Norwegian School of Economics

Bergen, Spring 2021

The Relation Between Leverage, Beta, and Stock Returns

An Empirical Study

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Master's thesis, MSc Economics and Business Administration, Finance

NORWEGIAN SCHOOL OF ECONOMICS AND BUSINESS ADMINISTRATION

Acknowledgements

This thesis represents our final chapter as students at the Norwegian School of Economics (NHH) and the end of an era. Being a student during the Covid-19 pandemic has been a challenging ordeal and a test of self-discipline. We cannot wait to utilize the skills and knowledge we have acquired throughout our studies.

We would like to give our sincerest gratitude to our supervisor, Nils Friewald, for helping and guiding us throughout this entire process. His insight and constructive feedback has helped immensely, and we are eternally grateful for all his help.

Bergen, June 2021

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Abstract

This thesis aims to shed some light on, and hopefully add to the economic puzzle that is the relationship between leverage, return, and systematic risk. The theory surrounding this particular topic, suggests that there should be a positive relationship between them. The research, however, gives contradictory results, leading to it being quite controversial. When applying a cross-sectional approach to our CRSP and CRSP/Compustat merged dataset, we find that leverage partly hold information on changes in equity returns, both positively and negatively related from Fama-MacBeth (1973) regression analysis, which supports both Hamada (1972) as well as Fama and French (1992). However, our empirical results suggest the leverage effect to have the strongest explanatory power when adjusting for beta and size effects. Thus, our thesis supports Modigliani and Miller (1958) and Hamada (1972), proving increased market leverage to hold information on increased returns. Contradictive to those results, we provide in accordance with Fama and French (1992), evidence of book leverage being negatively related to stock returns.

Furthermore, our results provide strong evidence supporting the CAPM provided by Sharpe (1964), with a short-horizon beta to hold strong explanatory power in increased equity returns. However, when adjusting for a beta estimated over a longer period, these effects tend to disappear. Also, our results provide evidence of leverage not being positively, nor siginificantly related to beta.

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1 Introduction

The theories surrounding the relationship between leverage, return and systematic risk following Modigliani and Miller (1958), Sharpe (1964), and Hamada (1972) in particular, and supplementary research conducted on the basis of these theories, have led to what is known as a controversial topic. This topic is often referred to as an *economic puzzle*. The theory provided by Modigliani and Miller (1958) and Hamada (1972) suggests that there should be a positive relationship between both leverage and return and leverage and equity betas, respectively. Research on these topics, however, has proven to give contradictive results, which encourages us to attempt to provide further evidence on this matter. In addition, following the publication of Markowitz (1952), the capital asset pricing model (CAPM) was discovered by Sharpe (1964), and despite its many flaws, it is still widely taught in academia and will be used as a means of calculating beta in our thesis.

The relationship between leverage, return and systematic risk will serve as the foundation behind our research questions. First, we will attempt to prove that there is a positive relationship between leverage and stock returns and add to the findings of Modigliani and Miller (1958). Following this, we look into the relationship between risk and stock returns. As suggested by the portfolio theory of Markowitz (1952), and later by the capital asset pricing model (CAPM) of Sharpe (1964), we expect to find a positive relationship between these two variables. Finally, we look into the relationship between systematic risk and leverage. If our first two hypotheses hold, we also expect to see a positive relationship between systematic risk and leverage, as discovered by Hamada (1972).

Hypothesis 1
There is a positive relationship between leverage and stock returns.

Hypothesis 2
There is a positive relationship between systematic risk and stock returns.

Hypothesis 3
There exist a significant positive relationship between systematic risk and leverage.

We will take a cross-sectional approach when studying the relationship between leverage, returns, and systematic risk. We use four different definitions of leverage; book and market leverage, in addition to the book and market leverage as defined by Fama and French (1992).

We perform a rolling CAPM estimation to obtain three different values of beta, calculated over one, two, and five years respectively. Additionally, we calculate returns in excess of the risk-free rate as provided by Fama and French from WRDS.

Our data consists of CRSP and CRSP/Compustat merged, obtained from WRDS, and we will run Fama-MacBeth regressions on our sample between the period of 1963-2020 to study the relationship between variables of interest. In addition, we gradually add variables of size and book-to-market to see whether these might capture some of the effects.

Initially, in order to analyze our data sample simply in accordance with Fama and French (1992), we divide our sample into quintile portfolios, based on our leverage ratios and beta. Then we conduct our cross-sectional Fama-MacBeth regressions on the given sample. Furthermore, we investigate the theory stated by Hamada (1972), revolving the relation between beta and leverage, thus, we finalize our empirical analysis by running Fama-Macbeth regressions for leverage on beta, in addition to adding size as a control variable, to see whether size captures any friction from our regressions.

Our empirical study shows mixed results surrounding this empirical puzzle. From our portfolio sorts, we first identify an inverse relationship between book leverage and equity returns, opposing our theoretical foundation of both Hamada (1972) and Modigliani & Miller (1958). Conversely, market leverage provides evidence in favor of these two studies, that greater leverage leads to higher returns. Astonishingly, beta appears to be unaffected by both book leverage and market leverage.

Our Fama-MacBeth regression concerning the relationship between leverage and returns show quite similar results as our portfolio sorts. Again, we provide evidence that increased book leverage might hold information on reduced equity returns, whereas higher market leverage could explain increased returns. However, these findings are not very significant, unless adjusting for either beta or size.

We then move on to examine the effects of leverage ratios as defined by Fama and French (1992). Also in this part of our study, we apply Fama-Macbeth regressions on our sample. Furthermore, we also test whether the effect of one Fama-French leverage ratio might catch the effects of the other Fama-French leverage ratio, in addition to controlling for book-to-market equity. To easier analyze our empirical results, we apply log-transformed leverage ratios, which also in this part of our study implies lower returns if Fama-French book leverage increases, as well as higher stock returns when Fama-French market leverage increases, supplementing our previous results. When regressing one log-transformed leverage and controlling for the other, and vice versa, our Fama-French leverage ratios yield similar results, both of which being greater and more significant when controlling for other variables. However, when adjusting for book-to-market equity, it seems as if the leverage effects on stock returns involving the Fama-French definitions of leverage, tend to dissolve. Since both ratios in combination are so closely related to book-to-market equity, it appears that the effects of these leverage definitions are simply caught up as the difference between book leverage and market leverage.

In addition to these findings, our results suggest another quite remarkable finding. Whenever our 1-year beta or 2-year beta was used as the explanatory variable alone, it was significant, even suggesting the CAPM to hold, just as proposed by Sharpe (1964). However, when controlling for a beta estimate calculated over a longer horizon (5-years), the explanatory power tends to fade. Additionally, as we do not presume that the conditions required for the CAPM to hold, we cannot conclude that the beta alone explains changes in the stock returns.

The final part of our empirical analyses studies the relationship between leverage and beta, as discovered by Hamada (1972). In his publication, he found a positive relationship between leverage and beta. However, when running cross-sectional regressions on our sample, the results are quite contradictive, suggesting the complete opposite, in addition to all variables being insignificant, also when adjusting for size.

We conclude that leverage is partly related to stock returns, in combination with other firm characteristics. However, contrary to more recent studies like Fama and French (1992), we also provide evidence that the beta estimates used in this thesis are able to explain *parts* of the changes in returns. The beta does not have strong enough explanatory power to explain them independently, however. Finally, we cannot find any evidence of leverage being related to beta.

This thesis is constructed as follows. Section 2 presents relevant theories and provide a literature review related to our research questions. Section 3 presents our methodology whereas section 4 explains the process of the data collection and data wrangling. Section 5 presents and analyze our empirical results, before presenting our conclusions in section 6.

2 Literature Review

In this section, we will go over basic capital structure theory and explain what is to expect when the capital structure changes, which we will go deeper into. Additionally, we will explain some of the most essential theories surrounding this area. Further, we will mention a few studies done on the topic of capital structure and show how there are contradictive results related to the fundamental theories.

2.1 Capital Structure

Capital structure is derived from a firm’s outstanding securities, the two most common being equity and debt, where the firm’s relative value consists of the value of its respective debt and equity. Whether or not a firm chooses debt or equity when in need of refunding depends on the circumstances, and who the counterpart is. However, the capital structure of a firm and the right choice is crucial for its value, in addition to its stock returns. We will in this section go deeper into the most essential theories concerning the capital structure and stock returns.

Miller Modigliani

Miller and Modigliani (1958) (henceforth also referred to as MM) published an empirical study in which they tested the effect that leverage has on the common stock. They argued that the capital structure of a firm is uncorrelated with its rate of return given perfect capital markets, which exists under the following three conditions: 1) no taxes, no issuance costs, no transaction costs, and no-arbitrage opportunities. 2) Homogeneous goods must be valued equivalently with their substitutes. 3) The borrowing cost is the same for all investors, as well as symmetric information for all investors, in which the financing decisions do not change either the cash flows of the firm or the information.

Modigliani-Miller Proposition I

“*The market value of any firm is independent of its capital structure and is given by capitalizing its expected return at the rate of p_k appropriate to its class.”* (Modigliani & Miller, 1958, p. 268)

By assuming that companies can be arranged into equivalent return classes denoted by *k, the* expected return will be denoted by p_k for every class in this section. The total cash flow generated by a firm's assets has to be identical to the paid-out dividends to its shareholders.

Following the law of one price, the assets of the firm, and its outstanding securities must be valued equally in the market. Since the issuance of new securities in perfect capital markets are irrelevant for the cash flows of a firm's assets, the capital structure of the firm is also equivalently irrelevant.

