ERASMUS UNIVERSITY ROTTERDAM
ERASMUS SCHOOL OF ECONOMICS
MSc Economics & Business
Master Specialisation Financial Economics

THE DRIVERS OF CEO COMPENSATION IN HIGH- AND LOW-TECHNOLOGY COMPANIES

An empirical research

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Date: June 2017

Preface and acknowledgements

Completing my second master thesis is one of the most challenging things I have ever done. I would like to thank my supervisor, Jan Lemmen, for guiding me throughout this thesis. Furthermore, I would like to thank my family, friends and girlfriend who supported me during the process.

Abstract

In this thesis we investigated the drivers of CEO compensation in 1,033 high- and 7,764 low-technology companies for the period 2004-2016. One major finding is that we found an endogenous relationship between firm performance and CEO compensation, for example the return on assets has a positive effect on salary. Next to that, the Tobin's Q has a negative impact on bonus and the dividend yield has a negative impact on the sum of restricted stock and stock options. Another major finding in this thesis is that we found a negative effect of stock options on innovation, and vice versa. This finding is in contrast with the literature. Finally, we find a positive impact of the market-to-book ratio on salary. The results also show that this positive relationship is stronger for high-technology companies than low-technology companies. Companies with high growth opportunities have a higher complexity. A CEO in a company with high growth opportunities might have to be compensated for this complexity.

JEL classification: J33; G30; M12; M13; M52; O31; O34

Keywords: CEO compensation, High-technology, Innovation, Intellectual property, Financial performance

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1 Introduction

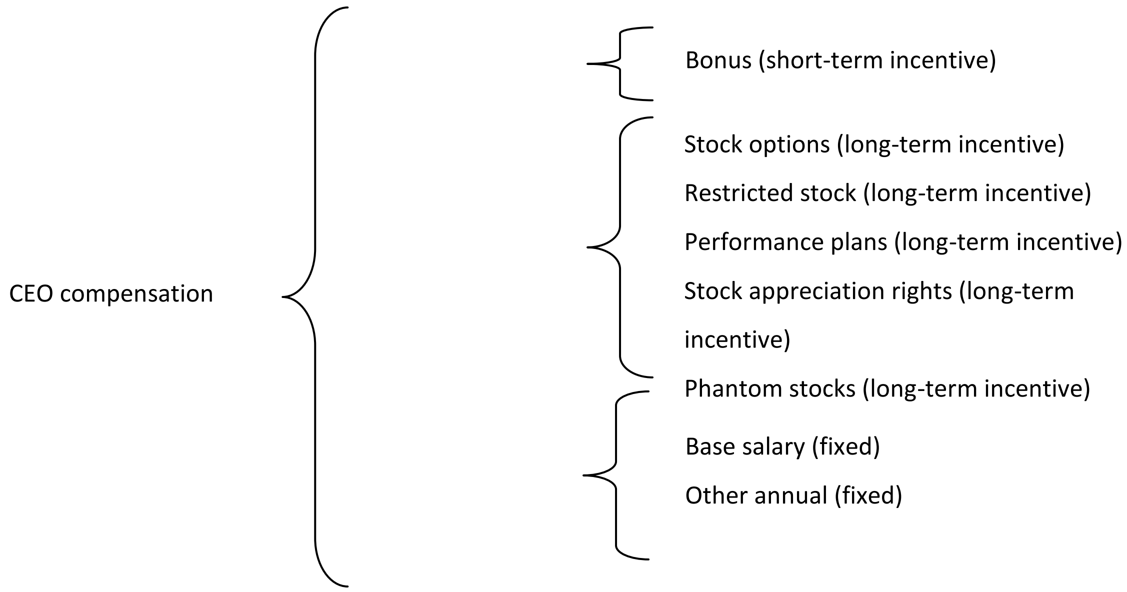
Executive compensation has been a topic of debate for a long period of time. The rapid rise in CEO compensation did provoke the public discussions. A part of the society sees the rise in CEO compensation as a result of CEOs power of setting their own compensations. Others state that compensation schemes are a result of optimal contracting in a highly competitive market for managerial talent. Politicians often claim that a CEO's compensation is too high, and out of proportion. For instance, in the Netherlands, there has been much grumbling among the political parties Party of Freedom (PVV) and Social Party (SP) about the 550.000 Euro annual salary the new CEO of SNS bank got. These political parties state that it is unfair that ordinary citizens suffer by the effects of steep tax increases while at the same time a CEO of a nationalized bank can earn such a high salary.

In general, CEOs in large companies have no or only a small proportion of equity at stake. This creates a moral mazard problem, because the CEOs do not bear the consequences of their managerial actions. Furthermore, CEOs have an information advantage over shareholders, since their tasks are unobservable for shareholders. Therefore, a CEO can maximize his own financial wealth at all costs, even if it is not beneficial at all for his company. The board of directors needs to ensure that the CEO's incentives are aligned with the shareholders'desires. Well-designed compensation packages provide CEOs with incentives to align mutual interests. According to the agency theory, governance mechanisms, such as a properly designed compensation scheme, can provide CEOs with incentives to align mutual interests (Berrone et al., 2007; Makri et al., 2006).

CEO compensation consists of short-term incentive, long-term incentive and fixed components (Figure 1). Bonus is a short-term incentive, because it motivates CEOs to perform well in a short period of time. Long-term compensation consists of long-term incentive components. The two most common long-term incentive plans are stock options and restricted stocks. Stock options give a CEO the right to purchase a number of shares at a certain price (i.e. strike price) during a certain period of time. Stock options can stimulate a CEO to increase the stock prices and earn the difference between the price at the moment of exercising the options and the strike price. Unlike stock options, restricted stocks give a CEO the right to receive a number of shares, when certain restrictions are met. Other examples of long-term incentive compensation plans are performance plans, stock appreciation rights and phantom stocks. Fixed components are salary and other annual compensation, such as a company car.

When the board of directors focus on short-term measurements of firm performance (such as stock performance and turnover), a bonus, which is a short-term incentive, might be appropriate. At the other hand, long-term incentives, such as stock options and restricted stock, are appropriate to motivate a CEO to pursue long-term firm performance goals.

Figure 1: Different components of CEO compensation



Appendix B shows the development of executive compensation (which is composed of salary, bonuses, long-term bonus payments, and stock options grants) over time. We can divide the period in four distinct periods. From the end of World War II to the 1950s, executive compensation decreased slightly. However, executives were mainly paid with cash compensation and bonuses (Appendix C). Stock options and restricted stocks were introduced in the 1950s. From the 1950s to the early 1960s, we observe low levels of CEO compensation and we see a flat growth in CEO compensation. From the 1960s until the 1970s, compensation levels grew slowly. The rapid growth in executive compensation started in the 1970s. From the 1970s to the early 2000s we see a fast growth in executive compensation. In the past 60 years, stock options and restricted stocks have emerged as the dominant component of executive pay for American CEOs.

CEOs are responsible for investing in the right R&D projects that lead to innovation. However, there is a large variance in whether expenditures in R&D will pay off (Balkin et al., 2000). Some R&D projects will result in a failure, which can have a huge impact on the firm's long-term performance. On the other hand, in high-technology markets, having the ability to innovate can be an important factor for a company's competitiveness and can result in higher profits (Balkin et. al, 2000). Furthermore, Lichtenberg & Siegel (1991) point out that investments in R&D are positively related to productivity growth. To sustain innovation, high-technology companies require a higher intensity of

R&D. Therefore, CEO compensation in high-technology companies should be aligned with innovation. Due to the long-time horizon of R&D investments, CEOs should be rewarded with long-term incentive plans, such as stock options.

In this thesis we examine the drivers of CEO compensation in high and low-technology companies. We classify a company as a high-technology company according to the Fama and French classification (Fama & French, 1997). This classification has previously been used by Faria (2014) and Bebchuk and Grinstein (2005). Following this classification, a high-technology company has a four-digit SIC code that has a value of 3570, 3571, 3572, 3576, 3577, 3661, 3674, 4812, 4813, 5045, 5961, 7370, 7371, 7372 or 7373 (see Appendix A), while all others are low-technology companies. In this thesis we use three databases, namely the Compustat North America database, the Compustat Executive Compensation database and the Orbis database. We focus on a sample of 1,033 American high-technology companies and 7,764 low-technology companies, for the period between 2004 and 2016. Our sample consists of panel data. Fixed- and random-effect models will be taken into account in the empirical analysis to control for the unobserved firm heterogeneity.

Our research question is

What influences CEO compensation in high- and low-technology companies?

To address our research question stated above, we will answer several sub-questions.

1. *What is the influence of firm performance on CEO compensation?*

We also examine whether the influence of innovation and firm performance on CEO compensation differs between high- and low-technology companies. The influence of innovation and firm performance on CEO compensation might differ between high- and low-technology companies.

2. *Does the relationship between CEO compensation and innovation differ between high- and low-technology companies?*
3. *Does the relationship between CEO compensation and firm performance differ between high-and low-technology companies?*

CEO compensation may also have a significant influence on innovation and firm performance.

4. *What is the influence of CEO compensation on innovation and firm performance?*

We are also interested in whether the influence of innovation and firm performance on CEO compensation is different between the period before the crisis (2004-2007) and the period after the crisis (2008-2016). The crisis might have an influence on the relationship between innovation and CEO compensation, and on the relationship between firm performance and CEO compensation.

5. *Does the influence of firm performance and innovation on CEO compensation differ between the period before the crisis and the period after the crisis?*

For the sixth sub-question, we split long-term compensation in stock options and restricted stock. We research the influence of the long-term incentives, stock options and restricted stock, on innovation.

6. *What is the influence of restricted stock and stock options on innovation?*

Furthermore, it is interesting to examine the influence of innovation and firm performance on the value of restricted stock granted and the value of all options granted.

7. *What is the influence of innovation and firm performance on restricted stock and stock options?*

Furthermore, we examine whether the relationship between innovation and long-term incentive compensation is stronger for small high-technology companies, compared to large low-technology companies.

8. *Does the influence of innovation on CEO compensation depend on size in high- and low-technology companies?*

Finally, we are interested in the relationship between the book-to-market ratio, which is an indicator of a firm's growth opportunities, and CEO compensation, and whether this relationship differs between high- and low-technology companies. Firms with greater growth opportunities (high book-to-market ratio) may require higher quality managers who might demand a higher salary.

9. *Does the relationship between the book-to-market ratio and CEO compensation depend on whether a company is a high- or low-technology company?*

The results show a positive influence of return on assets on salary (fixed compensation) and a positive influence of shareholder return on bonus (short-term incentive). These findings indicate that corporate board align the interests of the CEO with the interests of the shareholders. However, the results also a negative impact of Tobins' Q on bonus (short-term incentive) and a negative impact of dividend yield on the sum of restricted stock and stock options (long-term incentives).

We find mixed results on the question whether the relationship between CEO compensation and firm performance differs between high- and low-technology companies. The link between firm performance and CEO compensation depends on the performance measure that is being used. We find a positive association between a CEO's base salary and the interaction term between return on assets and the high-technology dummy variable. At the other hand, we observe a negative relationship between salary and the interaction term between the return on equity and the high-technology dummy. Furthermore, the results show a negative association between annual bonus and the interaction term between dividend yield and the high-technology dummy.

We find a negative effect of the logarithm of R&D expense on short-term incentives (annual bonus). Furthermore, we observe a negative relationship between annual bonus and the interaction term between the ratio of R&D expense scaled by total assets and the high-technology dummy.

We find evidence of an endogenous relationship between CEO compensation and our main independent variables, innovation and firm performance. The results show a positive influence of annual bonus on total shareholder return. Interestingly, salary decreases total shareholder return. This suggests that an increase in salary is not an appropriate stimulation for a higher shareholder return. Moreover, we find that fixed compensation and long-term incentives increase and decrease dividend yield, respectively. Finally, we find no evidence of a significant influence of CEO compensation on innovation.

We find a different effect of innovation on CEO compensation between the period before the crisis (2004-2007) and the period after the crisis (2008-2016). We find a stronger negative effect of R&D on bonus after the crisis (2008-2016) than before the crisis (2004-2007). Moreover, we observe a positive influence of the ratio of R&D expense scaled by total assets on annual bonus and salary in the period before the crisis and we observe no significant influence of the ratio of R&D expense scaled by total assets on CEO compensation in the period after the crisis.

We find a negative effect of options on innovation, measured by the logarithm of R&D expense and the ratio of R&D expense scaled by total assets. Furthermore, we find that R&D and R&D/ASSETS decrease stock options. This finding indicates that CEOs are not motivated by a change in equity-based compensation. Finally, we find no significant influence of innovation on restricted stock.

Interestingly, we also find a negative influence of total shareholder return on the value of stock options.

We find mixed results on the question whether the relationship between CEO compensation and innovation is not only different between high- and low-technology companies, but also between small, medium and large companies.

Finally, we find a positive impact of the market-to-book ratio on salary. The results also show that this positive relationship is stronger for high-technology companies than low-technology companies. Companies with high growth opportunities have a higher complexity. A CEO in a company with high growth opportunities might have to be compensated for this complexity. Furthermore, we find a negative relation between the market-to-book ratio and long-term incentives and this relation is more negative for low-technology companies than for high-technology companies.

This thesis makes an important contribution to the existing literature regarding executive compensation with building a better understanding of executive compensation in US-based high- and low-technology companies. The findings of this thesis are relevant due to six different reasons. First, this thesis differs from previous work on executive compensation, because, to our knowledge, this thesis is the first study that examines whether the effect of innovation on CEO compensation differs between large, medium and small companies. However, we find mixed results on the question whether the relationship between CEO compensation and innovation is not only different between high- and low-technology companies, but also between small, medium and large companies. Second, this thesis separates total CEO compensation in different components with different incentives, such as bonus (short-term incentive) and restricted stock (long-term incentive). Therefore, we can research on which component innovation or firm performance have an influence. Third, we use market- and accounting performance measures, which is not common in the literature. Fourth, we perform a fixed- and random-effect OLS regression model to investigate the drivers of CEO compensation among high- and low-technology companies. Fifth, we examine whether the influence of innovation and firm performance is different between the period before the crisis and the period after the crisis. Finally, this research use a simultaneous equation framework to mitigate the endogeneity problem.

The remainder of this thesis is organized as follows. Chapter 2 presents the literature review. Chapter 3 presents the hypotheses. Chapter 4 discusses the data, including the description of the variables and the data analysis, and it shows the methodology of this research. Chapter 5 presents the important findings of the empirical study. The thesis will be completed with a conclusion and discussion in Chapter 6, including a list of limitations and recommendations for further research.

2 Literature Review

2.1 Introduction

In this chapter we review and discuss the existing literature regarding the drivers of CEO compensation. Many factors contribute to the determination of CEO compensation. Section 2.2 presents the literature on the effect of innovation on CEO compensation. CEO compensation can be explained by multiple factors. In section 2.3 we discuss the literature regarding the different types of CEO compensation. In section 2.4 we discuss the literature on the influence of firm performance on CEO compensation. It is also interesting to examine whether the influence of firm performance on CEO compensation differs between high- and low-technology companies. Section 2.5 presents the literature on that topic. Section 2.6 presents the literature on the influence of firm size, CEO's age and CEO's ownership on executive compensation. In the literature, these factors are the most studied drivers of executive compensation.

2.2 Innovation

The literature shows that CEO compensation is related to the level of innovation in a company (Balkin et al., 2000; Farai et al., 2003). Balkin et al. (2000) use compensation and financial data on 90 high-technology and 74 low-technology firms in the United States for the period 1992 – 1994 to analyze the relationship between innovation and CEO pay. Their sample consists of companies, which are listed, in the Forbes 1994-1995 special issues on CEO pay. Balkin et al. (2000) define high-technology companies as those in an industry with R&D expense greater than 5% of their total sales (see Appendix A). In their regression model, innovation is a continuous independent variable and is calculated by summing up the number of patents and the values of R&D expenses (in millions of dollars). The number of patents were taken from the U.S. Patents Office. Return on assets (ROA) is used as measure for firm performance. Data about R&D expenditures and ROA are made available through Compact Disclosure. Compensation data were gathered from the Forbes database and the Lexis-Nexis database. Balkin et al. (2000) use two different measures of executive compensation. Firstly, they use cash compensation, which consists of CEO's base salary (fixed compensation) and bonus (short-term incentive). Secondly, they use long-term compensation. Long-term compensation is the sum of stock options, share plans, restricted stock and phantom stock (long-term incentives). Balkin et al. (2000) estimate a regression model including lagged independent variables.

After controlling for firm size, firm performance, an industry dummy, CEO tenure, inside directors' ratio (ratio of inside board members to outside board members), presence of persons or corporates with at least 5 percent shares and industry effects, the regressions show that, in the high-technology sample, an additional unit of the variable innovation in year t-1, increases the short-term CEO compensation in year t on average with 520-660 dollars. The regressions in the high-technology sample show some mixed evidence to suggest a positive influence of innovation on long-term CEO compensation. Furthermore, the study of Balkin et al. (2000) shows a positive influence of firm performance on short-term CEO compensation among high-technology companies. They find that for every one-percentage point increase in ROA, short-term CEO compensation among high-technology companies increases with 220-250 dollars.

Interestingly, Balkin et al. (2000) do not reveal evidence that innovation or firm performance have a significant influence on short-term or long-term CEO compensation among low-technology companies.

Balkin et al. (2000) use the number of patents and the values of R&D expenses as proxy for innovation. The study of Hall et al. (2005) shows that, in addition to R&D expenditures and the number of patents, patent citations also contain significant information on the market value of a company.

Building on the work of Balkin et al. (2000), Faria (2014) examine the relationship between innovation and CEO compensation for the period 2000-2010. In their work, they use a sample of 500 companies of the S&P 500 index in the United States. Corresponding compensation data were taken from the ExecuComp database. Financial and economic data were gathered from the DataStream database. R&D expense and the ratio R&D expense to sales are used as proxies for innovation. Different than in the study of Balkin et al. (2000), Faria (2014) uses a compensation proxy that consists of fixed, short-term incentive and long-term incentive components. Their compensation proxy, CEO total compensation, is defined as the sum of CEO's base salary, bonus, non-equity incentive plan compensation, grant-date fair value of option awards, grant-date fair value of stock awards, deferred compensation earnings reported as compensation, and other compensations. The Generalized Least Squares (GLS) method was used to estimate the regression coefficients. Faria (2014) find that, on average, an increase of R&D with one million dollar, increases CEO total compensation with 18 dollar. Furthermore, they find that, on average, if the ratio R&D expense/sales increases with one unit, CEO total compensation will increase with 13,900 Dollar.

Furthermore, the regressions of Faria (2014) show, for the same period, a positive link among high-technology firms between firm performance and cash compensation, and a positive link between firm performance and total compensation. Faria use a different classification for high-technology companies compared to Balkin et al. (2000). Faria (2014) define high-technology companies as companies that operate in an industry with a four-digit SIC code of 3570, 3571, 3572, 3576, 3577, 3661, 3674, 4812, 4813, 5045, 5961, 7370, 7371, 7372, or 7373 (see Appendix A). However, Balkin et al. (2000) define high-technology companies as those in an industry with R&D expense greater than 5% of their total sales. CEO cash compensation is defined as the sum of CEO's base salary and bonus. Return on assets (ROA) is used as proxy for firm performance. Faria (2014) report empirical evidence that, among high-technology companies, if ROA increases with one percentage point, CEO's total compensation increases with 118 dollar and CEO's cash compensation increases with 7.98 dollar.

Finally, Faria (2014) find that an increase of a CEO's total compensation with thousand dollar increases R&D expense with 8.50 million dollars. This suggests that there is an endogenous relationship between R&D expense and CEO total compensation.

In their paper, Bizjack et al. (1993) take a sample of 430 American companies. Contrary to the results from Faria (2014) and Balkin et al. (2000), Bizjack et al. (1993) find a significant negative effect of the ratio R&D divided by assets on the ratio of the sum of CEO's base salary and bonus to total CEO incentives. However, the influence of R&D is not significant anymore when the ratio of the sum of market value of equity plus book value of debt to book value of the total firm assets is included to the regression model.

Cheng (2004) also investigates the influence of R&D expense on CEO compensation using a sample of 160 companies, which are Forbes 500 companies in R&D-intensive industries. First, he hypothesizes that CEOs have a higher probability to reduce R&D spending when the CEO is retiring and when the company of the CEO faces a small loss or a small earnings decline. Compensation committees might anticipate on that by establishing the relationship between R&D and CEO compensation in the bonus contract of the CEO. Therefore, Cheng (2004) suggests that the influence of R&D expense on CEO compensation is stronger when the CEO approaches retirement and when the company of the CEO faces a small loss or a decline in earnings.

In his study, Cheng (2004) creates a dummy variable, which takes a value of 1 when the CEO is retiring and takes a value of 0 otherwise. Furthermore, he creates a second dummy variable, which takes a value of 1 if the company faces a small loss or a small earnings decline. Finally, he creates an interaction variable between R&D and the first dummy variable and an interaction variable between R&D and the second dummy variable. Cheng (2004) uses three proxies for CEO compensation: the change in CEO's cash compensation (CEO's base salary and bonus), the change in CEO's option compensation (value of stock granted) and the change in CEO's total compensation (the sum of CEO's base salary, bonus, value of stock options granted in the fiscal year, fringe benefits and other long-term incentives).

The findings of his empirical study show that the interaction variables have a positive influence on the change in CEO stock option compensation and CEO total compensation, and that the influence of the separate R&D variable on the change in CEO stock option compensation, CEO's cash compensation and CEO's total compensation is insignificant. Finally, they find a positive influence of the change in ROE on the change in CEO's cash compensation and CEO's total compensation.

Cheng (2004) also expects that CEO compensation has a significant effect on R&D expenditures, because stock options granted to a CEO early in a year may motivate the CEO to invest more in R&D later in the same year. Furthermore, Cheng (2004) suggests that R&D expense and CEO compensation might be determined simultaneously by a third variable (for example an exogenous shock that increases the demand for the products of a company). Cheng (2004) implements a two-stage least squares analysis due to this possible simulaneity. Interestingly, the outcomes of the two-stage least squares analysis show that Cheng's earlier findings do not suffer from endogeneity.

