Managerial Characteristics and Firm Risk

A Panel Study on the Relation between CEO Characteristics and Stock Volatility in the US

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Abstract: This thesis examines the relation between CEO characteristics and stock volatility for a sample of 227 S&P500 firms during the period of 1996 to 2010. After controlling for firm-specific factors, our results give strong evidence that certain CEO characteristics are significantly related to firm volatility. We find that age, time spent with the company and a CEO's base salary are negatively associated with volatility. On the other hand, time in role, CEO experience and education are positively associated with volatility. Our results are robust across different volatility measures and model specifications and carry implications for shareholders, corporate control bodies and investors.

Keywords: *CEO characteristics, managerial risk appetite, executive compensation, stock volatility, firm risk.*

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1. Introduction

Risk assessment has always been an important part of investors' decision making process as they balance expected performance against volatility and create corporate risk-return profiles for their investment decisions. It is therefore beneficial to study the factors that help explain and predict return volatility, including managerial characteristics. These characteristics may directly affect a firm's risk aversion, management style and corporate behavior, and thereby the level of stock volatility.

The recent financial and economic crises are vivid examples of how excessive managerial risk-taking can damage a firm's value and the interests of a wide range of stakeholders, including shareholders, employees, creditors and clients. Thus, to understand which factors affect a manager's attitude towards risk is of considerable academic and practical interest. Although there are studies that relate volatility to firm-specific factors, we only know of few other studies that examine the relation between managerial characteristics and stock volatility for non-financial firms.

Using a set of 227 S&P500 firms with a total of 583 CEOs over a period of 15 years, we examine managerial characteristics that could be associated with CEO risk appetite and the level of firm volatility. These characteristics include age, tenure, compensation, experience, education and power concentration.

The remainder of this thesis is structured as follows. In section two, we have a look at previous research related to our thesis. Thereafter, section three points out our contribution to the existing literature and presents our major hypotheses and expected results. We then describe the data as well as the methodology applied. This is followed by section five which presents our empirical findings and major economic insights of our analysis. Finally, we critically evaluate the validity of our findings and present our suggestions for further research as well as our conclusion.

2. Previous Research

We generally observe two different strands of existing empirical research that are related to our thesis. On the one hand, researchers have studied the relation between risk and return as well as diverse factors affecting firm risk, including company characteristics, managerial (equity based) compensation and corporate governance mechanisms. On the other hand, we find a vast amount of literature on CEOs and the impact that certain managerial characteristics can have on various corporate outcome variables, primarily on performance. However, the literature that links these two strands is very limited so far. This is especially true for the non-financial sector.

2.1. Firm Risk and Stock Volatility

Traditional research primarily focuses on the trade-off between risk and return, and more precisely on the rate of return required by investors in risky assets. In the 1960s, Sharpe (1964), Lintner (1965a,b) and Mossin (1966) independently introduced the Capital Asset Pricing Model (CAPM) which builds on Markowitz's (1952) mean-variance efficiency analysis and is derived within the Von Neumann and Morgenstern (1953) expected utility framework, which is based on the assumption of risk-averse investors. In the 1970s, Merton (1973) develops his Intertemporal Capital Asset Pricing Model (ICAPM) which can be regarded as an extension of the CAPM. Later, Fama and French (1993, 1996) suggest their three-factor model which uses diversified portfolios formed on size and book-to-market in addition to the market portfolio to predict returns. Based on that, Carhart (1997) introduces a four-factor model that additionally includes momentum. Until today, these models on risk and return are the pillars of modern portfolio and asset pricing theory and the inspiration for thousands of academic articles.

Many of the more recent studies look at diverse factors affecting firm risk, including company characteristics such as size and leverage. Firm size has been argued to affect volatility in either a positive or a negative direction. Anderson and Fraser (2000) and Saunders et al. (1990) document a negative effect of total assets on firm risk. On the contrary, Demsetz and Strahan (1997) argue that larger companies can undertake riskier investments and pursue riskier business strategies. According to Akhigbe and Martin (2008), higher leverage is also related to higher risk and increased firm volatility. Similarly to leverage and size, also the probability of default affects volatility. Vassalou and Xing (2004) find a significant effect of bankruptcy risk on stock returns and conclude that the size effect in fact is only a certain form of default effect, i.e. bigger firm size is related to a lower default risk.

Further, liquidity is also crucial for explaining stock returns and is therefore strongly related to firm volatility. Amihud (2002) shows that there exists an illiquidity premium which is priced in expected stock returns. He finds that expected stock returns are positively related to illiquidity. Pástor and Stambaugh (2003) confirm the importance of stock liquidity when explaining stock returns.

The effect of (equity based) compensation on firm risk in the context of agency conflicts between managers and shareholders has also been in the focus of numerous empirical contributions. For the financial sector, Chen et al. (1998) find that banks with low managerial equity ownership exhibit greater risk, while Saunders et al. (1990) find empirical evidence for the opposite. For the non-financial sector, numerous authors find a positive relationship between option-based compensation and firm risk, for example Agarwal and Mandelker (1987), DeFusco et al. (1990) and Chok and Sun (2007).

Other studies examine the impact that corporate governance mechanisms can have on firm risk. Pathan (2009), for example, examines the relevance of board structure on risk-taking and finds that a strong influence of CEOs on board decisions is negatively associated with risk-taking, whereas boards that reflect the shareholders' interests lead to more risk.

2.2. CEOs and Managerial Characteristics

The literature on CEOs and their effects on corporate outcomes is huge and there has always been a great effort to link managerial characteristics with corporate actions and behavior. Thereby, researchers mostly focused on the effect of CEO characteristics on corporate performance. Cooper et al. (2010) investigate the impact of CEO compensation, Henderson et al. (2006) study the effect of CEO tenure and Gottesman and Morey (2010) examine the influence of CEO educational background on firm performance. Further performance studies have been carried out by Aggarwal and Samwick (1999), Agrawal et al. (1991), Core et al. (1999), Coughlan and Schmidt (1985), Goldberg and Idson (1995), Jensen and Murphy (1990a,b), Lewellen et al. (1987) and Mehran (1995).

Not only the impact on corporate performance has been studied, also other corporate outcome variables and attributes have been of interest in recent research. Barker and Mueller (2002) explore the relationship between CEO characteristics and R&D spending, Custódio and

Metzger (2012) investigate the relation between CEO experience and bidder companies' M&A performance and Bebchuk and Grinstein (2005) study the effect of CEO pay on firm expansion decisions.

Other studies focus on the relation between management skills, executive compensation and a firm's decision whether to recruit a CEO internally or hire an external CEO. Murphy and Zábojník (2004, 2007) argue that general management skills (as measured by an MBA degree) have become relatively more important than firm-specific skills (as measured by CEO tenure in the firm). The authors show that the greater importance of general management skills, which in contrast to firm-specific skills are easily transferable across firms, has led to fewer internal promotions, more external CEO hires and an increase in executive pay. Frydman and Saks (2010) find similar results using CEO panel data from 1936 to 2005.

2.3. Relationship between CEOs and Firm Risk

The literature that captures the effect of managers' biographical characteristics on firm volatility is rather limited and predominantly focuses on financial institutions. Clayton et al. (2003) examine the impact of CEO turnover on equity volatility over the period of 1979 to 1995 for US mid- to large cap companies. The authors find that CEO turnovers cause a rise in volatility. Furthermore, voluntary turnovers increase volatility less than forced turnovers.

Anderson and Fraser (2000) study the effect of managerial shareholdings on bank risk-taking behavior. Their results propose a positive relationship between managerial shareholdings and firm risk in the late 1980s. However, the authors observe that, by the early 1990s, firm risk and managerial shareholdings became negatively related, following a change in legislation aimed at reduced risk-taking.

Similarly, Chen et al. (2006) examine the relation between option-based managerial compensation and risk-taking for commercial banking firms during 1992 to 2000 and find that risk-taking is induced by the structure of CEO compensation (proxied by stock options as a percentage of total compensation). Moreover, Chok and Sun (2007) relate managerial characteristics and CEO stock options to idiosyncratic volatility for a sample of biotech IPO firms from 1996 to 2001 and find that the board members' age, CEO stock options and resource dependence capabilities help explain idiosyncratic volatility.

Finally, Belghitar and Clark (2011) study the effect of CEO risk appetite (as proxied by age, time in role, wealth, number of educational degrees and time spent in other boards) on the stock volatility of 45 UK financial institutions from 2000 to 2008. Using four different measures of firm volatility, the authors find that biographical risk appetite measures are significant explanatory variables of firm risk.

Further studies on CEOs and risk (appetite) have been carried out by Campbell et al. (2001), Finkelstein and Hambrick (1990), Hall (1998), Hirshleifer and Suh (1992), Hitt and Tyler (1991), Johnson and Marietta-Westberg (2003) and Rosen et al. (2003).[1]

3. Purpose and Focus

The purpose of this thesis is to bring the two above-mentioned empirical strands together and make a contribution in the field of CEO studies by providing a sound empirical framework to investigate the relation between managerial characteristics and stock volatility.

3.1. Contribution to the Existing Literature

We lay the focus on managerial attributes and biographical data and intend to shed further light on the relation between different measures of return volatility and a comprehensive set of CEO characteristics that capture risk attitude. Our aim is to make a valuable contribution in this research area and provide a motivation to further explore this innovative field of study.

Contrary to most of the existing research, we focus on a relatively long period from 1996 to 2010. Thereby, we capture several economic downturns and crises, as well as years of corporate recovery and prosperity.[2] This drives stock volatility and creates a substantial amount of cross-sectional variation. Moreover, unlike most other studies that relate CEO characteristics and firm volatility, we exclude firms from the financial and utility sectors and create a large sample of US companies for which we test our hypotheses.

[1] Empirical findings and results of the stated papers will be presented in section 3.2. in the context of our hypotheses and expected results.

[2] See also Figure I for a graphical analysis of different volatility measures during this observation period.

Further, we define a unique set of managerial characteristics that include biographical data as well as other executive determinants, such as compensation and power concentration. Thereby, our set of variables does not only capture widely accepted risk attitude characteristics, but also explores new areas of managerial attributes that have not been accounted for so far. In comparison with existing studies, we gather data on a relatively large sample with 227 companies and 583 CEOs. With a total of 2,913 firm-CEO-year observations, our sample exhibits a substantial amount of cross-sectional and time-series variation.

