of some of the data collected from Datastream. Most notably was the high percentage of firms that had zero reported leverage during some of the years in our test period, something which we tried correcting for through our modified leverage factor. Since it is practically impossible to acquire all the relevant annual reports dating back to 1990, we were effectively forced to assume that the Datastream values were correct despite our skepticism to some of the figures. It is especially reasonable to postulate that the Datastream values from some of the earlier years are less reliable and thus less comparable with later years' data. Both of these issues suggest that a test period beginning at a later date might have been more desirable.

8.3.2 Leverage Factor

Our results provide no support for the existence of a leverage factor and in addition to the data issues mentioned, it is natural to ask why this is the case. Some of the following applies to the other factors as well.

8.3.2.1 Survivorship Bias

In order to avoid any potential problems associated with the calculation of true returns for delisted firms, we required that stocks in our dataset were listed as of April 2010. This data limitation lends itself to survivorship bias (section 5.2.3) which most likely had an effect on our leverage factor. Firms that are highly levered are usually regarded as more risky and it is possible that these firms have a higher bankruptcy frequency. This gives support to the supposition that our HLMLL returns are positively skewed. The extent to which this bias might have affected the ability of our HLMLL factor to explain returns is difficult to determine. Furthermore, the exact number of additional firms that would be included in our dataset if we were to include delisted firms is also difficult to calculate as we had many additional requirements imposed on our dataset. For example, determining the extent to which a small firm might be regarded as a Financial might be difficult if it was delisted 15 years ago and lacks readily available information.

8.3.2.2 Market Beta

The knowledge that theory states that the CAPM market beta should be increasing in leverage is relevant in trying to reason why our leverage factor was not able to reduce pricing errors. Section 7.3.1 highlights the fact that when sorting our stock returns by leverage, the time series regressions for the CAPM do not produce a beta that is uniformly increasing with the leverage portfolios. Although far from conclusive, this suggests that our market beta does not subsume the leverage factor.

8.3.2.3 Non-constant Premiums

By running regressions over a single time period, one makes the implicit assumption of constant risk premiums during that time period. It has been observed that risk premiums are not constant over time for possibly both rational and irrational reasons (Cochrane (1999)). Naturally, the risk premiums might change in such a way that they render insignificant results. This might help to explain why none of our leverage factor models performed well as plausibly the perceived importance or unimportance of leverage in Swedish asset pricing did not remain constant during out test period. One need not look further than leveraged buyout booms and subsequent credit crunches to know that history is scattered with changes in perceived risk associated with leverage. Worth noting is that Kidane et al. (2009) find that there is a negative leverage premium on Swedish stocks, although they test on a much smaller dataset. This counterintuitive finding is similar to that of Penman et al. (2007).

8.3.2.4 Irrational Pricing

Empirical research requires the formulation of hypotheses in order to test relevant theories. Since the aim of a study is to give support for the relevant hypotheses, in the process one might forget that the underlying theories do not necessarily have to depict reality. Although theoretical finance says that leverage should be regarded as an economic risk, this does not necessarily imply that the market on aggregate prices leverage as a risk factor. There have been numerous studies that suggest that investors have a tendency to be irrational and one can therefore not rule out the possibility that investors are irrational with regards to pricing leverage. This bears resemblance to the argument of changing premiums but the difference is that this issue cannot be resolved by simply testing for different time periods. Rather, it would require the use of subjective measures pertaining to psychological biases that cannot easily be incorporated into an asset pricing model.

8.3.2.5 Data Mining

The argument that goes against the notion of irrational pricing with regards to leverage as an asset pricing factor is that previous studies in acknowledged journals (section 2.4.2) have found that a leverage factor does indeed exist. While we hold many of these findings in high regard, we cannot categorically state that they must be free from data mining simply due to the credibility of the journals that they were published in. The fact that there has been an academic debate regarding the extent to which the HML factor is a data artifact and not representative of any underlying economic risk (Ferguson and Shockley (2003), Penman et al. (2007)), illustrates that even the most renowned findings are susceptible to data mining issues. Put to the very extreme, data mining could be given as a reason as to why we did not find a significant leverage factor; we were simply not as lucky as the studies we tried to emulate.

8.3.3 Asset Pricing Models Evaluation

While our additional leverage factor did not improve the other asset pricing models it should be acknowledged that these other models did not perform particularly well either. Both the CAPM and the FF 3-factor model have formed the basis for numerous academic studies and are frequently used by finance practitioners to determine the relevant cost of equity, construct indices, and benchmark portfolios.

Despite their prominent role in finance academia, it is important to note that there has been considerable scrutiny of both these models since their inception.

The CAPM has probably received the most criticism, which in some regards is quite natural given that it is based on strong assumptions and has existed since the 1960s. Although initially successful, the CAPM proved not to hold very well in subsequent decades and its decline prompted the search for additional factors that could explain returns. It should therefore not be surprising that our results indicate that although the market beta per se seems to be very significant on the Swedish stock market, the model fails to fully explain returns as evidenced by the pricing errors present in our time series regressions.

The most prominent model since the CAPM has been the FF 3-factor model published in 1992. The model has long been championed within academia and some practitioners, backed by its strong empirical support on US data, have adopted it in place of the CAPM. Despite this success, there have been studies that question the ability of the FF 3-factor model to explain returns. Most notably, there has been considerable evidence that the size effect has diminished in importance since Banz first discovered it in 1981 (van Dijk (2007)). Some papers also suggest that the FF 3-factor model does not perform as well when tested on international data (Malin and Veeraraghavan (2004)). All of these issues imply that our inability to find support for the FF 3-factor model on Swedish data covering a much more recent time period than the original study does not necessarily need to be regarded as a bewildering result. Our FF 3-factor model result is also similar to Emtemark and Liu (2009).

The Carhart 4-factor model which was published in 1997 differs fundamentally from the CAPM and the FF 3-factor model as it incorporates momentum which relates to investor psychology as opposed to underlying economic risk. The momentum effect is well-documented, but so is also the mean-reversal effect which is essentially momentum’s antithesis (Balvers et al. (2000)). While it is true that the momentum effect usually relates to shorter time periods than the mean-reversal effect, the Carhart assumption of a fixed time length for momentum is quite strong. It is possible that there is a momentum effect present in the Swedish stock market but that its length varies with both time and stocks and hence cannot be captured by the momentum factor that we constructed, leading to the observed insignificant results. The fact that the momentum effect is a result of irrational pricing means that there should be no reason to expect that it can be easily captured by an asset pricing model.

8.4 Further Research

Since none of the asset pricing models that were tested on our data performed particularly well, we decided to perform additional tests for different time periods to see if our results were specific to the test period that we had chosen. The indicative results from these tests are that our results seem not to hold over differing time periods. For example, when testing our models from 2000 to 2009, the leverage factor seems to be able to improve on the number of pricing errors present in the other models (see Table 39 in the Appendix). One possible reason for the differing result is that our data from the early 90s are not as reliable and that the relatively low number of firms is not adequate when constructing the factors and portfolios. It should be noted that the GRS tests for all the models during the period 2000 to 2009 still reject the null hypothesis that the alphas are jointly zero. Further tests indicate that the CAPM and FF 3-factor model seem to work relatively well when looking at a much shorter time period (2005 to 2009). The reverse is true for tests on our data dating back to 1995, which yield relatively similar results to the results we received from our original test period. In addition to data reliability issues, the differing results for the different time periods might suggest that risk premiums are not constant over time as discussed in section 8.3.2.3. Our reluctance to adjust our test period after these findings is due to the fact that this would effectively constitute ex-post data mining. Instead, we espouse further research designed to specifically test this aspect of risk premiums over time on Swedish data.

Some previous related studies (section 2.4.2) include additional factors together with a leverage factor. More specifically, Penman et al. (2007) include an operating risk factor and Ferguson and Shockley (2003) include the Altman Z-score as a measure of default risk. While these might have helped to improve our models, they have the drawback that they require accounting data that are not readily available to the extent that would be desired for our test period. This issue can partly be resolved by employing a more recent test period where more data are available and is something which future researchers might want to look into.

As mentioned in section 8.3.2.1, our data is most certainly affected by the survivorship bias. Further research could shed light on the extent to which this affects the leverage factor. Even better would be a general study pertaining to the survivorship bias in Sweden and the extent to which historical stock returns should be adjusted if individual delisted stock information is unavailable.

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10. Appendix

10.1 Formulas

Formula 1: Gibbons, Ross, and Shanken (1989) ("GRS") test statistic

Assuming that the ε are normally distributed and independent and identically distributed the GRS formula is (Sangiorgi (2009)):

$$\frac{T-N-K}{N}(1+\bar{f}'\hat{\Sigma}_f^{-1}\bar{f})^{-1}\,\hat{\alpha}'\,\hat{\Sigma}_\varepsilon^{-1}\hat{\alpha} \sim F_{N,T-N-K}$$

Where

- T is the number of time periods (sample size);
- N is the number of test assets;
- K is the number of factors;
- $\bar{f}$ is the vector of sample means of the factors;
- $\hat{\alpha}$ is the vector of estimated intercepts from the N time series regressions

$$\hat{\alpha} = [\hat{a}_1\ \hat{a}_2\ \cdots\ \hat{a}_N]'\ ;$$

- $\hat{\Sigma}_f$ is the estimated factor covariance matrix

$$\hat{\Sigma}_f = \frac{1}{T}\sum_{t=1}^{T}(f_t-\bar{f})(f_t-\bar{f})'\ ;$$

- $\hat{\Sigma}_\varepsilon$ is the estimated covariance matrix of the residuals in the N time series regressions

$$\hat{\Sigma}_\varepsilon = \frac{1}{T}\sum_{t=1}^{T}\hat{\varepsilon}_t\hat{\varepsilon}_t'\ ,$$

  Where $\hat{\varepsilon}_t$ is the N x 1 vector of residuals for each t, that is

  $\hat{\varepsilon}_t = [\hat{\varepsilon}_t^1\ \hat{\varepsilon}_t^2\ \cdots\ \hat{\varepsilon}_t^N]'\ ,\qquad \hat{\varepsilon}_t^i = R_t^{ei} - (\hat{\alpha}_i + \hat{\beta}_{i,f^1}f_t^1 + \hat{\beta}_{i,f^2}f_t^2 + \ldots)\ ;$

- $\bar{f}'\hat{\Sigma}_f^{-1}\bar{f}$ and $\hat{\alpha}'\hat{\Sigma}^{-1}_\varepsilon\hat{\alpha}$ are quadratic forms, and therefore are numbers.

Formula 2: Fama-MacBeth Procedure

Fama-MacBeth Procedure for a single factor. The multi factor procedure is simply an extension of the formula below (Sangiorgi (2009)):

A, Run time series regression to get β

$R^e_{it} = \alpha_i + \beta_{i,f} f_t + \varepsilon_{it}$ t = 1,2,…T for each i.

B, Instead of estimating a single cross-sectional regression with sample averages, run a cross-sectional regression at each time period

$R^e_{it} = \beta_{i,f}\lambda_t + \alpha_{it}$; i = 1,2,…N For each t.

C, Estimate the λ and α as the average across time

$$\hat{\lambda} = \frac{1}{T}\sum_{t=1}^{T}\hat{\lambda}_t\,; \quad \hat{\alpha} = \frac{1}{T}\sum_{t=1}^{T}\hat{\alpha}_t$$

D, Standard errors: assuming the time series is uncorrelated over time,

$$\sigma^2(\hat{\lambda}) = \frac{1}{T^2}\sum_{t=1}^{T}(\hat{\lambda}_t - \hat{\lambda})^2$$

$$Cov(\hat{\alpha}) = \frac{1}{T^2}\sum_{t=1}^{T}(\hat{\alpha}_t - \hat{\alpha})(\hat{\alpha}_t - \hat{\alpha})'$$

E, Test if all α are jointly zero.

$$\hat{\alpha}'\mathbb{C}\mathrm{ov}(\hat{\alpha})^{-1}\hat{\alpha} \sim \chi^2_{N-1}$$

Formula 3: Effect on beta from a change in capital structure

According to the CAPM, expected return on equity is increasing with equity beta, which in turn increases with leverage, ceteris paribus (Brealey and Myers (2003)):

$$\beta_E = \left[\beta_A - \beta_D\left(\frac{D}{V}\right)\right]\frac{V}{E}$$

Firm Value (V) = Debt Value (D) + Equity Value (E)

Where β_E is the equity (market) beta, β_D is the debt beta, and β_A is the asset beta.

10.2 Figures

Figure 1: The matrix below represents the six portfolios created in section 6.1.

	Median ME	
	Small Value	Big Value
70th BE/ME percentile		
	Small Neutral	Big Neutral
30th BE/ME percentile		
	Small Growth	Big Growth

The firms included in our final data sample are ranked at the end of June each year based on their ME and BE/ME, and then organized into their respective portfolio. The median stock size is used to split the firms into two groups, Small ("S") and Big ("B"). The sample is then split into three groups based on BE/ME, where the bottom percentile is 30% (Low, "L"), the middle percentile is 40% (Neutral, "M"), and the top percentile is 70% (High, "H").