Table 1
Summary of the literature on the effect of innovation on CEO compensation (Part 1)

CEO compensation component	Author(s)	Region and time period	Dependent variable	Independent variables	Control variables
Fixed and short-term incentives	Balkin et al. (2000)	USA, 1992-1994	Salary and bonus	0.52-0.66 (Innovation(-1)) 0.22-0.25 (ROA)	Assets; tenure; Insider director ratio; Individual owner control; Corporate owner control
Fixed and short-term incentives	Faria (2014)	USA, 2000-2010	Salary and bonus	0.000798 (ROA)	ROA; Common equity; cashflow; employees; return index; market cap; change in sales; high-techology dummy; Ln(assets); change in asset; ln(operating income before depreciation/assets); ln(sales); ln(the Net Income Before Extraordinary Items and Discontinued Operations); EPS; high-techology dummy; ln(common stock), Capital Surplus, Retained Earnings, and Treasury Stock adjustments); S&P dummy; year dummy
Fixed and short-term incentives	Bizjack et al. (1993)	USA, 1969-1988	Ratio of salary and bonus to total CEO compensation	-1.46 (R&D/assets)	Log(book value of assets); regulated utility dummy
Fixed and short-term incentives	Cheng (2004)	USA, 1984- 1997	LN(CEO's base salary and bonus) – LN(CEO's base salary and bonus(-1))	Not sign (R&D) 0.337 (ROE-ROE(-1))	Stock return, myopia dummy (1 if a company faces a small earnings decline or a small loss), horizon dummy (1 if CEO of the company is 63 years old or older)
Long-term incentives	Balkin et al. (2000)	USA, 1992-1994	Sum of stock options, restricted stock and phantom stock	0.68 (Innovation(-1)) -0.32 (ROA)	Assets; tenure; Insider director ratio; Individual owner control; Corporate owner control
Long-term incentives	Cheng (2004)	USA, 1984- 1997	LN(value of stock options granted)- LN(value of stock options granted(-1))	Not sign (R&D) Not sign (ROE-ROE(-1))	Stock return, myopia dummy, horizon dummy

Table 2
Summary of the literature on the effect of innovation on CEO compensation (Part 2)

CEO compensation component	Author(s)	Region and time period	Dependent variable	Independent variables	Control variables
Fixed, short- and long-term incentives	Faria (2014)	USA, 2000-2010	Sum of salary, bonus, non-equity incentive plan compensation, option awards, stock awards, deferred compensation earnings, and other compensations	0.0018 (R&D) 1.39 (R&D/sales) 0.0118 (ROA)	ROA; Common equity; cashflow; employees; return index; market cap; change in sales; high-techology dummy; Ln(assets); change in asset; ln(operating income before depreciation/assets); ln(sales); ln(the Net Income Before Extraordinary Items and Discontinued Operations); EPS; high-techology dummy; ln(common stock), Capital Surplus, Retained Earnings, and Treasury Stock adjustments); S&P dummy; year dummy
Fixed, short- and long-term incentives	Cheng (2004)	USA, 1984- 1997	LN(sum of salary, bonus, stock options, fringe benefits and other long-term incentives) - LN(sum of salary, bonus, stock options, fringe benefits and other long-term incentives (-1))	Not sign (R&D) 0.165 (ROE-ROE(-1))	Stock return, myopia dummy, horizon dummy

Table 3
Literature on the effect of CEO compensation on innovation

Author(s)	Region and time period	Dependent variable	Independent variables	Control variables
Faria et al. (2014)	USA, 2000-2010	R&D expense	8.50 (Sum of salary, bonus, non-equity incentive plan compensation, option awards, stock awards, deferred compensation earnings, and other compensations)	ROA; Common equity; cashflow; R&D/Assets; change in asset total; ROA(-1); ROA(-2); Patents/Sales; Net book value of brands, patents and trademarks

2.3 Different components of equity compensation

The two most important examples of equity compensation plans are stock options and restricted stock. Stock options give a CEO the right to purchase a number of shares at a certain price, known as the strike price, during a specific period of time. Stock options can stimulate a CEO to increase stock prices to earn the difference between the price at the moment of exercising the options and the strike price. Unlike stock options, restricted stocks give a CEO the right to receive a number of shares once certain restrictions are met.

It is important to distinguish between different types of equity compensation. A company can reward a CEO with stock ownership. Compensation via stock ownership gives a CEO the incentive to create firm value, but also to manage firm risk. Higher stock ownership increases the incentive to hedge the firm risk. Therefore, stock ownership leads to more risk-averse CEOs. Stock options have non-linear payoffs. Therefore, stock options lead to risk seeking CEOs (Baker et al., 2014).

For the year 1997, Ryan & Wiggins (2002) examine the relationship between R&D and CEO compensation in 1,088 companies using two-stage limited dependent variable models. Ryan & Wiggens (2002) conduct a two-stage limited dependent variable model, because they suggest that the values of equity-based awards, stock options and restricted stock awards, are endogenously determined by R&D expenditures. First, they find that a one unit increase in the ratio of equity-based awards to CEO’s total annual compensation, one unit in the ratio of stock options to CEO’s total annual compensation and one unit in the ratio of restricted stock to CEO’s total annual compensation increase the ratio of R&D expenses divided by total assets with 0.43, 0.62 and decreases the ratio of R&D expenses divided by total assets with 1.17 percentage point, respectively. Investments in R&D are long horizon projects. Equity-based awards induce a long-term focus. According to Ryan & Wiggens (2002), this can be an explanation of the positive influence of the ratio of equity-based awards to CEO’s total annual compensation on R&D expenses. Furthermore, they also find that a one unit increase in the ratio of R&D expenses divided by total assets increases the ratio of equity-based awards to CEO’s total compensation with 1.23 percentage point, increases the ratio of stock options to CEO’s total compensation with 1.55 percentage point and decreases the ratio of restricted stock scaled by CEO’s total compensation with 2.52 percentage points.

Finally, Ryan & Wiggins (2002) separate the sample into high- and low-technology companies. They characterize high-technology as companies with a SIC code between the range of 2830-2839, 3570-3579, 3600-3699, and 7370-7379 (see Appendix A). Ryan & Wiggins (2002) expect that high-technology companies make more use of equity-based compensation, especially stock options. They find that R&D expenditures increase stock options among high- and low-technology companies. R&D decreases restricted stock among high-technology companies, but the results indicate that R&D expense has no significant influence on restricted stock among low-technology companies.

Stock options and restricted stock have opposite influences on R&D expense. Stock options increase R&D expense among high- and low-technology companies. Furthermore, Ryan & Wiggins (2002) find that, among low-technology companies, awarding CEOs with restricted stock negatively affects the firm's level of R&D investment. Managers are risk averse and poorly diversified. Restricted stocks have linear payoffs. According to Ryan & Wiggins (2002), the strength of the risk-aversion can be so high, that restricted stocks discourage investments in innovation. At the other hand, Ryan & Wiggins (2002) hypothesizes that stock options encourage investing in risky R&D projects, because stock options have non-linear payoffs. Ryan & Wiggins (2002) argue that these findings can be important for compensation committees that have to structure compensation packages.

Writing on the same subject of equity awards and R&D investments, Bryan et al. (2000) test the determinants of stock options awards and restricted stock grants using a sample of over 1,700 companies for the period 1992-1997. They find that a one unit increase in the ratio R&D expense scaled by the market value of a company will induce an increase of 7.25 percentage points in the ratio of the value of CEO stock-based compensation to cash compensation. Furthermore, they find that the influence is stronger for S&P 500 firms than for non-S&P 500 firms (mid-cap and small-cap firms). Among mid-cap and small-cap firms, Bryan et al. (2000) find, in line with Ryan & Wiggins (2002), a significant negative influence of the ratio R&D expense divided by the market value of a firm on the ratio of the value of annual CEO restricted stock grants to cash compensation. Consistent with Ryan & Wiggins (2002), Bryan et al. (2000) also point out that because of the linear payoff of restricted stock and the concave utility function of a CEO, restricted stock is inefficient relative to stock options in inducing risk-averse CEOs to invest in risky, value-enhancing investment projects. The payoff function of stock options is convex in the stock price. Consequently, executive stock options provide a more efficient incentive mechanism. This explanation is in line with the theory of Manso (2010). Manso suggests that rewarding CEOs with restricted stock is suboptimal, because an effective compensation scheme that motivates innovation needs to tolerate early failure and have to reward achieving long-term success. This means that, according to Manso (2010), the optimal compensation has to include schemes that protect the CEO when failure occurs and schemes that encourage exploration. Stock options with long-vesting periods, option repricing, golden parachutes and managerial entrenchment are examples of these schemes. One limitation of the study of Bryan et al. (2000) is that they ignore the possible endogeneity between R&D investments and CEO stock compensation.

Nastasescu (2009) creates a dummy variable that equals one if R&D expenditures scaled by annual sales is greater than 5%, and zero otherwise. Nastasescu (2009) finds, among 764 publicly traded American firms that one unit increase in the ratio of R&D expenditures scaled by annual sales results in an increase of 0.59 in the ratio of stock options divided by restricted stock. Furthermore, he finds that one unit increase in the stock options/ restricted stock ratio results in an increase of 0.59 in the probability of investing in R&D.

Besides, Yu (2011) investigates the determinants of stock options using a sample including 954 companies from the S&P 1500 list. For the period 1992-2006, he finds no significant influence of the separate R&D variable on the value of the CEO's stock option awards. However, he finds that CEOs receive more stock grants when the CEO manages a company with great growth opportunities. The explanation behind this finding may be that growth companies need to use cash for R&D expenditures. Therefore, they may reward their CEOs more with stock grants. Yu (2011) also finds that CEOs receive more stock grants when the companies leverage is relatively low and when the CEO's stock ownership is high.

In summary, following the literature, a well-designed executive compensation plan needs to stimulate the CEO to take more risk and to become risk-neutral. Stocks option has, instead of restricted stock, non-linear payoffs and is therefore more appropriate.

Table 4
Summary of the literature on the influence of innovation on equity compensation

Author(s)	Region and time period	Dependent variable	Independent variables	Control variables
Ryan & Wiggins (2002)	USA, 1997	Dep 1: equity-based awards/Total compensation) Dep 2: stock options/Total compensation) Dep 3: restricted stock/Total compensation	Dep 1: 1.23 (R&D/Assets) Dep 2: 1.55 (R&D/Assets) Dep 3: -2.52 (R&D/Assets)	Market-to-book value of assets (-1); LN(Assets); Age; Tenure; Outside directors; Institutional ownership; Blockholder ownership; CEO's ownership; Variation of the operation cash flow; leverage; ratio of convertible debt divided by the market value of equity plus the book value of long-term debt; founding family dummy; chairman dummy
Bryan et al. (2000)	USA, 1992-1997	Dep1: The ratio stock-based compensation to cash compensation Dep2: The ratio of restricted stock grants to cash compensation	Dep 1: 7.25 (R&D/(market value)) Dep 2: -3.57 (R&D/(market value))	Variance of ROA divided by variance of stock returns; CEO's ownership; leverage; Age; free-cash flow divided by market value; marginal tax rate; financial reporting cost dummy
Yu (2011)	USA, 1992-2006	Change in stock options grants	Not sign (change in R&D)	R&D * Tobin's Q; R&D * Leverage; R&D * Stock ownership; R&D * Age dummy; R&D * Earnings dummy

Table 5
Summary of the literature on the influence of equity compensation on innovation

Author(s)	Region and time period	Dependent variable	Independent variables	Control variables
Ryan & Wiggins (2002)	USA, 1997	R&D/Assets	0.43 (equity-based awards/Total compensation) 0.62 (stock options/total compensation) -1.17 (restricted stock/Total compensation)	CEO's ownership; Institutional ownership; market-to-book value of assets (-1); age; age^2; solvency (-1); earnings before depreciation and amortization divided by the sum of interest expense, dividends, taxes and total capital expenditures (-1); market share; Herfindahl index
Nastasescu (2009)	USA, 2003	Dep 1: Dummy that equals one if R&D scaled by sales is greater than 5%, and zero otherwise Dep 2: Dummy that equals one if stock options is greater than restricted stock	Dep1: 0.59 (Dummy that equals one if stock options is greater than restricted stock) Dep 2: 0.59 (Dummy that equals one if R&D scaled by sales is greater than 5%, and zero otherwise)	Percentage CEO's ownership; log (assets); cash flow/ (market value); book value of long-term debt/ market value of equity; market to book ratio; market to book ratio (-1); cash bonus/(total compensation); tenure; chairman dummy

2.4 Influence of firm performance on CEO compensation

There is substantial evidence that firm performance is a major determinant of executive compensation (for example: Faria, 2014; Joskow and Rose, 1994; Zhou, 2000). For the period 1986-1995, Kato and Kubo (2004) find, in 51 Japanese companies, that a one percentage point increase in ROA will induce a 1.4 percentage increase in CEO's annual cash compensation. Zhou (2000) focuses on a sample of 755 Canadian companies. For the period 1991 – 1995, he investigates the relation between CEO pay and firm performance. His findings indicate that, for every 10 percentage points increase in return on assets, the CEO's cash compensation increases by 0.07 percent. Furthermore, he finds that, a 10 percentage points increase in return on equity, increases the CEO's cash compensation by 0.53 percent.

Another relevant study is from Joskow and Rose (1994). They use compensation data on 678 companies in the United States over the period 1970 – 1990. In the study of Joskow and Rose (1994), accounting profit is used as measure for firm performance. Their results show that one percent increase in accounting return, increases CEO's salary and bonus with 0.76 percentage point. Furthermore, they find that the strength of the relation between executive compensation and accounting return was stronger for the period 1980-1990 than for the period 1970 – 1980. Finally, they find that also past accounting return, in addition to current accounting return, has an influence on current CEO compensation.

Vemala et al. (2014) research whether the influence of firm performance on CEO compensation differs between the period before the crisis and the period after the crisis by splitting their sample period in a pre-crisis period (2004-2007) and a post-crisis period (2009-2012). They find that Tobins' Q has a positive influence on CEO's cash compensation, both pre- and post-crisis.

Sonenshine et al. (2016) also research whether the association between firm performance and CEO compensation differs between the period before the crisis (2003-2008) and the period after the crisis (2008-2012). In constrast with Vemala et al. (2014), they find that the influence of prior year's earnings per share on salary, cash compensation and CEO total compensation (sum of salary, bonus, the value of restricted stock granted, the total value of stock options exercised, and the value of long-term incentive payouts) is stronger after the crisis. Furthermore, they show that the influence of prior year's stock performance on salary, cash compensation and CEO total compensation (sum of salary, bonus, other annual compensation, restricted stock granted, stock options granted, long-term incentive payouts, and all other annual compensation) is stronger after the crisis. Finally, Sonenshine et al. (2016) find that after the crisis the composition of compensation shifted away from cash compensation toward equity compensation.

Table 6
Summary of the literature on the influence of firm performance on CEO compensation (Part 1)

CEO compensation component	Author(s)	Region and time period	Dependent variable	Independent variables	Control variables
Fixed	Sonenshine et al. (2016)	USA, 2003-2012	Ln(salary)	0.13 (EPS (-1)*Crisis) 1.40 (Return(-1)*Crisis)	Ln(sales)(-1)), Ln(sales)(-1)*Crisis, Merger value divided by market capitalization, Merger announcement, Merger announcement*Crisis, Divest value divided by market capitalization, Divest announcement, Independent board member dummy, Affiliated board member dummy, Independent board member dummy*Crisis, Affiliated board member dummy*Crisis, Crisis, New hire dummy, outside dummy, new outsider dummy, firm type dummy, EPS (-1), Return (-1), S&P performance
Fixed and short-term incentive	Kato & Kubo (2004)	Japan, 1986-1995	Ln(change in salary plus bonus)	1.4 (change in ROA)	Pre-taks profit dummy; change in sales; shareholder return
Fixed and short-term incentive	Zhou (2000)	Canada, 1991-1995	Ln(salary plus bonus)	0.007 (ROA) 0.053 (ROE)	Ln(sales); ln(assets); return to common stock
Fixed and short-term incentive	Joskow & Rose (1994)	USA, 1970-1990	Ln (salary plus bonus)	0.76 (accounting return)	Ln(sales)
Fixed and short-term incentive	Vemala et al. (2014)	USA, 2004-2012	Ln(salary plus bonus)	< 0.0001 (Tobins' Q)	Ln(assets); CEO duality; Board size; Tenure; Founder dummy; Age; Gender; Unemployment dummy; SIC

Table 7
Summary of the literature on the influence of firm performance on CEO compensation (Part 2)

CEO compensation component	Author(s)	Region and time period	Dependent variable	Independent variables	Control variables
Fixed and short-term incentive	Sonenshine et al. (2016)	USA, 2003-2012	Ln(salary plus bonus)	0.18 (EPS (-1)*Crisis) 0.56 (Return(-1)*Crisis)	Ln(sales)(-1)), Ln(sales)(-1)*Crisis, Merger value divided by market capitalization, Merger announcement, Merger announcement*Crisis, Divest value divided by market capitalization, Divest announcement, Independent board member dummy, Affiliated board member dummy, Independent board member dummy*Crisis, Affiliated board member dummy*Crisis, Crisis, New hire dummy, outside dummy, new outsider dummy, firm type dummy, EPS (-1), Return (-1), S&P performance
Fixed, short- and long-term incentive	Sonenshine et al. (2016)	USA, 2003-2012	Ln(sum of salary, bonus, non-equity incentive plan compensation, stock option exercises, stock awards, deferred compensation earnings, and other compensation)	0.040 (EPS (-1)*Crisis)	Ln(sales)(-1)), Ln(sales)(-1)*Crisis, Merger value divided by market capitalization, Merger announcement, Merger announcement*Crisis, Divest value divided by market capitalization, Divest announcement, Independent board member dummy, Affiliated board member dummy, Independent board member dummy*Crisis, Affiliated board member dummy*Crisis, Crisis, New hire dummy, outside dummy, new outsider dummy, firm type dummy, EPS (-1), Return (-1), S&P performance, Return(-1)*Crisis
Fixed, short- and long-term incentive	Sonenshine et al. (2016)	USA, 2003-2012	Ln(sum of salary, bonus, other annual, restricted stock granted, stock options granted, long-term incentive payouts, and all other annual)	0.32 (Return(-1)*Crisis)	Ln(sales)(-1)), Ln(sales)(-1)*Crisis, Merger value divided by market capitalization, Merger announcement, Merger announcement*Crisis, Divest value divided by market capitalization, Divest announcement, Independent board member dummy, Affiliated board member dummy, Independent board member dummy*Crisis, Affiliated board member dummy*Crisis, Crisis, New hire dummy, outside dummy, new outsider dummy, firm type dummy, EPS (-1), Return (-1), S&P performance, EPS(-1)*Crisis

2.5 Difference in influence of firm performance on CEO compensation between high-and low-technology companies

For the period 1993-1998, Kwon and Yin (2006) examine whether CEO's in high-technology companies are paid different than CEOs in low-technology companies, using student t-tests. Kwon and Yin (2006) use companies from the study of Francis and Schipper (1999) and companies that are listed on CNNFN.com. The sample contains 144 high-technology and 74 low-technology companies. Consistent with the study of Shim et al. (2009), high-technology companies are classified as companies in the computer, electronics, pharmaceutical and telecommunications industries (Appendix A). Kwon and Yin (2006) use executive compensation data from the ExecuComp data set, financial data from the Compustat data set and stock return data from CRSP (Center for Research in Security Prices).

The outcomes of the student t-tests are as follows. First, Kwon and Yin (2006) find that CEOs of high-technology companies are paid a significant, higher total compensation compared to CEOs of low-technology companies. Furthermore, CEOs of high-technology companies receive higher levels of stock options grants than CEOs of low-technology companies. Finally, the outcomes show that CEOs of high-technology companies receive on average a lower base salary and bonus, compared to CEOs of low-technology companies.

For the same period, Kwon and Yin (2006) also examine whether the relationship between the change in return of equity and executive compensation significantly differs between high- and low-technology companies. In their regression model, the dependent variable is the change in executive compensation deflated by prior year's base salary of the CEO. As measures of executive compensation, the study of Kwon and Yin (2006) uses CEO's base salary, short-term bonus, the sum of CEO's base salary and short-term bonus, value of the stock option grants using the Black-Scholes method, other compensation and total direct compensation. Kwon and Yin (2006) also include an interaction variable between change in return of equity and an industry dummy (which has a value of 1 if the company is a high-technology company and 0 otherwise) to their regression model.

In general, the outcomes of the regressions do not show that the relationship between the change in return of equity and CEO compensation differs between high-technology and low-technology companies. Only in the model with bonus as dependent variable, Kwon and Yin (2006) find that the relationship between the change in return of equity and bonus is larger for high-technology companies than for low-technology companies. Kwon and Yin (2006) do find a positive influence of the change in ROE on the change in bonus deflated by prior year's base salary of the CEO and on the change in cash compensation (CEO's base salary plus bonus) deflated by prior year's base salary of the CEO. Furthermore, they find a negative influence of the change in ROE on the change in other compensation deflated by prior year's base salary of the CEO.

Shim et al. (2009) also examine whether the relationship between firm performance and CEO compensation differs between high-technology companies and low-technology companies. In their work, Shim et al. (2009) study 111 high-technology and 165 low-technology companies in the United States for the period 1999-2001. Their sample consists of companies of the "Fortune's 500 America most admired companies" list and the "1999-2001 Top 800 CEO Paychecks" Forbes' list. Those lists also contain compensation data. Corresponding financial data are from Compustat. In the study of Shim et al. (2009), high-technology companies are classified as companies in the computer, electronics, pharmaceutical, and telecommunication industries (Appendix A).

Shim et al. (2009) use three different measures of executive compensation: CEO's base salary; long-term compensation; and total compensation (sum of CEO's base salary, bonus and long-term compensation). Return on equity (ROE), an accounting performance measure, and Tobin's Q, which mixes market value and accounting value, are used as measures for firm performance. A regression model including lagged independent variables is estimated using Ordinary Least Square (OLS) method.

The outcomes of the regressions are, as follows. Firstly, for the period 2000-2001, Shim et al. (2009) find that for every one percentage point increase in prior year's ROE, CEO's base salary increases with 0.21 percentage point among high-technology companies. Secondly, for the period 2000-2001, the regressions show that for every one percentage point increase in prior year's Tobin's Q, CEO's base salary increases with 0.16 percentage point among high-technology companies and with 0.018 percentage point among low-technology companies. Thirdly, for the period 1999-2000, Shim et al. (2009) find that for every one percentage point increase in prior year's Tobin's Q, long-term compensation increases with 0.20 percentage point among high-technology and low-technology companies. Furthermore, for the period 2000-2001, they find that one percentage point increase, will induce a 0.19 percentage point increase in long-term compensation among high-technology companies and a 0.15 percentage point increase in long-term compensation among low-technology companies. Fourthly, for the period 1999-2000, Shim et al. (2009) find that a one percentage point increase in prior year's Tobin's Q, CEO's total compensation (sum of CEO's base salary, bonus and long-term compensation) increases with 0.18 percentage point among high-technology and low-technology companies. For the period 2000-2001, Shim et al. (2009) find that for every one percentage point increase in prior year's Tobin's Q, CEO's total compensation increases with 0.27

percentage point among high-technology companies and with 0.19 percentage point among low-technology companies.