Finally, prior studies tend to focus on one dimension of managerial characteristics or compensation effects only. We look at multiple dimensions that could be related to firm volatility. By splitting our CEO biographical characteristics into different categories, we are able to investigate CEO experience, education, age and time in role, and to further look at CEO compensation and managerial power concentration.

3.2. Hypotheses and Expected Results

Generally, Gottesman and Morey (2006, 2010) find that CEO characteristics have an effect on organizational outcomes. More specifically, Hall (1998) develops a proxy for CEO risk attitude by using biographical characteristics of top executives and Johnson and Marietta-Westberg (2003) as well as Campbell et al. (2001) find a connection between managerial characteristics and company risk. Consequently, we develop our main hypothesis:

Hypothesis I: There exists a significant relationship between CEO characteristics and stock volatility.

Based on that, we develop further hypotheses that specify our characteristic categories and state our expected results. Where existing literature provides a controversial discussion, we include counter-arguments that challenge our own expectations and hypotheses.

Volatility and Age

Hitt and Tyler (1991) find that CEO age is negatively related to risk taking. The authors' main argument is that older and more experienced CEOs are more cautious and risk-averse. They find older CEOs to be more conservative and thereby less willing to accept additional risk. We agree with that point of view and conclude that older, more experienced CEOs are less willing to accept higher risks and to drive change.

Consequently, we develop our second hypothesis:

Hypothesis II: CEO age is negatively associated with stock volatility.

On the contrary, Chok and Sun (2007) find that CEO age is positively associated with firm volatility in the biotech industry. Further, Golden and Zajac (2001) find a positive relation between CEO age and a change in corporate strategy. They argue that a change in corporate strategy requires a substantial amount of experience, which is more inherent in older CEOs.

Volatility and Tenure

By having spent some time as CEO, executives may wish to conserve this state of nature. This is in line with Hitt and Tyler (1991) who argue that CEOs become more cautious with increasing age. Further, also agency theory provides a suitable argument that some CEOs try to secure their current position by building their own empire and entrenching their post. Empire building takes time and therefore, only CEOs that have been in their position for some time may exhibit this phenomenon. Bearing that in mind, Berger et al. (1997) find that CEO entrenchment leads to lower levels of firm leverage. In general, this avoidance of debt in turn has a negative effect on the probability of default. Therefore, one could argue that CEO tenure, in the context of managerial entrenchment, is negatively related to firm volatility. Regardless of CEO entrenchment and empire building, this standpoint is supported by the findings of Belghitar and Clark (2011) who document that CEO tenure negatively affects firm risk. We agree with that opinion and develop our third hypothesis:

Hypothesis III: CEO tenure is negatively associated with stock volatility.

On the contrary, one could expect older CEOs to exhibit a greater tenure value than their younger colleagues. In line with Chok and Sun (2007) and Golden and Zajac (2001), it could be argued that CEOs who have already been in their current role for some time are more willing to accept higher risks, which in turn should increase firm volatility. Supporters of this hypothesis may assume that CEOs are highly concerned with keeping their job during the first years after their appointment. This should drive "new" CEOs to take less risk. Accordingly, CEOs who have already been in their position for some time may often be benchmarked against their own past performance. This, in turn, could lead to increased risk-taking, and thus higher levels of firm volatility.

Volatility and Compensation

Coles et al. (2006) find that managerial compensation has an effect on a company's financial decision making. Hirshleifer and Suh (1992) find similar results and document that CEO compensation is positively related to risk-taking behavior. Both studies look at compensation in the form of stock options. On overall firm level, Chen et al. (2006) confirm these findings and positively associate option-based compensation with firm risk. They conclude that especially stock options induce higher risk-taking in CEOs and are therefore positively related to firm volatility. In contrast to existing studies, we only include CEOs' fixed salaries in our study and argue that managers with low fixed salaries have a greater appetite for risk. In order to compensate for their lower fixed salary, one could suggest they are keener on increasing firm risk by accepting riskier projects to magnify potential future corporate performance, and thus to increase their total compensation. Given this line of reasoning, CEOs with a lower fixed salary may be more willing to increase firm risk. Consequently, we develop our fourth hypothesis:

Hypothesis IV: CEO fixed salary is negatively associated with stock volatility.

On the other hand, one could question why the fixed-part of the managerial compensation should be associated with higher risk-taking and firm volatility. Since we leave out the option-based, variable compensation part, there might not be any strong reason, why compensation should be related to firm volatility at all. This is supported by the fact that we have not encountered any literature about the relation of a CEO's fixed salary and overall firm volatility.

Volatility and Experience

Hambrick et al. (1993) find a positive relation between CEO experience and the managers' willingness to maintain the corporate status quo. Similiary, Thomas and Ramaswamy (1996) find that CEO experience is negatively related to a change in corporate strategy. Finally, Finkelstein and Hambrick (1990) find that CEO experience is negatively associated with managerial risk appetite. We agree with that opinion and conclude that more experienced CEOs may be more risk-averse and less willing to accept the potential advantages of risk-taking. A reduced managerial risk appetite should thereby be negatively related to firm volatility. Consequently, we develop our fifth hypothesis:

Hypothesis V: CEO experience is negatively associated with stock volatility.

On the other hand, one could argue that managers need a certain level of experience to identify and value the potential advantages of higher risk-taking. This would imply that CEOs with a higher degree of experience exhibit a greater risk appetite. As argued by Belghitar and Clark (2011), this could have a positive effect on overall firm volatility.

Volatility and Education

Rosen et al. (2003) find that education is negatively related to risk-aversion, concluding that a higher degree of education leads to more risk-taking. The main argument is that education provides the ability to better evaluate and understand the characteristics and implications of a certain decision. Thus, risk is not necessarily perceived as something purely negative that one has to be afraid of. We find this argument coherent and develop our sixth hypothesis:

Hypothesis VI: CEO education is positively associated with stock volatility.

However, a less educated CEO may simply be less able to evaluate a problem at hand in its full complexity. Therefore, a CEO may just take a riskier decision due to a lack of understanding the consequences of this decision. Further, one could argue that education enables executives to more efficiently collect information about a decision making problem. This may enable educated CEOs to better identify potential drawbacks of a corporate decision or strategy, making them more reluctant to take a decision. Thereby, the higher degree of information about potential pitfalls may induce an unwillingness to take higher risks.

Volatility and Power Concentration

We measure power concentration in form of CEO duality in a wider sense, i.e. if a CEO is also member of the board at the time of his or her appointment. In past literature, researchers focused on the effect of CEO duality on corporate performance. Rechner and Dalton (1991) find that firms relying upon CEO duality have been outperformed by their peers that did not exhibit this sort of managerial power concentration. Bearing this finding in mind, managerial action and decision making may be less challenged by a control committee in firms with CEO power concentration, leading to less pressure to increase firm performance. Since risk and performance are often positively related, we argue that CEO power concentration is not only associated with lower performance but also lower risk. Thus, our seventh hypothesis states:

Hypothesis VII: CEO power concentration is negatively associated with stock volatility.

On the other hand, there is also literature that suggests different results. Elsayed (2007) and Baliga et al. (1996) document that there is no proof that CEO duality has an impact on corporate performance. Similarly, one could argue that also firm volatility should not be related to CEO duality.

4. Data and Methodology

In the section below, we elaborate on the kind of data collected and describe the sources used to gather the data as well as the variables built from that information. Moreover, we present the methodology applied in this study.

4.1. Data Selection

The data selection and gathering process constitutes a major part of this thesis. As we aim to thoroughly build a new, not yet existing database that comprises CEO- and company-related information for nearly 3,000 CEO-firm-year observations, we spent a significant proportion of our research resources on data collection and cleaning. Thereby, we are not only able to deliver a versatile study on CEO characteristics, but also to create a unique dataset that may prove beneficial and valuable for further research.

In our analysis, we focus on US listed companies that joined the S&P 500 on January 1, 1991 or later.[3] The S&P 500 is not only one of the most cited and used indices in financial research. It is also representative of the US economy and captures companies from all relevant industries. This provides our study with a broad scope and cross-sectional variation and makes our results applicable to a wide group of companies. From this list, we exclude all companies that have not had at least two CEOs between the time they joined the index and today. We do so to ensure a certain degree of leadership variation.

We further exclude all utility companies and financial institutions due to the heavy regulation in the utility sector and the accounting particularities in the financial industry. After excluding

[3] We do so for data availability reasons and to avoid any survivorship bias as well as to guarantee the creation of a random cross-sectional sample.

companies and CEOs with incomplete information,[4] we are left with 227 companies and 583 CEOs and in total, our panel includes 2,913 observations. Examples of famous CEOs in our sample include Bill Gates and Steve Ballmer (both Microsoft), Howard Schulz (Starbucks) and Eric Schmidt (today Google). Well-known companies in our sample include Ebay, Yahoo, Dell, Harley-Davidson, Time Warner, Moody's and Accenture.

We manually collect CEO biographical data online from the Forbes and BusinessWeek websites[5] that store profiles and information about American top executives. Further, we gather information from Execucomp, the companies' investor relations websites and annual reports to complete our data collection process on CEOs. We use accounting data from Compustat and stock data from the Center for Research in Security Prices (CRSP) as well as Compustat.

4.2. Definition of Variables

According to Hall (1998) and Belghitar and Clark (2011), biographical characteristics of CEOs are a good proxy for their risk appetite. We follow the same approach and apply the CEO risk appetite categories age, tenure, compensation, experience, education and power concentration.

Moreover, since not all investors can perfectly diversify their investment portfolio, this thesis focuses on total stock volatility and does not distinguish between systematic and idiosyncratic volatility. This distinction is suggested a field for further research.

Next, we define our dependent and independent variables as well as our control measures. The volatility measures are subdivided into two measures of total volatility (TV), two measures of downside volatility (DV) and two measures of upside volatility (UV).

Total Volatility Measures

French et al. (1987) use high-frequency data to calculate stock volatilities. Since technological progress makes high-frequency data available, this approach has been followed by many researchers. We also follow this idea and use daily stock data to estimate our volatility measures.

[4] We ensure that exclusions due to a lack of information are unsystematic and do not lead to selection biases.
[5] http://people.forbes.com and http://investing.businessweek.com.