Miller Modigliani Proposition II

"The expected yield of a share of stock is equal to the appropriate capitalization rate p_k *for a pure equity stream in a class, plus a premium related to financial risk to the debt-equity ratio times the spread between* p_k *and r."* (Modigliani & Miller, 1958, p. 271)

When it comes to proposition II, it argues that a firm that consists of 100% equity yields an expected return of i_j, equal to the rate of return p_k for an unlevered firm in MM I. On the other hand, the expected return of a levered firm equates the expected return of an unlevered firm p_k, plus p_k minus the cost of debt r, and is then multiplied by its debt-to-equity ratio D_j/S_j, also, because this proposition holds for realized return, it is equivalently valid for expected returns. When MM I states that the market value of a firm is independent of its capital structure, MM II says that the capital structure of the firm is crucial regarding its market value. Since the cost of debt is slightly lower than the cost of equity, one might argue that an increase in the leverage ratio of the firm would decrease its cost of capital, and as a result, increase its respective market value. However, this is not true, as leverage carries more risk than equity, hence its cost of capital, i_j will increase. By proving that the reduced cost from the debt´s lower interest rates is exactly equal to the rise in its cost of equity, the WACC of the firm remains unchanged.

2.2 Leverage and return

The seminal work of Modigliani and Miller (1958) has received a lot of attention through independent studies over the years, in which their theories have been tested extensively in numerous ways. In Modigliani and Miller's (1958) publication, they limited themselves to the Utility and Oil and Gas industry and found evidence suggesting that there exists a positive relationship between leverage and return. What will become evident in this section, however, is that this is not always the case. Some studies find results following the findings of Miller and Modigliani (1958), while others find no conclusive results or even opposite relationships. In the following paragraphs, we visit some studies based on Modigliani and Miller's (1958) findings.

Hamada (1972) published a study in which he tested the Modigliani-Miller theory by looking at the effect of the firm's capital structure on the systematic risk of common stock. By assuming that the theory proposed by MM (1958) holds, Hamada went on to test the relationship between the cross-sections of all firms. Using returns as profits after tax and interest, and industry as a proxy for business risk, he found that there was a positive relationship between leverage and stock returns. This result is in accordance with the findings of Modigliani and Miller (1958). Hamada (1972) also discovered that there exists a positive relationship between leverage and beta. Further, to account for the fact that Hamada (1972) had only assumed MM to hold in his studies, he also tested his findings against other "traditional" theories. Based on his interpretations of these theories, his data confirmed the Modigliani-Miller theory, which has provided further evidence in favor, on this controversial topic.

In addition to the findings of Hamada (1972), Bhandari (1988) also found evidence supporting the findings of Modigliani and Miller (1958). In his study, Bhandari (1988) argued that the debt-to-equity ratio could serve as a natural proxy for risk and proposed to use it as an additional variable to explain the expected return on common stocks.

Unlike Hamada (1972) and Bhandari (1988), Korteweg (2004) and Dimitrov and Jain (2006) reported a negative relationship between leverage and returns. Korteweg (2004) tested the second proposition of Modigliani and Miller (1958) by taking a time-series approach rather than cross-sectional, which would allow him to better control for the unlevered risk of firms, and in turn, help him formulate more powerful tests of the second proposition. Dimitrov and Jain (2006) hypothesized that financial leverage would be value relevant and found a negative relationship between financial leverage and contemporaneous and future adjusted returns, and argued that *"the information in changes in financial leverage is not impounded in stock prices in a timely fashion"* (Dimitrov & Jain, 2006).

Sivaprasad (2007) tested the effect of a firm's leverage on stock returns based on the explicit valuation model of Modigliani-Miller (1958) on all industries, whereas Modigliani and Miller only tested the utilities, oil, and gas industry. She found that for the utility sector, the results were consistent with Miller and Modigliani's findings, whereas, for other risk classes, the relationships were negative, which is consistent with more recent work, such as forementioned Korteweg (2004), Dimitrov and Jain (2006) and, Penman and Tuna (2007).

2.3 Risk and return

An article published by Markowitz (1952) on portfolio theory and the positive relationship between risk and return has, amongst other things, led to the discovery of the Capital Asset Pricing Model (CAPM) by Sharpe (1964). This model is to this day still widely taught in academia, despite being subject to scrutiny over the years. But due to the inherent flaws of the CAPM, there is no existing method able to accurately estimate the systematic risk of common stock[1]. As a result, there exist various approaches to estimate the risk of common stock in the literature.

In both the publication of Black, Jensen, and Scholes (1972), and Fama and MacBeth (1973), it was reported a positive simple relationship between average return and market beta. These publications were based on earlier years, however, and more recently, Fama and French (1992) published another study on this topic and found conflicting results. Fama and French (1992) found that this simple relationship disappears in the relatively more recent years when applying a cross-sectional approach, compared to the earlier years of Black, Jensen, and Scholes (1972) and Fama and MacBeth (1973). In the Fama and French (1992) study, however, they use a somewhat different approach when calculating their beta estimates. The rationale behind their estimation method is that existing studies on common stock betas have proven to be imprecise. Their paper tests the cross-sectional relationship between stock returns and different factors, among them, leverage, size, book-to-market, and beta. Their results provide evidence that the strong relationship between beta and equity returns somewhat disappears in more recent years. Furthermore, their results imply that factors such as size and book to market, E/P, and leverage are related to stock returns, with the book-to-market value of equity and size as the strongest parameters for risk in asset pricing.

[1] We will not go into details about the flaws related to the CAPM, however, information on this topic can be found at CAPM Model: Advantages and Disadvantages (investopedia.com).

3 Methodology

To thoroughly investigate our research questions of the relationship between leverage, beta, and returns, a solid econometrical foundation is required. In this section, we will explain our methodologies used to handle our empirical models, as well as go through key definitions for our study.

3.1 Beta estimation

As one of the main subjects in this thesis includes beta estimates, we have decided to follow the methods used by Bali, Engle, and Murray (2016), and estimate betas based on rolling regression windows, providing us with three different beta measures, to see whether the time-horizon on our beta estimates yields any significant differences in our empirical studies, as well as relative to earlier studies on the topic.

3.1.1 CAPM Beta estimated from simple rolling regressions

Our estimation technique is calculated by regressing a stock's monthly excess return on the market return for the preceding 12, 24, and 60 months, given a minimum of at least 10, 20, and 24 valid observations, respectively, following Bali et.al. (2016). These regressions will yield three different CAPM beta estimates that we can use in our main regressions. To be able to adjust for non-synchronous trading, which could end up as severely biased, beta is defined as:

$$\hat{\beta}_{i,t} = \sum_{l=0}^{5} \hat{\beta}_{i,t-1} \tag{1}$$

We estimate the beta as the sum of the slope coefficients from the regression following Dimson (1979), in rolling windows. The regression model is given by

$$r_{i,t} - r_{f,t} = \hat{\alpha}_i + \sum_{l=0}^{5} \hat{\beta}_{i,t-1} \left(r_{m,t-1} - r_{f,t-1}\right) + \hat{\epsilon}_{i,t} \tag{2}$$

where $r_{i,t}$ is the return in period *t* for stock *i*, $r_{f,t}$ is the risk-free rate in period *t*, and $r_{m,t}$ is the market return in the period.

The object of the Dimson beta is to improve the measurement of market beta and avoid biasedness for shares that are subject to non-synchronously trading. However, by estimating betas accordingly, on frequently traded stocks, any unwanted bias is not identified, hence the estimation method is valid for all stocks (Bali, Engle, & Murray, 2016). Henceforth, we refer to our CAPM beta estimates as: $\beta^{1y}, \beta^{2y}, \beta^{5y}$.

3.2 Variable definitions

3.2.1 Standard variables

Equity and Size

We define market equity (ME, in millions) following Fama and French (1992), as price times shares outstanding. In addition, we include a variable called *size* in our analysis, which refers to the log of market equity.

$$ME_t = Closing\ Price_t \times Shares\ Oustanding_t \quad (3)$$

$$Size = \log(ME) \quad (4)$$

We find the book equity (BE) using the same method as described by Fama and French (1992):

$$\begin{gathered} BE = Book\ value\ of\ stockholder\ Equity \\ + Balance\ sheet\ Deferred\ tax\ and\ investment\ credit \\ - book\ value\ of\ preferred\ stock \end{gathered} \quad (5)$$

All values are collected from the CRSP/Compustat merged database. As book value of the preferred stock, we use redemption value, liquidating value, or par value depending on availability. However, if the book value of stockholder equity is not available, book equity is calculated as :

$$Book\ Value\ of\ Common\ Equity + Par\ value\ of\ preferred\ stock \quad (6)$$

Or:

$$Book\ Value\ of\ Total\ Assets\ - Total\ Liabillites \quad (7)$$

depending on availability, in that specific order.

Book to market ratio

We also include the book-to-market ratio in some of our regression analyses later and define the variable as Fama and French (1992) did. That is, as the book value of equity over market equity.

$$BM = \frac{BE}{ME} \tag{8}$$

3.2.2 Leverage ratios

We will also test the effect that leverage has on returns in our analyses; hence we define and use several different measures of leverage ratios:

Book Leverage

We define Book Leverage (BLEV) as Book Debt (BD) over Total Assets (AT), where BD is derived from subtracting book equity from AT. The book leverage is then given by:

$$BLEV_t = \frac{BD_t}{AT_t} \tag{9}$$

Market Leverage

Market Leverage (MLEV) is calculated as total debt over total debt plus market equity (ME), where all variables come directly from CRSP/Compustat merged, and market equity is computed as the closing price at the end date of the fiscal year times shares outstanding.

$$MLEV_t = \frac{Long\ Term\ Debt_t + Debt\ in\ current\ Liabilities_t}{Long\ Term\ Debt_t + Debt\ in\ current\ liabilites_t + ME_t} \tag{10}$$

Fama French Leverage ratios

As we are interested in comparing the results of our study to the findings of Fama and French (1992), we include their leverage ratios in our analyses. Fama French Book Leverage (FF-BLEV) and Market Leverage (FF-MLEV) are computed as AT over BE and ME respectively, as shown in the following formulas:

$$FF - BLEV_t = \frac{AT_t}{BE_t} \tag{11}$$

$$FF - MLEV_t = \frac{AT_t}{ME_t} \tag{12}$$

3.3 Fama-MacBeth regression analysis

When using a sample of this magnitude, there is bound to be a large number of firms over the same specified period. Due to this, we come across cross-sectional correlations, which implies that there might exist a correlation between the error terms. Given that we are testing how returns are affected by leverage and systematic risk by individual firm characteristics, the intuitive approach would be to adjust for this by using the Fama-MacBeth regression model (1973).