Table 8
Summary of the literature on the difference in influence of firm performance on CEO compensation between high- and low-technology companies

CEO compensation component	Author(s)	Region and time period	Dependent variable	Independent variables	Control variables
Fixed	Kwon and Yin (2006)	USA, 1993-1998	The change in other compensation, deflated by year t-1 base salary	-0.1511 (change in ROE)	Stock returns; high-techology dummy * Stock returns; High-techology dummy * change in ROE; investment opportunity set
Fixed	Shim et al. (2009)	USA, 1999-2001	Ln(salary)	0.208 (ROE(-1)) 0.018-0.158 (Tobin's Q (-1))	Company reputation (-1); Ownership (-1); Assets (-1)
Short-term incentive	Kwon and Yin (2006)	USA, 1993-1998	The change in bonus, deflated by year t-1 salary	0.1435 (change in ROE)	Stock returns; high-techology dummy * Stock returns; High-techology dummy * change in ROE; investment opportunity set
Fixed and short-term incentive	Kwon and Yin (2006)	USA, 1993-1998	The change in salary plus bonus, deflated by year t-1 base salary	0.2311 (change in ROE)	Stock returns; high-techology dummy * Stock returns; High-techology dummy * change in ROE; investment opportunity set
Long-term incentive	Shim et al. (2009)	USA, 1999-2001	Ln (CEO's long-term compensation)	Not sign (ROE(-1)) 0.148-0.198 (Tobin's Q(-1))	Company reputation (-1); Ownership (-1); Assets (-1)
Fixed, short- and long- term incentive	Shim et al. (2009)	USA, 1999-2001	Ln(sum of salary, bonus and long-term compensation)	Not sign (ROE(-1)) 0.176-0.271 (Tobin's Q(-1))	Company reputation (-1); Ownership (-1); Assets (-1)

2.6 Other variables related to CEO compensation

Much literature has been linked to the role of firm size (Balkin et al., 2000; Bebchuck and Grinstein, 2005; Fahlenbrach, 2009; Farai et al., 2013; Finkelstein and Hambrick, 1989; Gabaix et al., 2013; Shim et al., 2009; Zhou, 2000). For Canadian companies, Zhou (2000) finds that for every one percentage increase in assets and every one percentage increase in sales, CEO's cash compensation increases with around 0.25 percentage point. Bebchuk and Grinstein (2005) also study whether CEO compensation and firm size (measured by sales) are related. Their sample of their research consists of United States based companies. Using the ExecuComp database, they examine those companies for the period 1997 – 2002 in order to understand the drivers of CEO compensation. Bebchuck and Grinstein (2005) find that for every one percentage increase in prior year's sales, CEO's total compensation increases with 0.13 percentage point, CEO's equity-based compensation with 0.31 percentage point and CEO's non-equity compensation with 0.21 percentage point. Furthermore, they find that an increase in firm size results in higher CEO pay, but a decrease in firm size does not lead to a reduction in CEO pay. For the period 1992-2011, Gabaix et al. (2013) find that, if firm value and sales increase with one percentage point, CEO's total compensation increase with 0.18 and 0.15 percentage point, respectively.

Cooper et al. (2009) find that firms with high growth opportunities (high market-to-book ratio) pay higher levels of cash compensation, compared to firms with low growth opportunities. Cooper et al. (2009) winsorize all variables of their variables at the 1 and 99 percentiles of their distributions.

Finkelstein and Hambrick (1989) find that the total assets are strongly related to total compensation and salary. They find that for every one percentage point increase in assets, CEO's cash compensation increases with 0.49 percentage point and CEO's base salary increases with around 0.45 percentage point. Interestingly, they find no evidence of a relationship between assets and the bonus of a CEO.

Balkin et al. (2000) find a significant positive relationship between assets and short-term CEO compensation (measured as salary and bonus) among high-technology firms. However, when innovation is added as variable to the regression model, the regressions in the sample of high-technology companies do not reveal evidence anymore of a relation between assets and short-term CEO compensation. Balkin et al. (2000)'s study is in line with the study of Shim et al. (2009), which also find a positive relationship between assets and CEO compensation among low-technology and high-technology companies.

A few studies find evidence of a positive relationship between CEO's age and CEO pay (McKnight et al., 2000; Rose and Shepard, 1994). For example, Rose & Shepard (1994) find a positive influence of CEO's age on CEO's cash compensation and CEO's total compensation. McKnight et al. (2000) study data on 100 public companies from the United Kingdom using annual reports and the FAME database. For the period 1992 – 1996, the regression outcomes show a non-linear relationship between the age of a CEO and his bonus. Furthermore, McKnight et al. (2000) find that CEO's age is positively related to CEO's salary. Finally, they find that shareholder return has a positive influence on CEO's bonus, share options and CEO's total compensation.

Moreover, Ozkan's (2007) results show that there is a negative relationship between the ownership of directors and CEO compensation. Ozkan (2007) suggests that director ownership may help to align the interests of directors with those of the shareowners by reducing the agency problem, as the director bears part of the costs of his actions. Therefore, higher ownership may limit excessive CEO compensation packages. This is consistent with the study of Ababoub & Chourou (2006), which also find a negative influence of CEO ownership on cash compensation (sum of salary and bonus) and total compensation (sum of cash compensation and value of new stock options awards). Finally, Ofek & Yermack (2000) point out that managers can be reluctant to sell a large amount of shares since outside investors may interpret the sell of shares as a negative signal about the firms' prospects.

Table 9
Summary of the literature on the influence of other variables on CEO compensation (Part 1)

CEO compensation component	Author(s)	Region and time period	Dependent variable	Independent variables	Control variables
Fixed	Finkelstein and Hambrick (1989)	USA, 1971, 1976, 1982 and 1983	Salary	0.41-0.53 (ln(assets))	ROE; SIC; general management dummy; Tenure; (Tenure)^2; CEO ownership; (CEO ownership)^2; CEO's family ownership; outside directors' ownership; ROE * outside directors' ownership
Fixed	Shim et al. (2009)	USA, 1999-2001	Ln(salary)	0.280-0.452 (assets(-1))	Reputation (-1); CEO ownership (-1); firm size (-1); ROE(-1); Tobin's Q (-1)
Fixed	McKnight et al. (2000)	UK, 1992-1996	Ln(salary)	0.011 (Age)	Ln(turnover); Turnover * Age; shareholder return; Shareholder return * Age
Short-term incentive	Finkelstein and Hambrick (1989)	USA, 1971, 1976, 1982 and 1983	Bonus	Not sign (ln(assets))	ROE; SIC; general management dummy; Tenure; (Tenure)^2; CEO ownership; (CEO ownership)^2; CEO's family ownership; outside directors' ownership; ROE * outside directors' ownership
Fixed and short-term incentive	Zhou (2000)	Canada, 1991- 1995	Ln (Salary plus bonus)	0.246-0.257 (ln(assets)) 0.248-0.252 (ln(sales))	Return to common stock; ROA; ROE
Fixed and short-term incentive	Finkelstein and Hambrick (1989)	USA, 1971, 1976, 1982 and 1983	Ln(Salary plus bonus)	0.49 (ln(assets))	ROE; SIC; general management dummy; Tenure; (Tenure)^2; CEO ownership; (CEO ownership)^2; CEO's family ownership; outside directors' ownership; ROE * outside directors' ownership
Fixed and short-term incentive	Ozkan's (2007)	UK, 1999-2005	Ln(salary plus bonus)	-0.013 (executive directors' ownership)	Ln(sales); shareholder return; Tobin's Q, board size; percentage of non-executive directors; total institutional ownership; executive directors' ownership^2; non-executive directors' ownership; non-executive directors' ownership^2; CEO age; tenure
Fixed and short-term incentive	Balkin et al. (2000)	USA, 1992-1994	Salary plus bonus	0.53 (assets)	Assets; CEO tenure; insider director ratio; Individual owner control; Corporate owner control

Table 10
Summary of the literature on the influence of other variables on CEO compensation (Part 2)

CEO compensation component	Author(s)	Region and time period	Dependent variable	Independent variables	Control variables
Fixed and short-term incentive	Rose & Shepard (1994)	USA, 1985-1990	ln(salary plus bonus)	0.005 (age)	Diversification index; ln(sales); ln(employees); market return; market return(-1); market return(-2); accounting return on equity; accounting return(-1); accounting return(-2); standard deviation of market return; tenure; outside hire dummy; founder dummy
Fixed and short-term incentive	Cooper et al. (2009	USA, 1994-2006	Salary plus bonus	0.07 (Market-to-book ratio)	Firm market capitalization; CAR (-1); CAR (-3); asset growth; accruals; abnormal capital expenditure; ROA
Fixed and short-term incentive	Ababoub & Chourou (2006)	Canada, 2001-2004	Ln(salary plus bonus)	-0.018 (Ownership) 0.031 (Ownership^2)	Ln(assets); ROA, market-to-book; age; tenure; duality; institutional
Long-term incentive	Shim et al. (2009)	USA, 1999-2001	Ln (long-term compensation))	0.186-0.264 (assets(-1))	Reputation (-1); CEO ownership (-1); firm size (-1); ROE(-1); Tobin's Q (-1)
Long-term incentive	Rose & Shepard (1994)	USA, 1985-1990	ln(sum of benefits, long-term and contingent compensation, stock options, stock appreciation rights, and stock accrual rights)	0.007 (age)	Diversification index; ln(sales); ln(employees); market return; market return(-1); market return(-2); accounting return on equity; accounting return(-1); accounting return(-2); standard deviation of market return; tenure; outside hire dummy; founder dummy
Long-term incentive	Bebchuk and Grinstein (2005)	USA, 1997-2002	Dep 2: Ln(CEO's equity-based compensation)	0.305 (ln(sales(-1)))	Ln(ROA); ln(return(-1)); ln(return(-2)); year dummy
Fixed, short- and long-term incentives	Shim et al. (2009)	USA, 1999-2001	Ln(sum of salary, bonus and long-term compensation)	0.143-0.301 (assets(-1))	Reputation (-1); CEO ownership (-1); firm size (-1); ROE(-1); Tobin's Q (-1)
Fixed, short- and long-term incentives	Ababoub & Chourou (2006)	Canada, 2001-2004	Ln(sum of salary, bonus and value of new stock option awards)	-0.023 (Ownership) 0.035 (Ownership^2)	Ln(assets); ROA, market-to-book; age; tenure; duality; institutional

Table 11
Summary of the literature on the influence of other variables on CEO compensation (Part 3)

CEO compensation component	Author(s)	Region and time period	Dependent variable	Independent variables	Control variables
Fixed, short- and long-term incentives	Gabaix et al. (2013)	USA, 1992-2011	Ln(sum of salary, bonus, long-term incentive payments, and the Black-Scholes value of options granted)	0.176 (ln(firm value)) 0.146 (ln(sales))	Ln(income)
Fixed, short- and long-term incentives	Bebchuk and Grinstein (2005)	USA, 1997-2002	Dep 1: Ln(CEO's total compensation)	0.138 (ln(sales(-1)))	Ln(ROA); ln(return(-1)); ln(return(-2)); year dummy
Fixed, short- and long-term incentives	Ozkan's (2007)	UK, 1999-2005	Ln(sum of salary, bonus, value of stock options and LTIP granted)	-0.016 (executive directors' ownership)	Ln(sales); shareholder return; Tobin's Q, board size; percentage of non-executive directors; total institutional ownership; executive directors' ownership^2; non-executive directors' ownership; non-executive directors' ownership^2; CEO age; tenure

3 Hypotheses Development

As stated in the introduction, the research question of this thesis is to look what influences CEO compensation in US-based high- and low-technology companies. Nine hypotheses are designed in order to test (i) whether firm performance has an influence on CEO compensation, (ii) whether the influence of innovation on CEO compensation is different between high-technology and low-technology companies, (iii) whether the influence of firm performance on CEO compensation is different between high-technology and low-technology companies, (iv) whether CEO compensation has an influence on firm performance and innovation, (v) whether the influence of firm performance and innovation on CEO compensation is different between the period before the crisis (2004-2007) than the period after the crisis (2008-2016), (vi) whether restricted stock and stock options have an influence on innovation, (vii) whether innovation and firm performance have an influence on restricted stock and stock options, (viii) whether the influence of innovation on CEO compensation depend on the interaction between the size of a company and whether a company is a high- or low-technology company and (ix) whether the relationship between the book-to-market ratio and CEO compensation depend on whether a company is a high- or low-technology company.

Hypothesis 1

Kato and Kubo (2004), Zhou (2000) and Joskow and Rose (1994) research the relationship between firm performance and CEO compensation. Their findings indicate a positive influence of firm performance on CEO compensation. Therefore, our first hypothesis is as follows:

H0: There is no relationship between firm performance and CEO compensation.
H1: Firm performance has a positive influence on CEO compensation.

Hypothesis 2

Based on the first hypothesis the question about the effect of firm performance on CEO compensation can be answered. To test the first hypothesis, we will use a regression model. We will elaborate in detail about the used regression models in section 4: Methods.

In the high-technology market, having the ability to innovate can be an important factor in a company's competitiveness and can result in high profits (Balkin et., 2000). To sustain innovation, these companies need to make high expenditures in R&D. Thus, CEOs are responsible for engaging in the right R&D projects, which lead to radical innovations. Therefore, CEO compensation in high-technology companies should be aligned with innovation. Balkin et al. (2000) find that innovation has a positive influence on short-term and long-term CEO compensation in high-technology companies, but they do not find a significant relationship among low-technology companies. For this reason, our second hypothesis decides whether or not the influence of innovation on CEO compensation differs between high-technology and low-technology companies. Therefore, the second hypothesis this thesis will address can be stated as follows:

H0: There is no difference in the influence of innovation on CEO compensation between high- and low-technology companies.
H1: The influence of innovation on CEO compensation is positive and stronger for high-technology companies than for low-technology companies.

Hypothesis 3

The second hypothesis allow us to discover the influence of innovation on CEO compensation and whether this influence differs between high- and low-technology companies. It may also be interesting to know whether the influence of firm performance on CEO compensation differs between high- and low-technology companies.

Shim et al. (2009) find a positive influence of firm performance (measured as return on equity) on the CEO's base salary among high-technology companies and they do not find this relationship among low-technology companies. Kwon and Yin (2006) also examine whether the influence of firm performance on bonus and cash compensation (sum of salary and bonus) differs between high-technology and low-technology companies. In general, the outcomes of their regressions do not show that the effect of firm performance on bonus and cash compensation differs between high-technology and low-technology companies.

For the third hypothesis, we will apply the same hypothesis as Kwon and Yin (2006) examined. So, we hypothesize whether the effect of performance on CEO compensation differs between high-technology and low-technology companies:

H0: There is no difference in the effect of firm performance on CEO compensation between high- and low-technology companies.
H1: The effect of firm performance on CEO compensation is positive and stronger in high-technology companies than in low-technology companies.

Hypothesis 4

Interestingly, the study of Faria (2014) finds that CEO total compensation has a positive influence on innovation. This suggests that there is an endogenous relationship between innovation and CEO total compensation. We expect that long-term incentives have a positive influence on innovation, and short- and long-term incentives have a positive influence on firm performance. This leads to our fourth hypothesis:

H0: CEO compensation has no influence on innovation and firm performance.
H1: Long-term incentives have a positive influence on innovation. Short- and long-term incentives have a positive influence on firm performance.

Hypothesis 5

Vemala et al. (2014) researched whether the influence of firm performance on CEO compensation differs between the period before the crisis and the period after the crisis by splitting their time period in a pre-crisis period (2004-2007) and a post-crisis period (2009-2012). They find that Tobins' Q has a positive influence on CEO's cash compensation, both pre- and post-crisis. However, Sonenshine et al. (2016) find different results. They find that that the influence of prior year's earnings per share and stock performance on salary, cash compensation and total compensation is stronger after the crisis than before the crisis. We will research whether the influence of firm performance and innovation differs between the period before the crisis (2004-2007) and the period after the crisis (2008-2016). Therefore, our fifth hypothesis is as follows:

H0: There is no difference in the influence of firm performance and innovation on CEO compensation between before the crisis and after the crisis.
H1: The influence of firm performance and innovation on CEO compensation is stronger in the period after the crisis (2008-2016) than in the period before the crisis (2004-2007).

Hypothesis 6

An equity compensation plan normally consists of different components. These components may have different impacts. The two most used components are stock options and restricted stock. Stock options give a CEO the right to purchase a number of shares at a certain price, named the strike price, through a specific period of time. Stock options can stimulate the CEO to increase stock prices to earn the difference between the price at the moment of exercising the options and the strike price. Unlike stock options, restricted stocks give a CEO the right to receive a number of shares once certain restrictions are met. Earlier research finds a different influence of stock options on innovation than restricted stock. For example, Ryan & Wiggins (2002) find that one unit in the ratio of stock options to CEO's total annual compensation increases the ratio of R&D expenses divided by total assets with 0.62 percentage point. However, one unit in the ratio of restricted stock to CEO's total annual compensation decreases the ratio of R&D expenses divided by total assets with 1.17 percentage point. Bryan et al. (2000) point out that because of the linear payoff of restricted stock and the concave utility function of a CEO, restricted stock is inefficient relative to stock options in inducing risk-averse CEOs to invest in risky, value-enhancing investment projects. The payoff function of stock options is convex in the stock price. Consequently, executive stock options provide a more efficient incentive mechanism. We will also research the influence of restricted stock and stock options on innovation. Therefore, the sixth hypothesis is as follows:

H0: Restricted stock and stock options have no influence on innovation.
H1: Restricted stock decreases innovation. Stock options increase innovation.

Hypothesis 7

Ryan & Wiggens (2002) find that one unit increase in the ratio of R&D expenses divided by total assets increases the ratio of stock options to CEO's total compensation with 1.55 percentage point and decreases the ratio of restricted stock scaled by CEO's total compensation with 2.52 percentage points. This leads to our seventh hypothesis:

H0: Innovation and firm performance have no influence on stock options and restricted stock.
H1: Innovation and firm performance increase stock options and decrease restricted stock.

Hypothesis 8

We expect that the influence of innovation on fixed and short-term incentive compensation is weaker for small, high-technology companies than for large, low-technology companies, because small, high-technology companies may have to use the cash for investing in R&D projects. In response to the low levels of cash compensation, the small, high-technology companies might use equity compensation to attract quality managers. So, we expect that the relationship between innovation and long-term incentive compensation is stronger for a company if the company is a high-technology company and small, compared to a large, low-technology company. The eight hypothesis is as follows:

H0: There is no difference in the effect of innovation on CEO compensation between large, low-technology companies and small, high-technology companies.
H1: The influence of innovation on long-term incentive compensation is stronger for small, high-technology companies than for large, low-technology companies. The influence of innovation on fixed and short-term incentive compensation is weaker for small, high-technology companies than for large, low-technology companies.

Hypothesis 9

Cooper et al. (2009) also find that firms with high growth opportunities (high market-to-book ratio) pay higher levels of cash compensation, compared to firms with low growth opportunities. The explanation behind this finding can be that companies with high growth opportunities has a higher level of complexity. A CEO in a company with high growth opportunities may have to be compensated for the complexity. We also expect that high-technology companies pay their CEOs with less cash compensation and more with long-term compensation.

Therefore, our last hypothesis is as follows:

H0: The market-to-book ratio has no influence on CEO compensation.
H1: The influence of the market-to-book ratio on fixed compensation is positive and the influence is stronger in low-technology companies than in high-technology companies.

This thesis will examine what determines CEO compensation in high and low-technology companies. Before actually investigating the hypotheses above, we will first describe our chosen methodology and data in the following chapter.

4 Methods

4.1 Data set

Table 12 shows our sample of 8,797 companies (on average). This sample consists of companies from the S&P 500 firms, S&P Midcaps 400 firms, S&P small caps 600 firms and firms which are not on a major S&P index. We have an unbalanced panel with 114,375 observations over a thirteen-year period (2004-2016). The sample includes different four-digit standard industrial classification (SIC) codes. According to the Fama and French classification (Fama and French, 1997), we classify a company as a high-technology firm if the four-digit SIC takes a value of 3570, 3571, 3572, 3576, 3577, 3661, 3674, 4812, 4813, 5045, 5961, 7370, 7371, 7372 or 7373 and as a low-technology firm otherwise. This classification has previously been used by Faria (2014) and Bebchuk and Grinstein (2005). In our sample, we have on average 1,033 (11,74%) high-technology and 7,764 (88,26%) low-technology companies, see Table 12.

Table 12
High- and low-technology companies over years

Year	Number of companies	High-technology companies	High-technology companies
2004	1,246	213	1,033
2005	9,505	1,404	8,101
2006	9,720	1,340	8,380
2007	9,790	1,280	8,510
2008	9,621	1,210	8,411
2009	9,604	1,164	8,440
2010	9,850	1,169	8,681
2011	10,473	1,174	9,299
2012	10,588	1,167	9,421
2013	10,490	1,136	9,354
2014	10,144	1,065	9,079
2015	9,655	947	8,708
2016	3,689	168	3,521
Average	8,797	1,033	7,764

The data come from three different sources. For the variables ASSETS, SALES, EMPL, R&D and MTOB we use the Compustat North America database. The definitions of the variables can be found in Appendix D. We use the Compustat Executive Compensation database to collect compensation data of all CEOs, named as LONG, SHORT, FIXED, RESTRICTED and OPTIONS. The Compustat Executive Compensation database also collects information on nine other independent variables: TSR, TOBINSQ, DIVIDENDYIELD, HIGHTECH, S&PINDEX, MALE, AGE, CEOOWN and YEARS. Finally, we gather information for the variables ROE, ROA and PATENTS from the Orbis database.

4.2 Variable definitions

4.2.1 Dependent variables

The dependent variable in our study is the CEO compensation. In accordance with the literature (for instance: Kato and Kubo, 2006) on executive compensation, we will focus on the CEO annual compensation.

CEO compensation consists of short-term incentive, long-term incentive and fixed components (see Figure 2). Our variable SHORT is the short-term incentive component of CEO compensation and is equal to the dollar value of the annual bonus earned by the CEO during the fiscal year (Balkin et al., 2000; McKnight et al., 2000; Shim et al. 2009; Zhou, 2000). The variable LONG is the long-term incentive component of CEO compensation and is defined as the sum of the value of all options granted during the fiscal year (valued by the company) and the value of restricted stock granted during the fiscal year (Ryan & Wiggens, 2002). The variable FIXED is the fixed component of CEO compensation and is equal to the CEO's base salary (Balkin et al., 2000; McKnight et al., 2000; Shim et al. 2009; Zhou, 2000).

We ran the Shapiro- Wilk test to test whether the compensation components LONG, FIXED and SHORT have a normal distribution, and we created box plot graphs , and we could reject the hypothesis that all compensation components have a normal distribution (Appendix E, Y, Z and AA). Similar to Zhou (2000), Gabaix et al. (2013) and Shim et al. (2009), this thesis also uses the natural logarithm of SHORT, FIXED and LONG to control for skewness in CEO compensation. These variables are called LN(SHORT), LN(FIXED) and LN(LONG). Additionally, in hypothesis 4, we test whether CEO compensation influences innovation and firm performance. If we find evidence that a component of CEO compensation has a significant influence on innovation or firm performance, we include a lagged dependent variable as independent variable for this component in order to control for endogeneity. These variables are called LAG(SHORT), LAG(LONG) and LAG(FIXED). Finally, consistent with studies as Cooper et al. (2009), we correct the distribution by winsorizing all variables of our sample at the 1 and 99 percentiles of their distributions.