According to Feunou et al. (2011), variance and standard deviation measures are appropriate proxies for risk and therefore applied in many financial studies. Consequently, we calculate the standard deviation of daily log returns and define *TV I* as follows:[6]

$$TV\ I_{iy} = \sigma_{iy} = \sqrt{\frac{1}{D_{iy}} \sum_{D=1}^{D_{iy}} (r_{iyd} - \bar{r}_{iy})^2} \tag{1}$$

According to Andersen et al. (2003, p.529), the use of high-frequency returns to construct realized volatilities enables research to avoid "potentially restrictive and complicated parametric multivariate ARCH or stochastic volatility models." We follow this approach and calculate the realized volatility of daily log returns (*TV II*). By assuming that daily log returns follow an MA(1) model, we estimate the yearly standard deviation as:[6]

$$TV\ II_{iy} = \sigma_{iy}^{realized\ vol} = \sqrt{\frac{D_{iy}-1}{D_{iy}} \sum_{D=1}^{D_{iy}} \left(r_{iyd} - \bar{r}_{iy}\right)^2 + 2 \sum_{D=1}^{D_{iy}-1} \left(r_{iyd} - \bar{r}_{iy}\right)\left(r_{iyd+1} - \bar{r}_{iy}\right)} \tag{2}$$

Up- and Downside Volatility Measures

According to Feunou et al. (2011), both up- and downside risk are relevant, even though investors are more concerned about downside risk. This is especially true in markets that are extremely volatile and investors want to be compensated for this downside potential. This asymmetry in stock markets has been studied extensively and is still a widely-discussed topic.[7] Barndorff-Nielsen et al. (2008) develop a semi-variance measure that accounts for realized downside risk. Ang et al. (2006) show that stock returns exhibit a compensation premium for downside risk. Feunou et al. (2011) define downside as the state, when a return falls below a defined threshold. When the return climbs above this threshold, it is called upside risk. We follow this definition and describe our up- and downside volatility measures in the following.

Downside volatility is measured by the standard deviation of negative daily log returns (*DV I*) and the standard deviation of below-average log returns (*DV II*). We apply two thresholds to

[6] D_{iy} is the amount of trading days in year y for stock i, r_{iyd} is the log return of stock i on day d in year y and $\bar{r}_{iy}$ is the sample mean of the daily log returns in year y for stock i: $\bar{r}_{iy} = \frac{1}{D_{iy}} \sum_{D=1}^{D_{iy}} r_{iyd}$.

[7] For a review of the respective literature in this field, see Bollerslev and Zhou (2006) and Brandt and Kang (2004) for more recent studies and Bekaert and Wu (2000) and Hansen (1994) for earlier work.

create our downside volatility measures and calculate the yearly variance of all daily log returns that are negative or zero as well as the yearly variance of all daily log returns that are below or equal to the average daily log return in the respective year. We then take the square root to compute the standard deviation:[8]

$$DV\ I_{iy} = \sigma_{iy}^{neg} = \sqrt{\frac{1}{D_{iy}^{neg}} \sum_{D=1}^{D_{iy}^{neg}} (r_{iyd}^{neg} - \bar{r}_{iy}^{neg})^2} \tag{3}$$

$$DV\ II_{iy} = \sigma_{iy}^{<avg} = \sqrt{\frac{1}{D_{iy}^{<avg}} \sum_{D=1}^{D_{iy}^{<avg}} (r_{iyd}^{<avg} - \bar{r}_{iy}^{<avg})^2} \tag{4}$$

Upside volatility is measured by the standard deviation of positive daily log returns ($UV\ I$) and the standard deviation of above average log returns ($UV\ II$). As with our downside volatility measures, we apply two thresholds to create our upside volatilities and calculate the yearly variance of all daily log returns that are positive as well as the yearly variance of all daily log returns that are above the average daily log return in the respective year. We then take the square root to compute the standard deviation:[9]

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[8] D_{iy}^{neg} is the amount of trading days in year y for stock i where the daily log return $r_{iyd} \leq 0$ and $D_{iy}^{<avg}$ is the amount of trading days in year y for stock i where the daily log return $r_{iyd} \leq \bar{r}_{iy}$. $\{r_{iyd}^{neg}\}_{D=1}^{D_{iy}^{neg}}$ are the daily log returns of stock i on day d in year y which have been zero or negative and $\{r_{iyd}^{<avg}\}_{D=1}^{D_{iy}^{<avg}}$ are the daily log returns of stock i on day d in year y which have been equal to or smaller than $\bar{r}_{iy}$. $\bar{r}_{iy}^{neg}$ is the sample mean of the daily zero or negative log returns in year y for stock i: $\bar{r}_{iy}^{neg} = \frac{1}{D_{iy}^{neg}} \sum_{D=1}^{D_{iy}^{neg}} r_{iyd}^{neg}$ and $\bar{r}_{iy}^{<avg}$ is the sample mean of the daily log returns that are equal or smaller than $\bar{r}_{iy}$ in year y for stock i: $\bar{r}_{iy}^{<avg} = \frac{1}{D_{iy}^{<avg}} \sum_{D=1}^{D_{iy}^{<avg}} r_{iyd}^{<avg}$.

[9] D_{iy}^{pos} is the amount of trading days in year y for stock i where the daily log return $r_{iyd} > 0$ and $D_{iy}^{>avg}$ is the amount of trading days in year y for stock i where the daily log return $r_{iyd} > \bar{r}_{iy}$. $\{r_{iyd}^{pos}\}_{D=1}^{D_{iy}^{pos}}$ are the daily log returns of stock i on day d in year y which have been positive and $\{r_{iyd}^{>avg}\}_{D=1}^{D_{iy}^{>avg}}$ are the daily log returns of stock i on day d in year y which have been greater than $\bar{r}_{iy}$. $\bar{r}_{iy}^{pos}$ is the sample mean of the daily positive log returns in year y for stock i: $\bar{r}_{iy}^{pos} = \frac{1}{D_{iy}^{pos}} \sum_{D=1}^{D_{iy}^{pos}} r_{iyd}^{pos}$ and $\bar{r}_{iy}^{>avg}$ is the sample mean of the daily log returns which are greater than $\bar{r}_{iy}$ in year y for stock i: $\bar{r}_{iy}^{>avg} = \frac{1}{D_{iy}^{>avg}} \sum_{D=1}^{D_{iy}^{>avg}} r_{iyd}^{>avg}$.

$$UV\ I_{iy} = \sigma_{iy}^{pos} = \sqrt{\frac{1}{D_{iy}^{pos}} \sum_{D=1}^{D_{iy}^{pos}} (r_{iyd}^{pos} - \bar{r}_{iy}^{pos})^2} \quad (5)$$

$$UV\ II_{iy} = \sigma_{iy}^{>avg} = \sqrt{\frac{1}{D_{iy}^{>avg}} \sum_{D=1}^{D_{iy}^{>avg}} (r_{iyd}^{>avg} - \bar{r}_{iy}^{>avg})^2} \quad (6)$$

Following Andersen et al. (2003), we use the logarithm of the volatility measures (1) – (6) in our regression framework.

CEO Characteristics

We include the CEO risk appetite categories age, tenure, compensation, experience, education and managerial power concentration. *Age* is defined as the CEO's age in years at year-end. Following Belghitar and Clark (2011), we use *log (age)* in our regression analysis. *Tenure* is the length of time in years that the CEO has already been in his or her current role at year-end.

Compensation is measured by a CEO's fixed *salary*. This is the dollar value of the base salary (cash and non-cash) earned by the CEO during the fiscal year. *Salary* is inflation-adjusted and indexed to the base year 2010 to make salaries comparable over time. Since a CEO's fixed base salary is determined upfront in his or her employment contract and does neither depend on the company's stock development nor on the firm's operational figures, we can rule out any endogeneity and reverse causality issues.

To account for experience, we include the variables *years with company*, *CEO experience* and *executive board experience*. *Years with company* measures the time that each CEO has worked for the company prior to being named CEO. This variable further captures whether a CEO is externally or internally hired (0 if he is externally hired). *CEO experience* is a dummy variable that equals 1 if the CEO has gained CEO experience at another company prior to being appointed to the current role and 0 if the CEO has never worked as CEO before. *Executive board experience* is a dummy variable that equals 1 if the CEO has been member of the executive management team (e.g. CFO or COO) prior to being appointed CEO and 0 otherwise.

Education is measured by the two variables *top education* and *MBA*. *Top education* is a dummy variable that equals 1, if the CEO holds at least one degree from a top-ranked educational institution, and 0 if not. We collect data about the universities each CEO attended,[10] choose eight recent well-known university rankings[11] and take the top 30 schools from each ranking. For every CEO, we allocate a value of 1 if he or she received at least one degree from one of these top universities and 0 otherwise.[12] *MBA* is also a dummy variable that equals 1 if the CEO holds an MBA and 0 if not.

Finally, we define managerial power concentration as CEO duality in a wider sense. CEO duality generally means that both the chairman of the board and the CEO are the same person. We widen this definition and look at CEOs that generally have been member of the board, not necessarily chairman.[13] *Board of directors membership* is a dummy variable which equals 1 if the CEO has been member of the board at the time of his or her appointment and 0 otherwise.

Control Variables

We include five control variables in order to capture various manifestations of firm heterogeneity. Most relevant empirical studies evaluate the effect of firm size on volatility. Size has been argued to affect volatility in either a positive or a negative direction. For the financial industry, Anderson and Fraser (2000) and Saunders et al. (1990) document a negative effect of total assets on firm risk. Their main argument stems from a company's opportunity to diversify its business activities which is related to total firm size. On the contrary, Demsetz and Strahan (1997) argue that larger companies can undertake riskier investments and pursue riskier business strategies and therefore firm size increases overall risk. Size is measured as the *log of total assets*.

Further, we control for *leverage*. According to Akhigbe and Martin (2008), company leverage affects volatility. Generally, higher leverage is related to higher risk and increased firm volatility. We define *leverage* as book value of total debt over the book value of total assets at year-end.

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[10] We distinguish between four levels of education: Bachelor, Master, MBA and Doctorate.

[11] FT Global MBA Ranking 2012; FT Masters in Management Ranking 2011; Times Higher Education Ranking 2012; Forbes America's Top Colleges Ranking 2011; Quacquarelli Symonds (THES - QS) World University Rankings 2011; The Times Higher Education Top North American Universities 2011-2012 Ranking; BusinessWeek Best Undergraduate Business Schools 2011 Ranking; BusinessWeek Best U.S. Business Schools 2010 MBA Ranking.