The regression process is divided into two different parts. The first part runs a regression on return and each factor included in the sample to estimate stock *i*´s exposure to each factor (f_j) every period *t* using the following regression model:

$$r_{i,t} - r_{f,t} = \hat{\alpha}_{i,t} + \sum_{j}^{J} \hat{\beta}_i^j \, f_{j,t} + \hat{\epsilon}_{i,t} \qquad (13)$$

On the left-hand side, $r_{i,t} - r_{f,t}$, is the excess return of stock *i* at time *t*, $\alpha_{i,t}$ is the constant intercept for stock *i*, β_i^j denotes each factor's estimated coefficient, and $f_{j,t}$ is each stock's different factor at time *t*.

The second part involves estimating the coefficient for each factor

$$\hat{\beta}_j = \frac{1}{T} \sum_{t=1}^{T} \beta_{j,t} \qquad (14)$$

$\hat{\beta}_j$ is the estimate for each factor in our models and is calculated as the average of all the slopes from the first stage regression model, throughout the entire cross-sectional sample. In addition, all t-statistics from our regression analyses are based on HAC standard errors following Newey and West (1987), to adjust for heteroskedasticity, following Andrews (1991)[2].

[2] HAC – Heteroskedasticity and autocorrelation consistent

4 Data Collection and filtering

Our CRSP and CRSP/Compustat merged datasets, are collected from the WRDS Wharton Research Data Services[3]. CRSP is a monthly stock return database, with our sample consisting of data from 1958-2020, and CRSP/Compustat merged is an annual fundamentals database for all listed NYSE, Amex, and NASDAQ stocks covering the period from 1963-2020. We use the Fama-French excess market return from the CRSP dataset as our proxy for market return, and the corresponding one-month US T-bill rate as a proxy for the risk-free rate of return. To avoid potential biases that may occur due to the high financial debt that financial firms possess, we decided to remove all financial firms with the corresponding SIC codes [6000-6999] from our datasets.

4.1 Data cleansing and filtering

Initially, we performed some basic cleansing of our CRSP sample by filtering out unnecessary data and removing missing values. All non-common stocks that did not have a share code of 10 or 11 were removed, along with all duplicates, to make sure our sample only consisted of common stocks and only one observation per month for each security. As financial firms possess large amounts of debt, we decided to remove them to prevent potential bias when running regressions on our sample. We sorted all observations into sectors based on their respective SICCD, a system for the classification of industries, and proceeded to remove all observations with a SICCD of 6000-6999, which is the interval in which all financial firms exist[4]. Following this, all firms with market equity of less than zero within our sample were removed, before calculating new return variables, adjusted for delistings. The proxy used as the risk-free rate, the US T-bill rate of Fama and French, was then added to the sample, before finally calculating our beta estimates.

In our CRSP/Compustat merged sample, we made sure to only use links established by using CUSIP values in the CRSP and Compustat database (LU), or links that had been researched

[3] Wharton Research Data Services (upenn.edu)

[4] *Agriculture* [1-999], *Mining* [1000-1499], *Construction* [1500-1799], *Manufacturing* [2000-3999], *Transportation* [4000-4999], *Wholesale* [5000-5199], *Retail* [5200-5999], *Finance* [6000-6799], *Services* [7000-8999] & *Public* [9000-9999]

and verified (LC)[5, 6, 7]. Similar to the procedures done on our CRSP sample, we made sure that there were no duplicates in the CRSP/Compustat sample as well. Following this, we removed all missing values of book equity, as these would only lead to additional missing values when creating necessary variables later on.

Before merging our CRSP sample with our CRSP/Compustat sample, we created reference dates to match the observations contained within each of the samples. The reference date for the CRSP/Compustat was set to the subsequent year for each observation, whereas for the CRSP sample, it was set to the preceding year, depending on the month of the observation. The rationale behind this is that the relevant account information to the return variable is either from the end of the preceding year, until May, or calculated at the end of the current year starting from June, for its corresponding return observation in the subsequent year. The CRSP and CRSP/Compustat samples were then merged using the reference dates, and all observations prior to 1963 were removed, based on Bali et al (2016). Finally, we created the variables we defined in the methodology chapter, before running the regressions.

[5] *"A unique identification number assigned to all stocks and registered bons in the United States and Canada"* - CUSIP Number Definition (investopedia.com)

[6] LC – Link research complete. Standard connection between databases

[7] LU – Unresearched link to issue by CUSIP

5 Empirical Results

In our empirical analyses, we start by presenting descriptive statistics of our data sample, before looking at portfolios based on leverage quintile breakpoints from stocks listed on NYSE, Amex, and NASDAQ. Then we move on to running Fama-MacBeth regressions on individual stocks to test whether our different leverage ratios and beta estimates affect the return of the stock, as well as including the log of ME in every regression model. First, we conduct our analyses using book leverage as the variable for leverage and run regressions using the three different beta estimates we have. Then we proceed to use market leverage as the variable for leverage and repeat the process. This is additionally done for Fama and French's (1992) definition of book and market leverage, where we also add the book to market ratio to compare our study with Fama and French's (1992). And as an addition to our study, we look into the relationship of leverage and beta on return when sorting portfolios based on sectors to investigate whether this could be used as a valid factor following Modigliani & Miller (1958).

5.1 Descriptive statistics

Table 1 - Summary statistics

This table presents the summary statistics of the central variables used in our analysis. We report the mean, standard deviation, 5%, 25%, 50%, 75%, and 95% quantiles and the average number of firms every month. We present all data as monthly sampled, and reports statistics for excess return (Ret), book leverage (BLEV), market leverage (MLEV), and our three beta measures (β), as well as market equity (ME). The data covers the observations of stock prices and firm characteristics obtained from CRSP and COMPUSTAT for the time period from 1963 to 2020, excluding financial firms (SIC codes 6000–6999).

Panel B	Mean	Std dev	q5%	q25%	q50%	q75%	q95%	Obs.
Ret (in %)	0,66	15,42	-19,06	-6,74	-0,40	6,39	22,99	3953,29
BLEV	0,47	0,21	0,13	0,31	0,47	0,62	0,91	3978,67
MLEV	0,25	0,22	0,00	0,06	0,20	0,39	0,66	3978,67
β^{1y}	1,16	1,29	-0,58	0,43	1,06	1,79	3,24	3935,61
β^{2y}	1,17	0,93	-0,09	0,60	1,08	1,65	2,75	3804,53
β^{5y}	1,17	0,70	0,22	0,71	1,10	1,55	2,40	3744,25
ME (in millions)	2099,45	10050,90	9,54	54,27	230,71	931,42	7762,89	3956,81

In the table above, we present the summary statistics for monthly excess returns. The table provides different beta measures, in addition to book and market leverage, including all firms in our sample, where Obs. represents the average number of firms in each month. We see similar beta values on all estimation horizons, even though they are a little high, with a difference of 0,16 and 0,17 from a beta estimate of 1, which may be due to our sample period. We also see more normally distributed beta values when expanding our calculation horizon, with lower extreme values. Furthermore, the only firms missing from our sample are either those with a missing share price in period *t* or those with a missing number of shares outstanding in period *t*.

5.2 Statistics from leverage portfolios

To start our empirical analyses, we divide our sample into five quintile portfolios sorted on the breakpoints of book leverage and market leverage, respectively. Furthermore, we have statistics for size measured as the log of ME, equal-weighted- and value-weighted return, as well as beta and the average number of firms in each portfolio. As one of our research questions relates to the relationship between beta and leverage, we also include five portfolios sorted on the quintile breakpoints of 2-year beta, presented in Panel C.

Table 2: Portfolios sorted by book leverage, market leverage and beta

This table presents quintile portfolios sorted by book leverage (BLEV), market leverage (MLEV), and beta (β). Panel A shows all quintiles based on book leverage. Panel B shows all quintiles based on market leverage. Panel C reports long-short portfolios based on both leverage measures and beta, and Panel D reports portfolio sort based on beta breakpoints. We report the logarithm of market equity(Size), equally-weighted return (Ret EW), value-weighted return (VW Ret). The data covers the observations of stock prices and firm characteristics obtained from CRSP and COMPUSTAT for the time period from 1963 to 2020, excluding financial firms (SIC codes 6000–6999).

Panel A: Quintile portfolios sorted by BLEV

Portfolio	1	2	3	4	5
BLEV	0,17	0,34	0,47	0,59	0,76
MLEV	0,04	0,14	0,24	0,35	0,47
Size	4,41	4,85	5,07	5,11	4,71
Ret EW (in %)	0,72	0,75	0,71	0,65	0,53
Ret VW(in %)	1,29	1,06	0,89	0,95	1,09
Beta	1,20	1,18	1,17	1,11	1,19
Avg. Number of firms	808,96	808,88	808,8	808,75	809,56

Panel B: Quintile portfolios sorted by MLEV					
Portfolio	1	2	3	4	5
MLEV	0,02	0,08	0,20	0,35	0,59
BLEV	0,25	0,36	0,48	0,57	0,68
Size	4,39	4,89	5,17	5,11	4,54
Ret EW(in %)	0,66	0,59	0,66	0,66	0,74
Ret VW(in %)	1,19	1,07	0,92	0,91	1,07
Beta	1,24	1,26	1,16	1,09	1,10
Avg. Number of firms	798,27	796,44	795,55	795,45	796,39

At first glance of the portfolio statistics, we see quite clearly, and as expected a relationship between book- and market leverage, since they are so similarly estimated. Second, the results show that highly book levered firms tend to have lower returns than low levered firms. When weighting each firm equally in portfolios, we find a spread in return of 0,19%, as well as a total spread in high minus low leverage portfolios of 0,20% for value-weighted portfolios. When looking at MLEV on the other hand, we find quite the opposing results. When sorting by equal-weighted portfolios, our results indicate that higher levered firms on average earn 0,12% higher returns, whereas, for value-weighted portfolios, we find that low levered firms on average earn 0,12% higher returns.