Figure 2: 3x3 matrix, adaption of Fama and French (1993)'s 5x5 matrix.

			BE/ME	
		Low	M	High
	Small	1	2	3
ME	M	4	5	6
	Big	7	8	9

The 3x3 portfolio matrix is based on our SMB and HML rankings. This gives us 9 portfolios that will help us to determine if inclusion of a leverage factor can help to improve pricing errors. The portfolios, 1-9, are S/L, S/M, S/H, M/L, M/M, M/H, B/L, B/M and B/H, where breakpoints are 1/3 and 2/3, based on the ME and BE/ME rankings for each portfolio. (The portfolios are numbered according to the matrix.)

10.3 Tables

10.3.1 Industry Classification

Table 3. Industry list including the number of firms in each industry group.

Industry #	Industry Group	Group Code	# of firms
1	Aerospace	1300	2
2	Apparel	1600	1
3	Automotive	1900	3
4	Chemicals	2500	2
5	Construction	2800	8
6	Diversified	3100	4
7	Drugs, Health care	3400	16
8	Electrical	3700	8
9	Electronics	4000	58
10	Food	4600	1
11	Machinery & Equipment	4900	11
12	Metal producers	5200	3
13	Metal producers manufacturers	5500	7
14	Oil, gas, coal	5800	4
15	Paper	6100	5
16	Printing & publishing	6400	3
17	Recreation	6700	6
18	Retailers	7000	6
19	Textiles	7300	2
20	Tobacco	7600	1
21	Transportation	7900	5
22	Utilities	8200	3
23	Misc	8500	42
		Sum	201

Firms are classified into industry groups according to the Datastream Mnemonic: WC06011. In total, there are 25 industry groups. The industry group Financials (4300) was removed according to our data adjustments described in section 5.2.2. The group Beverages (2200) was also removed because it did not contain any firms.

10.3.2 Average Excess Returns

ERM is the excess return on the market portfolio, known as the market risk premium, based on AFGX and our corresponding proxy for the risk-free rate; Swedish 30-day Treasury Bill middle rate. The Fama and French (1992) factors SMB and HML are constructed by six value weighted portfolios formed on size (ME) and book-to-market (BE/ME). PR1YR is Carhart (1997)'s momentum factor. HLMLL and HLMLL_ex are our leverage factors as defined in section 6.1.

Table 4: Average excess return on each factor portfolio during the entire test period.

Average Excess Returns - Factors (1990/07-2009/06)						
	ERM	**SMB**	**HML**	**PR1YR**	**HLMLL**	**HLMLL_ex**
Simple average (monthly)	0.27%	-0.02%	-0.08%	-0.67%	-0.14%	-0.29%
Simple average (yearly)	3.19%	-0.20%	-0.91%	-8.03%	-1.65%	-3.49%
Geometric average (monthly)	0.05%	-0.20%	-0.35%	-1.27%	-0.39%	-0.52%
Geometric average (yearly)	0.57%	-2.37%	-4.09%	-14.18%	-4.61%	-6.09%
Standard deviation (monthly)	6.60%	5.91%	7.24%	10.32%	7.08%	6.74%
Standard deviation (yearly)	22.86%	20.49%	25.10%	35.75%	24.54%	23.34%
Min return (monthly)	-22.59%	-37.67%	-28.32%	-59.02%	-27.56%	-26.85%
Max return (monthly)	26.45%	18.14%	24.76%	42.15%	22.22%	20.10%

10.3.3 Correlation Matrix

ERM is the excess return on the market portfolio, known as the market risk premium. The Fama and French (1992) factors SMB and HML are constructed by six value weighted portfolios formed on size (ME) and book-to-market (BE/ME). PR1YR is Carhart (1997)'s momentum factor. HLMLL and HLMLL_ex are our leverage factors as defined in section 6.1. All the factors are based on excess returns.

Table 5: Matrix showing the excess return correlations between all factors.

Correlation Matrix - Factors						
	ERM	**SMB**	**HML**	**PR1YR**	**HLMLL**	**HLMLL_ex**
ERM	1.00					
SMB	-0.31	1.00				
HML	-0.27	-0.29	1.00			
PR1YR	-0.19	0.13	-0.09	1.00		
HLMLL	0.19	-0.12	0.22	-0.23	1.00	
HLMLL_ex	0.08	-0.11	0.32	-0.11	0.93	1.00

10.3.4 Testing Models, Regressions

ERM is the excess return on the market portfolio, known as the market risk premium, based on AFGX and the risk-free rate proxy. The Fama and French (1992) factors SMB and HML are constructed by six value weighted portfolios formed on size (ME) and book-to-market (BE/ME). PR1YR is Carhart (1997)'s momentum factor. HLMLL and HLMLL_ex are our leverage factors as defined in section 6.1. All the factors are based on excess returns. α is the regression constant used to evaluate the model being tested.

Table 6: Regression (8) results for CAPM factor on SMB model.

SMB on CAPM						
Number of observations		228				
F(1, 226)		8.02				
Prob > F		0.0051				
R-squared		0.0990				
Root MSE		5.6257				
SMB	**Coef.**	**Robust Std. Err.**	**t-value**	**p-value**	**[95% Conf. Interval]**	
ERM	-.2819558	.0995805	-2.83	0.005	-.4781807	-.0857308
Constant (α)	.0584935	.365021	0.16	0.873	-.6607863	.7777733

Table 7: Regression (9) results for HML factor on CAPM + SMB model.

HML on CAPM + SMB test						
Number of observations		228				
F(2, 225)		19.64				
Prob > F		0.0000				
R-squared		0.2299				
Root MSE		6.3857				
HML	**Coef.**	**Robust Std. Err.**	**t-value**	**p-value**	**[95% Conf. Interval]**	
ERM	-.4395003	.0926979	-4.74	0.000	-.6221673	-.2568333
SMB	-.5124947	.0850507	-6.03	0.000	-.6800926	-.3448968
Constant (α)	.0326397	.4222827	0.08	0.938	-.7994951	.8647746

Table 8: Regression (10) results for PR1YR on FF 3-factor model.

PR1YR on FF 3-factor model test						
Number of observations		228				
F(3, 224)		3.69				
Prob > F		0.0128				
R-squared		0.0573				
Root MSE		10.086				
Pr1yr	**Coef.**	**Robust Std. Err.**	**t-value**	**p-value**	**[95% Conf. Interval]**	
ERM	-.3491035	.1275896	-2.74	0.007	-.6005329	-.0976741
SMB	.0241215	.169083	0.14	0.887	-.3090754	.3573183
HML	-.2109255	.1660005	-1.27	0.205	-.5380479	.1161968
Constant (α)	-.5915639	.6698267	-0.88	0.378	-1.911532	.728404

Table 9: Regression (11) results for HLMLL on Carhart 4-factor model.

HLMLL on Carhart 4-factor model test						
Number of observations		228				
F(4, 223)		5.53				
Prob > F		0.0003				
R-squared		0.1437				
Root MSE		6.6139				
HLMLL	**Coef.**	**Robust Std. Err.**	**t-value**	**p-value**	**[95% Conf. Interval]**	
ERM	.2760827	.0874877	3.16	0.002	.1036742	.4484912
SMB	.0841027	.1007192	0.84	0.405	-.1143805	.2825859
HML	.2914315	.0847444	3.44	0.001	.1244292	.4584339
PR1YR	-.1123399	.0557799	-2.01	0.045	-.2222632	-.0024167
Constant (α)	-.2626833	.4377113	-0.60	0.549	-1.125263	.5998964

Table 10: Regression (12) results for HLMLL_ex on Carhart 4-factor model.

HLMLL_ex on Carhart 4-factor model test						
Number of observations	228					
F(4, 223)	5.65					
Prob > F	0.0002					
R-squared	0.1371					
Root MSE	6.316					
HLMLL_ex	**Coef.**	**Robust Std. Err.**	**t-value**	**p-value**	**[95% Conf. Interval]**	
ERM	.2051928	.0852125	2.41	0.017	.0372681	.3731176
SMB	.0851604	.0936939	0.91	0.364	-.0994783	.2697992
HML	.361411	.0827649	4.37	0.000	.1983097	.5245124
PR1YR	-.0316081	.0465313	-0.68	0.498	-.1233054	.0600892
Constant (α)	-.3379095	.4176926	-0.81	0.419	-1.161039	.4852202

10.3.5 Time Series Regressions

Our 201 firms are formed into portfolios depending on their leverage ranking, their SMB and HML characteristics, or their industry classification. ERit is the monthly stock returns in excess of our proxy for the risk-free rate for portfolio i in month t. The constant (α) is the risk-adjusted abnormal return, known as the pricing error. ERM is the excess return on the market portfolio, known as the market risk premium. The Fama and French (1992) factors SMB and HML are constructed by six value weighted portfolios formed on size (ME) and book-to-market (BE/ME). PR1YR is Carhart (1997)'s momentum factor. HLMLL and HLMLL_ex are our leverage factors as defined in section 6.1. All the factors are based on excess returns. GRS test statistics are included for all the regressions.

10.3.5.1 Leverage Ranked Portfolios

Stocks with leverage are ranked into 10 deciles portfolios (1 being the lowest and 10 the highest). One additional portfolio (Zero) is created, containing the stocks that have zero leverage. Portfolios are rebalanced at the end of June each year.

Table 11: CAPM (Leverage Ranked)

Time series regression on the model from equation (13) based on 11 portfolios ranked by leverage.

Leverage Ranked Portfolios: CAPM

			Beta_ERM			Constant (α)		
Portfolio	**F**	**R-square**	**Coef**	**t-value**	**p-value**	**Coef**	**t-value**	**p-value**
Zero	54.47	0.2678	.8096731	7.38	0.000	.5106746	0.88	0.380
1	85.12	0.3239	.8087093	9.23	0.000	2.286062	4.49	0.000
2	172.61	0.5107	.9381888	13.14	0.000	.1734463	0.43	0.666
3	97.06	0.5029	1.212369	9.85	0.000	1.551669	3.02	0.003
4	185.53	0.5112	.9378995	13.62	0.000	1.457514	3.66	0.000
5	233.87	0.6777	1.212817	15.29	0.000	-.256433	-0.70	0.487
6	111.83	0.4769	.8477914	10.57	0.000	.6109818	1.60	0.112
7	125.95	0.5280	1.047795	11.22	0.000	.8332616	1.96	0.051
8	99.00	0.4752	.9276909	9.95	0.000	1.075842	2.53	0.012
9	146.76	0.5588	.9822624	12.11	0.000	.4632671	1.22	0.222
10	205.59	0.5780	.9563775	14.34	0.000	1.014138	2.85	0.005

Shaded area: significant values [5%]

GRS test statistic	5.4280235
p-value	1.290e-07

Table 12: FF 3-factor Model (Leverage Ranked)

Time series regression on the model from equation (14) based on 11 portfolios ranked by leverage.

Leverage Ranked Portfolios: FF 3-factor model

			Beta_ERM			Beta_SMB			Beta_HML			Constant (α)		
Portfolio	**F**	**R-square**	**Coef**	**t-value**	**p-value**	**Coef**	**t-value**	**p-value**	**Coef**	**t-value**	**p-value**	**Coef**	**t-value**	**p-value**
Zero	30.50	0.3545	.9757091	9.11	0.000	.556456	4.72	0.000	.0309831	0.27	0.788	.4780431	0.87	0.385
1	43.35	0.3360	.8820883	11.11	0.000	.2010798	1.72	0.086	.0565538	0.70	0.488	2.27415	4.48	0.000
2	72.94	0.5214	.994551	13.95	0.000	.1703004	2.00	0.046	.0282884	0.33	0.740	.1634096	0.41	0.684
3	51.80	0.5088	1.185266	9.98	0.000	.0247945	0.22	0.827	-.1155721	-1.08	0.282	1.550526	3.02	0.003
4	66.79	0.5390	.8310616	12.02	0.000	-.142248	-1.62	0.106	-.2262046	-2.99	0.003	1.466437	3.76	0.000
5	108.43	0.6796	1.185185	17.79	0.000	-.0820131	-1.09	0.278	-.0152824	-0.21	0.837	-.2515951	-0.68	0.497
6	80.09	0.5095	.9437557	14.80	0.000	.1001625	0.90	0.370	.2295697	3.32	0.001	.6045118	1.62	0.107
7	56.51	0.5429	1.08921	11.57	0.000	-.0196986	-0.23	0.820	.1592187	1.66	0.099	.8339899	1.98	0.048
8	50.16	0.5340	1.012687	11.80	0.000	-.0157903	-0.14	0.886	.3032164	3.41	0.001	1.075958	2.66	0.008
9	65.28	0.6109	1.104026	13.54	0.000	.1094129	1.03	0.302	.308183	4.34	0.000	.4560468	1.27	0.204
10	78.12	0.6101	1.07787	15.02	0.000	.2836535	4.19	0.000	.1407296	1.91	0.057	.9971717	2.91	0.004

Shaded area: significant values [5%]

GRS test statistic	5.4292087
p-value	1.310e-07

Table 13: Carhart 4-factor Model (Leverage Ranked)

Time series regression on the model from equation (15) based on 11 portfolios ranked by leverage.