[12] We do only account for one degree per degree level and take the most prestigious one, i.e. if a CEO has two bachelor degrees with at least one being from a top school, we assign a value of 1 for this particular degree level.

[13] CEOs that are also member of the board may be less subject to strict managerial control mechanisms, since they can actively influence the board of directors as controlling body.

Another variable that is well-accepted in finance and proofs to be important when explaining stock volatility is *book-to-market* ratio. *Book-to-market* is measured as book value of total equity divided by total market capitalization at year-end.

Also default probability affects volatility. Vassalou and Xing (2004) find a significant effect of bankruptcy risk on stock returns. To approximate default probability, we use a *Z-Score* that was developed by Altman (1968, 2000) in 1968 and further adjusted in 2000.[14] Generally, a higher Z-score indicates a lower probability of default. Altman (1968, 2000) uses five weighted business ratios to estimate the likelihood of financial distress:

$$Z = 1.2X_1 + 1.4X_2 + 3.3X_3 + 0.6X_4 + 1.0X_5 \quad (7)$$

where:

X_1 = Working capital/Total assets,
X_2 = Retained earnings/Total assets,
X_3 = Earnings before interest and taxes/Total assets,
X_4 = Market value of equity/Book value of total debt, and
X_5 = Sales/Total assets.

Further, we include liquidity. The hypothesis of an existing relation between stock liquidity and stock returns was first mentioned by Amihud and Mendelson (1980, 1986) and Glosten and Milgrom (1985). Amihud (2002) shows that there exists an illiquidity premium which is priced in expected stock returns. He finds that expected stock returns are positively related to illiquidity.[15] To account for *illiquidity*, we use an illiquidity measure which was develop by Yakov Amihud (2002, p.34) and is defined as "the average ratio of the daily absolute return to the (dollar) trading volume on that day".[16] This *illiquidity* ratio measures the percentage price change for one traded dollar of the respective stock per day:[17]

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[14] MacKie-Mason (1990) proposes a modified version of the Z-score, which does not include MV of equity/BV of total debt. For an application of this approach, see for example Cella (2011).We also test this modified Z-score, but do not find significantly different results.

[15] Pástor and Stambaugh (2003) confirm the importance of stock liquidity when explaining stock returns.

[16] Besides Amihud's liquidity measure, Lesmond (2005) describes share turnover as another liquidity measure. Turnover as liquidity measure is widely used in finance, e.g. by Levine and Schmukler (2006), Bekaert et al. (2005), Dahlquist and Göran (2001) and Rouwenhorst (1999). It is easy to construct and has intuitive appeal. However, it does not capture the cost per trade and solely includes trading volume, which is why we prefer Amihud's liquidity measure.

[17] D_{iy} is the number of trading days for stock i in year y, R_{iyd} is the return of stock i on day d in year y and $VOLD_{iyd}$ is the respective daily trading volume in thousands of dollars.

$$ILLIQ_{iy} = \frac{1}{D_{iy}} \sum_{D=1}^{D_{iy}} \frac{|R_{iyd}|}{VOLD_{iyd}} \quad (8)$$

[Insert Tables I-III]

A summarized definition of all variables can be found in Tables I-III.

4.3. Data Description

We arrange our data as a panel to which we apply our empirical methodology. Due to missing and incomplete accounting, stock or CEO data, we do not have a fully balanced panel with 15 observations per firm. Further, if a CEO changed during the year, we follow the Execucomp approach and assign the respective year to the CEO who had served as chief executive for the majority of this particular year. In our sample, a total of ten people were CEO of two different companies and 18 people were CEO of the same company for more than one period. On average, every firm had 2.6 CEOs during our observation period.

[Insert Table IV]

In our sample, the average CEO is 54.6 years old at year-end, has been in his or her current position for 6.9 years, earns a fixed salary of around $ 945,400 per year and has worked for the company for about eight years prior to his or her appointment. Around one quarter of all CEOs have been CEO at another firm before being appointed to their current chief executive position, nearly half of all CEOs have been member of the executive management team before being appointed CEO and 85 percent are member of the board of directors at the time of appointment. More than half of all CEOs have at least one degree from a top educational institution and around one third of the managers carry the academic title "Master of Business Administration" (MBA). The complete summary statistics are presented in Table IV.

4.4. Methodology

As dependent variables we use different measures of a company's stock return volatility. Thereby, the volatility for company i in year y is denoted V_{iy} with $V_{iy} \in \{TV\ I_{iy}, TV\ II_{iy},$

$DV\ I_{iy}, DV\ II_{iy}, UV\ I_{iy}, UV\ II_{iy}\}$. With X_{iy}, we denote the vector of CEO characteristics. The vector of the firm control variables is denoted F_{iy}:

$$V_{iy} = \beta X_{iy} + \gamma F_{iy} + \delta_i + \lambda_y + \xi_{iy} \quad (9)$$

β and γ are vectors of coefficients for the CEO characteristics and the firm control variables respectively. δ_i are time-invariant firm fixed effects or industry fixed effects respectively. λ_y are unobserved year fixed effects. ξ_{iy} is a disturbance term, assumed to be normally and independently distributed, with mean zero and variance σ_ξ^2.

[Insert Figures I and II]

Figures I and II show the average development of our different volatility measures over time and across industries. All six volatility measures show similar movements over our 15-year observation period. We observe two peaks between 1999 and 2001 and then again between 2007 and 2009. Thus, stock volatility was highest following the burst of the dotcom bubble as well as during the recent financial crisis.

Moreover, it becomes obvious that there are huge differences between individual years and industries. Taking this into account, we use year dummies to control for potential time trends in the variables of interest. For each volatility measure we apply two different specifications. The first regression is run with firm fixed effects in addition to year fixed effects, in order to control for observed and unobserved time-invariant firm characteristics. The second regression is run with industry fixed effects in addition to year fixed effects, in order to control for observed and unobserved time-invariant industry characteristics.[18]

We deal with potential heteroskedasticity issues by using robust standard errors. In this way, we do not have to rely on the assumption that ξ has the same variance for all values of X. The coefficients of interest are however not affected by potential heteroskedasticity, i.e. $\hat{\beta}$ is still an unbiased estimator of β.

[18] In order to include industry fixed effects we assign each firm to one of twelve industries based on its SIC code. For this purpose we use the twelve industry classification codes obtained from Kenneth French's website: http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/. Please refer to the appendix for detailed information on industry definitions and assigned SIC codes. After excluding utilities and financial institutions, this leaves us with ten industries (see also Figure II).

Another essential assumption of OLS regressions is that the values of ξ are independent of one another, since a non-independence of ξ between observations would lead to autocorrelation. In that case, the standard errors would be incorrect. This can occur when unmeasured variables are systematically similar between some pairs of observations, which is often true for panel data. We face this problem by clustering standard errors at the firm level in order for them to be robust to correlation within the observations of each firm. The coefficients of interest are again not affected by potential autocorrelation.[19]

5. Empirical Analysis and Findings

In the section that follows, we present our empirical findings and major economic insights of our analysis. We distinguish between findings on CEO characteristics and control variables.

5.1. CEO Characteristics

Our empirical analysis shows heterogeneous results for the various CEO characteristics across the different measures of firm volatility. This is true with regard to both the degree of statistical significance as well as the direction in which they are related to volatility.

[Insert Tables VI-VIII]

Log (age) shows significant coefficients in six of our twelve model specifications. The negative sign supports Hypothesis II, i.e. older CEOs are associated with less volatility in their companies' stock returns. Indeed, it seems to be the case that older CEOs are more cautious and less willing to accept higher risks and to drive change:

CEO age is negatively related to stock volatility.

Tenure seems to be even more relevant for explaining firm volatility. Eight of our twelve regressions show significant betas. The positive sign suggests that we have to reject Hypothesis III. Instead, we find arguments for the hypothesis that CEOs who have already been in their

[19] Petersen (2009) gives detailed information on diverse approaches to estimate standard errors in finance panels.

current position for some time tend to increased risk-taking, whereas relatively "new" CEOs take less risk in order to keep their job in the first couple of years:

CEO tenure is positively associated with stock volatility.

Furthermore, our results mainly confirm Hypothesis IV. *Salary* shows six significant negative betas supporting the hypothesis that managers with low fixed salaries have a greater appetite for risk in order to increase their total compensation:

CEO base salary is negatively correlated with stock volatility.

On the contrary, Hypothesis V has to be at least partly rejected in the light of our results. Our three proxies for CEO experience lead to heterogeneous results. On the one hand, *years with company* shows ten significant betas with negative signs, suggesting that experience with the firm prior to the chief executive's appointment is negatively related to firm volatility:

The number of years a CEO spent at the firm before being appointed is negatively related to volatility.

Moreover, these findings would lead to the conclusion that external hires (*years with company* = 0) are associated with higher firm risk.

Our *executive board experience* variable also shows negative coefficients. However, we merely observe two significant betas and therefore do not give much weight to the conclusions that can be drawn from these results.

On the other hand, *CEO experience* suggests a positive relationship between experience and firm risk, since five specifications show significant positive betas. This is, however, no surprise since many external hires have worked as CEOs at another firm before they have been appointed CEO. These results would be in line with the hypothesis that a certain level of experience is needed to identify and value the potential advantages of higher risk-taking:

CEO experience is positively associated with stock volatility.

With regard to the potential relationship between a CEO's education and stock volatility, we observe that our *top education* variable shows no significance in any of our regressions. However, whether a CEO does or does not hold an *MBA* seems to play a certain role. We see four significant coefficients whose positive signs confirm Hypothesis VI. Indeed, education seems to provide managers with the ability to better evaluate the characteristics and implications of a certain decision. Thus, risk is not necessarily perceived as something purely negative that one has to be afraid of. Moreover, our findings may reflect a certain degree of 'overconfidence' that has been attributed to MBA graduates by numerous studies:

CEOs holding an MBA degree are associated with higher stock volatility.

Finally, our proxy for CEO power concentration does not seem to be significantly related to firm risk. *Board of directors* membership does not show a single significant coefficient. We therefore reject Hypothesis VII in combination with the proxy we use in our analysis.

5.2. Control Variables

With regard to our control variables we mainly observe significant betas with the expected signs. *Log (total assets)* shows significant betas in eight cases. In line with Anderson and Fraser (2000) and Saunders et al. (1990) our analysis suggests a negative relationship between size and volatility. We thus support the argument that bigger companies have more opportunities to diversify their business activities leading to lower firm volatility:

Firm size is negatively correlated with stock volatility.