Furthermore, our results indicate that size also appears to be related to leverage. In both cases, we see that highly levered firms are bigger when looking at the size variable. When looking at BLEV we see that low-BLEV firms on average have a log(ME) of 4,41, whereas high-BLEV firms only have 4,71 log(ME). This is also the case for the MLEV sorted portfolios (4,39 vs. 4,54), albeit, for both leverage ratios, the biggest firms in terms of size are in the middling portfolios. In addition, when looking at beta from the leverage-sorted portfolios, we identify an inverse relationship between the variables, where firms with high leverage tend to have a lower beta, and vice versa. From Panel A, we observe only a slight change in beta when comparing the difference from high minus low leverage of 0,01. Looking at market leverage from Panel B, we notice different results. Highly levered firms have on average a beta estimate of 0,14 lower than low-levered firms.

Panel C: High minus Low portfolio Returns

	Book Leverage High minus Low	Market Leverage High minus Low	Beta High Minus low
Ret EW(in %)	-0,19	0,08	0,72
	-(1,65)	(1,34)	(1,50)
Ret VW(in %)	-0,20	-0,12	1,12
	-(1,22)	-(0,45)	(2,62)

We have also computed portfolio returns, using our estimated returns from sorting by BLEV, MLEV, and beta from panel A, B, and D, in particular high minus low portfolio returns, as presented in Panel C. We start by analyzing our results from book leverage, which in both cases gives a negative return of -0,19% and -0,20% for equal-weighted and value-weighted respectively, however, none of them are significantly different from zero. Moving on to our portfolios built on market leverage, we find that equal-weighted portfolios yield a positive return of 0,08%, whereas a value-weighted portfolio gives a negative return of -0,12%. From our beta portfolios, both when sorting portfolios equally-weighted and value-weighted yield positive returns, with an equal-weighted portfolio return of 0,72%. However, the equal-weighted beta portfolio along with the equal-weighted and value-weighted portfolios for both leverages are not significantly different from zero. Only the value-weighted beta portfolio yields a significant coefficient of 1,12%, which supports our preliminary predictions of beta being related to equity returns.

Panel D: Quintile portfolios sorted by Beta

Portfolio	1	2	3	4	5
Beta	0,01	0,70	1,10	1,55	2,55
BLEV	0,47	0,47	0,47	0,47	0,47
MLEV	0,28	0,25	0,24	0,24	0,24
Size	4,26	5,04	5,14	4,92	4,36
Ret EW(in %)	0,64	0,45	0,50	0,59	1,36
Ret VW(in %)	0,91	0,81	0,89	1,20	2,03
Avg. Number of firms	887,9	887,71	887,63	887,58	887,47

When looking at our portfolios constructed on beta breakpoints, we notice something quite remarkable. When sorting our portfolios on beta, the book and market leverage ratios seem to be unaffected by this sorting method. From our findings in Panel A, with a beta difference of only 0,01, the high minus low results in panel C are not that surprising. The book leverage, however, appears to be completely unaffected by the beta for all portfolios, which is quite an interesting result. MLEV seems to be slightly related to beta, with a leverage ratio of 0,28 vs. 0,24 when comparing low and high beta portfolios. Even though there is a small difference in leverage ratio, the ratios across the panels appear very similar, and once the beta is greater than one, leverage becomes unaffected by beta, with an MLEV ratio of 0,24.

We also notice that low beta firms, quite surprisingly, tend to be smaller than high beta firms in size, which might be explained by some small companies having negative betas and being negatively correlated with the market index. However, the biggest firms are on average in the portfolio with a beta closest to 1.

Finally, we also notice preliminary evidence that increased returns are related to increased beta. When sorting into equal-weighted portfolios, we see a high minus low return spread of 0,72%, and an even bigger spread when using value-weighted portfolios of 1,12% in returns.

5.3 Fama-MacBeth regression analysis on Book Leverage

We start by estimating the relationship between equity returns, beta, and book leverage (BLEV). We present our Fama-MacBeth regression results of stock returns on BLEV, and our three beta estimates.

Table 3: Fama-MacBeth regression analysis using BLEV

We conduct the Fama-MacBeth regression analysis at the individual firm level, conducting our analysis on monthly data on excess return, book leverage (BLEV), beta (β), the logarithm of ME (Size), and the logarithm of book leverage (BLEV). In panel A we conduct our regression analysis using β^{1y}. Panel B reports our results using β^{2y}. Panel C reports our results using β^{5y}. We report coefficient estimates and associated t-statistics (in parentheses) based on HAC standard errors following Newey and West (1987), to adjust for heteroskedasticity, as suggested by Andrews (1991). The data covers the observations of stock prices and firm characteristics obtained from CRSP and COMPUSTAT for the time period from 1963 to 2020, excluding financial firms (SIC codes 6000–6999).

Panel A	i	ii	iii	iv	v	vi	vii	viii	ix	x
BLEV	-0,33		-0,36	-0,63		-0,68				
	-(1,72)		-(2,22)	-(3,11)		-(3,97)				
β^{1y}		0,62	0,63		0,61	0,61		0,63		0,61
		(2,75)	(2,77)		(2,71)	(2,74)		(2,78)		(2,74)
Size				0,37	0,36	0,37			0,37	0,37
				(8,10)	(8,57)	(8,65)			(8,12)	(8,68)
log(BLEV)							-0,08	-0,08	-0,23	-0,24
							-(1,16)	-(1,44)	-(3,23)	-(3,93)
Firms	3979,99	3979,99	3979,99	3979,99	3979,99	3979,99	3979,99	3979,99	3979,99	3979,99

Panel B	i	ii	iii	iv	v	vi	vii	viii	ix	x
BLEV	-0,37		-0,44	-0,65		-0,73				
	-(2,02)		-(2,85)	-(3,31)		-(4,52)				
β^{2y}		0,55	0,54		0,54	0,54		0,55		0,54
		(2,24)	(2,24)		(2,24)	(2,26)		(2,25)		(2,26)
Size				0,35	0,33	0,34			0,35	0,34
				(7,80)	(8,12)	(8,20)			(7,82)	(8,23)
log(BLEV)							-0,09	-0,11	-0,24	-0,26
							-(1,43)	-(2,12)	-(3,44)	-(4,62)
Firms	3843,53	3843,53	3843,53	3843,53	3843,53	3843,53	3843,53	3843,53	3843,53	3843,53

Panel C	i	ii	iii	iv	v	vi	vii	viii	ix	x
BLEV	-0,35		-0,38	-0,62		-0,66				
	-(1,92)		-(2,48)	-(3,14)		-(4,07)				
β^{5y}		0,44	0,43		0,45	0,45		0,44		0,45
		(1,77)	(1,75)		(1,85)	(1,84)		(1,77)		(1,85)
Size				0,33	0,32	0,33			0,34	0,33
				(7,53)	(7,90)	(7,98)			(7,54)	(8,01)
log(BLEV)							-0,09	-0,10	-0,23	-0,24
							-(1,36)	-(1,89)	-(3,29)	-(4,29)
Firms	3775,28	3775,28	3775,28	3775,28	3775,28	3775,28	3775,28	3775,28	3775,28	3775,28

Panel A reports our results when regressing BLEV and 1-year beta, from which we see that BLEV is unrelated to return when isolated. When including beta, however, we see that leverage has an impact on returns with a coefficient of -0,36. These findings are also evident when including the log of size, then with a coefficient of -0,63. In addition, if we run a regression adjusting for both size and beta, our results show a coefficient of -0,68. When following Fama and French procedures (1992), by running the regressions on the log of BLEV, we can only find an effect on returns from leverage jointly shared with either beta and size or both. A noteworthy finding, on the other hand, is the one regarding beta, proving that in every model when using a short horizon beta, it is significantly related to stock returns.

In Panel B we find our most significant and strongest relationship between BLEV and stock returns, which represents the same regression as in Panel A, only using β^{2y}. From our results, we find a strong negative relation between BLEV and returns when including beta and size in our regression, of which both are significantly related to stock returns. In addition, we find evidence at a 5% level that leverage is solely negatively related to stock returns with an estimate of -0,37. When testing the log of BLEV, we find a significant relationship between leverage and returns, only when adjusting for the other factors as well, indicating a joint effect, with all coefficients being significant. Additionally, every model suggests that including size has a great impact on leverage effects on stock returns, as well as being significant itself. Adjusting for size makes the leverage estimate more than double of itself, compared to adjusting for the beta, as well as increasing the t-statistic for the leverage estimates.

Moving on to Panel C, we represent our results when using a longer horizon beta, β^{5y}, to test whether time effects in beta values may have an impact on leverage and stock returns. Our results imply that BLEV is only related to equity returns when adjusting for other factors, also when leverage is log-transformed. An interesting finding compared to the other models, when using a short horizon beta, is that the β^{5y} never has an impact on stock returns, whether using BLEV or log(BLEV), which is consistent with the results of Fama-French (1992), implying beta effects are subsumed by other factors. Furthermore, all models suggest a negative relationship between BLEV and equity returns. With its highest absolute value of estimates, when adjusting for both size and beta, the coefficients are -0,66 and -0,24 for BLEV and log(BLEV) respectively. Thus, we extract that leverage effects on stock returns are jointly accounted for by leverage and size, both consuming β^{5y} effects on equity returns. In addition to our results being less significant when comparing to our results using β^{2y}

Testing beta as the only explanatory variable, we obtain significant estimates of 0,62 and 0,55 for β^{1y} and β^{2y} respectively. Thus, it can be argued that beta holds some explanatory power regarding stock returns. Our beta estimate that is based on a longer time horizon is on the other hand insignificant, both when used as the only explanatory variable, and when adjusted for by other characteristics. Hence, we see that short-term betas explain a larger proportion of returns than long-term betas.

Our results support the conclusion of Fama-French (1992), which states that the effect that leverage has on equity returns is included in other factors. In this case, the leverage effects on returns are jointly shared with size effects. On some occasions, it is dependent on beta as well, except when using β^{2y}, where BLEV are independently related to stock returns.