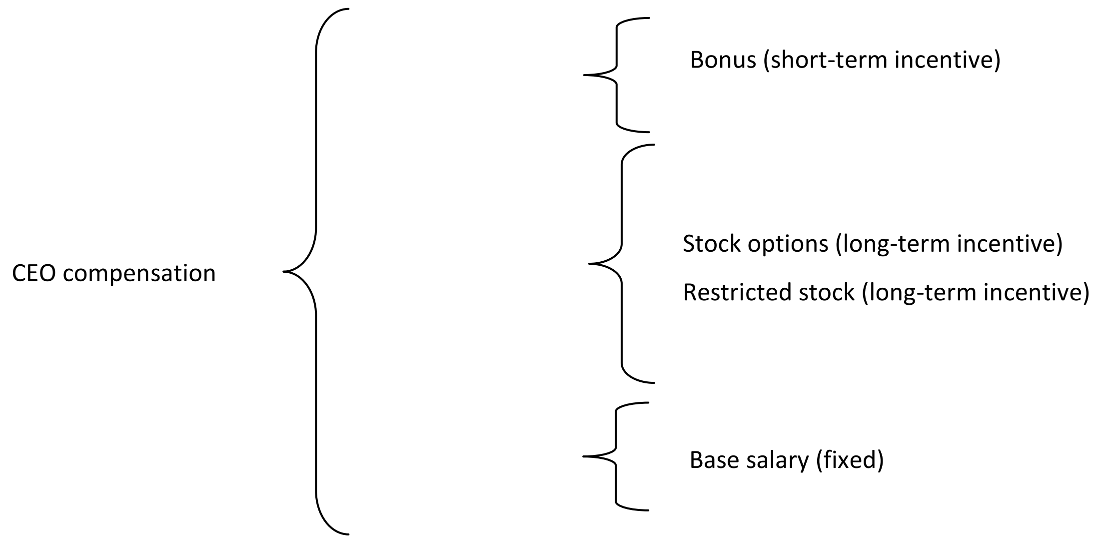
For hypothesis 6 and 7, we research the relationship between CEO compensation and two separate long-term incentive components of CEO compensation, restricted stock and stock options. RESTRICTED is the value of restricted stock granted during the fiscal year. OPTIONS is the value of all options granted during the fiscal year (valued by the company). We use OPTIONS and RESTRICTED instead of LN(OPTIONS) and LN(RESTRICTED), because LN(OPTIONS) and LN(RESTRICTED) have more missing observations (Table 13) LN(OPTIONS) and LN(RESTRICTED) are not able to be negative or zero.

Table 13

Number of observations for OPTIONS, LN(OPTIONS), RESTRICTED and LN(RESTRICTED)

	Number of observations
OPTIONS	18,052
LN(OPTIONS)	1,096
RESTRICTED	18,052
LN(RESTRICTED)	711

Figure 2: Three CEO compensation categories in our empirical analysis



4.2.2 Independent variables

Research and development expense

We expect innovation to be associated with higher CEO compensation among high-technology companies. We use R&D (in million US dollars) and R&D/ASSETS as independent variables to measure innovation (Balkin et al., 2000; Faria, 2014; Kwon and Yin, 2006). R&D is a continuous variable and is defined as the amount of money spent on R&D.. We follow Balkin et al. (2000) to lag R&D by one year. The variable is called LAG(R&D). We ran the Shapiro-Wilk test and showed that we can reject the hypothesis that R&D has a normal distribution (Appendix E). Therefore, we use the natural logarithm of R&D, which is called LN(R&D), instead of R&D.

Patents

PATENTS is included and is defined as the number of patents a firm has in the year 2016. We can reject the hypothesis that PATENTS has a normal distribution (Appendix E). Therefore, we use the natural logarithm of PATENTS, which is called LN(PATENTS).

Firm performance

Previous studies (e.g. Faria, 2014; Joskow and Rose, 1994; Zhou, 2000) analyzed the influence of firm performance on CEO compensation and found that CEO compensation is positively related with firm performance. In this thesis we use accounting performance measures, market performance measures and a mix of market performance- and accounting performance- measures. Return on assets and return on equity are accounting performance measures. Dividend yield and total shareholder return are market performance measures. Tobin's Q is a mix of market performance and accounting performance measures.

ROA is defined as the return on assets, calculated by multiplying the net income before extraordinary items and discontinued operations with 100, divided by total assets (Balkin et al., 2000; Henderson et al. 2006; Kato and Kubo, 2006; Zhou, 2000), ROE is the return on equity, calculated by multiplying the net income before extraordinary items and discontinued operations with 100, divided by total common equity (Shim et al. 2009; Zhou, 2000), DIVIDENDYIELD is the dividend yield at fiscal year-end, TSR is the total annual shareholder return, including the returns received by shareholders originating from reinvestments of dividends (McKnight et al., 2000) and TOBINSQ refers to Tobin's Q, which mixes market value with accounting value and is calculated by the market value of a firm plus total liabilities divided by the sum of equity book value plus total liabilities[1].Tobin's Q can be used as a proxy for growth opportunities. Firms with high Tobin's Q scores have higher growth potential. ROA, ROE, DIVIDENDYIELD, TSR and TOBINSQ are expressed as a percentage. Since prior research has

[1] DEFINITION OF TOBIN'S Q, http://www.investopedia.com/terms/q/qratio.asp (last visited June 21, 2017)

generally lagged return on assets (Balkin et al. 2000) and return on equity (Shim et al., 2009) by one year, we wish to remain methodologically consistent. These new variables are called LAG(ROA) and LAG(ROE).

Growth opportunities

MTOB is the market to book ratio, which measures the market value of a firm relative to its book or accounting value (Cooper et al., 2009)

Crisis

We also use CRISIS as a binary variable, which equals 0 for the years prior to the financial crisis of 2008 and equals 1 for the years after.

Industry

HIGHTECH is a categorical variable which takes a value of 1 when the company is a high-technology firm and takes a value of 0 when the company is a low-technology firm (Kwon and Yin, 2006). We follow Fama and French (1997) in classifying a company as a high-technology firm if the four-digit SIC takes a value of 3570, 3571, 3572, 3576, 3577, 3661, 3674, 4812, 4813, 5045, 5961, 7370, 7371, 7372 or 7373, and as a low-technology firm otherwise. This classification has previously been used by Faria (2014) and Bebchuk and Grinstein (2005).

Firm size

Previous studies (e.g. Balkin et al.,2000; Bebchuck and Grinstein, 2005) found a positive relationship between firm size and CEO compensation. In our thesis we use three different measures of firm size: ASSETS is a continuous variable and describes the total value of the firm's assets in millions of dollars (Faria, 2014; Kwon and Yin, 2006; Shim et al., 2009; Zhou, 2000), EMPL is a continuous variable and is defined as the total number of employees in thousands (Kato and Kubo, 2006), and SALES is a continuous variable and is defined as the total annual sales in millions of dollars (Balkin et al., 2000; Faria, 2014; Gabaix et al., 2013; Kato and Kubo, 2006; McKnight et al., 2000; Shim et al., 2009; Zhou, 2000). The Shapiro-Wilk test shows that we can reject the null hypothesis of a normal distribution for ASSETS, SALES and EMPL (Appendix E). Following the literature (Faria, 2014; Gabaix et al., 2013; Kwon and Yin, 2006; Shim et al., 2009; Zhou,2000), we adopt the practice of using the logarithm transformation (LN) for all size variables in our regressions. The new variables are called LN(ASSETS), LN(SALES) and LN(EMPL). Similar to Balkin et al. (2000) and Shim et al. (2009), we will also lag the variable ASSETS by one year. This variable is called LAG(ASSETS).

Interaction variables

With the variable CRISIS, we create the following interaction variables: LN(R&D)*CRISIS, LAG(R&D)*CRISIS, R&D/ASSETS*CRISIS, ROA*CRISIS, LAG(ROA)*CRISIS, ROE*CRISIS, LAG(ROE)*CRISIS, DIVIDENDYIELD*CRISIS, TSR*CRISIS and TOBINSQ*CRISIS.

We create interaction variables between the innovation variables, LN(R&D) and R&D/ASSETS, and dummy variable HIGHTECH. These new variables are called LN(R&D)*HIGHTECH and R&D/ASSETS*HIGHTECH.

We create interaction variables between the firm performance variables, ROA, ROE, DIVIDENDYIELD, TSR, TOBINSQ, LAG(ROA) and LAG(ROE), and dummy variable HIGHTECH. These new variables are called ROA*HIGHTECH, ROE*HIGHTECH, DIVIDENDYIELD*HIGHTECH, TSR*HIGHTECH, TOBINSQ*HIGHTECH, LAG(ROA)*HIGHTECH and LAG(ROE)*HIGHTECH.

We create a dummy variable, S&PINDEX, which equals 3 if the firm is a S&P 500 firm, equals 2 if the firm is a S&P Midcaps 400 firms, equals 1 if the firm is a S&P small caps 600 firms and equals 0 if the firm is not on a major S&P index. We combine S&PINDEX with binary variable HIGHTECH and create a new dummy variable S&PHIGHTECH. This variable equals 7 if the firm is a S&P 500 firm and is a high-technology firm, equals 6 if the firm is a S&P 500 firm and is a low-technology firm, equals 5 if the firm is S&P Midcaps 400 firm and is a high-technology firm, equals 4 if the firm is a S&P Midcaps 400 firm and is a low-technology company, equals 3 if the firm is a S&P small caps 600 firm and is a high-technology company, equals 2 if the firm is a S&P small caps 600 firm and is low-technology company, equals 1 if the firm is not a major S&P index and is a high-technology company, equals 0 if the firm is not on a major S&P index and is a low-technology company.

Finally, we create an interaction variables between LN(R&D) and S&PHIGHTECH and between R&D/ASSETS and S&PHIGHTECH. These variables are called LN(R&D)*S&PHIGHTECH and R&D/ASSETS*S&PHIGHTECH.

4.2.3 Control variables

Year

We also use YEARS as a categorical variable to control for shift in real compensation levels over time (Faria, 2014). YEARS takes a value of 0 if the year is 2004, takes a value of 1 if the year is 2005, takes a value of 2 if the year is 2006, takes a value of 3 if the year is 2007, takes a value of 4 if the year is 2008, takes a value of 5 if the year is 2009, takes a value of 6 if the year is 2010, takes a value of 7 if the year is 2011, takes a value of 8 if the year is 2012, takes a value of 9 if the year is 2013, takes a value of 10 if the year is 2014, takes a value of 11 if the year is 2015 and takes a value of 12 if the year is 2016.

CEO's age

Following McKnight et al. (2000), AGE is included in the empirical analysis. AGE is defined as a continuous variable and is the age of the CEO when appointed CEO. AGE is measured in years and has values between 27 and 96 years old (see Table 14).

Stock ownership

Based on prior research of Ababoub & Chourou (2006) and Shim et al. (2009), we expect a negative relationship between the shares owned by the CEO and a CEO's compensation. Ababoub & Chourou (2006) argue that compensation decreases, when a CEO's share ownership increases, because the interests of the CEO become more aligned with those of the shareholders.

CEOOWN is a continuous variable and is defined as the ratio of total shares that the CEO owns to the total outstanding shares (Shim et al. 2009). Similar to Shim et al. (2009), we will also lag CEOOWN by one year. This variable is called LAG(CEOOWN).

Gender

MALE is a binary variable which takes a value of 1 when the CEO of the company is a male and takes a value of 0 when the CEO of the company is a female.

Table 14
Descriptive statistics (Part 1)
This table illustrates the descriptive statistics of the data used in this paper. The table illustrates the number of observations, mean, maximum, minimum, standard deviation, skewness and kurtosis of all standard variables.

	Observations	Mean	Max	Min	SD	Skewness	Kurtosis
SHORT	18,052	232.81	76,951	0	1,364.64	27.19	1,172.77
High-technology companies	2,793	171.44	12,600	0	627.03	8.06	101.58
Low-technology companies	15,259	244.04	76,951	0	1,459.58	26.15	1,058.77
LONG	18,052	220.23	69,393.25	0	1,564.98	17.13	466.69
High-technology companies	2,793	266.26	46,563.36	0	1,689.79	13.29	263.80
Low-technology companies	15,259	211.80	69,393.25	0	1,540.95	18.02	517.60
FIXED	18,052	657.38	8,100	0	435.79	3.86	49.65
High-technology companies	2,793	527.21	2,556	0	319.04	1.49	6.78
Low-technology companies	15,259	681.20	8,100	0	449.87	3.98	50.62
R&D	42,502	125.72	14,035.29	0	665.12	9.99	124.92
High-technology companies	9,714	165.77	13,948	0	734.31	9.54	120.35
Low-technology companies	32,788	113.85	140,35.29	0	642.73	10.12	124.65
PATENTS	42,603	319.23	127,861	0	3,403.58	25.08	806.08
High-technology companies	5,891	644.58	127,861	0	5,646.35	18.50	399.37
Low-technology companies	36,712	267.03	120,209	0	2882.44	25.45	866.89
ROA	21,190	-0.72	98.303	-100	22.90	-1.46	7.01
High-technology companies	3,726	-2.78	97.84	-99.87	22.79	-1.30	6.23
Low-technology companies	17,464	-0.28	98.303	-100	22.90	-1.49	7.21
ROE	20,502	-6.85	984.62	-999.05	91.36	-2.84	40.57
High-technology companies	3,591	-12.86	847.95	-986.26	93.33	-2.84	34.17
Low-technology companies	16,911	-5.57	984.62	-999.05	90.89	-2.84	42.13

Table 15
Descriptive statistics (Part 2)

	Observations	Mean	Max	Min	SD	Skewness	Kurtosis
DIVIDENDYIELD	20,028	1.36	892.86	0	9.57	64.78	5297.55
High-technology companies	3,127	1.04	698.06	0	13.07	49.13	2,596.58
Low-technology companies	16,901	1.41	892.86	0	8.77	69.71	6,534.76
TSR	20,028	12.46	285,476.9	-99.56	3,008.08	76.64	6,357.07
High-technology companies	3,127	18.24	224,491.8	-99.33	4,186.45	50.20	2,652.37
Low-technology companies	16,901	5.76	285,476.9	-99.56	2,735.03	87.52	8,329.24
TOBINSQ	113,675	200.03	4,766,204	-1,628,663	17,151.54	186.39	53,915.93
High-technology companies	13,327	278.82	1,189,357	-1,628,663	19,396.56	-25.28	4,846.63
Low-technology companies	100,348	189.57	4,766,204	-1,228,882	16,830.95	228.58	64,730.06
R&D/ASSETS	42,351	0.17	1,981.5	-28.44	13.91	108.04	13,443.28
High-technology companies	9,690	0.18	155.96	-28.44	1.74	74.33	6,591.78
Low-technology companies	32,661	0.16	1,981.5	-0.037	15.81	95.36	10,441.99
ASSETS	87,590	5,245.82	2017,263	0	39,182.79	26.05	916.87
High-technology companies	12,680	4,331.68	403,821	0	20,326.81	8.70	97.12
Low-technology companies	74,910	5,400.56	2,017,263	0	41,534.01	25.40	847.86
MTOB	72,088	28,145.05	2.83e+08	-579,425.4	1,609,616	119.77	17,679.5
High-technology companies	10,600	23,455.68	7.19e+07	-109,112.9	877,553	64.21	4,736.69
Low-technology companies	61,488	28,953.45	2.83e+08	-579,425.4	1,704,336	116.78	16,432.12
EMPL	72,987	9.55	2300	0	43.33	22.44	925.14
High-technology companies	11,322	8.52	438.65	0	33.29	7.12	62.41
Low-technology companies	61,665	9.74	2300	0	44.93	23.29	943.52

Table 16
Descriptive statistics (Part 3)

	Observations	Mean	Max	Min	SD	Skewness	Kurtosis
SALES	87,029	2,944.08	483,521	0	14,844.68	14.96	329.08
High-technology companies	12,651	2,629.98	163,763	0	11,122.99	7.27	64.25
Low-technology companies	74,378	2,997.51	483,521	0	15,387.82	15.24	330.35
AGE	18,052	54	96	27	14.12	-2.23	10.15
High-technology companies	2,793	52	95	27	13.51	-2.13	9.84
Low-technology companies	15,259	54	96	31	14.19	-2.27	10.29
CEOOWN	18,052	1.89	100	0	6.12	8.18	131.08
High-technology companies	2,793	2.01	87.6	0	5.79	5.10	39.39
Low-technology companies	15,259	1.67	100	0	6.18	8.64	143.85
MALE	18,105	0.97	1	0	0.18	-5.11	27.10
High-technology companies	2,813	0.97	1	0	0.17	-5.60	32.33
Low-technology companies	15,292	0.96	1	0	0.18	-5.03	26.30

Table 17
Descriptive statistics (Part 4)

	Observations	Mean	Max	Min	SD	Skewness	Kurtosis
RESTRICTED	18,052	66.98	32,087	0	672.85	23.72	835.46
High-technology companies	2,793	61.91	13,657.4	0	562.03	13.67	233.77
Low-technology companies	15,259	67.91	32,087	0	691.22	24.54	868.63
OPTIONS	18,052	153.25	49,912.82	0	1,225.87	18.79	524.84
High-technology companies	2,793	204.35	46,563.36	0	1,468.94	16.60	412.80
Low-technology companies	15,259	143.89	49,912.82	0	1,175.77	19.25	549.32
YEARS	114,388	6.19	12	0	3.31	-0.030	1.84
High-technology companies	13,441	5.69	12	0	3.27	0.096	1.83
Low-technology companies	100,947	6.26	12	0	3.31	-0.047	1.84
CRISIS	114,388	0.65	1	0	0.48	-0.64	1.40
High-technology companies	13,441	0.59	1	0	0.49	-0.39	1.15
Low-technology companies	100,947	0.66	1	0	0.47	-0.67	1.45

4.3 Dataset adjustments

The original sample downloaded from the Compustat North America data base consists of 142,974 observations for the period between 2004 and 2016. We imposed several restrictions on our sample. We deleted a company from our sample, because the company does not have a registrated Ticker symbol. Furthermore, we deleted all duplicate observations. Finally, we deleted all negative observations for the variables SHORT, R&D and/or SALES.

The final sample used for the empirical analysis consists of 8,797 companies (on average) and 114,375 observations for the period 2004-2016. Table 18 provides an overview of the sample selection process.

Table 18
Sample selection process

	Number of observations
Initial sample from the Compustat North America data set	142,974
Deduct: Firms with no Ticker symbol	-735
	= 142,239
Added: Data from the ExecuComp data set	No change
	= 142,239
Added: Data from the Orbis data set	No change
	= 142,239
Deduct: All duplicate observations	-27,748
	= 114,491
Deduct: All observations where SHORT<0	- 1
	= 114,490
Deduct: All observations where R&D<0	-13
	= 114,477
Deduct: All observations where SALES<0	-102
Available firm-year observations	= 114,375

4.4 Data analysis

In this section we discuss the descriptive statistics of the variables used in our study. For the years 2004-2016, Tables 14-17 exhibit the descriptive statistics of all variables of our sample, including the the number of observations, mean, maximum, minimum, standard deviation, skewness and kurtosis of all standard variables.

Table 16 shows that the age of CEOs ranged from 27 to 96 years old with an average age of 54 years and a standard deviation of 14.12. Table 14 shows that CEO's salary (FIXED) has a minimum of $0 and a maximum of $8,100,000. We observe that CEOs in high-technology companies have a lower average salary ($527,210) than CEOs in low-technology companies ($681,200). A large variance in CEO bonus (SHORT) was found with the minimum of $0 and a maximum of $76,951,000. Again, CEOs in high-technology companies have a lower annual average bonus ($171,440) than CEOs in low-technology companies ($244,040). Long-term incentives, the sum of restricted stock and stock options, have a minimum of $0 and a maximum of $69,393,250. The average long-term incentives are higher for CEOs in high-technology companies ($266,260) than for CEOs in low-technology companies ($211,800). The average R&D expense is higher in high-technology companies ($165,770,000) than in low-technology companies ($113,850,000). Interestingly, the average value of Tobin's Q is high (200.03), both in high-technology (278.82) and low-technology companies (189.57).

High-technology companies do have more patents in 2016 than low-technology companies. High-technology companies have on average a lower return on assets, higher shareholder return, return on equity and dividend yield than low-technology companies. Only the Tobin's Q score is on average higher in high-technology companies than in low-technologies. Finally, CEOs in high-technology companies own on average more shares than CEOs in low-technology companies.

Panel A-D of Table 19 compare the evolution of CEO compensation over the period 2004-2016. For LONGINC, which is equal to the sum of the value of restricted stock granted and the value of all options granted, we only have available observations for the years 2005 and 2006. For SHORTINC (bonus) and FIXED (salary), there are no observations in the year 2004.

We observe that the average of short term incentives and fixed components decreased during the period 2005-2007. Furthermore, if we look at the evolution of the average bonus of a CEO during the period 2007-2016, we observe that the average short-term incentives and fixed components increased in that particular period with more than 10 thousand dollars and 110 thousand dollars, respectively.

In Table 20, we observe whether larger firms have higher compensation components than smaller firms. Furthermore, we separate our firms into high- and low-technology companies. As expected, in all four groups (not on a major S&P, S&P 600 small caps, S&P Midcaps 400 and S&P 500), the average short- and long-term incentives and fixed compensation are higher in high-technology companies than in low-technology companies. Moreover, we observe that the average of long-term incentives, which are the sum of stock options and restricted stock, is higher in companies that are not on a major S&P (for example: startups) than in companies that are on the S&P 600 small caps or on the S&P Midcaps 400. We also find that S&P 500 and S&P Midcaps 400 companies have on average higher fixed compensation (salary) than companies that are not on a major S&P and S&P 600 small caps companies.

Table 21 shows that firms with high growth opportunities (market-to-book ratio>1) have on average higher short- and long-term incentive compensation and higher fixed compensation than firms with low growth opportunities (market-to-book ratio<1). Interestingly, high-technology companies with high growth opportunities have on average higher short-term incentive compensation than low-technology companies with high-growth opportunities. An explanation might be that firms with greater growth opportunities (higher book-to-market ratio) might need higher quality managers who demand a higher cash compensation.

In Table 22, we observe that the average R&D expenditures are higher in the period after the crisis (2008-2016) than in the period before the crisis (2004-2007). The average share ownership of a CEO has decreased in the period 2007-2016. Total shareholder return has a downfall in the year 2008. However, on average, total shareholder return is higher in the period after the crisis than in the period before the crisis.

Before we do the empirical analysis we need to know if there is multicollinearity between our observed independent variables. Appendix F-P present the Pearson's correlation coefficients. If a correlation coefficient between two independent variables is high (i.e. 0.80), multicollinearity becomes a problem (Bryman & Cramer, 2005; Kumari, 2012). There are multiple correlations between two independent variables that exceed 0.80.