Further, in line with Akhigbe and Martin (2008) we find that *leverage* is positively related to stock volatility. Four significant betas support the argument that higher debt loading leads to higher firm risk:

Leverage is positively associated with stock volatility.

Book-to-market is the only control variable for which we observe heterogeneous coefficients, i.e. the betas are negative in regressions with downside volatility and positive with upside volatility. This might also be due to the fact that part of its effect is captured by Altman's *Z-score*.

However, the fact that we see significant betas underpins the explanatory power of the *book-to-market* ratio in the context of stock volatility.

With a total of eight significant coefficients our default probability measure (*Z-score*) also proves to be an essential variable in order to explain volatility. Our findings propose a positive relationship between a firm's volatility and its *Z-score*. Since a high *Z-score* signals low default probability, this is somewhat surprising, since we would expect higher volatility to be associated with higher probability of default. However, if we take apart the individual components of Altman's *Z-score* formula, the results are broadly in line with the findings for size. Since *total assets* can be found in four of the five denominators, it has an inversely proportional relationship with the *Z-score*. Thus, if higher *total assets* are, ceteris paribus, associated with a lower *Z-score* and if at the same time higher *total assets* are associated with less volatility, it follows that:

A firm's Z-score is positively related to stock volatility.

Illiquidity seems to be even more relevant for explaining firm volatility. All twelve regressions show highly significant betas. The positive sign suggests that higher stock illiquidity (as measured by Amihud's measure) is associated with higher firm volatility:

Liquidity is negatively associated with stock volatility.

5.3. Economic Insights

Our results highlight the importance of variables that proxy CEO risk appetite to explain stock volatility. Especially age, tenure, compensation and experience seem to be important variables. This is also true after controlling for firm-specific factors as well as year and company or sector fixed effects respectively. Overall, the empirical results summarized in Tables VI-VIII confirm our main hypothesis:

Our analysis reveals a significant relationship between CEO characteristics and stock volatility.

[Insert Figure III]

Our models show high R^2's in the range between 0.391 and 0.675 when controlling for company fixed effects. Thereof, the R^2's that can be attributed to our CEO variables range from 0.004 to 0.009. When controlling for industry fixed effects, we see R^2's in the range between 0.282 and 0.496. Thereof, the R^2's that can be attributed to our CEO variables range from 0.016 to 0.023, i.e. up to 2.3% of the variation that we observe in our volatility measures can be explained by our CEO characteristics. Figure III shows our models' fit for the specifications that include company fixed effects.

Our findings carry implications for shareholders, corporate control bodies and investors. Shareholders are interested in hiring the most suitable and capable CEOs. Corporate boards aim at having the right tools at hand to monitor and control executive management teams. Those insights may, for example, proof useful when designing managerial compensation contracts and setting up rules for corporate control bodies. Both shareholders and company boards benefit from a profound knowledge about biographical determinants of CEO risk appetite and their relation to overall firm volatility. Investors are often confronted with risk-return trade-offs and aim to optimize their decision making in a way where they have to balance risk against return or performance. Especially institutional investors, such as pension funds, benefit from insights about the driving factors of stock volatility and even though CEO characteristics and managerial risk appetite are not the only factors related to corporate risk, reliable results about the relationship between CEO characteristics and firm volatility enable a more informed decision making process.

6. Critical Evaluation and Limitations

First and foremost, our thesis should be considered as a descriptive study that tries to identify a significant relationship between certain CEO characteristics and stock volatility. In order to accurately interpret our findings, one has to bear in mind that our empirical approach does not enable us to properly assess the direction of cause and effect. When aiming to establish causality and find a causal relation between the single CEO characteristics and stock volatility, one should think of another study design, e.g. by testing the above mentioned managerial determinants within an event study framework.

We assume that certain characteristics are a good proxy for a CEO's attitude towards risk. This approach is somewhat simplistic and reduces complexity. Even though there exists literature

which states that the used characteristics are appropriate risk appetite proxies, we cannot be sure that this is in fact the case. More complex methods to estimate a CEO's risk attitude, such as estimating individual utility functions, might be more suitable. However, with regard to the huge amount of potential utility functions and the difficulty of verifying the appropriateness of any of those functions, this approach is also subject to critical assumptions and judgment.

Even though the standard deviation and variance of stock returns are well-accepted risk measures in finance, there exist manifold ways to measure volatility and firm risk, which could provide further insights and lead to alternative results.

We include five control variables that have been used extensively in other studies before. *Total assets* and *book-to-market* ratios are well-accepted control measures that capture significant size and valuation effects. However, we cannot be certain that those measures are perfect. The same is true for *leverage*. The degree to which a company uses debt instead of equity has been studied a lot and finance research agrees that *leverage* plays a significant role for firm risk and volatility. Nevertheless, there exists a variety of definitions that carry different implications. Other *leverage* measures might affect our results in a different way.

Further, the *Z-score* applied to measure the probability of default should not be taken as absolutely perfect. It is a good proxy that can be easily computed and is therefore suitable for finance research. However, one should not assume that this measure is fully accurate, especially because we use year-end accounting and stock data to calculate it. Moreover, Altman (1968) predominantly developed his *Z-score* for measuring the default probability of manufacturing companies. It is therefore questionable whether this measure is fully applicable and comparable across our ten different industries.

The like is true for Amihud's liquidity measure. *Liquidity* itself may play a role when explaining stock volatility, but the ways to measure it are manifold and each measure might cause (slightly) different results. Further, there may be other control variables that are also important but have not been taken into account in this study.

Moreover, in line with the approach used by Execucomp, we assign each year to only one CEO, even though the CEO might have changed during the respective year. This causes a certain degree of inaccuracy since that way, we are not fully able to assign the correct part of volatility

to each CEO. However, as CEOs usually stay in their position for several years, these inaccurate effects may only marginally carry authority.

We aim at creating a random sample for a broad cross-section of firms. However, the observation period, the choice of companies and the S&P 500 itself may cause problems. It is not uncommon that certain empirical models achieve different results over different periods and different samples. Our sample includes a broad selection of firms for a long period of time with nearly 3,000 observations. At a first glance, this might be a sound approach. However, a closer look reveals that we cover years of deep financial and economic distress and try to explain volatility measures for a very broad sample. The entire set-up is very specific and sensitive to the assumptions we have made.

Furthermore, the data we use, generally stems from reliable sources. However, we encountered several inconsistencies, especially for information about CEOs. Given that, the use of secondary sources involves a certain degree of risk and the danger that data is not totally accurate. We bear that in mind and try to erase errors in our data set by comparing different sources and performing reasonable cross-checks.

Apart from that, our analysis relies on certain direct or indirect assumptions that are generally related to panel data and OLS regressions. The approach we use, assumes that the Common Trends Assumption (CTA) holds. In other words, we indirectly assume that treated firms (e.g. *CEO experience* = 1) would have followed the same trend as non-treated firms (e.g. *CEO experience* = 0) if they had not been treated. Moreover, although we use robust and clustered standard errors, we still rely on the typical assumptions in the context of OLS regressions, one of which states that the individual relationships in any of the component regressions are linear since we apply linear regression estimations.

Another potential problem with drawing conclusions from multiple regressions may arise from multicollinearity, i.e. if two independent variables are themselves highly correlated.

[Insert Table V]

Table V shows that this might indeed be the case for some of our variables. Although this may affect the significance of our variables, the coefficients' signs carry meaningful information.

Nevertheless, when interpreting multiple regression results, one should exercise a suitable level of caution. They are certainly useful to identify factors that seem to have an impact on the dependent variable, a full formal proof would, however, require a manipulative experiment. Since this is rarely feasible, a comparison with other studies carried out by different researchers is another possibility to gain more confidence in the results.

Although most of our models show high R^2s, i.e. are able to explain a large part of the variation that we observe in our volatility measures, this is certainly not true for all specifications. Figure III shows our models' fit for the specifications that include company fixed effects.

7. Suggestions for Further Research

Our study identifies CEO characteristics that matter in explaining stock volatility. We examine a broad range of variables, but there is still room for further research in order to get deeper insights about important characteristics and their correlation with firm risk. Our versatile approach offers a good foundation to think about further characteristics and hypotheses and how they might be related to managerial risk attitude, and thereby firm volatility. Different time periods, data samples and model specifications may turn out useful when developing new hypotheses, e.g. the relationship between CEO characteristics and the volatility of small- to mid-cap stocks may even be stronger than for our large-cap sample.

Other than using biographical characteristics, research should also think of alternative approaches how to proxy a CEO's risk appetite. Thereby, the aforementioned estimation of utility functions is only one way to do so.

Besides the search of new relevant CEO characteristics and risk appetite proxies, future work should also focus on different measures of volatility. Volatility can be estimated in many ways and our proposed volatility measures are only one approach. Future studies may also use idiosyncratic and systematic risk as dependent variables. Since we do not believe that the common assumption of fully diversified investment portfolios holds for most investors, this thesis focuses on total stock volatility and does not distinguish between systematic and idiosyncratic volatility. This distinction is suggested a field for further research.

When speaking of stock volatility, researchers often try to capture company risk from an investor's perspective. However, there are further risk dimensions that may be related to a chief executive's characteristics and background. One could think of multiple variables that capture firm risk and try to find if there exists a relationship with CEO characteristics.

Also the combination of CEO studies on risk and performance may provide academic value. Therefore, future research should focus on CEO-related and managerial determinants that help investors' balance overall risk against expected return to optimize the allocation of capital.

Those findings may not only be of interest to investors, but to a variety of stakeholders such as employees, suppliers or clients. Including alternative target groups may enable research to develop useful approaches for further research.

Given that, also other members of the executive and non-executive management team may be the subject of future work. Thereby, one could investigate the impact of different management team structures and the interrelatedness of management teams and supervisory bodies.

Also interdepartmental research may be another way to make further progress. Especially psychologists who study human behavior could provide further insights for developing new hypotheses. We could, for example think of certain unobservable characteristics, such as courage, perseverance or ambition. In this sense, finance related research can benefit from other sciences and use their knowledge and methods to create academic value and develop new hypotheses.