Leverage Ranked Portfolios: Carhart 4-factor

			Beta_ERM			Beta_SMB			Beta_HML			Beta_PR1YR			Constant (α)		
Portfolio	**F**	**R-square**	**Coef**	**t-value**	**p-value**	**Coef**	**t-value**	**p-value**	**Coef**	**t-value**	**p-value**	**Coef**	**t-value**	**p-value**	**Coef**	**t-value**	**p-value**
Zero	27.58	0.3582	.9540245	8.61	0.000	.5579543	4.71	0.000	.0178815	0.16	0.876	-.0621149	-1.26	0.208	.4412981	0.80	0.423
1	32.55	0.3419	.9072751	11.03	0.000	.1993395	1.75	0.081	.0717715	0.89	0.375	.0721473	1.59	0.113	2.31683	4.59	0.000
2	56.38	0.5323	1.026101	14.57	0.000	.1681205	2.05	0.042	.0473507	0.60	0.550	.0903746	2.24	0.026	.2168719	0.54	0.587
3	36.51	0.5118	1.206815	9.64	0.000	.0233055	0.20	0.842	-.1025524	-1.01	0.314	.0617265	1.22	0.222	1.587041	3.04	0.003
4	55.91	0.5534	.8672105	11.64	0.000	-.1447458	-1.60	0.112	-.2043637	-2.82	0.005	.1035477	2.05	0.041	1.527692	4.00	0.000
5	95.29	0.6949	1.143388	17.80	0.000	-.0791251	-1.11	0.270	-.040536	-0.49	0.626	-.1197275	-1.51	0.132	-.3224216	-0.90	0.368
6	60.10	0.5096	.9471495	14.99	0.000	.099928	0.90	0.369	.2316202	3.37	0.001	.0097213	0.24	0.813	.6102626	1.63	0.104
7	42.79	0.5753	1.029501	11.24	0.000	-.015573	-0.18	0.861	.1231427	1.35	0.178	-.1710367	-2.30	0.023	.7328108	1.83	0.068
8	40.18	0.5375	.994332	12.11	0.000	-.014522	-0.14	0.892	.2921262	3.40	0.001	-.0525787	-0.87	0.383	1.044855	2.57	0.011
9	51.83	0.6133	1.089066	14.01	0.000	.1104465	1.01	0.312	.2991447	4.32	0.000	-.0428508	-0.96	0.339	.4306978	1.22	0.224
10	59.96	0.6118	1.065752	15.24	0.000	.2844908	4.32	0.000	.1334077	1.83	0.069	-.0347132	-0.71	0.480	.9766367	2.90	0.004

Shaded area: significant values [5%]

GRS test statistic	5.4327155
p-value	1.306e-07

Table 14: Our 5-factor Model (Leverage Ranked)

Time series regression on the model from equation (16) based on 11 portfolios ranked by leverage.

Leverage Ranked Portfolios: Carhart 4-factor + Leverage Factor (Our 5-factor model)

			Beta_ERM			Beta_SMB			Beta_HML			Beta_PR1YR			Beta_HLMLL			Constant (α)		
Portfolio	**F**	**R-square**	**Coef**	**t-value**	**p-value**	**Coef**	**t-value**	**p-value**	**Coef**	**t-value**	**p-value**	**Coef**	**t-value**	**p-value**	**Coef**	**t-value**	**p-value**	**Coef**	**t-value**	**p-value**
Zero	22.65	0.3592	.9681545	8.45	0.000	.5622587	4.75	0.000	.032797	0.29	0.776	-.0678645	-1.45	0.148	-.0511803	-0.55	0.583	.4278539	0.78	0.437
1	29.78	0.4083	1.009057	11.40	0.000	.2303451	1.96	0.052	.1792117	2.25	0.025	.0307316	0.63	0.531	-.3686634	-3.79	0.000	2.219988	4.64	0.000
2	46.67	0.5493	1.073732	15.09	0.000	.1826303	2.26	0.025	.0976301	1.35	0.177	.0709931	1.75	0.081	-.1725254	-2.34	0.020	.1715524	0.44	0.663
3	29.42	0.5118	1.206765	9.89	0.000	.0232905	0.20	0.839	-.1026046	-0.96	0.339	.0617466	1.15	0.250	.0001788	0.00	0.999	1.587088	3.04	0.003
4	45.67	0.5535	.8710951	11.45	0.000	-.1435624	-1.55	0.122	-.2002631	-2.63	0.009	.101967	1.95	0.052	-.0140705	-0.21	0.831	1.523996	3.99	0.000
5	76.92	0.6970	1.162243	17.23	0.000	-.0733814	-1.04	0.300	-.0206327	-0.24	0.810	-.1273997	-1.65	0.099	-.0682947	-1.20	0.230	-.3403615	-0.95	0.345
6	49.07	0.5105	.9572364	14.18	0.000	.1030008	0.92	0.357	.242268	3.30	0.001	.0056169	0.13	0.896	-.0365361	-0.57	0.566	.6006651	1.60	0.111
7	36.06	0.6055	.9599154	10.68	0.000	-.0367706	-0.42	0.674	.0496889	0.53	0.600	-.142722	-2.18	0.030	.2520447	3.46	0.001	.7990187	2.04	0.043
8	39.46	0.5650	.9323292	11.13	0.000	-.0334098	-0.31	0.754	.2266764	2.86	0.005	-.0273493	-0.45	0.651	.2245804	2.59	0.010	1.103848	2.82	0.005
9	53.67	0.6545	1.01492	13.32	0.000	.0878594	0.90	0.368	.2208764	3.37	0.001	-.0126802	-0.28	0.777	.2685652	4.12	0.000	.5012454	1.51	0.132
10	52.15	0.6220	1.030508	15.19	0.000	.2737545	4.00	0.000	.0962042	1.27	0.207	-.0203721	-0.41	0.685	.1276577	2.21	0.028	1.01017	3.03	0.003

Shaded area: significant values [5%]

GRS test statistic	5.4082792
p-value	1.443e-07

Table 15: Our 5-factor Model, Excluding Zero Leverage Portfolio (Leverage Ranked)

Time series regression on the model from equation (17) based on 11 portfolios ranked by leverage.

Leverage Ranked Portfolios: Carhart 4-factor + Leverage Factor* (Our 5-factor model with HLMLL_ex)

			Beta_ERM			Beta_SMB			Beta_HML			Beta_PR1YR			Beta_HLMLL_ex			Constant (α)		
Portfolio	**F**	**R-square**	**Coef**	**t-value**	**p-value**	**Coef**	**t-value**	**p-value**	**Coef**	**t-value**	**p-value**	**Coef**	**t-value**	**p-value**	**Coef**	**t-value**	**p-value**	**Coef**	**t-value**	**p-value**
Zero	23.22	0.3600	.968686	8.55	0.000	.5640392	4.79	0.000	.0437051	0.37	0.710	-.0643734	-1.33	0.184	-.0714521	-0.68	0.494	.4171538	0.76	0.449
1	33.16	0.4292	.9981215	11.89	0.000	.2370432	2.07	0.040	.2317814	2.94	0.004	.0581532	1.35	0.178	-.4427365	-4.63	0.000	2.167225	4.59	0.000
2	46.57	0.5483	1.061983	15.08	0.000	.1830123	2.30	0.022	.11055	1.54	0.125	.0848473	2.16	0.032	-.1748682	-2.18	0.030	.1577823	0.40	0.691
3	29.46	0.5132	1.193329	10.02	0.000	.0177086	0.16	0.876	-.1263052	-1.10	0.273	.0638038	1.25	0.212	.0657223	0.51	0.608	1.609249	3.07	0.002
4	45.86	0.5534	.8669049	11.47	0.000	-.1448726	-1.56	0.121	-.204902	-2.58	0.010	.1035948	2.04	0.043	.0014894	0.02	0.983	1.528196	4.00	0.000
5	76.15	0.6955	1.135484	17.46	0.000	-.0824054	-1.16	0.248	-.0544569	-0.66	0.513	-.11851	-1.49	0.137	.0385183	0.72	0.473	-.3094058	-0.86	0.390
6	48.57	0.5097	.9502903	14.44	0.000	.1012315	0.91	0.365	.2371523	3.14	0.002	.0092375	0.22	0.823	-.0153068	-0.23	0.816	.6050902	1.61	0.109
7	34.26	0.5785	1.011999	11.03	0.000	-.0228368	-0.25	0.800	.092316	1.01	0.316	-.1683407	-2.23	0.027	.0852953	1.20	0.231	.7616329	1.91	0.058
8	42.26	0.5808	.933795	11.80	0.000	-.0396464	-0.38	0.702	.185501	2.46	0.015	-.0432535	-0.78	0.435	.2950247	3.33	0.001	1.144546	2.95	0.003
9	55.51	0.6654	1.024203	14.05	0.000	.0835263	0.85	0.395	.1848985	2.93	0.004	-.0328591	-0.81	0.420	.3161117	5.01	0.000	.537515	1.64	0.102
10	54.10	0.6282	1.030888	15.76	0.000	.2700215	4.00	0.000	.0720016	0.97	0.333	-.0293428	-0.62	0.533	.1699065	2.64	0.009	1.03405	3.10	0.002

*Leverage factor HLMLL excluding zero leverage firms; HLMLL_ex

Shaded area: significant values [5%]

GRS test statistic	5.3896238
p-value	1.545e-07

Table 16: Modified 3-factor Model (Leverage Ranked)

Time series regression on the model from equation (18) based on 11 portfolios ranked by leverage.

Leverage Ranked Portfolios: Modified 3-Factor (HLMLL instead of HML)

			Beta_ERM			Beta_SMB			Beta_HLMLL			Constant (α)		
Portfolio	F	R-square	Coef	t-value	p-value	Coef	t-value	p-value	Coef	t-value	p-value	Coef	t-value	p-value
Zero	30.03	0.3544	.9661383	9.24	0.000	.538744	4.35	0.000	-.0228861	-0.24	0.813	.4747989	0.87	0.387
1	46.53	0.3943	.9156223	11.57	0.000	.1456405	1.33	0.186	-.3302524	-3.51	0.001	2.214588	4.58	0.000
2	67.59	0.5389	1.011697	14.03	0.000	.1424009	1.80	0.074	-.1672982	-2.18	0.030	.1332252	0.34	0.736
3	43.78	0.5054	1.243975	8.34	0.000	.080438	0.58	0.559	-.0447709	-0.45	0.653	1.538429	3.02	0.003
4	65.26	0.5174	.9475287	12.11	0.000	-.0340447	-0.43	0.666	-.0964357	-1.62	0.107	1.441123	3.64	0.000
5	85.57	0.6802	1.198422	15.00	0.000	-.0771351	-1.08	0.280	-.0368764	-0.70	0.487	-.2589508	-0.70	0.487
6	54.22	0.4775	.8383007	11.61	0.000	-.0154251	-0.14	0.891	.025786	0.44	0.660	.6167996	1.60	0.110
7	52.41	0.5816	.9650508	10.98	0.000	-.0767476	-1.00	0.318	.3064583	4.08	0.000	.8961701	2.21	0.028
8	48.63	0.5392	.8277397	10.04	0.000	-.1477694	-1.42	0.158	.2923261	3.15	0.002	1.140211	2.84	0.005
9	74.13	0.6299	.9101398	12.98	0.000	-.0220508	-0.24	0.807	.3305352	4.95	0.000	.527566	1.52	0.130
10	78.20	0.6161	.9879176	15.01	0.000	.2242632	3.26	0.001	.1589459	2.80	0.005	1.03132	3.01	0.003

Shaded area: significant values [5%]

GRS test statistic	5.4263725
p-value	1.324e-07

Table 17: Modified 3-factor Model, Excluding Zero Leverage Portfolio (Leverage Ranked)

Time series regression on the model from equation (19) based on 11 portfolios ranked by leverage.