5.4 Fama-MacBeth regression analysis on Market leverage

We now move on to our empirical analysis to test if market leverage (MLEV) is related to stock returns, and its role when controlling for beta as well as size. In table 4 presented below, we introduce a part of our Fama-MacBeth regression analysis on MLEV, which in total includes three different beta estimates.

Table 4: Fama-MacBeth regression analysis using MLEV

We conduct the Fama-MacBeth regression analysis at the individual firm level, conducting our analysis on monthly data on excess return, market leverage (MLEV), beta (β), the logarithm of ME (Size), and the logarithm of market leverage (MLEV). In panel A we conduct our regression analysis using β^{1y}. Panel B reports our results using β^{2y}. Panel C reports our results using β^{5y}. We report coefficient estimates and associated t-statistics (in parentheses) based on HAC standard errors following Newey and West (1987), to adjust for heteroskedasticity, as suggested by Andrews (1991). The data covers the observations of stock prices and firm characteristics obtained from CRSP and COMPUSTAT for the time period from 1963 to 2020, excluding financial firms (SIC codes 6000–6999).

Panel A	i	ii	iii	iv	v	vi	vii	viii	ix	x
MLEV	0,29		0,30	0,58		0,62				
	(1,06)		(1,28)	(2,18)		(2,65)				
β^{1y}		0,66	0,66		0,65	0,66		0,67		0,67
		(2,81)	(2,86)		(2,82)	(2,90)		(2,89)		(2,92)
Size				0,36	0,35	0,36			0,35	0,36
				(7,85)	(8,37)	(8,65)			(7,65)	(8,45)
log(MLEV)							0,06	0,07	0,06	0,08
							(1,72)	(2,39)	(1,74)	(2,50)
Firms	3433,98	3433,98	3433,98	3433,98	3433,98	3433,98	3433,98	3433,98	3433,98	3433,98

Panel B	i	ii	iii	iv	v	vi	vii	viii	ix	x
MLEV	0,20		0,10	0,51		0,43				
	(0,74)		(0,42)	(1,98)		(1,97)				
β^{2y}		0,56	0,56		0,57	0,58		0,57		0,58
		(2,25)	(2,24)		(2,31)	(2,36)		(2,28)		(2,38)
Size				0,34	0,32	0,33			0,33	0,33
				(7,58)	(7,87)	(8,19)			(7,36)	(7,98)
log(MLEV)							0,05	0,04	0,06	0,05
							(1,43)	(1,57)	(1,60)	(1,89)
Firms	3325,31	3325,31	3325,31	3325,31	3325,31	3325,31	3325,31	3325,31	3325,31	3325,31

Panel C	i	ii	iii	iv	v	vi	vii	viii	ix	x
MLEV	0,21		0,17	0,54		0,50				
	(0,79)		(0,73)	(2,09)		(2,37)				
β^{5y}		0,47	0,46		0,49	0,50		0,47		0,51
		(1,83)	(1,82)		(1,97)	(2,04)		(1,86)		(2,06)
Size				0,32	0,31	0,32			0,32	0,31
				(7,37)	(7,70)	(8,10)			(7,14)	(7,86)
log(MLEV)							0,05	0,05	0,06	0,06
							(1,48)	(1,80)	(1,72)	(2,22)
Firms	3269,18	3269,18	3269,18	3269,18	3269,18	3269,18	3269,18	3269,18	3269,18	3269,18

When conducting our analyses using MLEV, we find that MLEV and log(MLEV) are both unrelated to equity returns individually, in all panels. Also, when only adjusting for beta, we identify that all frictions are caught by systematic risk. However, when including beta as a factor alongside the log of MLEV in Panel A, we see a positive relationship between returns and log(MLEV) for our 1-year beta, with an estimate of 0,07, in accordance with the findings of both Hamada (1972) as well as Bhandari (1988), suggestions leverage to hold information on stock returns.

Our most significant results are found in Panel A when using our 1-year beta estimate. Despite MLEV not being related to return solely, or when adjusting for beta, except for log-transformed leverage. When including the log of size, we contract a positive relation of 0,58. If both size and beta are included as factors in our estimates, we find an even stronger relationship between MLEV and stock returns, in addition to an effect in log(MLEV) with coefficients of 0,62 and 0,08 accordingly.

Panel B reports our results using the 2-year beta, where β^{2y} seemingly is significantly related to returns. MLEV, on the other hand, only explains some of the information for returns when size is included as a factor, with estimates of 0,51, and 0,43. This implies that the size explains some of the relations between MLEV and returns. Looking at the log of market leverage, there does not exist any relation between MLEV and equity returns, implying that leverage effects are partially subsumed when including beta. Also, quite surprisingly, every estimate of size is highly significant, yet hardly has any effect on either beta or the log of MLEV.

Panel C of Table 4 presents our results using β^{5y}, which for some reason shows an insignificant relationship between beta and returns, except when controlling for size. MLEV only holds information on stock returns when size and beta are included, both of which give MLEV coefficients of 0,54 and 0,50. Furthermore, log(MLEV) only proves itself significant when controlling for size and beta as factors. Hence, our results might imply that MLEV essentially holds information of stock returns when controlling for these other factors, particularly for size.

Comparing the beta estimates from our models, our findings are very similar to the estimates when using BLEV (table 3), yet slightly different due to the first stage regression in the FM regression model. Our beta estimates decrease when adjusting for a longer time horizon, with

β^{1y} being both the most significant and of largest value with an estimate of 0,66, followed by β^{2y}, which is also significant with an estimate of 0,56. We may argue that CAPM holds, yet all other assumptions needed for the CAPM to be true, are not accounted for. When adjusting for a longer time-horizon beta, our results are more appropriate with the results of other recent studies, of beta not being significantly related to stock returns, proving that CAPM does not hold.

5.5 Fama French leverage

We also want to test our results against Fama-French (1992) as they define both market and book leverage differently from us, both using total assets over the market- and book equity, respectively. Thus, we have also tested their definitions of leverage in Fama-MacBeth regressions using the same characteristics as in our earlier analyses, including the log of both LEV variables as Fama and French do and finally presenting the results where we include both variables.

5.5.1 Fama-French Book Leverage

We start our Fama and French replication work by analyzing book leverage (FF-BLEV), presented in the table below.

Table 5: Fama-MacBeth regression analysis using FF-BLEV

We conduct the Fama-MacBeth regression analysis at the individual firm level, conducting our analysis on monthly data on excess return, leverage definitions used by Fama and French(1992, FF) book leverage (FF-BLEV), beta (β), the logarithm of ME (Size) and the logarithm of book leverage (FF-BLEV). In panel A we conduct our regression analysis using β^{1y}. Panel B reports our results using β^{2y}. Panel C reports our results using β^{5y}. We report coefficient estimates and associated t-statistics (in parentheses) based on HAC standard errors following Newey and West (1987), to adjust for heteroskedasticity, as suggested by Andrews (1991). The data covers the observations of stock prices and firm characteristics obtained from CRSP and COMPUSTAT for the time period from 1963 to 2020, excluding financial firms (SIC codes 6000–6999).

Panel A	i	ii	iii	iv	v	vi	vii	viii	ix	x
FF-BLEV	-0,02		-0,03	-0,01		-0,02				
	-(1,12)		-(2,19)	-(0,73)		-(1,87)				
β^{1y}		0,62	0,62		0,61	0,61		0,62		0,61
		(2,75)	(2,76)		(2,71)	(2,72)		(2,77)		(2,73)
Size				0,36	0,36	0,36			0,37	0,37
				(8,14)	(8,57)	(8,65)			(8,10)	(8,63)
log(FF-BLEV)							-0,14	-0,17	-0,18	-0,22
							-(2,06)	-(2,94)	-(2,56)	-(3,69)
Firms	3980,14	3980,14	3980,14	3980,14	3980,14	3980,14	3980,14	3980,14	3980,14	3980,14

Panel B	i	ii	iii	iv	v	vi	vii	viii	ix	x
FF-BLEV	-0,02		-0,03	-0,01		-0,02				
	-(1,24)		-(2,39)	-(0,88)		-(2,06)				
β^{2y}		0,55	0,55		0,54	0,54		0,55		0,54
		(2,24)	(2,25)		(2,24)	(2,25)		(2,24)		(2,26)
Size				0,34	0,33	0,33			0,35	0,34
				(7,86)	(8,12)	(8,18)			(7,81)	(8,18)
log(FF-BLEV)							-0,16	-0,20	-0,19	-0,23
							-(2,29)	-(3,40)	-(2,74)	-(4,09)
Firms	3843,65	3843,65	3843,65	3843,65	3843,65	3843,65	3843,65	3843,65	3843,65	3843,65

Panel C	i	ii	iii	iv	v	vi	vii	viii	ix	x
FF-BLEV	-0,02		-0,02	-0,01		-0,01				
	-(1,03)		-(1,54)	-(0,67)		-(1,25)				
β^{5y}		0,44	0,44		0,45	0,45		0,43		0,45
		(1,77)	(1,77)		(1,85)	(1,85)		(1,76)		(1,85)
Size				0,33	0,32	0,32			0,33	0,32
				(7,58)	(7,91)	(7,98)			(7,54)	(7,97)
log(FF-BLEV)							-0,15	-0,16	-0,18	-0,20
							-(2,11)	-(2,76)	-(2,52)	-(3,40)
Firms	3775,40	3775,40	3775,40	3775,40	3775,40	3775,40	3775,40	3775,40	3775,40	3775,40

Panel A describes our results using β^{1y}, where we quite surprisingly, as compared to Fama and French (1992), find evidence of returns being dependent on FF-BLEV only when adjusting for beta, with beta also being significantly related to equity returns. However, when using the log of FF-BLEV, our results suggest that there does exist a negative relationship between book leverage and return with a coefficient of -0,14, which decreases to -0,17 when adjusting for β^{1y}. Adding size in addition to beta yields a significant coefficient of -0,22. These results are somewhat in accordance with those found by Fama-French (1992), proving that the log of their book leverage measure is related to returns, however, our results differ from Fama and French (1992) when adjusting for other characteristics.