TSR has a high correlation with TSR*CRISIS, DIVIDENDYIELD has a high correlation with DIVIDENDYIELD*CRISIS, TOBINSQ has a high correlation with TOBINSQ*CRISIS, LAG(R&D) has a high correlation with LAG(R&D)*CRISIS and R&D/ASSETS has a high correlation with R&D/ASSETS*CRISIS. In hypothesis 5, we test whether the influence of innovation and firm performance on the different components of CEO compensation differs between the period before the crisis and the period after the crisis. Because of the significant high correlations, we will not use interaction variables to test the hypotheses. Now, we will separate the sample period in two different periods, the period before the crisis (2004-2007) and the period after crisis (2008-2016). In that way, we observe whether the coefficients of the firm performance variables and innovation variables have different signs.

CEOOWN has a high correlation with LAG(CEOOWN). We decide to exclude LAG(CEOOWN) from our regression model. Furthermore, we find that LN(ASSETS) has a high correlation with LN(EMPL) and LN(SALES). Furthermore, LN(SALES) has also a high correlation with LN(EMPL). Since, LN(ASSETS) has a higher correlation with the compensation components SHORT, LONG and FIXED than LN(SALES) and LN(EMPL, we decide to keep LN(ASSETS) in our regression models and to exclude variables LN(SALES) and LN(EMPL).

Finally, we observe that there is no significant correlation between the compensation components, LN(SHORT), LN(LONG) and LN(FIXED), and the variables DIVIDENDYIELD, ROA, LAG(ROA) and MTOB. However, we decide to keep DIVIDENDYIELD, ROA, LAG(ROA) and MTOB in the regression model because of their economic relevance.

Table 19
Mean compensation over years

Panel A

	2004	2005	2006	2007	2008	2009	2010
Number of companies	1,246	9,505	9,720	9,790	9,621	9,604	9,850
Mean SHORT	No obs	1,569.35	966.28	793.20	868.92	773.80	824.76
Mean LONG	No obs	2,280.02	347.73	No obs	No obs	No obs	No obs
Mean FIXED	No obs	653.05	642.43	609.96	632.94	634.44	651.36

Panel B

	2011	2012	2013	2014	2015	2016	Average
Number of companies	10,473	10,588	10,490	10,144	9,655	3,689	8,797
Mean SHORT	816.26	825.10	798.61	802.47	823.10	803.46	890.18
Mean LONG	No obs	No obs	No obs	No obs	No obs	No obs	No obs
Mean FIXED	662.77	668.89	683.18	694.61	706.83	728.83	657.38

Panel C

	2004	2005	2006	2007	2008	2009	2010
Mean SHORT							
High-technology companies	No obs	531.51	510.93	471.35	506.18	508.54	531.69
Low-technology companies	No obs	675.53	665.79	637.06	657.76	658.52	673.41
Mean LONG							
High-technology companies	No obs	2,650.33	510.23	No obs	No obs	No obs	No obs
Low-technology companies	No obs	2,211.51	318.86	No obs	No obs	No obs	No obs
Mean FIXED							
High-technology companies	No obs	531.51	510.93	471.35	506.18	508.54	531.69
Low-technology companies	No obs	675.53	665.79	637.06	657.76	658.52	673.41

Panel D

	2011	2012	2013	2014	2015	2016	Average
Mean SHORT							
High-technology companies	537.13	531.81	537.23	574.93	583.78	563.31	527.21
Low-technology companies	685.33	693.47	709.14	715.36	727.41	761.94	681.20
Mean LONG							
High-technology companies	No obs	No obs	No obs	No obs	No obs	No obs	No obs
Low-technology companies	No obs	No obs	No obs	No obs	No obs	No obs	No obs
Mean FIXED							
High-technology companies	537.13	531.81	537.23	574.93	583.78	563.31	527.21
Low-technology companies	685.33	693.47	709.14	715.36	727.41	761.94	681.20

Table 20
Mean compensation variables over firm size

	Not on a major S&P	S&P 600 small caps	S&P Midcaps 400	S&P 500
Mean SHORT	214.36	122.86	238.31	372.53
High-technology companies	164.57	113.52	134.63	276.30
Low-technology companies	227.30	124.18	255.39	386.60
Mean LONG	229.22	58.70	169.68	418.41
High-technology companies	257.70	64.52	189.56	557.28
Low-technology companies	221.81	57.88	166.40	398.11
Mean FIXED	583.38	502.64	649.45	930.06
High-technology companies	493.32	447.67	488.60	715.20
Low-technology companies	606.79	510.43	675.95	961.47

Table 21
Mean compensation variables over growth opportunities

	MTOB greater than 1	MTOB less than 1
Mean SHORT	153.79	257.72
High-technology companies	170.85	171.68
Low-technology companies	149.89	272.30
Mean LONG	178.63	233.34
High-technology companies	320.66	244.27
Low-technology companies	146.22	231.49
Mean FIXED	607.52	673.09
High-technology companies	487.31	543.33
Low-technology companies	634.95	695.09

Table 22
Average R&D expense, average CEO ownership rate and average total shareholder return over time

Panel A

	2004	2005	2006	2007	2008	2009	2010
Mean R&D	107.39	83.78	99.89	113.84	123.74	115.19	125.95
Mean CEOOWN	No obs	0.064	2.29	2.58	2.37	2.25	2.07
Mean TSR	10.22	13.93	16.80	6.25	-29.68	41.11	26.30

Panel B

	2011	2012	2013	2014	2015	2016	Average
Mean R&D	135.38	134.28	135.64	142.64	157.36	322.16	125.72
Mean CEOOWN	1.97	1.93	1.69	1.62	1.67	1.59	1.89
Mean TSR	1.90	16.72	36.48	9.71	-4.82	18.08	12.46

Panel C

	Pre-crisis period (2004-2007)	Post-crisis period (2008-2016)
Mean R&D	104.74	139.10
Mean CEOOWN	1.89	1.89
Mean TSR	2.60	18.97

4.5 Panel data

Our sample consists of observations from multiple companies over multiple years. For that reason, we deal with panel data. Panel data allows us to control for variables we are not able to measure and that vary across entities or that change over time.

For the analysis of panel data, a fixed effects model or a random effects model is a suitable model. In case that there are unobserved time-invariant differences between firms which are correlated with the independent variables in the sample, the fixed effects model is recommended to use. The fixed effect model can control for the unobserved firm heterogeneity. When the variation across firms is assumed to be uncorrelated with the independent variables in the model, the random effect model is recommended. Most studies in literature used fixed effects models (f.e. Cheng, 2004). However, the majority of papers using the fixed effects model do not justify their choicefor a fixed effects model.

We will use the -xset command in Stata to set Stata to handle panel data. Thereafter, we will use the -xtreg command to produce a fixed- or random-effect regression model. In case of a fixed effect regression model, we include a year dummy for the time fixed effects and use the "fe" option for the entity fixed effects. In case of a random effect regression model, we include a year dummy for the time random effects and use the "re" options for the entity random effects.

The Hausman test will be conducted to determine whether a fixed- or random-effect model is appropriate. The hypotheses of the Hausman test are as follows:

H0: Firm effects and independent variables are not correlated. Both fixed- and random-effect models are consistent. However, the fixed effect model is inefficient. Therefore, the random effect model is recommended.
H1: Firm effects and independent variables are correlated. The fixed effect model is consistent, the random effect model is inconsistent and the fixed effect model is therefore recommended.

4.6 Model estimation

4.6.1 Hypothesis 1: Influence of firm performance on CEO compensation

In this section, we describe the models used to test the hypotheses.

In the empirical analysis, we estimate six regression models. The following regression model is used as our initial model for the empirical analysis:

$$Compensation_{i,t} = \alpha + \beta_1 Performance_{i,t} + \beta_2 Size_{i,t} + \beta_3 Age_{i,t} + \beta_4 Years_{i,k} + \beta_5 Ownership_{i,t} + \beta_6 Male_{i,a} + \varepsilon_{i,t} + \mu_i$$

Equation 1: *Influence of firm performance on CEO compensation*

In the fixed effect model, there is assumed that $E(\mu_i | X_{i,t}) \neq 0$. In the the random effect model, it is assumed that $E(\mu_i | X_{i,t}) = 0$. In above model, we can test whether firm performance has a positive influence on the different components of CEO compensation (Hypothesis 1).

In this model,

$Compensation_{i,t}$ refers to the compensation variables, which are LN(SHORT), LONG and LN(FIXED), where i represents the company and t is the time subscript.

α is the intercept.

β measures the influence of an independent variable in year t for company i on $Compensation_{i,t}$.

$Performance_{i,t}$ refers to the firm performance variables, which are ROA, LAG(ROA), ROE, LAG(ROE) DIVIDENDYIELD, TOBINSQ and TSR.

$Size_{i,t}$ refers to the firm size variables, which are MTOB and LN(ASSETS).

$Age_{i,t}$ stands for the variable AGE.

$Years_{i,k}$ stands for the variable YEARS; $k = 0, \ldots, 12$

$Ownership_{i,t}$ stands for the variable CEOOWN.

$Male_{i,a}$ stands for the variable MALE; $a = o \; or \; 1$

$\varepsilon_{i,t}$ is the random error.

μ_i is the time-invariant unobservable firm effect.

4.6.2 Hypothesis 2: Difference in influence of innovation on CEO compensation between high- and low-technology companies

We regress CEO compensation on innovation by adding innovation to our initial model. Innovation consists of the variables LN(R&D) and R&D/ASSETS. With this new model, we examine whether the influence of innovation on CEO compensation is different between high- and low-technology companies (hypothesis 2). We structure the second model as follows:

$$Compensation_{i,t} = \alpha + \beta_1 Innovation_{i,t} + \beta_2 Innovation_{i,t} * Hightech_{i,m} + \beta_3 Size_{i,t} + \beta_4 Age_{i,t} + \beta_5 Years_{i,k} + \beta_6 Ownership_{i,t} + \beta_7 Performance_{i,t} + \beta_8 Male_{i,a} + \varepsilon_{i,t} + \mu_i$$

Equation 2: *The difference in influence of innovation on CEO compensation between high- and low-technology companies*

Where,

$Innovation_{i,t}$ refers to the innovation variables, which are LN(R&D) and R&D/ASSETS.

$Hightech_{i,m}$ stands for the variable HIGHTECH; $m = 0 \; or \; 1$

$Innovation_{i,t} * Hightech_{i,m}$ is an interaction variable between $Innovation_{i,t}$ and dummy variable HIGHTECH.

4.6.3 Hypothesis 3: Difference in influence of firm performance on CEO compensation between high- and low-technology companies

We examine whether the influence of firm performance on CEO compensation is different between high-technology and low-technology companies (hypothesis 3). We structure the third model as follows:

$$Compensation_{i,t} = \alpha + \beta_1 Performance_{i,t} + \beta_2 Performance_{i,t} * Hightech_{i,m} + \beta_3 Size_{i,t} + \beta_4 Age_{i,t} + \beta_5 Years_{i,k} + \beta_6 Ownership_{i,t} + \beta_7 Innovation_{i,t} + \beta_8 Male_{i,a} + \varepsilon_{i,t} + \mu_i$$

Equation 3: *The difference in influence of firm performance on CEO compensation between high- and low-technology companies*

Where,

$Performance_{i,t} * Hightech_{i,m}$ is an interaction variable between $Performance_{i,t}$ and dummy variable HIGHTECH.

4.6.4 Hypothesis 4: Influence of CEO compensation on innovation and firm performance

Our fourth objective is to test whether the components of CEO compensation also have an influence on innovation and firm performance (hypothesis 4). We use two specifications. This first specification is:

$$Performance_{i,t} = \alpha + \beta_1 \, Compensation_{i,t} + \beta_2 Innovation_{i,t} + \beta_3 Size_{i,t} + \beta_4 Age_{i,t} + \beta_5 Years_{i,k} + \beta_6 Ownership_{i,t} + \beta_7 Male_{i,a} + \varepsilon_{i,t} + \mu_i$$

Equation 4: *The influence of CEO compensation on firm performance*

The second specification is as follows:

$$Innovation_{i,t} = \alpha + \beta_1 \, Compensation_{i,t} + \beta_2 Performance_{i,t} + \beta_3 Size_{i,t} + \beta_4 Age_{i,t} + \beta_5 Years_{i,k} + \beta_6 Ownership_{i,t} + \beta_7 Male_{i,a} + \varepsilon_{i,t} + \mu_i$$

Equation 5: *The influence of CEO compensation on innovation*

4.6.5 Hypothesis 5: Difference in influence of innovation and firm performance on CEO compensation between the period before the crisis and after the crisis

We examine the influence of innovation and firm performance on CEO compensation in the pre-crisis time period (2004-2007) and in the post-crisis time period (2008-2016). In this way, we examine whether the influence of innovation and firm performance on CEO compensation is different between the period before the crisis and the period after the crisis. If we find a significant influence of CEO compensation on innovation and/or firm performance in hypothesis 4, then we use an simultaneous equation framework, including $Compensation_{i,t-1}$ as independent variable. The sixth regression model is as follows:

$$Compensation_{i,t} = \alpha + (\beta_1 \, Compensation_{i,t-1}) + \beta_2 \, Performance_{i,t} + \beta_3 Innovation_{i,t} + \beta_4 Size_{i,t} + \beta_5 Age_{i,t} + \beta_6 Ownership_{i,t} + \beta_7 Male_{i,a} + \varepsilon_{i,t} + \mu_i$$

Equation 6: *The difference in influence of innovation and firm performance on CEO compensation between the period before the crisis and the period after the crisis*

$Compensation_{i,t-1}$ refers to the lagged compensation variables, which are LAG(SHORT), LAG(LONG) and LAG(FIXED).

4.6.6 Hypothesis 6: Influence of restricted stock and stock options on innovation

Hypothesis 7 tests whether restricted stock and stock options also have an influence on innovation. The seventh model is as follows:

$$Innovation_{i,t} = \alpha + \beta_1 Compensation_{i,t} + \beta_2 Performance_{i,t} + \beta_3 Size_{i,t} + \beta_4 Age_{i,t} + \beta_5 Ownership_{i,t} + \beta_6 Male_{i,a} + \varepsilon_{i,t} + \mu_i$$

Equation 7: *The influence of restricted stock and stock options on innovation*

4.6.7 Hypothesis 7: Influence of innovation and firm performance on restricted stock and stock options

We examine whether innovation and firm performance have a significant influence on restricted stocks and stock options. Our eight model is as follows:

$$Compensation_{i,t} = \alpha + (\beta_1 Compensation_{i,t-1}) + \beta_2 Performance_{i,t} + \beta_3 Innovation_{i,t} + \beta_4 Size_{i,t} + \beta_5 Age_{i,t} + \beta_6 Ownership_{i,t} + \beta_7 Male_{i,a} + \beta_8 Performance_{i,t} * Hightech_{i,m} + \beta_9 Innovation_{i,t} * Hightech_{i,m} + \varepsilon_{i,t} + \mu_i$$

Equation 8: *The influence of innovation and firm performance on restricted stock and stock options*

$Compensation_{i,t}$ refers to the compensation variables RESTRICTED and OPTIONS.

4.6.8 Hypothesis 8: The difference in influence of innovation on CEO compensation between large, medium and small, high- and low-technology companies

Hypothesis 8 tests whether the influence of innovation depend on size in high- and low-technology companies. We will structure the nineth model as follows:

$$Compensation_{i,t} = \alpha + (\beta_1 Compensation_{i,t-1}) + \beta_2 Performance_{i,t} + \beta_3 Innovation_{i,t} + \beta_4 Size_{i,t} + \beta_5 Age_{i,t} + \beta_6 Ownership_{i,t} + \beta_7 Male_{i,a} + \beta_8 Innovation_{i,t} * S\&PindexHightech_{i,y} + \varepsilon_{i,t} + \mu_i$$

Equation 9: *The difference in influence of innovation on CEO compensation between large, medium and small, high- and low-technology companies*

$Compensation_{i,t}$ refers to the compensation variables, including LN(SHORT), LONG and LN(FIXED).

$S\&PindexHightech_{i,y}$ stands for the variable S&PHIGHTECH; 0, … , 7.

$Innovation_{i,t} * S\&PindexHightech_{i,y}$ is an interaction variable between $Innovation_{i,t}$ and dummy variable S&PHIGHTECH.

4.6.9 Hypothesis 9: Difference in influence of market-to-book ratio on CEO compensation between high- and low-technology companies

Finally, we are interested in the relationship between the book-to-market ratio, which is an indicator of a firm's growth opportunities, and CEO compensation, and whether this relationship differs between high- and low-technology companies. The last hypothesis is:

$$Compensation_{i,t} = \alpha + \left(\beta_1 Compensation_{i,t-1}\right) + \beta_2 Performance_{i,t} + \beta_3 Innovation_{i,t} + \beta_4 Size_{i,t} + \beta_5 Age_{i,t} + \beta_6 Ownership_{i,t} + \beta_7 Male_{i,a} + \beta_8 Markettobook_{i,t} * Hightech_{i,y} + \varepsilon_{i,t} + \mu_i$$

Equation 10: *The difference in influence of market-to-book ratio on CEO compensation between high- and low-technology companies*

$Markettobook_{i,t} * Hightech_{i,y}$ is an interaction variable between MTOB and HIGHTECH.

4.7 Other statistical tests

4.7.1 White test

The standard errors are biased and the estimates of the coefficients are inefficient if heteroskedasticity is present. We will test the regressions on heteroskedasticity using the White test (See Appendix Q). The hypotheses of the White test are as follows:

H0: The residuals are homoskedastic.

H1: The residuals are heteroskedastic.

4.7.2 Autocorrelation

Autocorrelation also leads to biased standard errors and inefficient coefficients. Therefore, we will also test the regressions on first-order autocorrelation using the Wooldridge test (Appendix R). The hypotheses of the Wooldridge test are as follows:

H0: No first-order autocorrelation in panel data.

H1: First-order autocorrelation in panel data.

If we observe heteroskedasticity and autocorrelation, we use cluster regression models to correct for the clustered errors.

4.8 Robustness check

Robustness checks estimate the sensitivity of the results. The prior research design already included several proxies for innovation, namely research and development and the ratio of research and development divided by total assets. Some papers (for example Balkin et al. (2000)) use simple patent counts to measure innovation. To check whether the findings are influenced by the use of research of development expense and the ratio of research and development divided by total assets as proxy for innovation, two other proxies for innovation are used: the logarithm of the number of patents and the ratio of the number of patents divided by the total assets.

5 Results

5.1 Introduction

In order to identify the drivers of CEO compensation in high-technology companies, and to examine whether these drivers are different compared to low-technology companies, we apply different panel regression models. The regression models are described in section "Methods". For hypothesis 1, we examine whether firm performance has a positive influence on CEO compensation. Next, we investigate whether the relationship between CEO compensation and innovation is different between high and low-technology companies in hypothesis 2. For answering hypothesis 3, we examine whether firm performance has a different influence on CEO compensation between high- and low-technology companies. For hypothesis 4, we investigate whether firm performance and innovation also depend on CEO compensation. Next, we investigate whether the influence of firm performance and innovation on CEO compensation differs between the period before the crisis (2004-2007) and the period after the crisis (2008-2016) in hypothesis 5. For hypothesis 6, we examine the influence of firm performance and innovation on stock options and restricted stock. Furthermore, we examine whether firm performance and innovation also depend on stock options and restricted stock (hypothesis 7). Moreover, we investigate whether the influence of innovation on CEO compensation depends on firm size in high- and low-technology companies in hypothesis 8. Finally, we investigate whether the relationship between the book-to-market ratio and CEO compensation depends on whether a company is a high- or low-technology company in hypothesis 9.

5.2 Hypothesis 1: Influence of firm performance on CEO compensation

5.2.1 Introduction

First, we use the observed data to investigate whether firm performance has a positive effect on CEO compensation. For this hypothesis, we use LN(SHORT), LN(LONG) and LN(FIXED) as our dependent variables.

ROA, TSR, DIVIDENDYIELD, TOBINSQ, ROA, ROE, and LAG(ROA) and LAG(ROE) are the independent variables and LN(ASSETS), MTOB, CEOOWN, AGE, MALE and YEARS are the control variables, except for the regression model with LN(LONG) as a dependent variable. In the regression models with LN(LONG) as dependent variable, we use the same set of indepedent variables, except ROA, LAG(ROA), ROE and LAG(ROE), because these variables have no observations in 2005 and 2006 and LN(LONG) has only observation in 2005 and 2006.

5.2.2 White test

We have tested the initial regression model on heteroskedasticity using the White test (Appendix O). For LN(SHORT), LN(LONG) and LN(FIXED), we can reject the null hypothesis, which suggests that the error terms are heteroscedastic.

5.2.3 Autocorrelation

We have also tested the initial regression model on autocorrelation using the -xtserial command. For LN(LONG) and LN(FIXED) we can reject the null hypothesis, which suggests that there is first-order autocorrelation (Appendix P). For LN(SHORT), we cannot reject the null hypothesis.

Because of heteroscedasticity (and autocorrelation), we decide to estimate all regression models with clustered errors.

5.2.4 Fixed- or random-effect model

Finally, we conduct a Hausman test. The Hausman test compares the random- and fixed-effect model and checks which one is appropriate. Though, the Hausman test cannot be performed with clustered standard errors. Since we deal with clustered standard erros we we use the -xtoverid command instead of the Hausman test.

For the dependent variables LN(SHORT) and LN(LONG), we find no significant result to reject the null hypothesis, suggesting the random effect model is appropriate. For the dependent variable LN(FIXED) we find that the fixed effect model is appropriate. Appendix Q presents the outcomes of these tests.

5.2.5 Regression outcomes

The following interpretations of the results are from Table 23. The number of observations in our regression models vary between the 698 and 4,380. Furthermore, we observe that the (adjusted and within) R squared measures of the regression models are low (0.0333-0.10). This means that that the models have low explanatory powers, despite the fact that we have included the market performance variables Tobin's Q and total shareholder return in the regression models.

We find that an increase of one percentage point in return on assets increases salary with 0.0029 percentage point on average. This is in line with Zhou (2000), who found that for every 10 percentage point increase in return on assets, CEO's cash compensation increases by 0.07 percent. Furthermore, we find that one percentage point increase in shareholder return increases short-term incentives (bonus) with 0.0015 percentage point on average. This finding is in line with McKnight et al. (2000), who found a positive influence of shareholder return on annual bonus. These findings indicate that corporate board align the interests of the CEO with the interests of the shareholders.

Table 23 also shows that one percentage point increase in Tobin's Q decreases bonus with 0.0015 percentage point. This finding seems not to be in line with a study of Vemala et al. (2014), who showed a positive influence of Tobin's Q on CEO's cash compensation (sum of salary and bonus). Moreover, one percentage point increase in dividend yield decreases long-term incentives with 0.17 percentage point. Finally, the results show no significant influence of the lags of ROA, ROE and the lags of ROE and Tobin's Q on CEO compensation.