Leverage Ranked Portfolios: Modified 3-Factor (HLMLL_ex* instead of HML)

			Beta_ERM			Beta_SMB			Beta_HLMLL_ex			Constant (α)		
Portfolio	F	R-square	Coef	t-value	p-value	Coef	t-value	p-value	Coef	t-value	p-value	Coef	t-value	p-value
Zero	30.09	0.3551	.9646979	9.48	0.000	.5355892	4.30	0.000	-.0478526	-0.46	0.647	.4643542	0.85	0.398
1	50.39	0.4056	.8775946	11.83	0.000	.1331204	1.24	0.215	-.3739057	-3.93	0.000	2.161133	4.51	0.000
2	66.35	0.5344	.9902917	14.07	0.000	.1401574	1.78	0.076	-.1500898	-1.79	0.075	.1182257	0.30	0.767
3	43.14	0.5047	1.235256	8.36	0.000	.0855623	0.61	0.540	.0147522	0.13	0.896	1.551286	3.04	0.003
4	65.08	0.5154	.934901	12.18	0.000	-.0347848	-0.44	0.661	-.0812105	-1.29	0.198	1.434106	3.61	0.000
5	92.14	0.6802	1.18988	15.13	0.000	-.0703109	-0.97	0.334	.0371271	0.70	0.484	-.2406886	-0.65	0.518
6	54.97	0.4797	.8394723	12.06	0.000	-.0110066	-0.10	0.922	.0622047	1.03	0.306	.631114	1.64	0.102
7	49.02	0.5412	1.011625	10.29	0.000	-.0867344	-1.11	0.270	.1397064	1.91	0.057	.8821042	2.10	0.037
8	56.45	0.5616	.8596683	11.11	0.000	-.1333718	-1.29	0.199	.3627705	3.93	0.000	1.197297	3.05	0.003
9	79.65	0.6468	.9477662	13.98	0.000	-.0086896	-0.10	0.924	.382192	5.81	0.000	.5835141	1.72	0.088
10	83.02	0.6239	1.005239	15.58	0.000	.2321669	3.39	0.001	.1979715	3.23	0.001	1.062581	3.12	0.002

*Leverage factor HLMLL excluding zero leverage firms; HLMLL_ex

Shaded area: significant values [5%]

GRS test statistic	5.4239659
p-value	1.335e-07

10.3.5.2 3x3 Portfolios

Stocks are grouped into 3x3 (9) portfolios based on their SMB and HML rankings according to Figure 2. Portfolios are rebalanced at the end of June each year. The portfolios, 1-9, are S/L, S/M, S/H, M/L, M/M, M/H, B/L, B/M and B/H, where breakpoints are 1/3 and 2/3, based on the ME and BE/ME rankings for each portfolio.

Table 18: CAPM (3x3)

Time series regression on the model from equation (13) based on 9 portfolios ranked by SMB and HML.

3x3 Portfolios: CAPM

			Beta_ERM			Constant (α)		
Portfolio	**F**	**R-square**	**Coef**	**t-value**	**p-value**	**Coef**	**t-value**	**p-value**
1	30.85	0.2374	.6783073	5.55	0.000	1.101978	2.12	0.035
2	73.39	0.3560	.7865596	8.57	0.000	1.43093	3.14	0.002
3	76.54	0.2726	.5837821	8.75	0.000	1.463361	3.50	0.001
4	221.92	0.5624	1.058867	14.90	0.000	.5214554	1.28	0.203
5	156.46	0.5760	.9641863	12.51	0.000	.4896083	1.36	0.174
6	131.33	0.4684	.9006374	11.46	0.000	.6114208	1.46	0.146
7	529.28	0.7817	1.22375	23.01	0.000	.9360456	3.30	0.001
8	250.11	0.6701	.9926948	15.81	0.000	.7386311	2.45	0.015
9	173.60	0.5716	.8883778	13.18	0.000	1.152843	3.47	0.001

Shaded area: significant values [5%]

GRS test statistic	6.7136139
p-value	1.754e-08

Table 19: FF 3-factor Model (3x3)

Time series regression on the model from equation (14) based on 9 portfolios ranked by SMB and HML.

3x3 Portfolios: FF 3-factor model

			Beta_ERM			Beta_SMB			Beta_HML			Constant (α)		
Portfolio	F	R-square	Coef	t-value	p-value	Coef	t-value	p-value	Coef	t-value	p-value	Coef	t-value	p-value
1	42.82	0.4974	.8553306	9.88	0.000	.7584253	8.18	0.000	-.1248108	-1.26	0.209	1.057948	2.45	0.015
2	67.14	0.5622	1.038903	13.76	0.000	.7557262	9.27	0.000	.1330907	1.72	0.086	1.386371	3.67	0.000
3	113.09	0.6074	.9415604	17.37	0.000	.7922663	10.56	0.000	.4555745	8.75	0.000	1.415805	4.61	0.000
4	104.26	0.6784	1.228864	16.73	0.000	.5771535	5.02	0.000	.0246276	0.37	0.713	.4876301	1.40	0.162
5	125.55	0.7320	1.193969	17.66	0.000	.6439459	9.90	0.000	.1634534	2.90	0.004	.4515065	1.57	0.117
6	72.21	0.6313	1.199173	14.25	0.000	.5665081	7.49	0.000	.470528	6.06	0.000	.5770311	1.65	0.100
7	524.44	0.8834	1.015331	27.66	0.000	-.2601755	-5.01	0.000	-.4578345	-13.88	0.000	.952483	4.59	0.000
8	203.11	0.7498	1.049338	21.21	0.000	-.0963448	-1.80	0.074	.2840976	5.12	0.000	.7435103	2.81	0.005
9	102.12	0.6686	1.01529	17.09	0.000	.0681267	0.83	0.407	.3650984	6.29	0.000	1.147886	3.92	0.000

Shaded area: significant values [5%]

GRS test statistic	6.8715174
p-value	1.094e-08

Table 20: Carhart 4-factor Model (3x3)

Time series regression on the model from equation (15) based on 9 portfolios ranked by SMB and HML.

3x3 Portfolios: Carhart 4-factor

			Beta_ERM			Beta_SMB			Beta_HML			Beta_PR1YR			Constant (α)		
Portfolio	F	R-square	Coef	t-value	p-value	Coef	t-value	p-value	Coef	t-value	p-value	Coef	t-value	p-value	Coef	t-value	p-value
1	33.67	0.5073	.8872961	10.56	0.000	.7562166	8.30	0.000	-.1054975	-1.13	0.260	.0915646	1.42	0.158	1.112114	2.60	0.010
2	53.31	0.5656	1.021138	14.04	0.000	.7569537	9.28	0.000	.1223573	1.61	0.109	-.050887	-1.27	0.206	1.356268	3.63	0.000
3	87.17	0.6110	.9260671	17.31	0.000	.7933368	10.72	0.000	.4462136	8.58	0.000	-.0443801	-1.60	0.111	1.389552	4.55	0.000
4	79.71	0.6803	1.214661	17.33	0.000	.5781349	5.19	0.000	.0160465	0.25	0.806	-.0406831	-0.95	0.344	.4635635	1.35	0.179
5	97.53	0.7366	1.174191	17.40	0.000	.6453125	10.15	0.000	.1515038	2.67	0.008	-.0566531	-1.83	0.068	.4179926	1.45	0.149
6	58.16	0.6376	1.175144	14.83	0.000	.5681684	7.92	0.000	.45601	6.21	0.000	-.0688303	-1.76	0.080	.5363136	1.55	0.123
7	389.92	0.8835	1.016908	27.37	0.000	-.2602845	-4.97	0.000	-.4568817	-14.03	0.000	.0045173	0.20	0.845	.9551552	4.60	0.000
8	171.24	0.7540	1.031311	19.86	0.000	-.0950993	-1.82	0.070	.2732058	5.03	0.000	-.0516382	-1.85	0.065	.712963	2.70	0.007
9	79.90	0.6710	1.00218	17.61	0.000	.0690325	0.82	0.413	.3571773	6.12	0.000	-.0375541	-1.00	0.320	1.12567	3.90	0.000

Shaded area: significant values [5%]

GRS test statistic	6.7625839
p-value	1.555e-08

Table 21: Our 5-factor Model (3x3)

Time series regression on the model from equation (16) based on 9 portfolios ranked by SMB and HML.

3x3 Portfolios: Carhart 4-factor + Leverage Factor (Our 5-factor model)

			Beta_ERM			Beta_SMB			Beta_HML			Beta_PR1YR			Beta_HLMLL			Constant (α)		
Portfolio	F	R-square	Coef	t-value	p-value	Coef	t-value	p-value	Coef	t-value	p-value	Coef	t-value	p-value	Coef	t-value	p-value	Coef	t-value	p-value
1	27.59	0.5093	.8702573	10.17	0.000	.7510261	8.14	0.000	-.1234836	-1.41	0.159	.0984978	1.55	0.122	.0617164	0.64	0.523	1.128326	2.63	0.009
2	44.95	0.5736	1.053781	13.80	0.000	.7668978	9.45	0.000	.1568153	2.07	0.040	-.0641697	-1.59	0.114	-.1182369	-1.62	0.106	1.325209	3.57	0.000
3	73.50	0.6241	.9616978	17.74	0.000	.8041909	11.17	0.000	.4838251	9.08	0.000	-.0588785	-2.15	0.033	-.1290579	-2.48	0.014	1.35565	4.52	0.000
4	66.02	0.6833	1.236257	15.79	0.000	.5847137	5.36	0.000	.0388434	0.59	0.554	-.0494708	-1.10	0.271	-.0782237	-1.09	0.278	.4430154	1.31	0.190
5	83.57	0.7419	1.148579	17.21	0.000	.6375101	9.93	0.000	.1244674	2.12	0.035	-.0462312	-1.60	0.112	.0927712	1.89	0.060	.442362	1.55	0.123
6	47.31	0.6418	1.151358	15.03	0.000	.5609226	7.77	0.000	.4309017	6.21	0.000	-.0591516	-1.54	0.125	.0861548	1.28	0.203	.5589451	1.64	0.102
7	339.73	0.8947	1.057594	26.98	0.000	-.2478905	-5.28	0.000	-.4139342	-12.01	0.000	-.0120379	-0.54	0.590	-.1473672	-4.21	0.000	.9164443	4.63	0.000
8	132.87	0.7572	1.012228	19.60	0.000	-.1009127	-1.95	0.052	.2530611	4.42	0.000	-.0438729	-1.53	0.128	.0691233	1.67	0.096	.7311205	2.78	0.006
9	63.12	0.6715	.9945626	17.25	0.000	.066712	0.80	0.427	.3491363	5.73	0.000	-.0344544	-0.90	0.371	.0275915	0.55	0.581	1.132918	3.90	0.000

Shaded area: significant values [5%]

GRS test statistic	6.7829189
p-value	1.476e-08

Table 22: Our 5-factor Model, Excluding Zero Leverage Portfolio (3x3)

Time series regression on the model from equation (17) based on 9 portfolios ranked by SMB and HML.

3x3 Portfolios: Carhart 4-factor + Leverage Factor* (Our 5-factor modell with HLMLL_ex)

			Beta_ERM			Beta_SMB			Beta_HML			Beta_PR1YR			Beta_HLMLL_ex			Constant (α)		
Portfolio	F	R-square	Coef	t-value	p-value	Coef	t-value	p-value	Coef	t-value	p-value	Coef	t-value	p-value	Coef	t-value	p-value	Coef	t-value	p-value
1	26.85	0.5073	.8862294	10.58	0.000	.7557739	8.22	0.000	-.1073762	-1.21	0.226	.0917289	1.42	0.157	.0051983	0.05	0.959	1.113871	2.59	0.010
2	45.49	0.5755	1.04953	14.18	0.000	.7687373	9.50	0.000	.1723654	2.23	0.027	-.0552606	-1.37	0.171	-.1383691	-1.86	0.064	1.309512	3.53	0.001
3	77.42	0.6300	.9594376	18.01	0.000	.8071864	11.38	0.000	.5049898	9.13	0.000	-.0495205	-1.83	0.069	-.1626297	-2.98	0.003	1.334598	4.50	0.000
4	64.01	0.6845	1.234624	16.47	0.000	.5864198	5.35	0.000	.0512067	0.77	0.445	-.0437581	-1.00	0.319	-.0972859	-1.32	0.188	.4306896	1.29	0.200
5	84.13	0.7414	1.155219	17.37	0.000	.6374386	9.89	0.000	.1180879	1.94	0.054	-.0537306	-1.79	0.074	.0924596	1.68	0.094	.4492356	1.57	0.119
6	48.97	0.6495	1.144171	15.25	0.000	.5553137	7.80	0.000	.4014562	5.80	0.000	-.0640591	-1.72	0.087	.1509465	1.99	0.047	.5873199	1.74	0.083
7	330.12	0.8939	1.047414	27.21	0.000	-.2476235	-5.19	0.000	-.40315	-11.33	0.000	-.000182	-0.01	0.993	-.1486719	-4.00	0.000	.9049176	4.56	0.000
8	136.34	0.7588	1.013034	19.76	0.000	-.1026849	-1.99	0.048	.2410132	4.16	0.000	-.0488227	-1.79	0.074	.089075	2.03	0.043	.7430623	2.82	0.005
9	63.07	0.6735	.989272	17.59	0.000	.0636754	0.76	0.449	.3344421	5.18	0.000	-.0355657	-0.96	0.339	.0629069	1.03	0.302	1.146927	3.92	0.000

*Leverage factor HLMLL excluding zero leverage firms; HLMLL_ex

Shaded area: significant values [5%]

GRS test statistic	6.6898006
p-value	1.973e-08

Table 23: Modified 3-factor Model (3x3)

Time series regression on the model from equation (18) based on 9 portfolios ranked by SMB and HML.