Finally, based on our findings, future research may aim to properly assess the direction of cause and effect, i.e. the exact underlying relationship between stock volatility and relevant managerial characteristics identified by our analysis. When aiming to reveal causality, one should think of another study design, e.g. by testing the above mentioned managerial determinants within an event study framework. This would help to derive further economic implications as well as more specific suggestions for investors, corporate boards and regulators.

8. Concluding Remarks

We provide empirical evidence for a significant relationship between certain CEO characteristics and different measures of firm volatility. We consider age, time in role, compensation, experience, education and power concentration. Further, we use six different measures of stock volatility, apply a robust regression framework and use a proper model design to extract our results. By splitting our managerial characteristics into the aforementioned categories, we include multiple dimensions of CEO risk appetite that drive firm volatility.

Our sample contains 227 non-financial and non-utility firms and 583 CEOs during the period from 1996 to 2010, resulting in a total of 2,913 observations. We observe a high degree of variation in firm volatility over different industries and years. This is partly due to several economic downturns and crises, as well as years of corporate recovery and prosperity.

After controlling for firm-specific factors, our results give strong evidence that certain CEO characteristics are significantly related to stock volatility. We find that age, time spent with the company and a CEO's base salary are negatively associated with volatility. On the contrary, time in role, CEO experience and education are positively associated with volatility. We do not find any significant relation between managerial power concentration and volatility. Our findings are robust across different measures of volatility and model specifications.

The presented results are useful when designing managerial compensation contracts and setting up rules for corporate control bodies and therefore interesting for shareholders and corporate boards. Further, insights about the drivers of CEO risk appetite and firm volatility are valuable to investors, such as pension funds, and help them optimizing their risk assessment.

Finally, we find it worth mentioning that we do not say that higher volatility is negative per se. This thesis does not provide an assessment of the trade-off between risk and return. As stated above, a thorough understanding of the risks involved as well as intentional risk-taking can implicate higher returns. This might leave room for further research on CEO characteristics that are associated with certain risk-return configurations.

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Table I: Definitions of Volatility Measures

Variable	Definition	Unit
Total Volatility (TV)		
TV I	Standard deviation of daily log returns	Ratio
TV II	Realized volatility of daily log returns[20]	Ratio
Downside Volatility (DV)		
DV I	Standard deviation of negative daily log returns[21]	Ratio
DV II	Standard deviation of below-average daily log returns[22]	Ratio
Upside Volatility (UV)		
UV I	Standard deviation of positive daily log returns	Ratio
UV II	Standard deviation of above-average daily log returns	Ratio

[20] Assuming that daily log returns follow an MA(1) model.

[21] Negative daily log returns include daily log returns that are zero.

[22] Below-average returns include daily log returns that equal the average daily stock return in the respective year.

Table II: Definitions of CEO Variables

Variable	Definition	Unit
Age	The CEO's age at year-end	Years
Tenure	The length of time that the CEO has been in the current role	Years
Salary	The dollar value of the base salary (cash and non-cash) earned by the CEO during the fiscal year (inflation-adjusted; base year 2010)	$ k
Years with Company	The length of time that the CEO has worked at the company prior to being named CEO (0 if external hire)	Years
CEO Experience	Dummy variable that equals 1 if the CEO has gained CEO experience prior to being appointed to the current role and 0 if the CEO has never worked as CEO before	0 or 1
Top Education	Dummy variable for whether the CEO holds at least one degree from a top-ranked educational institution (1=yes; 0=no)	0 or 1
MBA	Dummy variable that equals 1 if the CEO holds an MBA and 0 if not	0 or 1
Executive Board	Dummy variable for whether the CEO has been member of the executive board (e.g. CFO) prior to being appointed CEO (1=yes; 0=no)	0 or 1
Board of Directors	Dummy variable indicating whether the CEO has been member of the board of directors at appointment (1=yes; 0=no)	0 or 1

Table III: Definitions of Control Variables

Variable	Definition	Unit
Total Assets	The company's book value of total assets at year-end	$ m
Leverage	The book value of total liabilities over the book value of total assets	Ratio
Book-to-Market	The company's book value of common equity divided by the total market capitalization at year-end	Ratio
Z-Score	The Altman Z-score is a combination of five weighted business ratios that is used to estimate the likelihood of financial distress	Ratio
Illiquidity	The Amihud (2002) measure is defined as the average ratio of the daily absolute return to the (dollar) trading volume on that day	Ratio

Table IV: Descriptive Statistics

Variable	Obs	Mean	Std Dev	Min	Max
Age	2,913	54.6	7.7	32	87
Tenure	2,913	6.9	6.9	0.5	42.9
Salary	2,913	945.4	500.6	0.001	6,483
Years with Company	2,913	8.2	9.4	0	44
CEO Experience	2,913	0.23	0.42	0	1
Top Education	2,913	0.55	0.50	0	1
MBA	2,913	0.33	0.47	0	1
Executive Board	2,913	0.49	0.50	0	1
Board of Directors	2,913	0.85	0.36	0	1
Total Assets	2,913	8,288	14,481	89.7	208,504
Leverage	2,913	0.521	0.225	0.032	1.731
Book-to-Market	2,913	0.375	0.347	-4.295	4.613
Z-Score	2,913	5.9	12.8	-55.4	339.3
Illiquidity	2,913	0.001	0.024	0.000	1.140
TV I	2,913	0.0136	0.0084	0.0033	0.2218
TV II	2,913	0.2097	0.1134	0.0526	0.9985
DV I	2,913	0.0106	0.0079	0.0021	0.0744
DV II	2,913	0.0107	0.0083	0.0021	0.0861
UV I	2,913	0.0085	0.0052	0.0021	0.0921
UV II	2,913	0.0085	0.0054	0.0020	0.1141

Table V: Pearson Correlation Coefficients[23]

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	**Log (Age)**	1																			
2	**Tenure**	**0.35**	1																		
3	**Salary**	**0.13**	-0.04	1																	
4	**Years with Company**	**0.12**	**-0.13**	0.04	1																
5	**CEO Experience**	**0.05**	**-0.12**	**0.15**	**-0.22**	1															
6	**Top Education**	-0.01	0.01	-0.04	**-0.06**	0.02	1														
7	**MBA**	-0.02	**-0.07**	**-0.06**	-0.03	0.02	**0.22**	1													
8	**Executive Board**	-0.04	**-0.27**	0.01	**0.43**	**-0.27**	-0.02	**0.07**	1												
9	**Board of Directors**	-0.03	**-0.09**	0.01	0.01	**0.10**	0.01	**-0.09**	0.00	1											
10	**Log (Total Assets)**	**0.05**	**-0.12**	**0.49**	**0.06**	**0.12**	0.01	**0.08**	**0.13**	0.01	1										
11	**Leverage**	**0.11**	**-0.14**	**0.20**	0.02	**0.08**	-0.01	0.05	0.04	**0.10**	**0.22**	1									
12	**Book-to-Market**	0.04	**-0.07**	**0.14**	**0.05**	0.04	-0.02	-0.01	0.03	0.01	**0.24**	**-0.13**	1								
13	**Z-Score**	**-0.08**	**0.10**	**-0.15**	**-0.05**	**-0.06**	0.04	-0.03	**-0.09**	-0.03	**-0.19**	**-0.35**	**-0.18**	1							
14	**Illiquidity**	0.00	-0.02	0.00	0.01	0.01	-0.02	-0.03	0.04	0.02	-0.02	0.03	0.02	-0.02	1						
15	**Log (TV1)**	**-0.09**	**0.11**	**-0.16**	**-0.17**	0.04	0.01	0.00	**-0.16**	-0.04	**-0.23**	**-0.10**	0.01	**0.16**	**0.07**	1					
16	**Log (TV2)**	**-0.09**	**0.12**	**-0.15**	**-0.18**	**0.05**	0.01	0.01	**-0.17**	-0.04	**-0.23**	**-0.10**	0.01	**0.16**	**0.05**	**0.98**	1				
17	**Log (DV1)**	**-0.07**	**0.13**	**-0.15**	**-0.14**	0.02	0.01	0.01	**-0.14**	-0.04	**-0.21**	**-0.09**	-0.04	**0.18**	**0.07**	**0.93**	**0.92**	1			
18	**Log (DV2)**	**-0.07**	**0.12**	**-0.15**	**-0.14**	0.01	0.01	0.01	**-0.14**	-0.04	**-0.21**	**-0.09**	-0.04	**0.18**	**0.07**	**0.92**	**0.92**	**1.00**	1		
19	**Log (UV1)**	**-0.11**	**0.06**	**-0.15**	**-0.17**	**0.07**	0.02	-0.01	**-0.16**	-0.04	**-0.24**	**-0.07**	**0.07**	**0.10**	**0.08**	**0.84**	**0.82**	**0.62**	**0.61**	1	
20	**Log (UV2)**	**-0.11**	**0.06**	**-0.15**	**-0.17**	**0.07**	0.02	-0.01	**-0.16**	-0.04	**-0.24**	**-0.07**	**0.07**	**0.10**	**0.08**	**0.84**	**0.82**	**0.62**	**0.61**	**1.00**	1

[23] Bold texts indicate statistical significance at the 1% level.