A few control variables also have a significant influence on CEO compensation. We find that CEO's bonus and the sum of restricted stock and stock options increase with 0.020 and 0.014 percentage point, respectively when CEO's age increases with one year. This might be because older CEOs are more experienced than younger CEOs. This might increase their compensation. For the first two regression outputs in Table 23, the values 2004, 2005, 2006 and 2007 of variable YEARS are excluded, because LAG(ROA) and LAG(ROE) have no observations in those years. Therefore, we take the year 2008 as our base year. In general, we find that CEOs receive a higher base salary after 2008 than in the year 2008. We observe that CEO's in the years 2008, 2009, 2010, 2011, 2012, 2013, 2014 and 2015 earn 0.12, 0.071, 0.067, 0.058, 0.045 and 0.031 percentage point higher salaries than CEOs in 2008, respectively. Furthermore, we observe that CEOs receive, in general lower bonuses after 2008 than in the year 2008. CEOs in 2011 and 2014 receive 0.25 and 0.35 percentage point less bonuses than CEOs in 2008, respectively. So, we observe that CEOs in the years after the Financial Recession in 2008, in general, receive higher base salaries and annual lower bonuses, than in 2008. In hypothesis 5, we test whether the influence of innovation and firm performance on CEO compensation also differs between the period before the crisis (2004-2007) and the period after the crisis (2008-2016).

Table 23
Regression results Hypothesis 1
Influence of firm performance on CEO compensation

Variables	LN(SHORT)=Bonus	LN(FIXED)=Salary	LN(LONG)= Sum of stock options and restricted stock
ROA	-0.013 (0.0087)	0.0029** (0.0014)	
LAG(ROA)	0.0014 (0.0054)	0.00022 (0.0012)	
ROE	0.0054 (0.0034)	-0.00015 (0.00041)	
LAG(ROE)	-0.0021 (0.0014)	-0.000034 (0.00036)	
TOBINSQ	-0.0015** (0.00064)	-0.000027 (0.00027)	0.0015 (0.0034)
DIVIDENDYIELD	-0.0023 (0.023)	0.0044 (0.0064)	-0.17*** (0.030)
TSR	0.0015** (0.00078)	-0.00012 (0.00016)	0.000094 (0.00085)
LN(ASSETS)	0.40*** (0.060)	0.17*** (0.036)	0.52*** (0.024)
CEOOWN	0.035 (0.022)	0.0051 (0.0079)	-0.000048 (0.021)
MTOB	0.00023 (0.0024)	0.000086** (0.000039)	-0.00031 (0.00029)
AGE	0.020** (0.0080)	0.0020 (0.0030)	0.014*** (0.0013)
MALE	-0.50 (0.40)	-0.049 (0.10)	0.18 (0.20)
YEARS; (2008 is base year)			
-2009	-0.11 (0.099)	0.031* (0.016)	
-2010	0.12 (0.12)	0.045** (0.020)	
-2011	-0.25** (0.12)	0.058*** (0.022)	
-2012	-0.15 (0.13)	0.042 (0.027)	
-2013	-0.20 (0.14)	0.067** (0.031)	
-2014	-0.35* (0.19)	0.071** (0.032)	
-2015	0.46 (0.29)	0.12** (0.055)	
Constant	1.79*** (0.65)	4.88*** (0.34)	2.61*** (0.26)
Adjusted R-squared		0.033	
Within R-squared	0.10		0.090
Number of observations	698	4,380	1,268

*** , ** and * indicate statistical significance at the one, five and ten percent levels, respectively ($p < 0.01$; $p < 0.05$; $p< 0.1$). Robust standard deviations are in parentheses.

5.3 Hypothesis 2: Difference in influence of innovation on CEO compensation between high- and low-technology companies

Next, we investigate the second hypothesis that tests whether the relationship between innovation and CEO compensation is different between high- and low-technology companies. For the second hypothesis, LN(R&D), R&D/ASSETS, and R&D/ASSETS*HIGHTECH and LN(R&D)*HIGHTECH are the independent variables of interest and ROA, LAG(ROA), ROE, LAG(ROE), TSR, TOBINSQ, DIVIDENDYIELD LN(ASSETS), MTOB, CEOOWN, AGE, MALE and YEARS are the control variables. HIGHTECH is a binary variable which is equal to 0 if the company is a low-technology company and is equal to 1 if the company is a high-technology company.

Table 24 presents the outcomes for hypothesis 2. Between 5.5% and 22% of the variance in degree of CEO compensation can be explained by our independent variables (N=369, 687 and 2,366). We find a negative influence of the interaction variable R&DASSETS*HIGHTECH on annual bonus. Furthermore, we find that, for every 1 percent increase in R&D, annual bonus decreases with 0.24 percent on average. It seems to be that this finding is in line with Bizjack et al. (1993), which finds a negative influence of innovation on cash compensation. Interestingly, we find, after adding the innovation variables, a positive influence of return on equity and the lag of return on equity on the natural logarithm of annual bonus. At the same time, in contrast with the findings in hypothesis 1, we observe a negative influence of return on assets on the natural logarithm of CEO's bonus. Moreover, if we look at columns (2), (3) and (4) of table 24, we find statistically significant coefficients for LN(ASSETS). This means that the natural logarithm of total assets has a positive effect on the salary of a CEO, the annual bonus and the sum of restricted stock and stock options. We find that if total assets increase with one percentage point, CEO's salary, annual bonus and the sum of restricted stock and stock options increase with 0.15, 0.58 and 0.52 percentage point on average, respectively. This indicates that CEOs in larger firms receive higher salaries and bonuses, and receive larger equity-based compensation packages compared to CEOs in smaller firms. MTOB, defined as the market-to-book ratio, a proxy for a firm's growth opportunities, is negatively related to the natural logarithm of the sum of restricted stock and stock options.

Table 24
Regression results Hypothesis 2
Difference in influence of innovation on CEO compensation between high-and low-technology companies

Variables	LN(SHORT)=Bonus	LN(FIXED)=Salary	LN(LONG)= Sum of stock options and restricted stock
LN(R&D)	-0.24* (0.14)	0.070 (0.057)	0.050 (0.054)
R&D/ASSETS	5.61 (3.67)	-0.061 (0.59)	0.50 (0.89)
LN(R&D)*HIGHTECH	0.094 (0.097)	-0.0079 (0.11)	-0.0018 (0.048)
R&D/ASSETS*HIGHTECH	-9.17** (3.85)	0.33 (0.79)	1.64 (2.03)
ROA	-0.040*** (0.010)	0.0031* (0.0019)	
LAG(ROA)	0.003278 (0.0060)	-0.00067 (0.0017)	
ROE	0.015*** (0.0042)	-0.00013 (0.00056)	
LAG(ROE)	-0.0027** (0.0012)	-0.000094 (0.00052)	
TOBINSQ	-0.00092 (0.0014)	-0.00020 (0.00033)	0.0061 (0.010)
DIVIDENDYIELD	-0.031 (0.026)	0.0233* (0.0126)	-0.15*** (0.041)
TSR	0.00078 (0.00086)	6.91e-07 (0.00022)	0.00041 (0.0011)
LN(ASSETS)	0.58*** (0.15)	0.15** (0.061)	0.52*** (0.060)
CEOOWN	0.087*** (0.029)	0.020** (0.0094)	0.54*** (0.16)
MTOB	-0.0025 (0.0020)	0.000080** (0.000034)	-0.00043* (0.00024)
AGE	0.014 (0.011)	0.000037 (0.0036)	0.014*** (0.0017)
MALE	-0.54*** (0.18)	-0.11 (0.097)	0.18 (0.39)
YEARS; (2008 is base year)			
-2009	-0.015 (0.13)	0.049** (0.023)	
-2010	0.21 (0.15)	0.059** (0.027)	
-2011	-0.22 (0.17)	0.080*** (0.030)	
-2012	0.17 (0.20)	0.069* (0.038)	
-2013	-0.050 (0.19)	0.092** (0.041)	
-2014	-0.013 (0.25)	0.11** (0.044)	
-2015	0.52 (0.32)	0.16** (0.073)	
Constant	1.30 (0.91)	4.82*** (0.43)	2.39*** (0.52)
Adjusted R-squared		0.055	
Within R-squared	0.22		0.10
Number of observations	369	2,366	687

*** , ** and * indicate statistical significance at the one, five and ten percent levels, respectively ($p < 0.01$; $p < 0.05$; $p < 0.1$). Robust standard deviations are in parentheses.

5.4 Hypothesis 3: Difference in influence of firm performance on CEO compensation between high- and low-technology companies

Hypothesis 3 tests whether firm performance has a different influence on CEO compensation between high- and low-technology companies.

For the third hypothesis, ROA*HIGHTECH, ROE*HIGHTECH, TSR*HIGHTECH, DIVIDENDYIELD*HIGHTECH, and LAG(ROE)*HIGHTECH and LAG(ROA)*HIGHTECH are the variables of interest. ROA, TSR, DIVIDENDYIELD, TOBINSQ, ROE, LN(ASSETS), MTOB, MALE, CEOOWN, AGE, YEARS, LN(R&D), R&D/ASSETS, and LAG(ROA), LAG(ROE) and LAG(CEOOWN) are the control variables.

The outcomes for hypothesis 3 are shown in Table 25. Looking at the goodness of fit, the regression models have low explanatory power with (adjusted and within) R-squares between 0.0051-0.26 (N=369, 687 and 2,366). In respect to performance, ROE*HIGHTECH and TOBINSQ*HIGHTECH are both negatively and significantly related to the natural logarithm of salary. An explanation for these findings can be that high-technology companies are often focused on growth and therefore need money for R&D expenditures. So, we expect that growth companies more often use long-term compensation (such as restricted stock and stock options) as a compensation method. This is examined in Hypothesis 9. Shim et al. (2009) also examined the relationship between return on equity and salary among high- and low-technology companies. However, they found a positive influence of firm performance (measured as return on equity) on the CEO’s base salary among high-technology companies and they do not found this relationship among low-technology companies. Furthermore, we observe a positive influence of the interaction variable ROA*HIGHTECH on salary. Moreover, the results show a negative relationship between DIVIDENDYIELD*HIGHTECH and bonus. Return on assets, Tobin’s Q and prior year’s return on equity are negatively related to short-term incentives (CEO’s bonus). Interestingly, current year’s return on equity has a positive association with CEO’s bonus.

If we look at our control variables, we find that one percentage point increase in CEO’s ownership increases bonus and salary with 0.099 and 0.019 percentage point, respectively. Interestingly, we find that male CEOs have a lower bonus than female CEOs for the period 2008-2015.

Table 25
Regression results Hypothesis 3
Difference in influence of firm performance on CEO compensation between high- and low-technology companies

Variables	LN(SHORT)=Bonus	LN(FIXED)=Salary	LN(LONG)= Sum of stock options and restricted stock
ROA*HIGHTECH	-0.019 (0.014)	0.0081*** (0.0027)	
LAG(ROA)*HIGHTECH	0.0093 (0.027)	0.0074 (0.0056)	
ROE*HIGHTECH	-0.00039 (0.0015)	-0.00059* (0.00033)	
LAG(ROE)*HIGHTECH	0.015 (0.013)	-0.0028 (0.0022)	
TOBINSQ*HIGHTECH	0.0074 (0.020)	-0.010** (0.0041)	0.013 (0.022)
DIVIDENDYIELD*HIGHTECH	-0.32* (0.18)	0.0085 (0.058)	-0.31 (0.30)
TSR*HIGHTECH	0.0027 (0.0033)	-0.00012 (0.00056)	0.0042 (0.0029)
LN(R&D)	-0.11 (0.15)	0.065 (0.052)	0.062 (0.049)
R&D/ASSETS	-2.33 (3.61)	0.27 (0.42)	0.74 (0.80)
ROA	-0.034*** (0.012)	0.00018 (0.0019)	
LAG(ROA)	-0.013 (0.0084)	-0.0014 (0.0017)	
ROE	0.016*** (0.0035)	0.00024 (0.00062)	
LAG(ROE)	-0.0024** (0.0012)	6.10e-06 (0.00055)	
TOBINSQ	-0.0038*** (0.0014)	-0.00013 (0.00028)	0.0010 (0.012)
DIVIDENDYIELD	-0.011 (0.023)	0.023 (0.014)	-0.16*** (0.036)
TSR	0.00025 (0.00090)	0.000098 (0.00026)	-0.00052 (0.0012)
LN(ASSETS)	0.49*** (0.15)	0.17*** (0.063)	0.52*** (0.057)
CEOOWN	0.099*** (0.031)	0.019** (0.0091)	0.54*** (0.16)
MTOB	-0.0033 (0.0021)	0.000080** (0.000035)	-0.00052** (0.00026)
AGE	0.0058 (0.012)	-0.00023 (0.0037)	0.014*** (0.0017)
MALE	-1.33*** (0.38)	-0.13 (0.096)	0.20 (0.40)
YEARS; (2008 is base year)			
-2009	0.0064 (0.13)	0.045** (0.022)	
-2010	0.22 (0.15)	0.053** (0.027)	
-2011	-0.16 (0.17)	0.074** (0.029)	
-2012	0.23 (0.21)	0.060 (0.038)	
-2013	0.037 (0.20)	0.083** (0.041)	
-2014	0.056 (0.25)	0.10** (0.043)	
-2015	0.62* (0.36)	0.16** (0.072)	
Constant	2.91*** (1.09)	4.75*** (0.44)	2.38*** (0.51)
Adjusted R-squared		0.060	
Within R-squared	0.26		0.0051
Number of observations	369	2,366	687

*** , ** and * indicate statistical significance at the one, five and ten percent levels, respectively ($p < 0.01$; $p < 0.05$; $p< 0.1$). Robust standard deviations are in parentheses.

5.5 Hypothesis 4: Influence of CEO compensation on innovation and firm performance

5.5.1 Introduction

Faria (2014) also found that CEO total compensation has a positive influence on innovation. For that reason, we examine in hypothesis 4 also whether there exists an endogenous relationship between the CEO compensation and our main independent variables, innovation and firm performance. For the fourth hypothesis, ROA, TSR, DIVIDENDYIELD, ROE, LN(R&D) and R&D/ASSETS are our dependent variables. For the regression models including TSR and DIVIDENDYIELD as dependent variable, our independent variables are LN(R&D), R&D/ASSETS, LN(ASSETS), MTOB, CEOOWN, AGE, LN(SHORT), LN(FIXED) and LN(LONG). For ROA and ROE, the independent variables are LN(R&D), R&D/ASSETS, LN(ASSETS), MTOB, CEOOWN, AGE, LN(SHORT) and LN(FIXED). For the regression models including LN(R&D) and R&D/ASSETS as dependent variables, the independent variables are ROA, LAG(ROA), ROE, LAG(ROE), TSR, TOBINSQ, DIVIDENDYIELD, LN(ASSETS), MTOB, CEOOWN, AGE, LN(FIXED), LN(SHORT) and LN(LONG).

5.5.2 White test

We tested the initial regression model on heteroskedasticity using the White test (Appendix Q). For LN(R&D) and DIVIDENDYIELD, we cannot reject the null hypothesis suggesting that the error terms are homoscedastic. For ROA, TSR, TOBINSQ, R&D/ASSETS and ROE, the errors are heteroskedastic.

5.5.3 Autocorrelation

We also tested the initial regression model on autocorrelation using the -xtserial command. For ROE and TSR, we cannot reject the null hypothesis, suggesting that there is no first-order autocorrelation. For ROA, TOBINSQ, DIVIDENDYIELD, LN(R&D) and R&D/ASSETS, we reject the null hypothesis, suggesting that there is first-order autocorrelation. As a result, we decide to estimate the regression models including innovation or firm performance dependent variables with clustered errors because of heteroscedasticity and autocorrelation.

5.5.4 Fixed- or random-effect model

Finally, we conduct the Hausman test. The Hausman test compares the random effect model with the fixed effect model in order to know which one is appropriate. The Hausman test cannot be performed with clustered standard errors. We use the -xtoverid command instead of the Hausman test, if we deal with clustered standard errors.

For the dependent variables ROA, ROE, DIVIDENDYIELD, TOBINSQ, TSR, LN(R&D) and R&D/ASSETS, we find no significant result to reject the null hypothesis, suggesting the random effect model is appropriate. Appendix Q presents the outcomes of these tests.

5.5.5 Regression outcomes

Table 26 presents the the outcomes for hypothesis 4. The within R-squares are between 0.0000 and 0.42. The number of observations of the regression models vary between 458 and 698. We find evidence of an endogenous relationship between CEO compensation and firm performance. The elasticity of total shareholder return to bonus is measured as 11.88, suggesting that, on average, a 1 percent increase in bonus increases total shareholder return with 11.88 percentage point. Interestingly, we also find that a 1 percent increase salary will translate into a 14.97 percentage point decrease in total shareholder return. This suggests that an increase in salary is not an appropriate stimulation for a higher shareholder return. Finally, we observe that a 10 percent increase in salary and the sum of restricted stock and stock options, increases and decreases dividend yield with 2.0 and 0.92 percentage point, respectively. Thus, we find evidence that CEO compensation has a significant influence on firm performance.

Table 26
Regression results Hypothesis 4
Influence of CEO compensation on innovation and firm performance

Variables	ROA	ROE	TOBINSQ	TSR	DIVIDENDYIELD	R&D/ASSETS	LN(R&D)
LN(R&D)	-1.09 (2.09)	-1.70 (5.45)	-0.22 (0.20)	0.63 (1.75)	-0.20*** (0.051)		
R&D/ASSETS	-12.10 (60.04)	-75.56 (171.20)	7.73** (3.90)	-53.75 (32.92)	0.42 (0.65)		
TOBINSQ						0.00051 (0.00038)	0.0015 (0.0040)
DIVIDENDYIELD						-0.0036* (0.0018)	-0.18*** (0.055)
TSR						-0.000067** (0.000031)	-0.00045 (0.00059)
LN(ASSETS)	2.67 (0.22)	3.22 (4.91)	0.83** (0.41)	-3.69* (2.19)	0.42*** (0.063)	-0.018*** (0.0048)	0.79*** (0.043)
CEOOWN	0.25 (0.29)	0.33 (0.30)	0.69*** (0.23)	2.23 (7.19)	-0.0076 (0.11)	-0.020*** (0.0043)	-0.38*** (0.083)
MTOB	0.014 (0.013)	-0.69*** (0.046)	0.0040 (0.0052)	-0.079* (0.048)	-0.0026*** (0.00091)	0.00021 (0.00015)	0.0016 (0.0011)
AGE	-0.054 (0.10)	-0.18 (0.30)	0.0014 (0.0048)	0.027 (0.066)	-0.0020 (0.0015)	-0.00014* (0.000084)	-0.0024** (0.0010)
MALE	8.71** (3.52)	29.66*** (8.71)	-1.50 (1.03)	1.72 (15.91)	0.42*** (0.14)	0.0015 (0.010)	-0.35 (0.33)
LN(SHORT)	-0.62 (0.53)	2.19 (2.40)	0.051 (0.074)	11.88*** (1.84)	-0.019 (0.021)	-0.0017 (0.0017)	-0.061 (0.044)
LN(FIXED)	0.15 (1.45)	-2.23 (3.94)	-0.13 (0.29)	-14.97*** (4.92)	0.20** (0.086)	0.0072 (0.0057)	0.044 (0.073)
LN(LONG)			0.14 (0.14)	-0.78 (1.66)	-0.092*** (0.034)	0.0016 (0.0016)	0.045 (0.029)
Constant	-14.38 (13.84)	-21.91 (43.38)	-3.67 (2.67)	65.57** (28.08)	-2.36*** (0.49)	0.14*** (0.030)	-1.52*** (0.49)
Within R-squared	0.019	0.42	0.0000	0.081	0.0017	0.23	0.33
Number of observations	472	458	585	586	586	698	585

*** , ** and * indicate statistical significance at the one, five and ten percent levels, respectively ($p < 0.01$; $p < 0.05$; $p < 0.1$). Robust standard deviations are in parentheses.

5.6 Hypothesis 5: Difference in influence of innovation and firm performance on CEO compensation between the period before the crisis and after the crisis

In hypothesis 1, we already saw that CEOs after 2008 receive, in general, a higher base salary and lower bonus. For hypothesis 5, we investigate the fifth hypothesis that tests whether the effect of innovation and firm performance on CEO compensation is different between the period before the crisis (2004-2007) and the period after the crisis (2008-2016).

For hypotheses 5, 6, 7, 8 and 9, we will include prior year's fixed compensation as independent variable in the regression model where LN(FIXED) is the dependent variable. Furthermore, we will include prior year's short-term incentive as independent variable in the regression model where LN(SHORT) is the dependent variable. LN(LONG) has only observations for the years 2005 and 2006 (see table 19). For hypotheses 5, 6, 7, 8 and 9, we decide therefore to not include LAG(LONG) in the regression models where LN(LONG) is the dependent variable.

Furthermore, we will exclude the variables ROA, LAG(ROA), ROE and LAG(ROE) from our regression model, because these variables have no observations for the years 2004-2006. We separate our time period into two periods. The first period is from 2004 till 2007 and the second period is from 2008 till 2016. In that way, we can research whether the influence of innovation and firm performance on CEO compensation differs between the period before the crisis (2004-2007) and the period after the crisis (2008-2016). Interestingly, in Chapter 4, we have already observed that the R&D expenditures are higher in the period after the crisis than in the period before the crisis (see Table 22).

Table 27 shows the results for hypothesis 5. The regression models have low explanatory power with R-squares between 0.1288-0.4208 (N=413, 945, 1,390 and 5,349). We find a stronger negative effect of R&D on bonus after the crisis (2008-2016) than before the crisis (2004-2007). This is in line with what we expected.

Furthermore, we find that for the period before the crisis (2004-2007), one percent increase in the ratio R&D/ASSETS increases CEO's bonus and salary with 1.40 and 0.51 percentage point, respectively. R&D/ASSETS has no significant influence on CEO's bonus and salary in the period after the crisis (2008-2016). Ten percentage point increase in the market-to-book ratio, increases short-term incentives (bonus) with 0.050 percentage point in the period before the crisis. In the period after the crisis, we find no evidence of a relationship between the market-to-book ratio and CEO's bonus.

Interestingly, prior year's fixed compensation has a decreasing effect on current year's fixed compensation in the period before the crisis. However, we find an increasing effect of prior year's fixed compensation on current year's fixed compensation in the post-crisis period.