3x3 Portfolios: Modified 3-factor (HLMLL instead of HML)

			Beta_ERM			Beta_SMB			Beta_HLMLL			Constant (α)		
Portfolio	**F**	**R-square**	**Coef**	**t-value**	**p-value**	**Coef**	**t-value**	**p-value**	**Coef**	**t-value**	**p-value**	**Coef**	**t-value**	**p-value**
1	41.42	0.4899	.9100751	9.63	0.000	.8224399	8.91	0.000	.0006212	0.01	0.995	1.053989	2.43	0.016
2	56.06	0.5549	.9907128	12.28	0.000	.6828495	7.87	0.000	-.0582769	-0.79	0.431	1.379879	3.63	0.000
3	48.54	0.4535	.7385619	11.66	0.000	.5600434	6.68	0.000	.0156862	0.29	0.773	1.433592	3.98	0.000
4	106.07	0.6797	1.227526	15.90	0.000	.5602337	4.97	0.000	-.0536561	-0.78	0.438	.4784571	1.40	0.164
5	130.14	0.7299	1.097555	19.65	0.000	.5713121	9.57	0.000	.1390021	2.92	0.004	.4826878	1.67	0.096
6	48.88	0.5428	.9540082	11.94	0.000	.3427491	4.35	0.000	.2170087	2.43	0.016	.63274	1.64	0.103
7	217.27	0.8190	1.261306	24.65	0.000	-.0458166	-1.02	0.310	-.2531431	-6.53	0.000	.8904696	3.43	0.001
8	152.14	0.7155	.898202	15.64	0.000	-.2300382	-4.12	0.000	.1486145	3.51	0.001	.7804168	2.77	0.006
9	57.35	0.5925	.8318952	11.66	0.000	-.108593	-1.33	0.186	.1297167	2.43	0.016	1.183922	3.63	0.000

Shaded area: significant values [5%]

GRS test statistic	6.8677606
p-value	1.107e-08

Table 24: Modified 3-factor Model, Excluding Zero Leverage Portfolio (3x3)

Time series regression on the model from equation (19) based on 9 portfolios ranked by SMB and HML.

3x3 Portfolios: Modified 3-Factor (HLMLL_ex* instead of HML)

			Beta_ERM			Beta_SMB			Beta_HLMLL_ex			Constant (α)		
Portfolio	**F**	**R-square**	**Coef**	**t-value**	**p-value**	**Coef**	**t-value**	**p-value**	**Coef**	**t-value**	**p-value**	**Coef**	**t-value**	**p-value**
1	39.84	0.4909	.9125494	9.99	0.000	.8178643	8.87	0.000	-.0434177	-0.39	0.697	1.040536	2.40	0.017
2	55.76	0.5559	.9844007	12.73	0.000	.6798776	7.86	0.000	-.073296	-0.96	0.338	1.368199	3.59	0.000
3	48.32	0.4534	.7406721	11.77	0.000	.5600561	6.71	0.000	.0121765	0.21	0.832	1.434416	3.99	0.000
4	103.35	0.6809	1.222075	16.64	0.000	.5568079	4.96	0.000	-.0740995	-1.03	0.303	.4656708	1.37	0.171
5	129.59	0.7290	1.114547	19.60	0.000	.5746953	9.56	0.000	.1392788	2.68	0.008	.4996276	1.72	0.087
6	53.27	0.5638	.9763986	12.59	0.000	.3559485	4.49	0.000	.2933945	3.19	0.002	.6825191	1.82	0.071
7	237.21	0.8248	1.23194	25.02	0.000	-.0549988	-1.18	0.239	-.2826266	-7.38	0.000	.8507172	3.33	0.001
8	164.58	0.7205	.91489	16.55	0.000	-.2235915	-4.04	0.000	.1760545	4.09	0.000	.8068666	2.89	0.004
9	57.84	0.6029	.845078	12.19	0.000	-.1003183	-1.21	0.226	.1790671	3.01	0.003	1.214811	3.76	0.000

*Leverage factor HLMLL excluding zero leverage firms; HLMLL_ex

Shaded area: significant values [5%]

GRS test statistic	6.7704717
p-value	1.500e-08

10.3.5.3 Industry Sorted Portfolios

We form our stocks into 23 industry portfolios based on the industry classification from Datastream (DS Mnemonic: WC06011). The portfolio allocation can be seen in Table 3.

Table 25: CAPM (Industry Sorted)

Time series regression on the model from equation (13) based on 23 industry portfolios.

Industry Portfolios: CAPM

			Beta_ERM			Constant (α)		
Portfolio	F	R-square	Coef	t-value	p-value	Coef	t-value	p-value
1	22.78	0.1378	.7600394	4.77	0.000	.839271	0.80	0.422
2	5.77	0.1643	1.267651	2.40	0.020	6.400367	2.75	0.008
3	144.72	0.5412	1.073777	12.03	0.000	.6630225	1.55	0.123
4	58.14	0.2895	.9711353	7.62	0.000	.7346895	1.10	0.273
5	90.31	0.4877	1.073982	9.50	0.000	.3037575	0.64	0.522
6	58.96	0.3687	1.039299	7.68	0.000	.3160899	0.54	0.587
7	102.91	0.4020	.8378028	10.14	0.000	.7836596	1.71	0.088
8	103.24	0.4342	.9595843	10.16	0.000	.6511368	1.36	0.174
9	135.31	0.5680	1.734806	11.63	0.000	.7359243	1.13	0.261
10	3.58	0.0226	.1518783	1.89	0.061	1.560098	2.68	0.008
11	164.33	0.5505	.9183433	12.82	0.000	.6477123	1.80	0.073
12	123.23	0.4003	1.025782	11.10	0.000	.9192878	1.68	0.094
13	213.90	0.5660	1.005299	14.63	0.000	.4320566	1.12	0.262
14	8.27	0.0872	.8288152	2.88	0.005	4.052112	2.65	0.009
15	80.83	0.4483	.8442823	8.99	0.000	.295818	0.73	0.466
16	14.66	0.2024	1.029637	3.83	0.000	.3136579	0.36	0.717
17	44.73	0.1812	.5981877	6.69	0.000	1.156447	2.08	0.038
18	70.10	0.2925	.6817256	8.37	0.000	1.912006	4.13	0.000
19	12.80	0.1115	.3902806	3.58	0.000	.4932851	1.04	0.299
20	0.15	0.0013	.0319469	0.38	0.702	1.235123	2.63	0.009
21	67.05	0.2773	.8995274	8.19	0.000	-.5482077	-0.87	0.386
22	52.64	0.3817	1.007672	7.26	0.000	.9566925	1.48	0.140
23	54.42	0.3549	.7169316	7.38	0.000	.5651927	1.35	0.179

Shaded area: significant values [5%]

GRS test statistic	14.328827
p-value	1.110e-16

Table 26: FF 3-factor Model (Industry Sorted)

Time series regression on the model from equation (14) based on 23 industry portfolios.

Industry Portfolios: FF 3-factor model

			Beta_ERM			Beta_SMB			Beta_HML			Constant (α)		
Portfolio	**F**	**R-square**	**Coef**	**t-value**	**p-value**	**Coef**	**t-value**	**p-value**	**Coef**	**t-value**	**p-value**	**Coef**	**t-value**	**p-value**
1	9.87	0.2187	1.11648	5.24	0.000	.1974401	0.98	0.331	.6281286	3.46	0.001	.7002971	0.71	0.482
2	2.85	0.2126	1.282501	2.42	0.019	.507892	0.95	0.349	.9281531	1.64	0.106	6.330887	2.76	0.008
3	100.86	0.6438	1.167885	14.91	0.000	-.0916837	-1.09	0.277	.4066424	5.45	0.000	.6673029	1.75	0.082
4	32.26	0.3577	1.082742	9.71	0.000	.4952225	4.01	0.000	-.0949967	-0.87	0.387	.7059751	1.11	0.268
5	47.20	0.5416	1.16634	11.81	0.000	-.0188884	-0.14	0.885	.3311334	4.18	0.000	.3039809	0.67	0.503
6	25.45	0.4569	1.253171	8.01	0.000	.2091651	1.65	0.100	.5250743	3.73	0.000	.3024573	0.56	0.575
7	61.14	0.4683	1.00678	13.32	0.000	.3785993	3.76	0.000	.2794451	3.47	0.001	.6377713	1.50	0.135
8	48.58	0.4673	.9834347	10.39	0.000	-.1195568	-1.40	0.162	.1951193	2.07	0.040	.6576107	1.41	0.160
9	66.35	0.6791	1.412349	13.11	0.000	-.314364	-2.11	0.036	-.7926138	-6.27	0.000	.7564226	1.34	0.180
10	1.58	0.0315	.2136866	2.14	0.035	.0967261	0.94	0.349	.0998103	1.04	0.299	1.506695	2.58	0.011
11	66.02	0.5971	.9434082	14.07	0.000	-.1182484	-1.27	0.206	.1979857	3.10	0.002	.654102	1.91	0.057
12	80.91	0.4853	1.186368	13.21	0.000	.0783343	0.83	0.409	.4694905	4.64	0.000	.9134559	1.80	0.074
13	74.79	0.5930	1.048031	13.64	0.000	-.0465397	-0.56	0.577	.1893373	2.80	0.006	.4342748	1.16	0.247
14	5.11	0.1052	1.068324	3.91	0.000	.4686445	1.37	0.173	.3375821	0.91	0.367	3.809724	2.36	0.020
15	58.51	0.5553	.8592423	12.08	0.000	-.2329852	-2.81	0.005	.2733954	3.83	0.000	.3087183	0.84	0.401
16	16.74	0.2641	1.340264	5.03	0.000	.706841	5.12	0.000	.3773861	2.58	0.010	.2713076	0.33	0.744
17	18.78	0.2361	.7652157	6.76	0.000	.424389	3.15	0.002	.1605732	1.69	0.092	1.131195	2.10	0.036
18	30.04	0.2961	.6557381	8.50	0.000	-.0129273	-0.12	0.907	-.0757376	-0.98	0.329	1.912964	4.12	0.000
19	18.75	0.2167	.5788031	6.35	0.000	.4892226	4.10	0.000	.1714693	2.34	0.020	.4642122	1.03	0.305
20	2.06	0.0509	.1490202	1.70	0.092	.0796069	0.73	0.464	.2041959	2.42	0.017	1.211703	2.65	0.009
21	30.60	0.3617	1.151676	9.57	0.000	.3638682	2.82	0.005	.5069628	4.64	0.000	-.5708412	-0.95	0.341
22	21.13	0.4310	.7950847	6.52	0.000	-.1471151	-1.16	0.247	-.3702981	-3.03	0.003	.999869	1.59	0.113
23	49.75	0.4189	.7895372	11.08	0.000	.3205918	3.34	0.001	-.0602953	-0.85	0.395	.5466007	1.35	0.177

Shaded area: significant values [5%]

GRS test statistic	14.187866
p-value	1.110e-16

Table 27: Carhart 4-factor Model (Industry Sorted)

Time series regression on the model from equation (15) based on 23 industry portfolios.

Industry Portfolios: Carhart 4-factor

			Beta_ERM			Beta_SMB			Beta_HML			Beta_PR1YR			Constant (α)		
Portfolio	**F**	**R-square**	**Coef**	**t-value**	**p-value**	**Coef**	**t-value**	**p-value**	**Coef**	**t-value**	**p-value**	**Coef**	**t-value**	**p-value**	**Coef**	**t-value**	**p-value**
1	7.63	0.2196	1.126245	5.33	0.000	.2020007	0.99	0.324	.6317033	3.54	0.001	.0385904	0.52	0.606	.6934925	0.69	0.490
2	5.87	0.3861	1.104398	2.81	0.007	1.200917	2.16	0.035	.6573432	1.17	0.246	1.780429	3.68	0.001	6.46027	3.20	0.002
3	75.42	0.6438	1.167042	14.61	0.000	-.0916255	-1.09	0.278	.4061329	5.51	0.000	-.0024151	-0.05	0.957	.6658742	1.75	0.082
4	24.23	0.3578	1.084099	9.61	0.000	.4951287	3.99	0.000	-.0941766	-0.87	0.388	.0038879	0.05	0.960	.708275	1.11	0.267
5	37.97	0.5505	1.132915	11.75	0.000	-.0165789	-0.13	0.893	.3109381	3.65	0.000	-.095746	-1.52	0.130	.247341	0.55	0.582
6	20.21	0.4593	1.233843	8.34	0.000	.2105006	1.63	0.104	.5133965	3.80	0.000	-.0553645	-0.73	0.465	.2697056	0.51	0.611
7	48.47	0.4851	.978409	13.05	0.000	.3762671	3.94	0.000	.2631113	3.29	0.001	-.1059156	-2.48	0.014	.5996976	1.42	0.158
8	36.34	0.4680	.9746253	10.04	0.000	-.1189481	-1.39	0.166	.1897968	2.05	0.042	-.0252341	-0.42	0.676	.6426831	1.37	0.172
9	97.18	0.7255	1.298323	13.70	0.000	-.3064853	-2.40	0.017	-.8615076	-6.89	0.000	-.3266259	-2.55	0.011	.5632025	1.13	0.261
10	2.35	0.0570	.2367056	2.36	0.020	.1060519	1.03	0.305	.1036579	1.12	0.267	.0978963	2.47	0.015	1.506468	2.60	0.011
11	54.46	0.6044	.9676841	14.61	0.000	-.1199257	-1.38	0.169	.2126531	3.40	0.001	.0695379	1.96	0.052	.6952381	2.05	0.041
12	60.83	0.4864	1.19845	12.53	0.000	.0774995	0.82	0.416	.47679	4.67	0.000	.034607	0.77	0.442	.9339282	1.83	0.069
13	56.77	0.5951	1.062227	13.74	0.000	-.0475206	-0.57	0.567	.1979147	2.96	0.003	.0406656	1.02	0.309	.4583311	1.21	0.226
14	4.16	0.1152	1.105741	4.02	0.000	.4831119	1.41	0.161	.3431717	0.93	0.353	.165584	1.34	0.181	3.811854	2.37	0.020
15	43.71	0.5556	.8642647	11.90	0.000	-.2333322	-2.79	0.006	.2764299	3.81	0.000	.0143866	0.32	0.750	.3172289	0.86	0.393
16	12.54	0.2649	1.325266	4.90	0.000	.7078773	5.06	0.000	.3683246	2.57	0.011	-.0429608	-0.51	0.609	.2458936	0.30	0.765
17	15.07	0.2390	.782479	6.93	0.000	.4231962	3.07	0.002	.1710036	1.74	0.083	.0494505	0.79	0.430	1.160448	2.19	0.030
18	22.29	0.2979	.6678964	8.51	0.000	-.0137674	-0.13	0.900	-.0683917	-0.90	0.368	.0348271	0.80	0.427	1.933567	4.20	0.000
19	15.84	0.2362	.616371	6.84	0.000	.4866268	4.39	0.000	.1941675	2.75	0.006	.1076125	2.62	0.009	.5278719	1.18	0.241
20	2.67	0.0835	.1746696	2.04	0.043	.0886174	0.83	0.407	.2145017	2.59	0.010	.1017848	2.02	0.045	1.197051	2.65	0.009
21	23.54	0.3658	1.126384	9.42	0.000	.3656158	2.93	0.004	.4916815	4.42	0.000	-.072449	-1.16	0.246	-.6136994	-1.03	0.306
22	16.58	0.4362	.7765448	6.20	0.000	-.153628	-1.25	0.212	-.3777473	-3.16	0.002	-.073572	-1.08	0.281	1.01046	1.61	0.109
23	37.76	0.4224	.8059639	11.44	0.000	.3194568	3.44	0.001	-.0503705	-0.73	0.468	.0470538	1.06	0.290	.574436	1.44	0.152