Table VI: The Determinants of Total Volatility (TV)

	Log (Total Volatility I)		Log (Total Volatility II)	
	(1)	(2)	(1)	(2)
Log (Age)	-0.103	-0.241*	-0.107	-0.251*
	(-1.08)	(-2.89)	(-1.08)	(-3.17)
Tenure	0.00533**	0.00467*	0.00541**	0.00499**
	(3.01)	(3.13)	(3.01)	(3.37)
Salary	-0.0000687*	-0.00000345	-0.0000753*	-0.00000153
	(-2.15)	(-0.29)	(-2.15)	(-0.13)
Years with company	-0.00380*	-0.00312**	-0.00409**	-0.00334**
	(-2.53)	(-3.61)	(-2.61)	(-3.34)
CEO experience	0.0302	0.0540**	0.0344	0.0634**
	(1.13)	(3.44)	(1.21)	(3.69)
Top Education	-0.0245	-0.00144	-0.0214	-0.00111
	(-0.91)	(-0.06)	(-0.77)	(-0.05)
MBA	0.0322	0.0615*	0.0335	0.0643*
	(1.09)	(2.97)	(1.13)	(2.81)
Executive Board	0.00578	-0.0377	-0.000819	-0.0394
	(0.22)	(-1.64)	(-0.03)	(-1.73)
Board of Directors	0.0118	0.00156	0.00816	0.00291
	(0.30)	(0.06)	(0.20)	(0.11)
Log (Total Assets)	-0.0462*	-0.0632*	-0.0378	-0.0594
	(-2.00)	(-2.57)	(-1.61)	(-2.17)
Leverage	-0.00336	0.0642	0.0571	0.0944*
	(-0.04)	(1.78)	(0.69)	(2.60)
Book-to-Market	-0.0342	0.0774	-0.0484	0.0805
	(-0.63)	(1.53)	(-0.91)	(1.59)
Z-score	0.00281**	0.00266*	0.00307**	0.00284*
	(2.92)	(2.58)	(3.05)	(2.87)
Illiquidity	1.285***	1.492***	0.957***	1.128***
	(8.18)	(13.67)	(11.71)	(11.73)
Constant	-3.417***	-2.994***	-0.696	-0.245
	(-8.78)	(-5.39)	(-1.72)	(-0.44)
Company Fixed Effects	Yes	No	Yes	No
Year Fixed Effects	Yes	Yes	Yes	Yes
Industry Fixed Effects	No	Yes	No	Yes
N	2,913	2,913	2,913	2,913
R^2	0.574	0.419	0.564	0.399
R^2 attributed to CEO data	0.008	0.021	0.009	0.023
Adj. R^2	0.533	0.411	0.522	0.391

t statistics in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The coefficients' standard errors are adjusted for the effects of non-independence by clustering on each firm. For a full definition of variables see Tables I-III.

Table VII: The Determinants of Downside Volatility (DV)

	Log (Downside Volatility I)		Log (Downside Volatility II)	
	(1)	(2)	(1)	(2)
Log (Age)	-0.159	-0.265*	-0.168	-0.271*
	(-1.30)	(-3.12)	(-1.34)	(-3.23)
Tenure	0.00929***	0.00741**	0.00956***	0.00755**
	(3.95)	(3.35)	(3.96)	(3.31)
Salary	-0.0000844*	-0.0000146	-0.0000863*	-0.0000136
	(-2.10)	(-1.32)	(-2.05)	(-1.20)
Years with company	-0.00474**	-0.00333*	-0.00474*	-0.00330*
	(-2.60)	(-2.93)	(-2.53)	(-2.83)
CEO experience	0.0110	0.0477*	0.0112	0.0454
	(0.32)	(2.36)	(0.32)	(2.17)
Top Education	-0.0229	-0.00691	-0.0224	-0.00683
	(-0.63)	(-0.25)	(-0.61)	(-0.24)
MBA	0.0416	0.0703**	0.0434	0.0720**
	(1.15)	(3.47)	(1.18)	(3.50)
Executive Board	0.0240	-0.0354	0.0244	-0.0364
	(0.73)	(-1.09)	(0.73)	(-1.09)
Board of Directors	0.00441	0.0000443	0.00501	0.000366
	(0.09)	(0.00)	(0.10)	(0.01)
Log (Total Assets)	-0.0272	-0.0546*	-0.0268	-0.0543*
	(-0.98)	(-2.81)	(-0.95)	(-2.82)
Leverage	-0.0762	0.0769	-0.0836	0.0766
	(-0.83)	(1.75)	(-0.89)	(1.69)
Book-to-Market	-0.104*	0.0209	-0.110*	0.0151
	(-2.22)	(0.46)	(-2.25)	(0.33)
Z-score	0.00507***	0.00473**	0.00502**	0.00468*
	(3.43)	(3.32)	(3.32)	(3.21)
Illiquidity	1.450***	1.796***	1.547***	1.911***
	(7.14)	(25.35)	(6.56)	(27.98)
Constant	-3.654***	-3.293***	-3.617***	-3.262***
	(-7.18)	(-5.85)	(-6.98)	(-5.84)
Company Fixed Effects	Yes	No	Yes	No
Year Fixed Effects	Yes	Yes	Yes	Yes
Industry Fixed Effects	No	Yes	No	Yes
N	2,913	2,913	2,913	2,913
R^2	0.404	0.293	0.391	0.282
R^2 attributed to CEO data	0.009	0.017	0.009	0.016
Adj. R^2	0.347	0.284	0.333	0.273

t statistics in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The coefficients' standard errors are adjusted for the effects of non-independence by clustering on each firm. For a full definition of variables see Tables I-III.

Table VIII: The Determinants of Upside Volatility (UV)

	Log (Upside Volatility I)		Log (Upside Volatility II)	
	(1)	(2)	(1)	(2)
Log (Age)	-0.0271	-0.213*	-0.0253	-0.212*
	(-0.33)	(-2.60)	(-0.31)	(-2.53)
Tenure	0.00172	0.00184	0.00173	0.00186
	(1.01)	(1.32)	(1.02)	(1.33)
Salary	-0.0000617*	0.00000701	-0.0000628*	0.00000589
	(-2.39)	(0.48)	(-2.39)	(0.40)
Years with company	-0.00265	-0.00282**	-0.00264	-0.00286**
	(-1.85)	(-3.85)	(-1.85)	(-3.91)
CEO experience	0.0313	0.0607*	0.0318	0.0605**
	(1.18)	(3.19)	(1.21)	(3.26)
Top Education	-0.0207	0.00761	-0.0215	0.00734
	(-0.92)	(0.42)	(-0.95)	(0.40)
MBA	0.00626	0.0413	0.00499	0.0410
	(0.22)	(2.06)	(0.17)	(2.03)
Executive Board	-0.00552	-0.0388*	-0.00608	-0.0384*
	(-0.22)	(-2.37)	(-0.24)	(-2.34)
Board of Directors	0.0156	-0.00298	0.0167	-0.00143
	(0.45)	(-0.11)	(0.48)	(-0.05)
Log (Total Assets)	-0.0765***	-0.0875*	-0.0768***	-0.0877*
	(-3.62)	(-3.02)	(-3.65)	(-3.02)
Leverage	0.158*	0.139**	0.154	0.138**
	(2.01)	(3.98)	(1.96)	(3.95)
Book-to-Market	0.0570	0.156*	0.0612	0.159*
	(0.90)	(2.80)	(0.95)	(2.81)
Z-score	0.00101	0.000977	0.000896	0.000876
	(1.73)	(1.65)	(1.43)	(1.47)
Illiquidity	1.454***	1.604***	1.358***	1.505***
	(7.99)	(7.57)	(8.36)	(7.81)
Constant	-4.032***	-3.458***	-4.020***	-3.449***
	(-11.85)	(-6.28)	(-11.82)	(-6.22)
Company Fixed Effects	Yes	No	Yes	No
Year Fixed Effects	Yes	Yes	Yes	Yes
Industry Fixed Effects	No	Yes	No	Yes
N	2,913	2,913	2,913	2,913
R^2	0.675	0.496	0.673	0.494
R^2 attributed to CEO data	0.004	0.017	0.004	0.017
Adj. R^2	0.644	0.489	0.642	0.487

t statistics in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The coefficients' standard errors are adjusted for the effects of non-independence by clustering on each firm. For a full definition of variables see Tables I-III.