Table 27
Regression results Hypothesis 5
Difference in influence of innovation and firm performance on CEO compensation between the period before the crisis and the period after the crisis

Variables	LN(SHORT)=Bonus Pre-crisis	LN(SHORT)=Bonus Post-crisis	LN(FIXED)=Salary Pre-crisis	LN(FIXED)=Salary Post-crisis
LAG(SHORT)	0.00054*** (0.00015)	0.00024*** (0.000075)		
LAG(FIXED)			-0.00038*** (0.00011)	0.00045*** (0.000070)
LN(R&D)	-0.12* (0.062)	-0.20*** (0.079)	-0.061 (0.076)	0.024 (0.027)
R&D/ASSETS	1.40** (0.64)	1.70 (1.10)	0.51*** (0.20)	0.12 (0.16)
TOBINSQ	0.028 (0.12)	-0.00059 (0.00054)	0.0040 (0.0033)	-0.000016 (0.00012)
DIVIDENDYIELD	-0.046 (0.085)	-0.0051 (0.041)	0.011 (0.011)	0.0088 (0.0062)
TSR	0.0026 (0.0020)	0.00056 (0.00066)	-0.00042 (0.00034)	0.00012 (0.00012)
LN(ASSETS)	0.46*** (0.091)	0.52*** (0.089)	0.22*** (0.082)	0.16*** (0.029)
CEOOWN	-0.015 (0.020)	0.030 (0.028)	0.0057* (0.0032)	0.015** (0.0058)
MTOB	0.0050*** (0.00097)	0.000013 (0.000013)	$3.21*10^{-6}$ ($3.86*10^{-6}$)	$1.26*10^{-6}$ ($7.18*10^{-6}$)
AGE	0.0057** (0.0026)	0.014* (0.0079)	-0.00063 (0.00092)	0.0019 (0.069)
MALE	1.95*** (0.71)	0.91** (0.45)	0.26 (0.18)	0.10 (0.069)
Constant	0.0069 (0.92)	0.24 (0.74)	4.90*** (0.57)	4.44*** (0.20)
Adjusted R-squared			0.065	0.089
Within R-squared	0.00080	0.026		
Number of observations	413	945	1,390	5,349

*** , ** and * indicate statistical significance at the one, five and ten percent levels, respectively ($p < 0.01$; $p < 0.05$; $p < 0.1$). Robust standard deviations are in parentheses.

5.7 Hypothesis 6: Influence of restricted stocks and stock options on innovation

For hypothesis 6, we examine the influence of restricted stocks and stock options on innovation. LN(R&D) and R&D/ASSETS are our dependent variables. Table 28 shows the results for hypothesis 6. The regression models have within R-squared values of 0.080 and 0.42 (N=7,712 and 9,595). Interestingly, we observe that options have a decreasing effect on R&D/ASSETS and LN(R&D), which is in contrast with our expectations. For example, Ryan & Wiggins (2002) find that one unit in the ratio of stock options to CEO's total annual compensation increases the ratio of R&D expenses divided by total assets with 0.62 percentage point. Furthermore, we find that an increase in CEO ownership decreases the ratio of R&D expense divided by total assets. Finally, ten percent increase in total shareholder return decreases the ratio of R&D expense divided by total assets and R&D expense with 0.00086 and 0.0079 percentage point, respectively. The findings indicate that CEOs are not motivated by a change in equity-based compensation.

Table 28
Regression results Hypothesis 6
Influence of restricted stock and stock options on innovation

Variables	R&D/ASSETS	LN(R&D)
RESTRICTED	$-5.20*10^{-7}$ ($3.89*10^{-7}$)	$-6.61*10^{-6}$ ($5.62*10^{-6}$)
OPTIONS	$-1.23*10^{-6}$*** ($2.94*10^{-7}$)	-0.000010*** ($3.59*10^{-6}$)
TOBINSQ	0.000033 (0.000070)	-0.00037** (0.00018)
DIVIDENDYIELD	0.000030 (0.00026)	0.0049 (0.0047)
TSR	-0.000087*** (0.000017)	-0.00079*** (0.000088)
LN(ASSETS)	-0.028*** (0.0036)	0.69*** (0.020)
CEOOWN	-0.00041* (0.00025)	0.000015 (0.0022)
MTOB	$1.19*10^{-6}$ ($7.65*10^{-7}$)	$9.49*10^{-6}$ ($6.20*10^{-6}$)
AGE	0.00012 (0.000072)	0.00058 (0.00048)
MALE	0.00027 (0.0024)	0.073 (0.066)
Constant	0.25*** (0.026)	-1.27*** (0.16)
Within R-squared	0.080	0.42
Number of observations	9,595	7,712

*** , ** and * indicate statistical significance at the one, five and ten percent levels, respectively ($p < 0.01$; $p < 0.05$; $p< 0.1$). Robust standard deviations are in parentheses.

5.8 Hypothesis 7: Influence of innovation and firm performance on restricted stock and stock options

Hypothesis 7 tests whether stock options and restricted stocks depend on firm performance and innovation. For the seventh hypothesis, RESTRICTED and OPTIONS are our dependent variables. These variables have only observations for the years 2005 and 2006. Our independent variables are LN(R&D), R&D/ASSETS, TSR, DIVIDENDYIELD, TOBINSQ, LN(ASSETS), MTOB, MALE, CEOOWN and AGE.

For both RESTRICTED and OPTIONS, the errors are heteroskedastic, there is first-order autocorrelation and the fixed effect model is appropriate (Appendix Q-S).

Table 29 shows the results for hypothesis 7. The regression models have low explanatory power with adjusted R-squares between 0.011-0.046 (N=7,712). For the years 2005 and 2006, we find that R&D and R&D/ASSETS decrease stock options and we find no significant influence of innovation on restricted stock. This is not in line with Ryan & Wiggins (2002), who find that R&D expenditures increase stock options among high-technology companies and among low-technology companies.

Interestingly, we also find a negative influence of total shareholder return on the value of stock options. Furthermore, we find that a 1 percent increase in dividend yield, decreases the value of stock options and the value of restricted stock with 65,850 and 16,400 dollars on average, respectively.

Furthermore, the results show that, an increase of ten percentage point in market-to-book ratio, decreases the value of restricted stock granted with 37 dollars. We find no significant influence of the market-to-book ratio on the value of stock options granted. Finally, we find a negative influence of CEO ownership on stock options and restricted stock. This may indicate stronger monitoring by the corporate board if CEO ownership increases.

Table 29
Regression results Hypothesis 7
Influence of innovation and firm performance on restricted stock and stock options

Variables	RESTRICTED	OPTIONS
LN(R&D)	-25.82 (28.84)	-106.47** (52.67)
R&D/ASSETS	-191.57 (116.76)	-1,084.95*** (340.43)
TOBINSQ	0.14 (0.12)	0.45 (0.47)
DIVIDENDYIELD	-16.40*** (5.91)	-65.85*** (16.57)
TSR	-0.0043 (0.087)	-0.49** (0.19)
LN(ASSETS)	-86.09** (35.16)	-366.92*** (86.65)
CEOOWN	-7.98*** (1.72)	-80.74** (32.70)
MTOB	-0.0037** (0.0015)	-0.0029 (0.0032)
AGE	-2.28 (1.65)	-6.21*** (1.49)
MALE	412.32* (240.37)	392.67* (215.58)
Constant	555.34** (244.71)	3,496.74*** (615.92)
Adjusted R-squared	0.011	0.046
Number of observations	7,712	7,712

*** , ** and * indicate statistical significance at the one, five and ten percent levels, respectively ($p < 0.01$; $p < 0.05$; $p< 0.1$). Robust standard deviations are in parentheses.

5.9 Hypothesis 8: The difference in influence of innovation on CEO compensation between large, medium and small, high- and low-technology companies

Hypothesis 8 tests whether the relationship between compensation and innovation differs between S&P 500 high-technology, S&P 500 low-technology, S&P Midcaps 400 high-technology, S&P Midcaps 400 low-technology, S&P small caps 600 high-technology, S&P small caps 600 low-technology, not on a major S&P index high-technology and not on a major S&P index low-technology companies. LN(SHORT), LN(FIXED) and LN(LONG) are our dependent variables. For hypothesis 8, we use dummy variable S&PHIGHTECH. This variable equals 7 if the firm is a S&P 500 firm and is a high-technology firm, equals 6 if the firm is a S&P 500 firm and is a low-technology firm, equals 5 if the firm is S&P Midcaps 400 firm and is a high-technology firm, equals 4 if the firm is a S&P Midcaps 400 firm and is a low-technology company, equals 3 if the firm is a S&P small caps 600 firm and is a high-technology company, equals 2 if the firm is a S&P small caps 600 firm and is low-technology company, equals 1 if the firm is not a major S&P index and is a high-technology company, equals 0 if the firm is not on a major S&P index and is a low-technology company. Furthermore, we make interaction variables between LN(R&D) and S&PHIGHTECH and between R&D/ASSETS and S&PHIGHTECH. Table 30 shows the results for hypothesis 8. The regression models have low explanatory power with adjusted R-squares between 0.15-0.41 (N=368, 687 and 2,359). We find that the relationship between compensation and R&D expense does not differ between S&P 500 high-technology, S&P 500 low-technology, S&P Midcaps 400 high-technology, S&P Midcaps 400 low-technology, S&P small caps 600 high-technology, S&P small caps 600 low-technology, not on a major S&P index high-technology and not on a major S&P index low-technology companies. However, we do observe that among S&P small caps 600 low-technology firms, the ratio of R&D expense divided by total assets increases CEO's bonus with 9.96 percentage point. Furthermore, we find that, among firms that are not on a major S&P index and are high-technology companies, the ratio of R&D expense divided by total assets decreases CEO's bonus with 5.49 percentage point. In addition, the results show a negative influence of the ratio of R&D expense divided by total assets on CEO's bonus among S&P Midcaps 400 firms that are low-technology companies. Finally, among S&P 500 high-technology firms, there is a positive association between the ratio of R&D expense divided by total assets and long-term incentives.

Table 30
Regression results Hypothesis 8
The difference in influence of innovation on CEO compensation between large, medium and small, high- and low-technology companies

Variables	LN(SHORT)=Bonus	LN(FIXED)=Salary	LN(LONG)= Sum of stock options and restricted stock
LAG(SHORT)	0.000072 (0.000046)		
LAG(FIXED)		0.00068*** (0.00011)	
LN(R&D)*S&PHIGHTECH(=0)	-0.069 (0.17)	-0.0029 (0.048)	0.045 (0.058)
LN(R&D)*S&PHIGHTECH(=1)	0.0017 (0.14)	0.0054 (0.14)	0.069 (0.081)
LN(R&D)*S&PHIGHTECH(=2)	-0.24 (0.14)	0.12 (0.078)	0.025 (0.082)
LN(R&D)*S&PHIGHTECH(=3)	-0.61 (0.37)	0.31 (0.23)	0.20 (0.16)
LN(R&D)*S&PHIGHTECH(=4)	0.24 (0.25)	0.017 (0.063)	0.024 (0.086)
LN(R&D)*S&PHIGHTECH(=5)	0.15 (0.29)	0.084 (0.11)	-0.15 (0.23)
LN(R&D)*S&PHIGHTECH(=6)	-0.23 (0.18)	0.25 (0.20)	0.078 (0.061)
LN(R&D)*S&PHIGHTECH(=7)	-0.0079 (0.27)	0.19 (0.17)	0.0070 (0.074)
R&D/ASSETS* S&PHIGHTECH(=0)	1.52 (4.17)	-0.48 (0.61)	0.43 (0.91)
R&D/ASSETS* S&PHIGHTECH(=1)	-5.49* (3.13)	0.52 (0.32)	0.45 (2.85)
R&D/ASSETS* S&PHIGHTECH(=2)	9.96** (4.77)	0.55 (0.86)	0.16 (1.43)
R&D/ASSETS* S&PHIGHTECH(=3)	10.17 (9.78)	-3.45 (2.41)	-6.01 (5.61)
R&D/ASSETS* S&PHIGHTECH(=4)	-72.64*** (25.55)	0.20 (0.65)	-0.057 (4.69)
R&D/ASSETS* S&PHIGHTECH(=5)	-6.13 (8.18)	-0.26 (1.48)	9.40 (7.40)
R&D/ASSETS* S&PHIGHTECH(=6)	10.21 (7.81)	-2.01 (2.99)	-0.77 (2.02)
R&D/ASSETS* S&PHIGHTECH(=7)	-17.19 (7.81)	0.53 (3.32)	6.17* (3.31)
ROA	-0.045*** (0.010)	0.0038 (0.0018)	
LAG(ROA)	0.0020 (0.0071)	-0.0012** (0.0016)	
ROE	0.018*** (0.0039)	-0.00036 (0.00061)	
LAG(ROE)	-0.0028** (0.0012)	-0.000025 (0.00053)	
DIVIDENDYIELD	-0.029 (0.025)	0.017 (0.011)	-0.16*** (0.042)
TOBINSQ	0.000041 (0.0017)	0.000093 (0.00033)	0.0055 (0.0098)
TSR	0.0014 (0.00095)	0.000070 (0.00022)	0.00021 (0.0012)
LN(ASSETS)	0.54*** (0.17)	0.12* (0.060)	0.49*** (0.064)
MTOB	-0.00047 (0.0021)	0.000051** (0.00002)	-0.00046* (0.00024)
AGE	0.011 (0.0099)	-0.0027 (0.0034)	0.014*** (0.0018)
CEOOWN	0.084*** (0.026)	0.018** (0.0075)	0.55*** (0.16)
MALE	-0.57*** (0.18)	-0.11 (0.085)	0.24 (0.40)
Constant	1.54 (0.98)	4.77*** (0.34)	2.57*** (0.55)
Adjusted R-squared		0.15	
Within R-squared	0.41		0.27
Number of observations	368	2,359	687

*** , ** and * indicate statistical significance at the one, five and ten percent levels, respectively (p < 0.01; p < 0.05; p< 0.1). Robust standard deviations are in parentheses.

5.10 Hypothesis 9: Difference in influence of market-to-book ratio on CEO compensation between high- and low-technology companies

Finally, we examine whether the influence of the book-to-market ratio on CEO compensation differs between high- and low-technology companies. For hypothesis 9, we use an interaction term between MTOB and HIGHTECH (MTOB*HIGHTECH). The (adjusted and within) R-squares are between 0.094 and 0.12 (N=368, 687 and 2,359). We find a positive influence of the market-to-book ratio on salary. This is in line with the study of Cooper et al. (2009), which finds that firms with high growth opportunities (high market-to-book ratio) pay higher levels of cash compensation, compared to firms with low growth opportunities. The explanation behind this finding can be that companies with high growth opportunities has a higher level of complexity. A CEO in a company with high growth opportunities may have to be compensated for the complexity. The results also show that this positive relationship is stronger for high-technology companies than low-technology companies. Furthermore, Table 31 shows a negative relation between the market-to-book ratio and the sum of stock options and restricted stock and this relation is more negative for low-technology companies than for high-technology companies.

Table 31
Regression results Hypothesis 9
Difference in influence of market-to-book ratio on CEO compensation between high- and low-technology companies

Variables	LN(SHORT)=Bonus	LN(FIXED)=Salary	LN(LONG)= Sum of stock options and restricted stock
LAG(SHORT)	0.000089 (0.000047)		
LAG(FIXED)		0.00069*** (0.00011)	
MTOB*HIGHTECH	0.036 (0.034)	0.0059** (0.0030)	0.00087* (0.00052)
LN(R&D)	-0.055 (0.14)	0.040 (0.045)	0.069 (0.83)
R&D/ASSETS	-3.59 (3.12)	0.18 (0.40)	0.70 (0.83)
ROA	-0.046*** (0.010)	0.0034* (0.0018)	
LAG(ROA)	0.00040 (0.0045)	-0.0011 (0.0016)	
ROE	0.018*** (0.0045)	-0.00013 (0.00053)	
LAG(ROE)	-0.0020* (0.0011)	-0.00013 (0.00053)	
DIVIDENDYIELD	-0.024 (0.025)	0.015 (0.011)	-0.16*** (0.038)
TOBINSQ	-0.0045*** (0.0011)	-0.000086 (0.00028)	0.0057 (0.0097)
TSR	0.0013 (0.0010)	0.00010 (0.00022)	0.00046 (0.0011)
LN(ASSETS)	0.40*** (0.15)	0.16*** (0.050)	0.50*** (0.059)
MTOB	-0.00087 (0.0028)	0.000053*** (0.000019)	-0.00059*** (0.00021)
AGE	0.013 (0.010)	-0.00030 (0.0034)	0.014*** (0.0017)
CEOOWN	0.081*** (0.026)	0.018** (0.0075)	0.53*** (0.15)
MALE	-0.061*** (0.21)	-0.13 (0.090)	0.19 (0.42)
Constant	2.28** (0.92)	4.71*** (0.32)	2.47*** (0.53)
Adjusted R-squared		0.12	
Within R-squared	0.11		0.094
Number of observations	368	2,359	687

*** , ** and * indicate statistical significance at the one, five and ten percent levels, respectively ($p < 0.01$; $p < 0.05$; $p < 0.1$). Robust standard deviations are in parentheses.

5.11 Robustness check

In Appendix T-X, the outcomes of the robustness check are presented. To check whether the prior obtained results are influenced by the use of LN(R&D) and R&D/ASSETS as proxies for innovation, some regressions are re-estimated using LN(PATENTS) and PATENTS/ASSETS.

The robustness check for hypothesis 3 shows that one percentage point increase in the number of patents, decreases fixed salary with 0.015 percentage point. However, we do not find a negative influence of LN(R&D) on LN(FIXED). For hypothesis 5, we find a negative influence of PATENTS/ASSETS on short-term compensation incentives in the period before the crisis (2004-2007). This is not in line with our findings for R&D/ASSETS, because here we find a positive impact of R&D/ASSETS on LN(SHORT) in the pre-crisis period.

For hypothesis 8, we find different results between the influence of R&D/ASSETS and PATENTS/ASSETS on CEO compensation and between the influence of LN(R&D) and LN(PATENTS) on CEO compensation. For example, we find a positive influence of PATENTS/ASSETS and a negative influence of R&D/ASSETS on LN(SHORT) among S&P Midcaps 400 firms that are low-technology companies.

In conclusion, the findings are different when we re-estimate our regressions using PATENTS/ASSETS and LN(PATENTS) instead of R&D/ASSETS and LN(R&D) as independent variable.

6 Conclusion and discussion

The main purpose of this thesis was to investigate what are the drivers of CEO compensation and examine whether these drivers are different in high-technology companies compared to low-technology companies.

The research question addressed in this paper is: *What influences CEO compensation in US-based high-technology companies?*

To address our research question stated above, we have formulated nine sub-questions. These sub-questions are:

1. What is the influence of firm performance on CEO compensation?
2. Does the relationship between CEO compensation and innovation differ between high-and low-technology companies?
3. Does the relationship between CEO compensation and firm performance differ between high-and low-technology companies?
4. What is the influence of CEO compensation on innovation and firm performance?
5. Does the influence of firm performance and innovation on CEO compensation differ between the period before the crisis and the period after the crisis?
6. What is the influence of restricted stock and stock options on innovation?
7. What is the influence of innovation and firm performance on restricted stock and stock options?
8. Does the influence of innovation on CEO compensation depend on size in high- and low-technology companies?
9. Does the relationship between the book-to-market ratio and CEO compensation depend on whether a company is a high- or low-technology company?

The answer to the research question is provided based on the results of the hypotheses. The hypotheses are as follows:

H1: "*Firm performance has a positive influence on CEO compensation.*"

H2: "*The influence of innovation on CEO compensation is positive and stronger for high-technology companies than for low-technology companies.*"

H3: "*The effect of firm performance on CEO compensation is positive and stronger in high-technology companies than in low-technology companies.*"

H4: “*Long-term incentives have a positive influence on innovation. Short- and long-term incentives have a positive influence on firm performance.*”

H5: “*The influence of firm performance and innovation on CEO compensation is stronger in the period after crisis (2008-2016) than in the period before the crisis (2004-2007).*”

H6: “*Restricted stock decreases innovation. Stock options increase innovation.*”

H7: “*Innovation increases stock options and decreases restricted stock.*”

H8: “*The influence of innovation on long-term incentive compensation is stronger for small, high-technology companies than for large, low-technology companies. The influence of innovation on fixed and short-term incentive compensation is weaker for small, high-technology companies than for large, low-technology companies.*”

H9: “*The influence of the market-to-book ratio on fixed compensation is positive and the influence is stronger in low-technology companies than in high-technology companies.*”

Panel data from the Compustat Executive Compensation, Orbis and the Compustat North American data source are used to answer our research question and sub-questions. This thesis focuses on a sample of 1,033 American high-technology companies and 7,764 low-technology companies, in the period between 2004 and 2016, which constitutes a sample of 114,375 observations. Our sample consists of panel data. Fixed- and random-effect models are used in our empirical analysis to control for the unobserved firm heterogeneity.

CEO compensation consists of short-term incentive, long-term incentive and fixed components. In our empirical analysis, we use the natural logarithm of salary (fixed), natural logarithm of annual bonus (short-term incentive), the natural logarithm of the sum of restricted stock and stock options (long-term incentive), the value of restricted stock granted (long-term incentive), the value of stock options granted (long-term incentive) as dependent variables. Other dependent variables in our empirical study are return on assets, return on equity, Tobin’s Q, total shareholder return, dividend yield, the natural logarithm of research and development expense and the ratio of research and development expense divided by total assets. Our main independent variables of interest are return on assets in year t, return on assets in year t-1, return on equity in year t, return on equity in year t-1, Tobin’s Q, dividend yield, total shareholder return, the natural logarithm of research and development expense and the ratio of R&D expense scaled by total assets.

The results show a positive influence of return on assets on salary (fixed compensation). This evidence is in line with Zhou (2000), who found a positive impact of return on assets on CEO’s cash compensation (sum of salary and bonus). Furthermore, we find that one percentage point increase in shareholder return increases short-term incentives (bonus) with 0.0015 percentage point on average. This finding is in line with McKnight et al. (2000), who found a positive influence of shareholder return on annual bonus. These findings indicate that corporate board align the interests of the CEO with the interests of the shareholders.

However, we also find a negative impact of Tobins' Q on bonus (short-term incentive) and of dividend yield on the sum of restricted stock and stock options (long-term incentives). We find mixed results on the question whether the relationship between CEO compensation and firm performance differs between high- and low-technology companies. The link between firm performance and CEO compensation depends on the performance measure that is used. We find a positive association between CEO's base salary and the interaction term between return on assets and the high-technology dummy variable. At the other hand, we observe a negative relationship between salary and the interaction term between the return on equity and the high-technology dummy. Furthermore, we find a negative association between annual bonus and the interaction term between dividend yield and the high-technology dummy. The explanation behind these findings might be that high-technology companies are more often growth companies, which need to use the cash for R&D expenditures. Therefore, these companies may reward their CEOs more with long-term compensation instead of cash compensation. The negative relationship between salary and the interaction term between the return on equity and the high-technology dummy is not in line with the study of Shim et al. (2009), who found a positive influence of return on equity on the CEO's base salary among high-technology companies and they do not find this relationship among low-technology companies.

Our empirical study shows a negative effect of the logarithm of R&D expense on short-term incentives (annual bonus). This finding conflicts with outcomes of earlier research. The literature (for example Balkin et al., 2000) showed a positive influence of innovation on (short- and long-term) CEO compensation. Furthermore, we observe a negative relationship between annual bonus and the interaction term between the ratio of R&D expense scaled by total assets and the high-technology dummy. This finding does not support hypothesis 2, which states that the influence of innovation on CEO compensation is positive and stronger for high-technology companies than for low-technology companies.