Shaded area: significant values [5%]

GRS test statistic	13.679819
p-value	1.110e-16

Table 28: Our 5-factor Model (Industry Sorted)

Time series regression on the model from equation (16) based on 23 industry portfolios.

Industry Portfolios: Carhart 4-factor + Leverage Factor (Our 5-factor model)

			Beta_ERM			Beta_SMB			Beta_HML			Beta_PR1YR			Beta_HLMLL			Constant (α)		
Portfolio	F	R-square	Coef	t-value	p-value	Coef	t-value	p-value	Coef	t-value	p-value	Coef	t-value	p-value	Coef	t-value	p-value	Coef	t-value	p-value
1	6.23	0.2198	1.113188	5.41	0.000	.2028427	0.99	0.326	.6225697	3.54	0.001	.0414068	0.56	0.577	.0296482	0.26	0.799	.691465	0.69	0.491
2	5.16	0.3919	1.237896	2.71	0.009	1.143242	2.10	0.041	.7885946	1.31	0.196	1.754664	3.65	0.001	-.362565	-0.74	0.465	6.2912	3.23	0.002
3	60.43	0.6445	1.156163	14.27	0.000	-.0949396	-1.12	0.264	.3946488	5.17	0.000	.0020117	0.04	0.965	.0394059	0.59	0.555	.6762255	1.77	0.078
4	21.90	0.3631	1.047406	8.63	0.000	.4839508	3.80	0.000	-.1329102	-1.13	0.261	.0188188	0.24	0.809	.1329081	1.08	0.281	.7431877	1.17	0.242
5	30.19	0.5507	1.126771	11.53	0.000	-.0184506	-0.15	0.882	.3044523	3.46	0.001	-.0932459	-1.45	0.148	.022255	0.30	0.766	.253187	0.57	0.572
6	18.15	0.4996	1.138332	8.34	0.000	.1814054	1.59	0.113	.4125761	3.32	0.001	-.0165006	-0.24	0.808	.3459487	3.58	0.000	.3605806	0.70	0.486
7	40.44	0.4873	.9571444	11.79	0.000	.3753265	3.86	0.000	.2474553	2.95	0.004	-.0988092	-2.23	0.027	.0648504	0.76	0.451	.6142427	1.45	0.148
8	32.52	0.4988	.9035768	9.52	0.000	-.1405915	-1.73	0.085	.1147983	1.18	0.239	.003676	0.06	0.953	.257345	3.06	0.002	.7102833	1.55	0.123
9	82.16	0.7255	1.298563	13.21	0.000	-.3064121	-2.35	0.020	-.861254	-6.25	0.000	-.3267236	-2.65	0.009	-.0008701	-0.01	0.993	.5629739	1.12	0.266
10	2.56	0.0781	.306584	2.77	0.006	.1008945	0.97	0.332	.1561192	1.58	0.117	.0827132	2.11	0.037	-.1548048	-2.03	0.045	1.497244	2.59	0.011
11	43.40	0.6047	.9618638	14.36	0.000	-.1216988	-1.41	0.159	.2065091	3.23	0.001	.0719063	2.01	0.045	.0210819	0.41	0.682	.700776	2.05	0.041
12	46.50	0.4884	1.178062	12.26	0.000	.0712887	0.75	0.456	.4552684	4.24	0.000	.0429031	0.96	0.341	.0738479	1.08	0.283	.9533268	1.86	0.064
13	46.78	0.6033	1.028643	13.80	0.000	-.0577514	-0.71	0.478	.1624632	2.57	0.011	.0543313	1.39	0.165	.1216461	1.90	0.058	.4902855	1.32	0.188
14	3.99	0.1236	1.225439	4.38	0.000	.4768552	1.42	0.159	.4329901	1.09	0.279	.1391258	1.08	0.282	-.2645585	-1.12	0.267	3.799317	2.35	0.020
15	35.77	0.5558	.8687872	11.25	0.000	-.2319545	-2.76	0.006	.2812038	3.64	0.000	.0125464	0.27	0.789	-.0163809	-0.25	0.801	.3129259	0.84	0.404
16	10.23	0.2690	1.284601	4.81	0.000	.6954897	5.09	0.000	.3253993	2.27	0.024	-.0264141	-0.33	0.745	.1472912	1.33	0.186	.2845845	0.34	0.731
17	12.32	0.2428	.8067594	6.90	0.000	.4305927	3.20	0.002	.1966339	1.94	0.054	.0395706	0.62	0.537	-.0879461	-1.02	0.307	1.137346	2.15	0.032
18	24.96	0.4594	.8086968	9.42	0.000	.0291244	0.25	0.805	.0802366	1.11	0.269	-.0224655	-0.45	0.652	-.5099937	-5.86	0.000	1.7996	4.47	0.000
19	12.94	0.2429	.6429848	6.71	0.000	.4947341	4.46	0.000	.2222608	3.20	0.002	.0967832	2.34	0.020	-.0963978	-1.13	0.261	.5025498	1.13	0.262
20	2.17	0.0848	.162723	1.94	0.054	.088969	0.83	0.406	.2056737	2.52	0.013	.1049156	2.09	0.038	.0331724	0.43	0.670	1.20273	2.67	0.009
21	19.00	0.3658	1.123869	9.42	0.000	.3648498	2.92	0.004	.4890274	4.32	0.000	-.0714259	-1.14	0.256	.0091071	0.11	0.914	-.6113072	-1.02	0.310
22	13.58	0.4364	.7666069	5.56	0.000	-.1533355	-1.25	0.213	-.3850908	-3.04	0.003	-.0709676	-1.04	0.301	.0275948	0.26	0.798	1.015183	1.61	0.109
23	30.66	0.4312	.7746115	10.23	0.000	.309906	3.40	0.001	-.0834659	-1.11	0.270	.0598113	1.36	0.174	.1135616	1.71	0.088	.6042668	1.51	0.133

Shaded area: significant values [5%]

GRS test statistic	17.121118
p-value	1.110e-16

Table 29: Our 5-factor Model, Excluding Zero Leverage Portfolio (Industry Sorted)

Time series regression on the model from equation (17) based on 23 industry portfolios.

Industry Portfolios: Carhart 4-factor + Leverage Factor* (Our 5-factor modell with HLMLL_ex)

			Beta_ERM			Beta_SMB			Beta_HML			Beta_PR1YR			Beta_HLMLL_ex			Constant (α)		
Portfolio	**F**	**R-square**	**Coef**	**t-value**	**p-value**	**Coef**	**t-value**	**p-value**	**Coef**	**t-value**	**p-value**	**Coef**	**t-value**	**p-value**	**Coef**	**t-value**	**p-value**	**Coef**	**t-value**	**p-value**
1	6.12	0.2237	1.079188	5.35	0.000	.2021464	0.98	0.331	.5750836	3.29	0.001	.0342301	0.45	0.652	.1493112	1.02	0.311	.7399697	0.72	0.472
2	5.23	0.3984	1.273532	2.95	0.005	1.12367	2.07	0.044	.8509155	1.39	0.171	1.740618	3.61	0.001	-.524713	-1.06	0.295	6.256304	3.22	0.002
3	60.75	0.6444	1.159145	14.43	0.000	-.0949029	-1.12	0.264	.392224	5.05	0.000	-.0011987	-0.03	0.979	.0384851	0.53	0.596	.6788787	1.77	0.078
4	21.26	0.3594	1.068064	8.95	0.000	.4884738	3.85	0.000	-.1224195	-1.01	0.312	.0063579	0.08	0.935	.0781461	0.63	0.527	.7346813	1.16	0.247
5	30.34	0.5535	1.114534	11.71	0.000	-.0242073	-0.19	0.846	.2785643	3.14	0.002	-.0929147	-1.48	0.140	.0895761	1.09	0.278	.2776096	0.62	0.535
6	18.53	0.5135	1.147663	8.73	0.000	.1747337	1.58	0.116	.361606	3.05	0.003	-.0420893	-0.65	0.518	.419994	3.72	0.000	.4116256	0.79	0.428
7	40.46	0.4861	.9676901	12.20	0.000	.3744681	3.87	0.000	.2491214	2.86	0.005	-.1053408	-2.47	0.014	.0451202	0.53	0.595	.6166616	1.45	0.148
8	35.87	0.5196	.9030409	9.74	0.000	-.1486575	-1.85	0.066	.0637133	0.68	0.497	-.0142072	-0.26	0.797	.3488644	4.24	0.000	.7605677	1.68	0.094
9	80.64	0.7357	1.34859	14.45	0.000	-.2856232	-2.39	0.017	-.7729714	-6.54	0.000	-.334369	-2.68	0.008	-.2449736	-2.65	0.009	.4804236	0.98	0.329
10	2.42	0.0774	.2908042	2.69	0.008	.1043943	1.00	0.319	.1727061	1.65	0.101	.102287	2.56	0.012	-.168162	-1.85	0.067	1.428169	2.47	0.015
11	43.42	0.6065	.9551823	14.47	0.000	-.1251143	-1.46	0.146	.1906333	2.92	0.004	.0714637	2.04	0.043	.0609271	1.03	0.303	.715826	2.09	0.038
12	46.18	0.4906	1.175628	12.26	0.000	.068028	0.72	0.473	.4365943	3.94	0.000	.0381225	0.84	0.402	.111219	1.46	0.145	.9715102	1.89	0.060
13	47.83	0.6076	1.02993	13.88	0.000	-.0609247	-0.75	0.453	.1410293	2.28	0.023	.0456406	1.21	0.228	.157398	2.22	0.027	.5115174	1.38	0.169
14	3.66	0.1193	1.16852	4.20	0.000	.4819477	1.41	0.162	.4248754	1.03	0.306	.170562	1.39	0.168	-.202632	-0.69	0.492	3.726303	2.25	0.026
15	34.88	0.5559	.8598659	11.34	0.000	-.2351578	-2.77	0.006	.2686822	3.37	0.001	.0150642	0.33	0.740	.0214374	0.31	0.756	.3244728	0.87	0.386
16	10.25	0.2676	1.299593	4.93	0.000	.6972222	5.05	0.000	.3231057	2.23	0.027	-.0390061	-0.46	0.645	.1251177	1.03	0.306	.288172	0.35	0.729
17	12.29	0.2423	.8000653	6.97	0.000	.430495	3.17	0.002	.2019788	2.00	0.047	.0467414	0.75	0.452	-.0857063	-0.94	0.351	1.131487	2.14	0.033
18	27.29	0.4746	.7825175	9.55	0.000	.0338034	0.30	0.764	.1334933	1.83	0.069	.0171708	0.39	0.694	-.5586021	-6.22	0.000	1.74481	4.39	0.000
19	12.89	0.2430	.6372031	6.84	0.000	.4952727	4.46	0.000	.2308596	3.16	0.002	.1044035	2.57	0.011	-.1015247	-1.12	0.262	.4935657	1.11	0.270
20	2.29	0.0889	.1562718	1.88	0.063	.0868026	0.82	0.413	.189912	2.30	0.023	.099859	2.00	0.047	.0742372	0.86	0.392	1.231692	2.74	0.007
21	19.37	0.3660	1.131199	9.50	0.000	.3676143	2.95	0.003	.500163	4.28	0.000	-.0731908	-1.18	0.240	-.0234678	-0.26	0.798	-.6216294	-1.03	0.303
22	14.23	0.4392	.7514828	5.73	0.000	-.1561001	-1.29	0.200	-.411244	-3.21	0.002	-.0761953	-1.12	0.266	.1011279	0.88	0.379	1.057648	1.67	0.096
23	30.11	0.4231	.7989831	10.82	0.000	.3165596	3.41	0.001	-.0626658	-0.80	0.422	.0481291	1.08	0.279	.0340203	0.49	0.627	.5859318	1.45	0.149

*Leverage factor HLMLL excluding zero leverage firms; HLMLL_ex

Shaded area: significant values [5%]

GRS test statistic	17.076239
p-value	1.110e-16

Table 30: Modified 3-factor Model (Industry Sorted)

Time series regression on the model from equation (18) based on 23 industry portfolios.