Figure I: Volatilities over Time

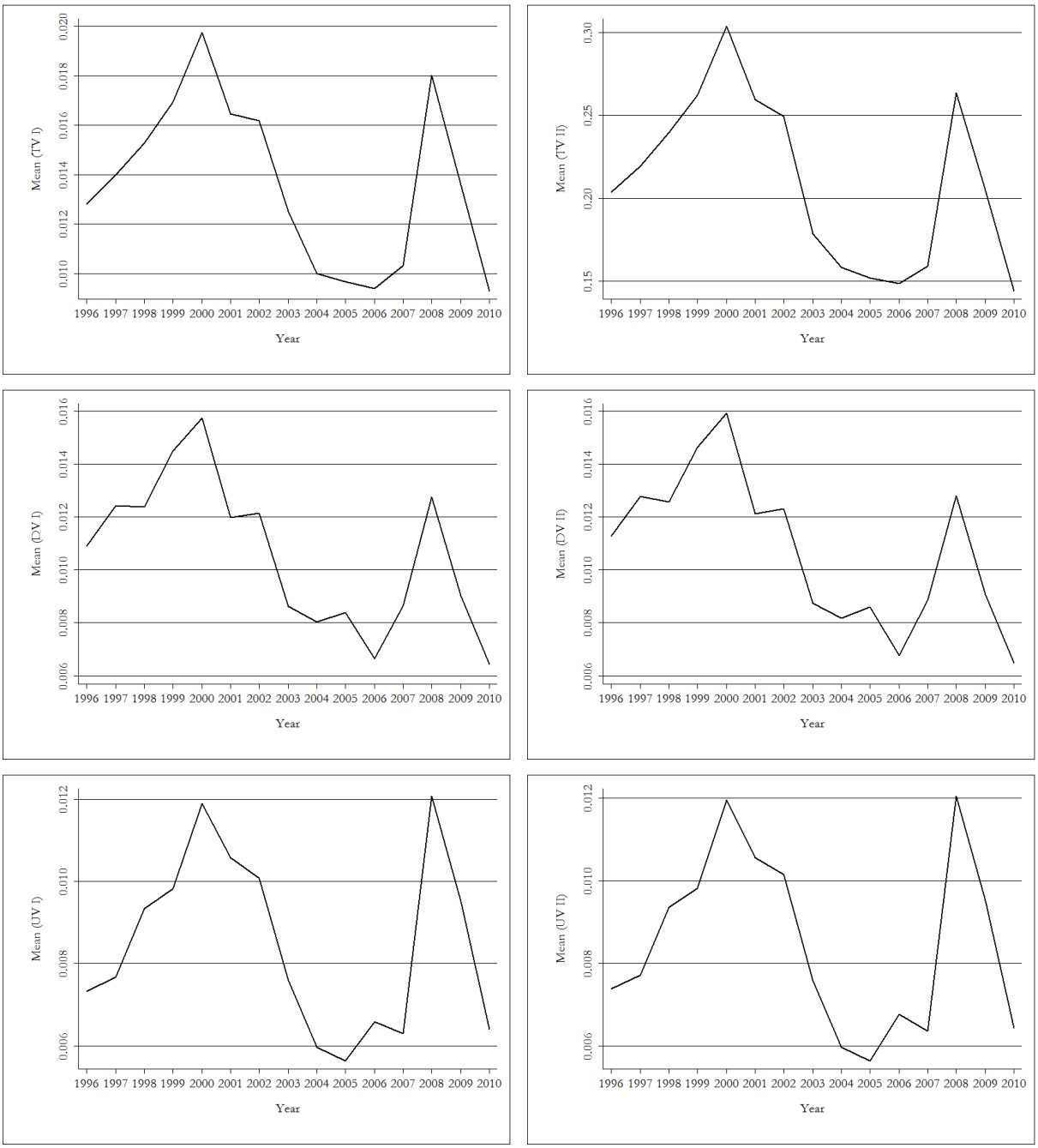
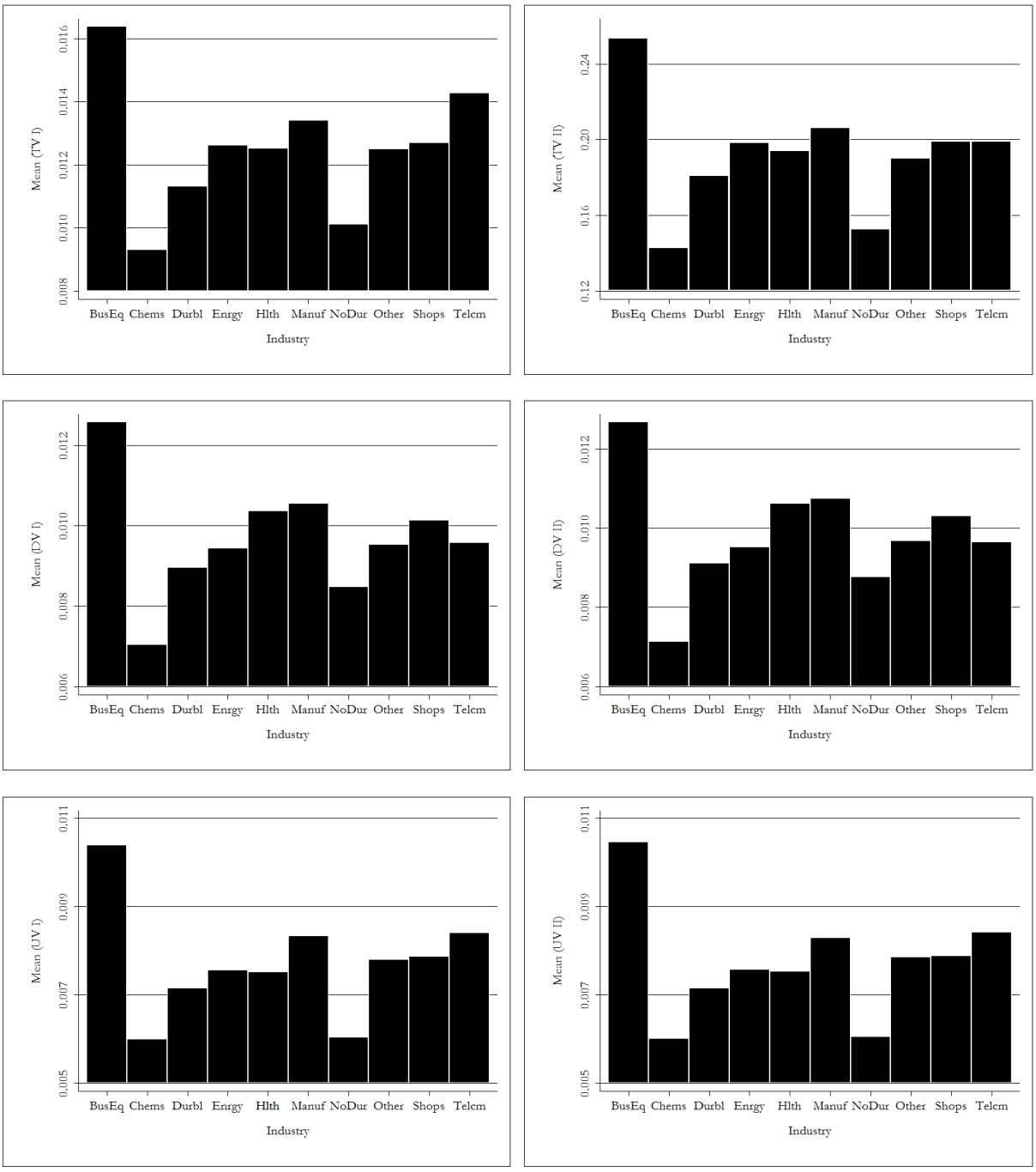
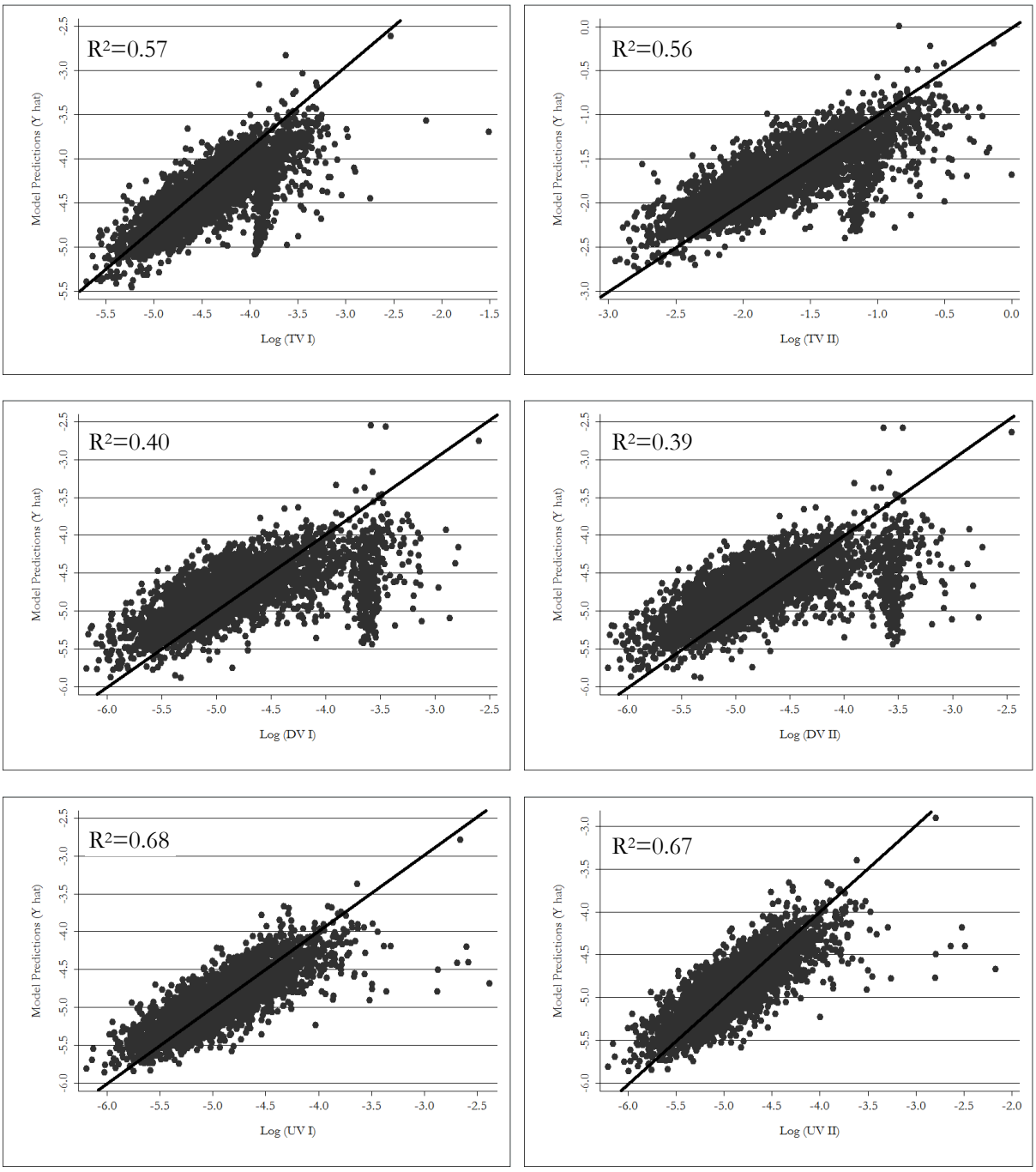


Figure II: Volatilities across Industries[24]



[24] Industries are sorted in alphabetical order. We use the 12 industry classification codes obtained from Kenneth French's website: http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/. Please refer to the appendix for detailed information on industry definitions and assigned SIC codes.

Figure III: Fit of the Models[25]



[25] Figure III shows the models' fit and R^2 for the six specifications that include company fixed effects.

Appendix: Industry Classification

No.	Abbreviation	Industry Name	Included Subsectors	SIC Codes
1	NoDur	Consumer Non-Durables	Food, Tobacco, Textiles, Apparel, Leather, Toys	0100-0999 2000-2399 2700-2749 2770-2799 3100-3199 3940-3989
2	Durbl	Consumer Durables	Cars, TV's, Furniture, Household Appliances	2500-2519 2590-2599 3630-3659 3710-3711 3714-3714 3716-3716 3750-3751 3792-3792 3900-3939 3990-3999
3	Manuf	Manufacturing	Machinery, Trucks, Planes, Office Furniture, Paper, Printing	2520-2589 2600-2699 2750-2769 3000-3099 3200-3569 3580-3629 3700-3709 3712-3713 3715-3715 3717-3749 3752-3791 3793-3799 3830-3839 3860-3899
4	Enrgy	Energy	Oil, Gas, and Coal Extraction and Allied Products	1200-1399 2900-2999
5	Chems	Chemicals	Chemicals and Allied Products	2800-2829 2840-2899
6	BusEq	Business Equipment	Computers, Software, and Electronic Equipment	3570-3579 3660-3692 3694-3699 3810-3829 7370-7379
7	Telcm	Telecom	Telephone and Television Transmission	4800-4899
8	Utils	Utilities	Utilities	4900-4949
9	Shops	Shops	Wholesale, Retail, and Some Services (Laundries, Repair Shops)	5000-5999 7200-7299 7600-7699
10	Hlth	Healthcare	Healthcare, Medical Equipment, and Drugs	2830-2839 3693-3693 3840-3859 8000-8099
11	Money	Finance	Banking, Insurance, Asset Management, Trading Firms	6000-6999
12	Other	Other	Mines, Construction, Building Materials, Transport, Hotels, Business Services, Entertainment	All other