If we move on and look at Panel B of Table 5, which reports our results using β^{2y}, we find similar estimates. FF-BLEV is only significant when adjusting for beta, with the main difference being a significant relationship when adding size in addition to beta. Furthermore, we find even stronger evidence and a more negative relationship when log transforming FF-BLEV, supporting our results from Panel A, with estimates ranging from -0,16 independently, to -0,23 when all characteristics are included.

Panel C shows our regression analysis for a longer horizon beta value, using our 5-year beta value. In all our models, all leverage estimates are very similar, with a few exceptions of slightly smaller estimates in Panel C, compared to Panel A and B. The biggest differences in the leverage estimates are found when using log(FF-BLEV), still very similar results regarding leverage estimates. However, the models differ the most when looking at the long horizon beta compared to the two short-horizon betas. In Panel C, our results are in accordance with Fama and French (1992), proving beta does not hold information on equity returns, as well as size consuming some of the leverage effects on stock returns.

5.5.2 Fama-French Market Leverage

We now move on to our Fama-French analysis, by presenting our result from our Fama-MacBeth regression using Fama-French market leverage (FF-MLEV), all regressions are from table 6.

Table 6: Fama-MacBeth regression using FF-MLEV

We conduct the Fama-MacBeth regression analysis at the individual firm level, conducting our analysis on monthly data on excess return, leverage definitions used by Fama and French(1992, FF) market leverage (FF-MLEV), beta (β), the logarithm of ME (Size) and the logarithm of market leverage (FF-MLEV). In panel A we conduct our regression analysis using β^{1y}. Panel B reports our results using β^{2y}. Panel C reports our results using β^{5y}. We report coefficient estimates and associated t-statistics (in parentheses) based on HAC standard errors following Newey and West (1987), to adjust for heteroskedasticity, as suggested by Andrews (1991). The data covers the observations of stock prices and firm characteristics obtained from CRSP and COMPUSTAT for the time period from 1963 to 2020, excluding financial firms (SIC codes 6000–6999).

Panel A	i	ii	iii	iv	v	vi	vii	viii	ix	x
FF-MLEV	0,08		0,08	0,16		0,16				
	(2,18)		(2,21)	(4,93)		(5,24)				
β^{1y}		0,64	0,64		0,62	0,63		0,66		0,67
		(2,82)	(2,86)		(2,78)	(2,85)		(2,97)		(3,00)
Size				0,40	0,36	0,40			0,40	0,41
				(9,10)	(8,64)	(9,72)			(8,81)	(9,53)
log(FF-MLEV)							0,26	0,28	0,39	0,42
							(3,54)	(4,39)	(5,45)	(6,73)
Firms	3941,32	3941,32	3941,32	3941,32	3941,32	3941,32	3941,32	3941,32	3941,32	3941,32

Panel B	i	ii	iii	iv	v	vi	vii	viii	ix	x
FF-MLEV	0,07		0,05	0,15		0,14				
	(1,92)		(1,50)	(4,76)		(4,63)				
β^{2y}		0,56	0,55		0,55	0,56		0,58		0,60
		(2,28)	(2,28)		(2,29)	(2,35)		(2,41)		(2,55)
Size				0,37	0,33	0,36			0,38	0,37
				(8,88)	(8,09)	(9,26)			(8,62)	(9,18)
log(FF-MLEV)							0,23	0,22	0,37	0,37
							(3,22)	(3,50)	(5,39)	(6,42)
Firms	3808,45	3808,45	3808,45	3808,45	3808,45	3808,45	3808,45	3808,45	3808,45	3808,45

Panel C	i	ii	iii	iv	v	vi	vii	viii	ix	x
FF-MLEV	0,07		0,06	0,15		0,14				
	(1,89)		(1,76)	(4,76)		(4,98)				
β^{5y}		0,46	0,46		0,47	0,49		0,50		0,55
		(1,87)	(1,88)		(1,94)	(2,05)		(2,05)		(2,31)
Size				0,36	0,32	0,35			0,37	0,36
				(8,66)	(7,93)	(9,26)			(8,41)	(9,27)
log(FF-MLEV)							0,23	0,23	0,37	0,39
							(3,18)	(3,72)	(5,45)	(6,89)
Firms	3739,25	3739,25	3739,25	3739,25	3739,25	3739,25	3739,25	3739,25	3739,25	3739,25

Panel A reports the results for FF-MLEV using β^{1y}, which quite surprisingly shows a significant positive relation between returns and all characteristics in every model, as well as FF-MLEV and stock returns, with a coefficient of 0,08, which is also the only model where FF-MLEV holds information on stock returns independently. When adjusting for beta, size, and when including both, leverage tends to hold more, and stronger, information on equity returns. Analyzing our results using the log of FF-MLEV, where all our models prove a positively significant coefficient. Our Fama-MacBeth regression suggests a positive relationship with an estimate of 0,28 between log(FF-MLEV) and returns. When including beta, size, and both, as dependent variables, we find an interrelation between the characteristics of 0,29, 0,39, and 0,42 accordingly, which is quite the opposite of Fama and French (1992), where FF-MLEV decrease when adjusting for other characteristics, especially size.

When moving on to Panel B, our estimates show that FF-MLEV only influences returns when adjusted for size. The log-transformed measure of FF-MLEV is however always significantly related to returns. When using β^{2y}, we see a clear positive relationship between the log of FF-MLEV and returns, with a coefficient of 0,23. The same results as in Panel A also apply to Panel B, with a higher interrelation when more characteristics are included in our regression model, where both panel yields rising estimates when including beta, size, and beta plus size accordingly.

In Panel C we use β^{5y}, which discovers no relation between FF-MLEV and equity returns, except when adjusting for size, suggesting size holds information on leverage effects on equity returns. Here, like in Panel B, log(FF-MLEV) proves a strong relationship between leverage and stock returns, with an estimate equal to the estimate when using β^{2y}, of 0,23. However, when controlling for beta and size we extract slightly higher, as well as a more significant t-stat, correlation of 0,39.

5.5.3 Combining FF-BLEV and FF-MLEV

We continue our FF-LEV analysis following Fama-French (1992) methodology by including both the log of FF-BLEV and FF-MLEV in the same Fama-MacBeth regressions. Our procedures of presenting our data are the same as in the previous analyses, with each panel showing results using different beta estimates from 1-year to 5-year accordingly.

Table 7: Fama-Macbeth regression using log(FF-BLEV) and log(FF-MLEV)

We conduct the Fama-MacBeth regression analysis at the individual firm level, conducting our analysis on monthly data on excess return, beta (β), the logarithm of ME (Size) and leverage definitions used by Fama and French(1992, FF) and use the logarithm of book leverage (FF-BLEV). In panel A we conduct our regression analysis using β^{1y}. Panel B reports our results using β^{2y}. Panel C reports our results using β^{5y}. We report coefficient estimates and associated t-statistics (in parentheses) based on HAC standard errors following Newey and West (1987), to adjust for heteroskedasticity, as suggested by Andrews (1991). The data covers the observations of stock prices and firm characteristics obtained from CRSP and COMPUSTAT for the time period from 1963 to 2020, excluding financial firms (SIC codes 6000–6999).

Panel A	i	ii	iii	iv
β^{1y}		0,67		0,68
		(3,02)		(3,08)
Size			0,42	0,42
			(8,98)	(9,81)
log(FF-BLEV)	-0,46	-0,52	-0,62	-0,71
	-(6,18)	-(8,10)	-(7,72)	-(10,64)
log(FF-MLEV)	0,37	0,41	0,55	0,61
	(4,72)	(5,95)	(7,04)	(8,88)
Firms	3941,32	3941,32	3941,32	3941,32

Panel B	i	ii	iii	iv
β^{2y}		0,59		0,63
		(2,48)		(2,67)
Size			0,39	0,39
			(8,80)	(9,50)
log(FF-BLEV)	-0,46	-0,50	-0,62	-0,68
	-(6,08)	-(7,71)	-(7,63)	-(10,39)
log(FF-MLEV)	0,34	0,35	0,53	0,55
	(4,45)	(5,10)	(7,04)	(8,77)
Firms	3808,45	3808,45	3808,45	3808,45

Panel C	i	ii	iii	iv
β^{5y}		0,52		0,58
		(2,13)		(2,47)
Size			0,38	0,38
			(8,58)	(9,57)
log(FF-BLEV)	-0,44	-0,46	-0,60	-0,64
	-(5,84)	-(7,28)	-(7,42)	-(9,86)
log(FF-MLEV)	0,34	0,35	0,53	0,56
	(4,37)	(5,20)	(7,04)	(9,12)
Firms	3739,25	3739,25	3739,25	3739,25

When including only the log of our two FF-LEV measures, we identify a significant interrelation between them both and equity returns, both with quite strong coefficients of -0,46 and 0,37 for log(FF-BLEV) and log(FF-MLEV) accordingly, when using β^{1y}. Furthermore, in all models, we see that every estimate of log(FF-BLEV) yields a negative value, and the opposite for FF-MLEV with a positive value, which is valid for every model. This indicates that an increase in book leverage might cause a decrease in returns, whereas an increase in market leverage could on the other hand explain some of the increase in stock returns. Only using the log FF-BLEV and FF-MLEV, we see that the estimates of FF-MLEV and FF-BLEV become slightly smaller from every model when the beta horizon is longer.

When adding beta as an explanatory variable the leverage estimates become more significant and increase (decrease if negative). However, comparing Panel A and Panel C, we see smaller changes in our estimates when using a longer horizon beta value, which could come from less variation in our β^{5y} estimate. In addition, we see that beta is less significant as well as holding less information on stock returns when using a longer estimation period in the given beta, yet beta is significant for every beta measure.

Looking at the size variable, we see a greater change in estimates than from only using the beta, indicating size holds more information on leverage effects on returns than beta. Book leverage extracts equal estimates when using β^{1y} and β^{2y}, of -0,62, while FF-MLEV have coefficients of 0,55 and 0,53 accordingly. The results from Panel C are quite similar to the ones in Panel A and B, equivalent to the previous points made in this chapter, our models using β^{5y} indicates that leverage holds less information on stock returns compared to the models when using β^{1y} and β^{2y}, yet holds significant information on stock returns.