Industry Portfolios: Modified 3-factor (HLMLL instead of HML)

			Beta_ERM			Beta_SMB			Beta_HLMLL			Constant (α)		
Portfolio	**F**	**R-square**	**Coef**	**t-value**	**p-value**	**Coef**	**t-value**	**p-value**	**Coef**	**t-value**	**p-value**	**Coef**	**t-value**	**p-value**
1	8.35	0.1481	.6968975	4.75	0.000	-.1022981	-0.48	0.633	.1796176	1.35	0.178	.8313052	0.79	0.429
2	2.01	0.1703	1.373344	2.18	0.034	.304766	0.58	0.564	-.1309944	-0.26	0.794	6.106658	2.66	0.010
3	73.47	0.5824	.9638844	11.67	0.000	-.2886309	-3.78	0.000	.1429925	2.11	0.036	.7071638	1.71	0.088
4	31.68	0.3581	1.10816	8.56	0.000	.5513082	4.45	0.000	.0923806	0.81	0.418	.7200518	1.13	0.259
5	38.65	0.5064	.9978936	10.16	0.000	-.1782107	-1.33	0.184	.1295977	1.74	0.084	.3388865	0.72	0.471
6	23.41	0.4495	.9411377	7.53	0.000	-.0231131	-0.25	0.803	.459624	3.84	0.000	.4050587	0.73	0.464
7	47.60	0.4377	.8307753	10.32	0.000	.2469273	2.53	0.012	.1621773	1.90	0.059	.7219092	1.64	0.102
8	49.84	0.4935	.8470111	8.67	0.000	-.1965968	-2.42	0.016	.2865827	3.63	0.000	.7172669	1.57	0.117
9	69.13	0.5728	1.784334	12.84	0.000	.0811392	0.72	0.473	-.1336598	-0.98	0.329	.705699	1.07	0.285
10	2.63	0.0422	.1938946	2.36	0.020	.0202367	0.21	0.836	-.1358542	-1.81	0.073	1.574263	2.71	0.008
11	49.70	0.5755	.8467075	11.62	0.000	-.2153264	-2.33	0.021	.0547837	1.01	0.314	.6707507	1.90	0.058
12	57.44	0.4214	.9479191	9.79	0.000	-.1477293	-1.69	0.092	.1816028	2.68	0.008	.9625475	1.79	0.075
13	79.71	0.5881	.9385075	15.34	0.000	-.1316534	-1.79	0.075	.1488074	2.10	0.037	.4681242	1.25	0.213
14	3.31	0.0987	.9078829	2.94	0.004	.2616399	0.72	0.475	-.1921304	-0.88	0.382	4.07462	2.67	0.009
15	46.29	0.5137	.7294998	9.36	0.000	-.3687559	-4.44	0.000	.0542132	0.90	0.369	.3277223	0.85	0.397
16	13.98	0.2511	1.131824	4.49	0.000	.5327246	4.00	0.000	.2408244	2.05	0.041	.3284047	0.39	0.698
17	18.18	0.2253	.7030408	7.09	0.000	.3382914	2.69	0.008	-.0474942	-0.57	0.566	1.127605	2.09	0.038
18	40.89	0.4550	.7742992	10.21	0.000	-.0127494	-0.12	0.907	-.4823144	-5.66	0.000	1.82081	4.46	0.000
19	16.85	0.2002	.5150647	5.85	0.000	.3960795	3.51	0.001	-.0657366	-0.83	0.410	.4575858	1.01	0.316
20	0.24	0.0068	.0151073	0.18	0.856	-.0308111	-0.31	0.756	.0577411	0.71	0.481	1.253488	2.67	0.008
21	22.56	0.2895	.9007796	7.89	0.000	.116778	0.87	0.383	.1588551	1.78	0.076	-.5247564	-0.83	0.405
22	17.48	0.3838	1.026121	7.05	0.000	.0619178	0.47	0.638	-.0511132	-0.47	0.639	.9315542	1.44	0.153
23	46.26	0.4208	.8029141	10.51	0.000	.3574387	3.71	0.000	.0742235	1.19	0.235	.5584339	1.38	0.169

Shaded area: significant values [5%]

GRS test statistic	17.769491
p-value	1.110e-16

Table 31: Modified 3-factor Model, Excluding Zero Leverage Portfolio (Industry Sorted)

Time series regression on the model from equation (19) based on 23 industry portfolios

Industry Portfolios: Modified 3-factor (HLMLL_ex* instead of HML)

			Beta_ERM			Beta_SMB			Beta_HLMLL_ex			Constant (α)		
Portfolio	F	R-square	Coef	t-value	p-value	Coef	t-value	p-value	Coef	t-value	p-value	Coef	t-value	p-value
1	9.22	0.1669	.7162484	5.05	0.000	-.0631839	-0.30	0.764	.3547202	2.24	0.026	.9303483	0.88	0.381
2	2.00	0.1734	1.415621	2.30	0.025	.2792554	0.53	0.600	-.2770762	-0.59	0.556	6.051975	2.66	0.010
3	76.12	0.5855	.9799624	12.01	0.000	-.2824688	-3.68	0.000	.1690034	2.33	0.021	.732493	1.78	0.077
4	31.76	0.3556	1.122502	8.92	0.000	.5477194	4.47	0.000	.0365656	0.33	0.745	.7141073	1.12	0.263
5	39.91	0.5151	1.010174	10.59	0.000	-.1682396	-1.26	0.209	.1952509	2.44	0.016	.3747695	0.81	0.421
6	25.51	0.4742	.9926614	8.12	0.000	-.003007	-0.03	0.974	.5461013	4.20	0.000	.4873564	0.89	0.376
7	45.67	0.4331	.8556478	10.87	0.000	.245351	2.50	0.013	.1425525	1.62	0.106	.7442768	1.69	0.093
8	58.05	0.5177	.8774194	9.32	0.000	-.1807728	-2.25	0.025	.3720413	4.86	0.000	.7782694	1.74	0.083
9	51.63	0.6092	1.785466	12.44	0.000	.0444462	0.43	0.669	-.4547214	-4.22	0.000	.5908626	0.96	0.337
10	1.78	0.0319	.1640085	1.99	0.049	.0256391	0.26	0.794	-.0973492	-1.10	0.272	1.533607	2.64	0.009
11	51.88	0.5821	.850174	11.98	0.000	-.2078101	-2.29	0.023	.1142066	1.93	0.054	.6956482	1.98	0.049
12	60.16	0.4322	.9663616	10.28	0.000	-.1361192	-1.58	0.115	.2509398	3.51	0.001	1.005868	1.88	0.061
13	81.85	0.5969	.9540437	15.59	0.000	-.122952	-1.68	0.095	.1978328	2.67	0.008	.5012284	1.35	0.178
14	2.89	0.0939	.8598488	2.79	0.006	.2893481	0.78	0.436	-.0401395	-0.15	0.882	4.032779	2.63	0.010
15	47.48	0.5193	.7331705	9.70	0.000	-.3617777	-4.35	0.000	.108606	1.73	0.086	.3510053	0.91	0.362
16	13.32	0.2499	1.161442	4.60	0.000	.5382413	4.02	0.000	.2379954	1.86	0.064	.356737	0.42	0.676
17	18.10	0.2243	.6960144	7.10	0.000	.3394722	2.69	0.008	-.0251711	-0.28	0.778	1.128704	2.10	0.037
18	45.33	0.4654	.7171604	10.16	0.000	-.0279687	-0.27	0.789	-.5166584	-5.70	0.000	1.751776	4.34	0.000
19	16.73	0.1979	.5055945	5.91	0.000	.3972259	3.53	0.001	-.0395202	-0.47	0.636	.4576685	1.00	0.317
20	0.94	0.0253	.0211607	0.26	0.792	-.015671	-0.16	0.874	.1441295	1.59	0.113	1.304339	2.81	0.006
21	22.02	0.2882	.9205298	8.04	0.000	.1200086	0.90	0.370	.1530711	1.61	0.109	-.507271	-0.80	0.423
22	18.14	0.3835	1.016928	7.18	0.000	.0626719	0.47	0.637	-.0446985	-0.39	0.695	.9204067	1.42	0.159
23	45.48	0.4166	.815688	10.88	0.000	.352161	3.60	0.000	.0064095	0.10	0.920	.5466017	1.34	0.181

*Leverage factor HLMLL excluding zero leverage firms; HLMLL_ex

Shaded area: significant values [5%]

GRS test statistic	17.78182
p-value	1.110e-16

10.3.6 Fama-MacBeth (1973) ("FM") Regressions

Our 201 firms are formed into portfolios depending on their leverage. ERit is the monthly stock return in excess of the risk-free rate for portfolio i in month t. Beta_ERM is the market beta received from the time series regression (13). ln(ME) is the natural logarithm of the average portfolio size. BE/ME is the average portfolio book-to-market ratio. Beta_PR1YR is the momentum beta obtained from a time series regression with the ERM and PR1YRt factors. Lev is the average portfolio leverage (as defined in section 5.1, equation (5)). "Coef." are the average premiums for each respective beta or stock characteristic over the T periods.

10.3.6.1 Leverage Ranked Portfolios

Stocks with leverage are ranked into 10 deciles portfolios (1 being the lowest and 10 the highest). One additional portfolio (Zero) is created, containing the stocks that have zero leverage. Portfolios are rebalanced at the end of June each year.

Table 32: FM regression, CAPM (Leverage Ranked)

FM cross-section results corresponding to equation (20).

Fama-MacBeth (1973): CAPM (Leverage Ranked)						
Number of observations		2508				
Number of time periods		228				
F (1, 227)		0.85				
Prob > F		0.3565				
Average R-square		0.1151				
Variable	**Coef.**	**Fama-MacBeth Std. Err.**	**t-value**	**p-value**	**[95 % Conf. Interval]**	
Beta_ERM	-1.084985	1.174367	-0.92	0.357	-3.39904	1.22907
Constant	2.195347	1.102865	1.99	0.048	.0221855	4.368509

Table 33: FM regression, FF 3-factor Model (Leverage Ranked)

FM cross-section results corresponding to equation (21).

Fama-MacBeth (1973): FF 3-factor model (Leverage Ranked)						
Number of observations		2508				
Number of time periods		228				
F (3, 227)		0.67				
Prob > F		0.5702				
Average R-square		0.4014				
Variable	**Coef.**	**Fama-MacBeth Std. Err.**	**t-value**	**p-value**	**[95 % Conf. Interval]**	
Beta_ERM	-1.454864	1.166717	-1.25	0.214	-3.753844	.8441154
ln(ME)	.0700237	.1102777	0.63	0.526	-.1472752	.2873226
BE/ME	.3236088	.5132246	0.63	0.529	-.6876846	1.334902
Constant	1.930355	1.516601	1.27	0.204	-1.058061	4.918772

Table 34: FM regression, Carhart 4-factor Model (Leverage Ranked)

FM cross-section results corresponding to equation (22).

Fama-MacBeth (1973): Carhart 4-factor model (Leverage Ranked)						
Number of observations		2508				
Number of time periods		228				
F (4, 227)		0.44				
Prob > F		0.7765				
Average R-square		0.4941				
Variable	**Coef.**	**Fama-MacBeth Std. Err.**	**t-value**	**p-value**	**[95 % Conf. Interval]**	
Beta_ERM	-.9236848	1.18535	-0.78	0.437	-3.259381	1.412011
ln(ME)	.0312228	.1144507	0.27	0.785	-.1942987	.2567444
BE/ME	.1827297	.5379521	0.34	0.734	-.8772885	1.242748
Beta_ PR1YR	1.781077	1.638051	1.09	0.278	-1.446653	5.008806
Constant	1.900569	1.587547	1.20	0.232	-1.227643	5.028782

Table 35: FM regression, Our 5-factor Model (Leverage Ranked)

FM cross-section results corresponding to equation (23).

Fama-MacBeth (1973): Our 5-factor model (Leverage Ranked)						
Number of observations		2508				
Number of time periods		228				
F (5, 227)		0.47				
Prob > F		0.7997				
Average R-square		0.5721				
Variable	**Coef.**	**Fama-MacBeth Std. Err.**	**t-value**	**p-value**	**[95 % Conf. Interval]**	
Beta_ERM	-.9856105	1.180469	-0.83	0.405	-3.311688	1.340467
ln(ME)	.0288726	.1239561	0.23	0.816	-.2153791	.2731243
BE/ME	.3855802	.5707917	0.68	0.500	-.7391474	1.510308
Beta_ PR1YR	2.007868	1.883823	1.07	0.288	-1.704147	5.719884
Leverage	.0002747	.0088626	0.03	0.975	-.0171887	.0177382
Constant	1.891133	1.690767	1.12	0.265	-1.440472	5.222738

Table 36: FM regression, our modified 5-factor model (Leverage Ranked)

FM cross-section results corresponding to equation (24).

Fama-MacBeth (1973): Our 5-factor model* (Leverage Ranked)						
Number of observations		2280				
Number of time periods		228				
F (5, 227)		1.49				
Prob > F		0.1932				
Average R-square		0.6202				
Variable	**Coef.**	**Fama-MacBeth Std. Err.**	**t-value**	**p-value**	**[95 % Conf. Interval]**	
Beta_ERM	-1.121742	1.608462	-0.70	0.486	-4.291168	2.047684
ln(ME)	-.1669369	.1678224	-0.99	0.321	-.4976257	.1637519
BE/ME	.9036451	.6500197	1.39	0.166	-.377199	2.184489
Beta_ PR1YR	1.947934	2.153576	0.90	0.367	-2.295622	6.191489
Leverage	-.012037	.0110983	-1.08	0.279	-.0339059	.0098319
Constant	4.046229	2.286329	1.77	0.078	-.4589131	8.551372

*Excluding zero leverage portfolio

Table 37: FM regression, modified 3-factor model (Leverage Ranked)

FM cross-section results corresponding to equation (25).

Fama-MacBeth (1973): Modified 3-factor model (Leverage Ranked)						
Number of observations		2508				
Number of time periods		228				
F (3, 227)		0.90				
Prob > F		0.4426				
Average R-square		0.3705				
Variable	**Coef.**	**Fama-MacBeth Std. Err.**	**t-value**	**p-value**	**[95 % Conf. Interval]**	
Beta_ERM	-1.433142	1.161477	-1.23	0.219	-3.721797	.8555141
ln(ME)	.1042161	.1108745	0.94	0.348	-.1142588	.322691
Leverage	-.00305	.0080081	-0.38	0.704	-.0188297	.0127298
Constant	1.682831	1.529652	1.10	0.272	-1.331302	4.696964

Table 38: FM regression, modified 3-factor model with HLMLL_ex (Leverage Ranked)

FM cross-section results corresponding to equation (26).

Fama-MacBeth (1973): Modified 3-factor model* (Leverage Ranked)						
Number of observations		2280				
Number of time periods		228				
F (3, 227)		1.10				
Prob > F		0.3503				
Average R-square		0.3835				
Variable	**Coef.**	**Fama-MacBeth Std. Err.**	**t-value**	**p-value**	**[95 % Conf. Interval]**	
Beta_ERM	-1.836279	1.275934	-1.44	0.151	-4.350468	.6779098
ln(ME)	-.0445537	.1340261	-0.33	0.740	-.308648	.2195406
Leverage	-.0094123	.0082978	-1.13	0.258	-.0257628	.0069381
Constant	3.832722	1.826267	2.10	0.037	.2341184	7.431325

*Excluding zero leverage portfolio

Table 39: Summary of Time Series Regressions for the period 2000-07 to 2009-06

The table shows the number of constants statistically different from zero per time series regression model for different portfolio formations, and the corresponding GRS test statistics, and the p-values for the GRS tests.

Model		Portfolio Formation	Time Series Regressions Results: Number of Significant Constants	GRS	p-value
CAPM	(13)	Leverage Ranked Portfolios	4 out of (11)	3.853	1.3007E-04
FF 3-factor model	(14)		3 out of (11)	3.158	1.1332E-03
Carhart 4-factor model	(15)		3 out of (11)	3.026	1.7169E-03
Our 5-factor model	(16)		3 out of (11)	2.994	1.9124E-03
Our 5-factor model with HLMLL_ex	(17)		**2 out of (11)**	**2.829**	**3.1542E-03**
Modifed 3-factor model	(18)		4 out of (11)	3.788	1.6452E-04
Modified 3-factor model with HLMLL_ex	(19)		4 out of (11)	3.895	1.1869E-04
CAPM	(13)	3x3 Portfolios	6 out of (9)	4.082	1.7838E-04
FF 3-factor model	(14)		5 out of (9)	3.148	2.2833E-03
Carhart 4-factor model	(15)		4 out of (9)	3.042	3.0660E-03
Our 5-factor model	(16)		4 out of (9)	3.051	3.0196E-03
Our 5-factor model with HLMLL_ex	(17)		**3 out of (9)**	**2.814**	**5.6904E-03**
Modifed 3-factor model	(18)		6 out of (9)	4.026	2.1378E-04
Modified 3-factor model with HLMLL_ex	(19)		6 out of (9)	4.173	1.4393E-04
CAPM	(13)	Industry Sorted Portfolios	11 out of (23)	5.989	5.4400E-10
FF 3-factor model	(14)		7 out of (23)	4.659	1.1540E-07
Carhart 4-factor model	(15)		7 out of (23)	3.979	2.0670E-06
Our 5-factor model	(16)		7 out of (23)	4.272	6.4890E-07
Our 5-factor model with HLMLL_ex	(17)		**6 out of (23)**	**3.521**	**1.5460E-05**
Modifed 3-factor model	(18)		11 out of (23)	6.369	1.7290E-10
Modified 3-factor model with HLMLL_ex	(19)		13 out of (23)	5.454	5.0580E-09

10.4 List of Firms

Table 40: The listed firms which are included in our final dataset.

1	3L SYSTEM AB
2	A-COM AB
3	ACADEMEDIA AB
4	ACANDO AB
5	ACCELERATOR NORDIC AB
6	ACTIVE BIOTECH AB
7	ADDNODE AB
8	ADDTECH AB
9	ADDVISE AB
10	AF AB
11	ALFA LAVAL AB
12	ALLIANCE OIL COMPANY LIMITED
13	ALTERO AB
14	ANOTO GROUP AB
15	ARCAM AB
16	AROS QUALITY GROUP AB
17	ARTIMPLANT AB
18	ASPIRO AB
19	ASSA ABLOY AB
20	ATLAS COPCO AB
21	AVENSIA INNOVATION AB
22	AXFOOD AB
23	AXIS AB
24	AXLON GROUP AB
25	B&B TOOLS AB
26	BEIJER ALMA AB
27	BEIJER ELECTRONICS AB
28	BERGS TIMBER AB
29	BETSSON AB
30	BETTING PROMOTION SWEDEN AB
31	BILIA AB
32	BILLERUD AB
33	BIOGAIA AB
34	BIOINVENT INTERNATIONAL AB
35	BIOLIN SCIENTIFIC AB
36	BIOPHAUSIA AB
37	BIOTAGE AB
38	BJORN BORG AB
39	BOLIDEN AB
40	BONG LJUNGDAHL AB
41	BORAS WAFVERI AB
42	BRIO AB
43	BTS GROUP AB
44	CARDO AB
45	CELLPOINT CONNECT AB
46	CISION AB
47	CLAS OHLSON AB
48	CONCORDIA MARITIME AB
49	CONFIDENCE INTERNATIONAL AB
50	CONNECTA AB
51	CONPHARM AB
52	CONSILIUM AB
53	CREATIVE ANTIBIOTICS SWEDEN AB
54	CTT SYSTEMS AB
55	CYBERCOM GROUP EUROPE AB
56	DIAMYD MEDICAL AB
57	DORO AB
58	DUROC AB
59	EFFNET HOLDING AB
60	ELANDERS AB
61	ELECTROLUX AB
62	ELEKTA AB
63	ELEKTRONIKGRUPPEN BK AB
64	ELOS AB
65	ELVERKET VALLENTUNA AB
66	ENEA AB
67	ENIRO AB
68	LM ERICSSON TELEPHONE COMPANY
69	EUROPEAN INSTITUTE OF SCIENCE AB
70	FAGERHULT AB
71	FEELGOOD SVENSKA AB
72	FENIX OUTDOOR AB
73	FINGERPRINT CARDS AB
74	FIREFLY AB
75	FOLLOWIT HOLDING AB
76	FORSSTROM HIGH FREQUENCY AB
77	G & L BEIJER AB
78	GENLINE HOLDING AB
79	GETINGE AB
80	GETUPDATED INTERNET MARKETING AB
81	AB GEVEKO
82	GLYCOREX TRANSPLANTATION AB
83	GUNNEBO AB
84	HALDEX AB
85	HEDSON TECHNOLOGIES INTERNATIONAL AB
86	H & M HENNES & MAURITZ AB
87	HEXAGON AB
88	HIFAB GROUP AB
89	HIQ INTERNATIONAL AB
90	HL DISPLAY AB
91	HOGANAS AB
92	HOLMEN AB
93	HUMAN CARE AB
94	IBS AB PUBLIKT AKTIEBOLAG
95	ICM KUNGSHOLMS AB
96	IDL BIOTECH AB
97	IMPACT COATINGS AB
98	INDUSTRIAL AND FINANCIAL SYSTEMS, IFS AB
99	INTELLECTA AB
100	INTOI AB
101	INTRUM JUSTITIA AB
102	INVISIO HEADSETS AB
103	ITAB SHOP CONCEPT
104	JEEVES INFORMATION SYSTEMS AB
105	JLT MOBILE COMPUTERS AB
106	JM AB
107	KABE HUSVAGNAR AB
108	KARO BIO AB
109	KNOW IT AB
110	LABS2 GROUP AB
111	LAGERCRANTZ GROUP AB
112	LAMMHULTS DESIGN GROUP AB
113	LAPPLAND GOLDMINERS AB
114	LBI INTERNATIONAL AB
115	LUNDIN PETROLEUM AB
116	MALMBERGS ELEKTRISKA AB
117	MEDA AB
118	MEDIVIR AB
119	MEKONOMEN AB
120	MICRONIC LASER SYSTEMS AB
121	MIDELFART SONESSON AB
122	MIDWAY HOLDINGS AB
123	MODUL 1 DATA AB
124	MSC KONSULT AB
125	MULTIQ INTERNATIONAL AB
126	MUNTERS AB
127	NCC AB
128	NEONET
129	NET INSIGHT AB
130	NETONNET AB
131	NETREVELATION HOLDING AB
132	NEW WAVE GROUP AB
133	NIBE INDUSTRIER AB
134	NOBIA AB
135	NOLATO AB
136	NOTE AB
137	NOVACAST AB
138	NOVOTEK AB
139	OBDUCAT AB
140	OEM-INTERNATIONAL AB
141	OPCON AB
142	ORASOLV AB.
143	ORC SOFTWARE AB
144	ORTIVUS AB
145	PA RESOURCES AB
146	PARTNERTECH AB
147	PEAB AB
148	POOLIA AB
149	PRECIO SYSTEMUTVECKLING LTD
150	PRECISE BIOMETRICS
151	PREVAS AB
152	PRICER AB
153	PROACT IT GROUP AB
154	PROBI AB
155	PROFFICE AB
156	PROFILGRUPPEN AB
157	Q-MED AB
158	RAYSEARCH LABORATORIES AB
159	READSOFT AB
160	REDERI AB TRANSATLANTIC
161	REJLERKONCERNEN AB
162	RNB RETAIL AND BRANDS AB
163	RORVIK TIMBER AB
164	ROTTNEROS AB
165	SAAB AB
166	SANDVIK AB
167	SAS AB
168	SVENSKA CELLULOSA AKTIEBOLAGE
169	SCANIA AB
170	SECO TOOLS AB
171	SECTRA AB
172	SECURITAS AB
173	SEMCON AB
174	SENSYS TRAFFIC AB
175	SIGMA AB
176	SINTERCAST AB
177	SKANE-MOLLAN
178	SKANSKA AB
179	SKF AB
180	SKISTAR AB
181	SOFTRONIC AB
182	SRAB SHIPPING AB
183	SSAB SVENSKT STAL AKTIEBOLAGET
184	STARBREEZE AB
185	STUDSVIK AB
186	SVEDBERGS I DALSTORP AB
187	SWECO AB
188	SWEDISH MATCH AB
189	TAURUS ENERGY AB
190	TELE2 AB
191	TELIASONERA AB
192	TICKET TRAVEL GROUP AB
193	TRELLEBORG AB (PUBL.)
194	TRICORONA AB
195	UNIBET GROUP PLC
196	VBG GROUP AB
197	VITA NOVA VENTURES AB
198	VITEC SOFTWARE GROUP AB
199	VITROLIFE AB
200	AKTIEBOLAGET VOLVO
201	XANO INDUSTRI AB