In our last model, when adjusting for both size and beta, we identify the lesser impact on every characteristic when the beta horizon in the model is longer, in addition to every estimate becoming less significant, however, all estimates are very significant and jointly hold information on stock returns. For instance, looking at Panel B using β^{2y}, our results provide a BLEV estimate of -0,68, and 0,55 for MLEV using Fama and French definitions, which only increase when adjusting for other variables. Our findings illustrate that both FF-BLEV in addition to FF-MLEV does hold information on stock returns, which only increase when adjusting for the log of size and beta. Thus, we can say that all variables jointly hold information on equity returns, somewhat supporting the findings of Fama and French (1992), which states that leverage and size jointly hold information on stock returns. However, when adjusting for other characteristics, our estimates increase and are stronger, whereas Fama and French find the opposite. Also, it must be accounted for that the time periods in the data samples are different. Another point worth mentioning is that the beta measure that is the least related to returns, is our 5-year beta measure, yet significantly positively related to stock returns. Which similarly to Fama and French (1992) betas are calculated on a longer time horizon.

Furthermore, to test whether any other factor might catch the influence on returns, we added in another variable, as argued by Fama and French (1992) very similar to the relation between FF-BLEV and FF-MLEV, which is the log of book-to-market, while using the 2-year beta.

Table 8: Fama-MacBeth regression analysis using log(FF-BLEV), log(FF-MLEV), 2-year beta, and adjusting for log(B/M)

We conduct the Fama-MacBeth regression analysis at the individual firm level, conducting our analysis on monthly data on excess return, 2-year beta (β^{2y}), the logarithm of ME (Size), the logarithm of book-to-market equity (BM), and leverage definitions used by Fama and French(1992, FF) and use the logarithm of book leverage (FF-BLEV). We report coefficient estimates and associated t-statistics (in parentheses) based on HAC standard errors following Newey and West (1987), to adjust for heteroskedasticity, as suggested by Andrews (1991). The data covers the observations of stock prices and firm characteristics obtained from CRSP and COMPUSTAT for the time period from 1963 to 2020, excluding financial firms (SIC codes 6000–6999).

	i	ii
β^{2y}	0,63	0,63
	(2,66)	(2,66)
Size	0,39	0,39
	(9,45)	(9,48)
log(BM)	0,54	0,65
	(8,67)	(10,07)
log(FF-BLEV)	-0,13	
	-(1,88)	
log(FF-MLEV)		-0,11
		-(1,54)
Firms	3808,44	3808,44

Our results imply that whenever book to market is added, the effect of leverage is jointly subsumed by the other factors, indicating that book to market, size, and beta collectively accounts for leverage impacts on returns, following Fama and French (1992). However, these findings were not found in table 7, thus arguments for book-to-market holding leverage effects on stock returns might apply, and the difference between market leverage and book leverage explain the leverage effect on stock returns, in accordance with Fama and French (1992).

5.6 Industry based portfolio regressions

As an addition to our analyses, we decided to take a look at the effect that both leverage and beta might have on excess return when sorting our sample into industry-based portfolios. When Modigliani and Miller (1958) found evidence of a positive relationship between leverage and returns, they conducted their study on the Utility and the Oil and Gas industry. Hamada (1972) tested the tax leverage proposition of Modigliani and Miller (1958) and found evidence supporting their findings. Based on this, we found it fitting to test our variables of interest on industry-based portfolios.

Table 9 reports the results on the effect of leverage on returns in various sectors, given by:

$$r_{it} - r_{f,t} = \hat{a}_i + \sum b_1 \times leverage_{it} + \hat{e}_{i,t} \tag{15}$$

When examining the table, we observe a positive leverage coefficient in the Agriculture, Transportation, Retail, and Public sectors. The leverage coefficient for the Agriculture sector suggests that for a one-unit increase in leverage, returns will increase by 2.24%. In the Transportation, Retail, Services, and Public sectors, we observe positive leverage coefficients, suggesting an increase in returns of 1,30%, 1,00%, and 2,24%, respectively, when increasing leverage by one unit.

In the Mining, Wholesale, and Service sectors, we observe a negative leverage coefficient, suggesting that a one-unit increase in leverage would lead to a decrease in returns of 1,57%, 0,91%, and 0,39%, respectively. In the remaining sectors, we observe no significant relationship between leverage and return. It is important to keep in mind that there are no additional control variables in our industry-based portfolio regressions, which means that the sign and magnitude are highly unlikely to remain unaffected when additional variables are accounted for. The table does, however, illustrate what the relationship between the variables might look like. Additionally, the standard errors have been made robust to heteroskedasticity.

Table 9: Regression results with leverage as the only independent variable

Table 9 displays the regression results of leverage as the independent variable for all sectors excluding the financial sector. The leverage is calculated as a ratio of the difference of total assets and book equity on the total assets, as explained in the methodology chapter. The stock returns for each company are calculated on a monthly basis in excess of the risk-free rate, as a percentage. The risk-free rate is provided by Kenneth French, retrieved from the WRDS database.

	Agriculture	Mining	Construction	Manufacturing	Transportation	Wholesale	Retail	Services	Public
BLEV	2,34	-1,57	-0,27	-0,12	1,30	-0,91	1,00	-0,39	2,24
	(2,26)	-(5,81)	-(0,44)	(0,13)	(3,73)	-(2,35)	(3,68)	-(2,37)	(7,81)
Firms	9686	152056	38389	1297635	263322	118724	441151	297363	3844

Table 10 reports the results on the effect of beta on returns in various sectors, given by:

$$r_{it} - r_{f,t} = \hat{a}_i + \sum b_1 \times \hat{\beta}^{2y}{}_{it} + \hat{e}_{it} \qquad (16)$$

The first thing to notice when examining table 10 is that all beta values with an acceptable significance level, are all positive. The results suggest that for a one-unit increase in the beta value, the excess return of the Mining, Construction, Manufacturing, Transportation, and Retail sectors would increase by 1,13%, 0,55%, 0,17%, 1,71%, and 0,81%, respectively. The standard errors have similar to the regression presented in table 9 been made robust to heteroskedasticity.

Table 10: Regression results with beta as the only independent variable

Table 10 displays the regression results of beta as the independent variable for all sectors excluding the financial sector. The beta variable is computed as a rolling CAPM regression of the previous 24 months of observation, as explained in the methodology chapter. The stock returns for each company are calculated monthly in excess of the risk-free rate, as a percentage. The risk-free rate is provided by Kenneth French, retrieved from the WRDS database.

	Agriculture	Mining	Construction	Manufacturing	Transportation	Wholesale	Retail	Services	Public
β^{2y}	0,99	1,13	0,55	0,17	1,71	-0,20	0,81	-0,05	0,18
	(1,91)	(4,93)	(3,51)	(2,44)	(8,39)	-(1,44)	(7,39)	-(0,41)	(0,69)
Firms	10159	163683	40240	1424073	282227	125968	220567	467931	266737

Table 11 reports the results on the effect of both leverage and beta on returns, given by:

$$r_{it} - r_{f,t} = \hat{a}_i + \sum b_1 \times leverage_{it} + b_2 \times \hat{\beta}^{2y}{}_{i,t} + \hat{e}_{it} \qquad (17)$$

When controlling for risk using the rolling CAPM regression of the previous 24 months to compute the beta of a stock, we see that in the Transportation sector, the effect of the leverage coefficient on excess return has been reduced to 1,18, suggesting that a one-unit increase in leverage leads to 1,18% increase in excess return. In the Retail and Public sectors, however, we observe a slight increase in the effect of leverage on excess return when controlling for risk. The leverage coefficient of the Retail sector has increased to 1,04, whereas the Public Sector has increased to 2,38. The leverage of the Agriculture coefficient appears to no longer be significant when controlling for risk. This may seem odd, considering that the beta coefficient appears to be insignificant as well. We could argue that the beta coefficient explains some of the effects that leverage appeared to have on excess return, but not enough for itself to be significant. This might indicate that there exists some relationship between leverage and beta, which we will examine in table 12. The sectors with negative leverage coefficients in table 9 are still statistically significant in Table 11 when controlling for risk. According to the output in table 11, the Mining, Wholesale, and Service sector should see a decrease of -2,18%, -1,09%, and -0,45% in returns excess of the risk-free rate. The leverage coefficient of these three sectors shows a stronger impact on the excess return when controlling for risk, as compared to the output in Table 9.

When it comes to the beta outputs in Table 11, the first thing to notice is that Manufacturing no longer appears to have a significant beta coefficient on the 95% significance level, whereas the beta coefficient of the Service sector has become significant. All observable beta coefficients that are significant, display a positive relationship between risk and return. The beta coefficient of the Mining, Construction, Transportation, Retail, and Service Sector has a beta coefficient of 1,29, 0,61, 2,04, 0,78, and 0,27, respectively.

In the three tables, we have presented so far, the relationship between leverage and excess return appears to differ when examining different sectors. This indicates that there could be significant advantages and disadvantages of increasing a company’s leverage, based on the sector in which it belongs. When controlling for risk, the Transportation, Retail, and Public sector seem to benefit from levering up, whereas the Mining, Wholesale, and Service sectors might be worse off.

Table 11: Regression results with leverage and beta

Table 11 displays the regression results of both the leverage and the beta as independent variables for all sectors excluding the financial sector. The leverage is calculated as a ratio of the difference of total assets and book equity on the total assets, as explained in the methodology chapter. The beta variable is computed as a rolling CAPM regression of the previous 24 months of observation, as explained in the methodology chapter. The stock returns for each company are calculated monthly in excess of the risk-free rate, as a percentage. The risk-free rate is provided by Kenneth French, retrieved from the WRDS database.

	Agriculture	Mining	Construction	Manufacturing	Transportation	Wholesale	Retail	Services	Public
BLEV	0,84	0,02	0,15	0,09	0,09	-0,12	0,38	0,16	0,81
	(4,64)	(0,37)	(1,61)	(4,83)	(2,20)	-(1,89)	(8,17)	(4,58)	(10,93)
β^{2y}	-0,89	-1,76	-1,18	-0,78	-0,49	-1,26	-0,96	-0,80	-2,29
	-(4,91)	-(26,84)	-(12,59)	-(44,27)	-(13,10)	-(20,05)	-(20,86)	-(23,14)	-(30,98)
Firms	8966	142262	359656	1236042	249776	111854	187280	405920	193367

When we regressed both leverage and beta on excess return, we noticed changes in both variables compared to regressing them independently on the excess return. This suggests that there might exist a relationship between leverage and beta. Due to these noticeable changes, we ran a regression of leverage on our two-year beta estimate to get a better understanding of the underlying relationship between these two variables on the industry-based portfolios. We tested the following model on our portfolios,

$$\beta_{it}^{2y} = \hat{a}_i + \sum b_1 \times leverage_{it} + \hat{e}_{it} \tag{18}$$

As it is natural to assume that risk will increase when increasing debt, we argue that beta is the dependent variable, and leverage the independent variable. The result of this regression is presented in table 12.

Table 12: Regression on beta with leverage as the independent variable

Table 12 displays the regression results of leverage on beta for all sectors excluding the financial sector. The leverage is calculated as a ratio of the difference of total assets and book equity on the total assets, as explained in the methodology chapter. The beta variable is computed as a rolling CAPM regression of the previous 24 months of observation, as explained in the methodology chapter.

	Agriculture	Mining	Construction	Manufacturing	Transportation	Wholesale	Retail	Services	Public
BLEV	0,09	0,37	0,41	-0,16	0,03	-0,07	-0,10	-0,46	0,10
	(1,96)	(27,91)	(12,14)	-(32,32)	(2,66)	-(4,35)	-(8,90)	-(57,07)	(12,75)
Firms	9686	152056	38389	1297635	263322	118724	441151	297363	3844

The results that are particularly interesting from this test, is that in the cases of the Mining, Construction, and Transport sectors, the inclusion of beta in the regression model in Table 11 shows an increase in the beta estimates when we include leverage. What we observe in Table 12, is that these sectors show a positive and significant relationship between leverage and beta, meaning that leverage appears to have a positive impact on the beta of a company in these sectors. If we look at the Retail sector, we notice a negative leverage coefficient on the regression of leverage on beta, and when we examine table 10 and table 11, we see that the beta estimate in this particular sector has decreased when including leverage as an independent variable in the regression. This suggests that in the Retail sector, leverage is associated with lower betas. In the Service sector we see that the inclusion of beta and leverage in the regression gives a positive, and significant beta estimate, whereas in the regression with beta as the only independent variable, we do not observe a significant relationship between beta and leverage. When we look at Table 12, however, we observe a significantly negative relationship between leverage and beta in the Service sector. As we can only speculate as to what the coefficient in table 10 could turn out to be, we could argue that given the relationship discovered, a negative coefficient in Table 12 suggests that the coefficient in Table 10 should be larger than 0.27, as observed in Table 11.

We found that for the Mining, Construction, and Transportation sector, there exists a positive relationship between leverage and beta. This is reflected in Table 11, as we see an increase in the beta coefficient when including leverage, compared to solely regressing beta on excess return as presented in table 10. In the Retail sector, we see the opposite relationship, where the leverage coefficient is negative as shown in Table 12, and by comparing Table 11 to Table 10 we see a reduction in the beta coefficient when including leverage.

5.7 Cross-sectional relationship between Beta and Leverage

Our empirical study also investigates the relationship between our two definitions of book and market leverage to beta in accordance with Hamada (1972). We conduct the regression models using a 2-year beta, as well as BLEV, MLEV and adjusting for the size. In addition, we tested the same model, when using the log of our leverage ratios, which provided close to identical results, thus we exclude our results for log(LEV), in our analysis.

Table 13: Fama-MacBeth regression analysis using 2-year beta as the dependent variable, and BLEV, MLEV, and Size as independent variables

We conduct the Fama-MacBeth regression analysis at the individual firm level, conducting our analysis on monthly data on 2-year beta (β^{2y}), book leverage (BLEV), market leverage (MLEV), the logarithm of ME (Size). We report coefficient estimates and associated t-statistics (in parentheses) based on HAC standard errors following Newey and West (1987), to adjust for heteroskedasticity, as suggested by Andrews (1991). The data covers the observations of stock prices and firm characteristics obtained from CRSP and COMPUSTAT for the time period from 1963 to 2020, excluding financial firms (SIC codes 6000–6999).

	i	ii	iii	iv
BLEV	-0,03	-0,02		
	-(0,15)	-(0,12)		
MLEV			-0,24	-0,25
			-(1,13)	-(1,15)
Size		-0,01		-0,01
		-(0,55)		-(0,73)
Number of firms	3753,33	3753,33	3753,33	3753,33

In all models, our results show a negative relationship between beta and leverage, which is contradictive with the theory provided by Hamada (1972). Furthermore, in chapter 5.4, when estimating the effect of MLEV, beta, and size on stock returns, all characteristics are positively related to stock returns, yet MLEV and beta are negatively related. In Panel B from table 5, we see whenever adding beta in our model, the estimate of MLEV tends to decrease, hence our results are the opposite of those discovered by Hamada (1972). Additionally, from table 5 looking at market leverage, we see that when adjusting for size and beta, our leverage estimate's impact on returns decreases compared to when only adjusting for size. Hence when adjusting for size when regressing leverage on beta, we see that size consumes some of the information regarding leverage effects on beta.

Book Leverage, on the other hand, is as expected when looking at chapter 5.3, negatively related to stock returns. However, all estimates are very insignificant, thus we conclude opposite of Hamada (1972), that there is no relation between either leverage measure or beta.

5.8 Robustness

Our empirical analyses provides mixed evidence in the relation between leverage and return. The results using book leverage suggests from portfolio sorts that increased leverage should result in reduced stock returns, which is also consistent with our evidence from the Fama-MacBeth regression analysis. In addition, we included t-statistics following Newey and West (1987), adjusting for heteroskedasticity to increase the robustness of our models. Furthermore, Korteweg (2004), as well Dimitrov and Jain (2006), found similar results in their studies. Hence, we can conclude our book leverage analysis to be considered robust.

From our results when analyzing market leverage, the portfolio sorts suggest the opposite compared to book leverage, consequently higher leverage yields higher returns, which also is consistent with our Fama-MacBeth regressions, even when adjusting for other factors, as well as using the log of MLEV. These findings are also in compliance with those found by both, Bhandari (1988), Hamada (1972) in addition to the results of Modigliani and Miller (1958)

Replicating Fama and French (1992), our results suggest an inverse relation between FF-BLEV and FF-LEV. Book leverage estimated from the definition of Fama and French implies the same results as our definition of book leverage, whereas FF-MLEV gives equal results as market leverage as we define it. When comparing our results using log(FF-LEV), we see contradicting information on stock returns individually, which are jointly shared when adjusting for other factors, such as size and beta. However, all explanatory power is subsumed by book to market when controlled for. Hence our conclusion is equivalent to the one of Fama and French (1992), thus robust.

6 Conclusion

In our thesis we have applied different techniques to investigate the relationship between different leverage measures, betas, and stock returns, both individually and when controlling for different factors. Our models are based on Fama and French (1992), by conducting portfolio sorting and running regressions based on Fama-MacBeth (1973). Our model implies already from portfolio sorts, by using summary statistics, that low-levered compared to high-levered firms obtain higher returns. We complement evidence of shareholders only demanding a risk premium for higher leverage based on book values when the systematic risk factors are based on a 2-year horizon. Furthermore, there does not exist significant evidence from the high minus low portfolio sorts of higher leverage giving higher returns.

If we control for other characteristics when using BLEV and MLEV, we see a more mutual relation between leverage and equity returns. This either implies that on some occasions the leverage effects are subsumed by size in particular, or sometimes beta, or a jointly explained relation between leverage together with the other factors, and stock returns. Consequently, we find a strong explanatory power when using beta based on a horizon of less than or equal to two years, which is consistent with Sharpe (1964). Conversely, when adjusting for size and leverage, some of the explanatory power from beta is consumed by these factors, mainly by size. Furthermore, with the short horizon beta to be significant in almost every model, our results might somewhat surprisingly suggest that CAPM holds, however, we do not assume all other assumptions to be true, hence we cannot conclude CAPM to hold.

Consistent with the findings of Fama and French (1992), our results provide information on the log of FF-BLEV and FF-MLEV not being able to explain equity returns individually. Whereas conducting the log of the leverage ratios, the leverage-return relation consists of an inverse relation between FF-BLEV and FF-MLEV. Those being higher FF-BLEV reduces returns, whereas increased FF-MLEV increase returns. Also, when adjusting for beta and size, a jointly explanatory power in the information of stock returns hold. The log relation between the Fama and French leverage ratios also holds information on stock returns and becomes more significant when accounting for size and beta. However, when adjusting for book-to-market our results imply that whenever book-to-market is added, the effect of leverage is consumed by the other factors, indicating that book-to-market, size, and beta collectively account for leverage impacts on returns, following Fama and French (1992).

Throughout our empirical results, we have found mixed evidence of leverage being related to stock returns. In compliance with MM (1958), as well as Bhandari (1988) we see that leverage independently on some occasions holds information on stock returns, also when adjusting for other characteristics, similarly to Hamada (1972). However, it seems our results are more consistent with Fama and French (1992), since leverage is, jointly with beta and size, correlated to returns, also when using the log of leverage. Furthermore, we have found strong evidence, quite contrary to Fama and French (1992), that beta is related to returns, comparable to Sharpe (1964). These results are quite surprising compared to other studies conducted and might imply that CAPM holds. However, we do not have enough evidence to draw this conclusion, and a reason behind our significant beta values, when estimated on a shorter horizon, might be our sample period. Finally, we cannot find any strong evidence of leverage being related to beta. Despite finding significant evidence of both factors being related to returns, from our Fama-MacBeth regression analysis in chapters 5.3 and 5.4. However, there does not exist any significant relationship between the two, from our cross-sectional regression analysis. These findings contradict Hamada (1972), both regarding leverage not being positively related to beta, as well as leverage not being significantly related to beta.

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