We find evidence for an endogenous relationship between CEO compensation and firm performance. The results show a positive influence of annual bonus on total shareholder return. Interestingly, salary decreases total shareholder return. This suggests that an increase in salary is not an appropriate stimulation for a higher shareholder return. Moreover, we find that fixed compensation and long-term incentives increase and decrease dividend yield, respectively. Finally, we find no evidence of a significant influence of CEO compensation on innovation.

We find a different effect of innovation on CEO compensation between the period before the crisis (2004-2007) and the period after the crisis (2008-2016). We find a stronger negative effect of R&D on bonus after the crisis (2008-2016) than before the crisis (2004-2007). This is in line with what we expected. We observe a positive influence of the ratio of R&D expense scaled by total assets on annual bonus and salary in the period before the crisis and we observe no significant influence of the ratio of R&D expense scaled by total assets on CEO compensation in the period after the crisis. Finally, we observe that the R&D expense is on average higher in the period after the crisis than in the period before the crisis.

Ryan & Wiggins (2002) found a positive association between stock options and the ratio of R&D expense divided by total assets. Interestingly, we find a negative effect of options on innovation, measured by the logarithm of R&D expense and the ratio of R&D expense scaled by total assets. Furthermore, we find that R&D and R&D/ASSETS decrease stock options. This finding indicates that CEOs are not motivated by a change in equity-based compensation. We find no significant influence of innovation on restricted stock. This is not in line with Ryan & Wiggins (2002), who found that R&D expenditures increase stock options among high- and low-technology companies. Interestingly, we also find a negative influence of total shareholder return on the value of stock options.

We find mixed results on the question whether the relationship between CEO compensation and innovation is not only different between high- and low-technology companies, but also between small, medium and large companies.

Last but not least, we find a positive impact of the market-to-book ratio on salary. This corrobates with the study of Cooper et al. (2009), who found that firms with high growth opportunities (high market-to-book ratio) pay higher levels of cash compensation, compared to firms with low growth opportunities. An explanation behind this finding is that companies with high growth opportunities has a higher level of complexity. A CEO in a company with high growth opportunities may have to be compensated for the complexity. The results also show that this positive relationship is stronger for high-technology companies than low-technology companies. Furthermore, we find a negative relation between the market-to-book ratio and long-term incentives and this relation is more negative for low-technology companies than for high-technology companies.

Our thesis contributes to the existing literature regarding executive compensation by providing a better understanding of executive compensation in US-based high- and low-technology companies.

Our findings are relevant for six different reasons. First, this study differs from previous work on executive compensation, because, to our knowledge, we examine for the first time whether the effect of innovation on CEO compensation differs between large, medium and small companies. Second, this thesis separates total CEO compensation in different components with different incentives, such as bonus (short-term incentive) and restricted stock (long-term incentive). Therefore, we can research on which component innovation or firm performance have an influence. Third, we used market- and accounting performance measures, which is not common in the literature. Accounting performance measures are described as a backward-looking measure of firm performance. Market performance measures are forward-looking firm performance measures. Fourth, we performed a fixed- and random-effect OLS regression model to investigate the drivers of CEO compensation among high- and low-technology companies. Fifth, we examined whether the influence of innovation and firm performance is different between the period before the crisis and the period after the crisis. Finally, this research used a simultaneous equation framework to mitigate the endogeneity problem.

The findings in this thesis can be important for shareholders, since the compensation that a CEO receives is deducted from their share of the profits. Policy makers might also be interested in the outcomes of this research. For example, the results show a positive influence of annual bonus on total shareholder return. This supports the idea of giving bonuses to CEOs for excellent achievements. Furthermore, the findings in this thesis may have important implications for corporate boards. This thesis can help corporate boards by designing remuneration schemes. Efforts to improve firm performance should focus on salary, since there is a positive association between salary and dividend yield. If the purpose of the corporate boards is to stimulate innovation, we would not advise them to increase CEO's salary, bonus or long-term compensation, since there is no positive relation between innovation and any CEO compensation component.

This thesis has several limitations. The first limitation is the independent variables used to test the hypotheses. A bunch of independent variables are used in the empirical study of this thesis. However, the adjusted R-squares of the regression models are relatively small. This would imply that there are other variables that explain the CEO compensation for a big part. For example, leverage or board structure could be relevant factors. It may also be interesting to research whether non-financial performance measures, such as customer satisfaction, influence CEO compensation. Finally, we neglect takeover threats, where CEOs may have a strong incentive to cut R&D expense.

Another limitation is that, although we estimated a regression model with the dependent variables lagged by one year, endogeneity might still affect the fixed effect regressions. This means that firm performance increases CEO compensation (salary, bonus and long-term compensation), but CEO compensation has also a positive effect on firm performance.

Third, we only focus on CEOs. Companies are run by multiple executives. In future research, it might be interesting to extend the research to other participants of the executive board.

Another limitation in this thesis is that we only took into account bonus, salary and two equity compensation plans (stock options and restricted stock) as a measure for compensation. However, many other instruments to reward a CEO exist (f.e. phantom stocks).

Fifth, we examined whether there is a relationship between innovation and CEO compensation and between firm performance and CEO compensation. However, we did not research the precise mechanisms by which CEO compensation is linked to firm performance and R&D investments.

To check whether the results in the empirical analysis are influenced by the use of research and development expense (PATENTS) as proxy for innovation, we re-estimated the regressions as robustness check using the number of patents as independent variable. Unfortunately, we only have information about the number of patents in a firm for the year 2016. Therefore, the variance in PATENTS is low and PATENTS is highly correlated with the constant term.

Seventh, Compustat Executive Compensation changed in 2006 the definition of TDC1. This may bias our results, since our sample consists of panel data for the period between 2004 and 2016.

For further research, it would be interesting to investigate the drivers of CEO compensation in European low- and high-technology companies. Some compensation elements can be more or less common in Europe. Another suggestion for future research is to investigate the influence of a peer group on short- and long-term CEO compensation.

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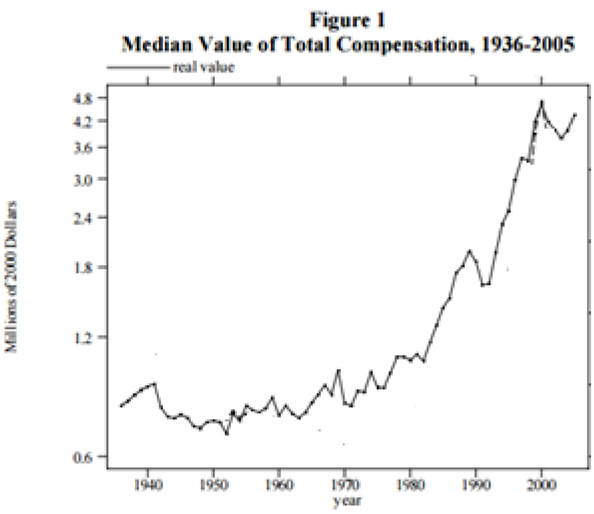
8 Appendix

APPENDIX A. High-technology definitions

Author(s)	High-technology companies	Low-technology companies
Balkin et al. (2000)	Companies that are in an industry with R&D expense greater than 5% of their total sales	Companies that are not in an industry with R&D expense greater than 5% of their total sales
Shim et al. (2009) and Kwon & Yin (2006)	Companies in the computer, electronics, pharmaceutical, and telecommunication industries.	Companies that are not in the computer, electronics, pharmaceutical, and telecommunication industries.
Faria (2014)	Companies that operate in an industry with a four-digit SIC code of 3570, 3571, 3572, 3576, 3577, 3661, 3674, 4812, 4813, 5045, 5961, 7370, 7371, 7372, or 7373	Companies that do not operate in an industry with a four-digit SIC code of 3570, 3571, 3572, 3576, 3577, 3661, 3674, 4812, 4813, 5045, 5961, 7370, 7371, 7372, or 7373
Ryan & Wiggins (2002)	Companies that operate in an industry with a SIC code between the range of 2830-2839, 3570-3579, 3600-3699, and 7370-7379.	Companies that do not operate in an industry with a SIC code between the range of 2830-2839, 3570-3579, 3600-3699, and 7370-7379.

APPENDIX B. Evolution of CEO compensation over time



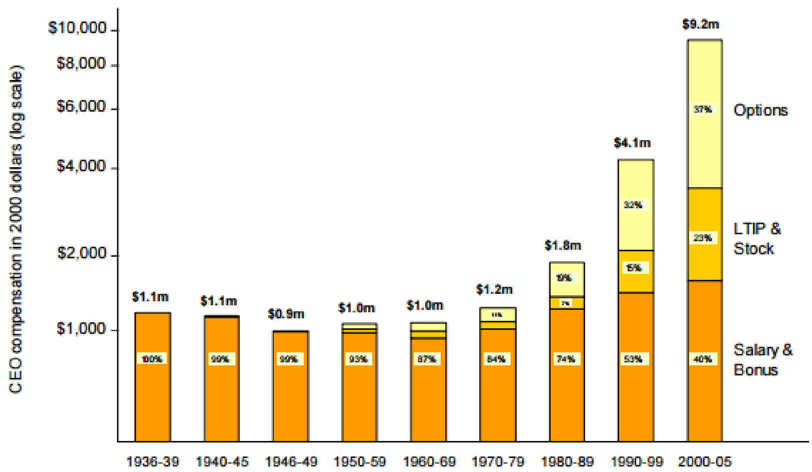
Source: (Frydman & Saks, 2005)

APPENDIX C. Evolution of different CEO components over time

Figure 2: The Structure of CEO Compensation

Panel A: The structure of CEO compensation from 1936 to 2005

The diagram shows the median level and the average composition of CEO pay in the 50 largest firms in 1940, 1960, and 1990 (for a total of 101 firms). Compensation data is hand-collected from proxy statements for all available years from 1936 to 1992; the S&P ExecuComp database is used to extend the data to 2005 (Frydman & Saks 2010). The figure depicts total compensation and the three main components that can be separately tracked over the sample period: salaries and current bonuses, payouts from long-term incentive plans (including the value of restricted stock), and the grant-date values of option grants (calculated using Black-Scholes). The component percentages are calculated by computing the percentages for average CEO pay in each period and then applying them to median CEO pay, as in Murphy (1999). All dollar values are in inflation-adjusted 2000 dollars. Note that the vertical axis is on a log scale.



Source: (Frydman & Jenter, 2010)

APPENDIX D. List of definitions

FIXED	CEO’s base salary (in thousands of dollars)
SHORT	CEO’s annual bonus (in thousands of dollars)
RESTRICTED	Value of restricted stock granted during the fiscal year (in thousands of dollars)
OPTIONS	Value of all options granted during the fiscal year (valued by the company, in thousands of dollars)
LONG	The sum of the value of restricted stock granted and the value of all options granted (in thousands of dollars)
R&D	Research and development expense (in millions of dollars)
R&D/ASSETS	The ratio of research of development expense divided by total assets (in percentage)
PATENTS	The number of patents a firm has in the year 2016
ROA	Return on assets (in percentage)
ROE	Return on equity (in percentage)
DIVIDENDYIELD	Dividend yield rate (in percentage)
TOBINSQ	Tobin’s Q (in percentage)
TSR	The total annual shareholder return (in percentage)
MTOB	Market-to-book ratio (in percentage)
CRISIS	Crisis dummy, which equals 0 for years 2004, 2005, 2006 and 2007 and equals 1 for years 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015 and 2016.
HIGHTECH	High-technology dummy, which takes a value of 1 when the company is a high-technology firm and takes a value of 0 when the company is a low-technology firm
ASSETS	The total value of the firm’s assets (in millions of dollars)
EMPL	The total number of employees (in thousands)
SALES	Total annual sales (in millions of dollars)
S&PINDEX	S&P index dummy, which equals 3 if the firm is a S&P 500 firm, equals 2 if the firm is a S&P Midcaps 400 firms, equals 1 if the firm is a S&P small caps 600 firms and equals 0 if the firm is not on a major S&P index
YEARS	Years dummy, which equals 0 if the year is 2004, takes a value of 1 if the year is 2005, takes a value of 2 if the year is 2006, takes a value of 3 if the year is 2007, takes a value of 4 if the year is 2008, takes a value of 5 if the year is 2009, takes a value of 6 if the year is 2010, takes a value of 7 if the year is

	2011, takes a value of 8 if the year is 2012, takes a value of 9 if the year is 2013, takes a value of 10 if the year is 2014, takes a value of 11 if the year is 2015 and takes a value of 12 if the year is 2016.
AGE	The age of the CEO (in years)
CEOOWN	The ratio of total shares that the CEO owns to the total outstanding shares (in percentage)
MALE	which takes a value of 1 when the CEO of the company is male and takes a value of 0 when the CEO of the company is female.

APPENDIX E. Outputs of Shapiro-Wilk test

Variables	The Shapiro–Wilk test p-value	Normal or non-normal distribution
SHORT	0.00	Non- normal distribution
LONG	0.00	Non- normal distribution
FIXED	0.00	Non- normal distribution
RESTRICTED	0.00	Non- normal distribution
OPTIONS	0.00	Non-normal distribution
R&D	0.00	Non-normal distribution
PATENTS	0.00	Non-normal distribution
EMPL	0.00	Non-normal distribution
SALES	0.00	Non-normal distribution
ASSETS	0.00	Non-normal distribution
ROE	0.00	Non-normal distribution
ROA	0.00	Non-normal distribution
DIVIDENDYIELD	0.00	Non-normal distribution
TOBINSQ	0.00	Non-normal distribution
CEOOWN	0.00	Non-normal distribution
AGE	0.00	Non-normal distribution
MTOB	0.00	Non-normal distribution

APPENDIX F. Correlation matrix 1

	LN(SHORT)	LN(LONG)	LN(FIXED)	LAG(SHORT)	LAG(LONG)	LAG(FIXED)	LN(R&D)	LAG(R&D)	LN(PATENTS)
LN(SHORT)	1.00								
LN(LONG)	0.61***	1.00							
LN(FIXED)	0.42***	0.57***	1.00						
LAG(SHORT)	0.32***	0.25***	0.078***	1.00					
LAG(LONG)	0.13***	0.58***	0.057***	0.19***	1.00				
LAG(FIXED)	0.40***	0.48***	0.46***	0.17***	0.10***	1.00			
LN(R&D)	0.24***	0.47***	0.17***	0.14***	0.10***	0.44***	1.00		
LAG(R&D)	0.14***	0.30***	0.05***	0.11***	0.049***	0.27***	0.45***	1.00	
LN(PATENTS)	0.05*	No obs	0.061***	0.016	0.035***	0.17***	0.61***	0.35***	1.00
ROA	0.033	No obs	0.0051	0.021*	0.013	0.046***	0.16***	0.068***	0.071***
ROE	0.030	No obs	0.029**	0.0094	0.014	0.058***	0.15***	0.054***	0.068***
DIVIDENDYIELD	-0.0045	0.022	0.010	-0.0035	-0.0063	0.015*	0.0022	0.012	0.011
TSR	0.018	0.050*	0.0006	-0.0021	-0.0027	0.0046	0.0102	-0.0002	-0.0094
TOBINSQ	0.036**	0.11***	0.017**	0.0024	0.0021	0.021***	0.018***	0.0028	0.026***
LAG(ROA)	0.0071	No obs	-0.0078	0.013	No obs	0.053***	0.16***	0.071***	0.064***
LAG(ROE)	-0.022	No obs	0.024*	0.0051	No obs	0.063***	0.15***	0.054***	0.065***
R&D/ASSETS	-0.12***	-0.11***	-0.059***	-0.028***	-0.0033	-0.098***	-0.013**	-0.0040	-0.032***
LN(R&D)*CRISIS	-0.059***	No obs	0.10***	-0.059***	-0.20***	0.27***	0.71***	0.36***	0.46***
R&D/ASSETS*CRISIS	-0.15***	No obs	-0.066***	-0.079***	-0.086***	-0.14***	-0.010*	-0.0034	-0.031***
LAG(R&D)*CRISIS	0.096***	No obs	0.036***	0.063***	-0.038***	0.23***	0.38***	0.87***	0.31***
TSR*CRISIS	0.019	No obs	0.0020	-0.0025	-0.0031	0.0047	0.0104	0.0018	-0.011
DIVIDENDYIELD*CRISIS	-0.014	No obs	0.0067	-0.0082	-0.016**	0.015*	0.0029	0.013	0.022**
TOBINSQ*CRISIS	0.0095	No obs	0.0111	0.0023	0.0019	0.0204***	0.015***	0.0024	0.022***
LN(ASSETS)	0.40***	0.52***	0.28***	0.12***	0.090***	0.53***	0.78***	0.34***	0.36***
MTOB	-0.017	-0.038	-0.0034	-0.0019	-0.0028	-0.0048	-0.028***	-0.0033	-0.019**
LN(EMPL)	0.31***	0.39***	0.26***	0.074***	0.087***	0.47***	0.70***	0.31***	0.32***

APPENDIX G. Correlation matrix 2

	LN(SHORT)	LN(LONG)	LN(FIXED)	LAG(SHORT)	LAG(LONG)	LAG(FIXED)	LN(R&D)	LAG(R&D)	LN(PATENTS)
LN(SALES)	0.38***	0.47***	0.28***	0.11***	0.095***	0.53***	0.69***	0.32***	0.30***
LAG(ASSETS)	0.19***	0.33***	0.13***	0.12***	0.042***	0.38***	0.35***	0.56***	0.24***
LN(R&D)* SPHIGHTECH	0.20***	0.40***	0.14***	0.14***	0.089***	0.42***	0.74***	0.56***	0.54***
R&D/ASSETS* SPHIGHTECH	-0.018	0.16***	-0.031***	-0.0037	0.027***	-0.026**	0.36***	0.25***	0.25***
YEARS	-0.19***	-0.028	0.017**	-0.11***	-0.22***	0.052***	0.062***	0.033***	0.011
AGE	0.077***	0.22***	0.11***	0.025***	-0.086***	0.20***	0.023**	0.020**	-0.015
CEOOWN	0.0028	-0.0060	-0.082***	0.020**	0.0043	0.0091	-0.13***	-0.037***	-0.12***
LAG(CEOOWN)	0.043**	-0.046	-0.089***	0.0026	-0.048***	0.0071	-0.13***	-0.033***	-0.12***
MALE	0.069***	0.063**	-0.012	0.020**	0.011	-0.011	-0.040***	-0.020**	-0.053***
LN(R&D)*HIGHTECH	-0.059***	0.15***	-0.14***	0.010	0.040***	-0.10***	0.42***	0.18***	0.22***
R&D/ASSETS*HIGHTECH	-0.12***	0.025	-0.050***	-0.015	0.0008	-0.068***	-0.015***	-0.0035	-0.016**
ROE* HIGHTECH	0.027	No obs	-0.0011	0.0028	0.0051	0.0007	0.055***	0.041***	0.059***
ROA* HIGHTECH	-0.0082	No obs	-0.016	0.0031	0.025*	-0.023*	0.096***	0.075***	0.096***
TSR* HIGHTECH	0.0047	0.054*	-0.0075	-0.0019	-0.0016	-0.0052	0.0024	-0.0007	-0.0063
TOBINSQ* HIGHTECH	-0.014	0.070**	-0.025***	0.0014	0.015*	-0.0086	0.042***	0.0035	0.013*
DIVIDENDYIELD* HIGHTECH	-0.020	0.0219	-0.0012	-0.0033	-0.0029	-0.0029	-0.0063	0.012	0.029***
LAG(ROE)* HIGHTECH	0.025	No obs	-0.0083	0.0020	No obs	-0.0019	-0.0060***	0.044***	0.055***
LAG(ROA)* HIGHTECH	0.015	No obs	-0.029**	0.0005	No obs	-0.018	0.11***	0.081***	0.098***
RESTRICTED	0.18***	0.42***	0.050***	0.046***	0.14***	0.029***	0.042***	-0.0020	No obs
OPTIONS	0.21***	0.59***	0.049***	0.050***	0.30***	0.017**	0.086***	0.017*	No obs
MTOB*HIGHTECH	0.0098	0.023	-0.0062	-0.0016	-0.0015	-0.0085	-0.0077	-0.0019	-0.021***
SHORT	0.43***	0.34***	0.12***	0.53***	0.064***	0.13***	0.13***	0.10***	0.016
LONG	0.24***	0.66***	0.092***	0.058***	0.30***	0.023***	0.089***	0.013	No obs
FIXED	0.47***	0.50***	0.83***	0.17***	0.089***	0.87***	0.44***	0.27***	0.17***
RD	0.14***	0.24***	0.18***	0.13***	0.059***	0.26***	0.43***	0.98***	0.33***
PATENTS	0.15***	No obs	0.13***	0.057***	0.012	0.19***	0.26***	0.47***	0.35***
RDCRISIS	0.065***	No obs	0.14***	0.070***	-0.038***	0.22***	0.34***	0.86***	0.29***
ASSETS	0.20***	0.24***	0.25***	0.12***	0.046***	0.38***	0.35***	0.57***	0.22***
EMPL	0.21***	0.20***	0.21***	0.039***	0.046***	0.25***	0.42***	0.37***	0.13***
SALES	0.21***	0.26***	0.25***	0.079***	0.069***	0.34***	0.34***	0.46***	0.21***
RDHIGHTECH	0.033*	0.16***	0.00020	0.086***	0.035***	0.025**	0.24***	0.50***	0.18***

APPENDIX H. Correlation matrix 3

	ROA	ROE	DIVIDENDYIELD	TSR	TOBINSQ	LAG(ROA)	LAG(ROE)	R&D/ASSETS	LN(R&D)* CRISIS
ROA	1.00								
ROE	0.66***	1.00							
DIVIDENDYIELD	-0.0066	0.0041	1.00						
TSR	-0.0082	-0.0011	-0.0030	1.00					
TOBINSQ	-0.0051	0.019**	0.0017	0.0004	1.00				
LAG(ROA)	0.58***	0.42***	-0.0046	-0.016	0.019**	1.00			
LAG(ROE)	0.40***	0.42***	0.0086	-0.0031	0.015*	0.67***	1.00		
R&D/ASSETS	-0.063***	-0.16***	-0.019**	-0.0004	-0.034***	-0.071***	-0.048***	1.00	
LN(R&D)* CRISIS	0.12***	0.12***	0.0047	0.015	0.014***	0.14***	0.14***	-0.0063	1.00
R&D/ASSETS* CRISIS	-0.046***	-0.13***	-0.023**	0.0039	-0.025***	-0.060***	-0.046***	0.99***	-0.0019
LAG(R&D)* CRISIS	0.056***	0.046***	0.0095	0.0013	0.0023	0.063***	0.050***	-0.0033	0.45***
TSR*CRISIS	-0.024*	-0.011	-0.0023	0.88***	0.0003	-0.016	-0.0031	-0.0008	0.018*
DIVIDENDYIELD *CRISIS	-0.011	0.0060	0.87***	-0.0017	0.0014	-0.0092	0.0066	-0.014	0.057***
TOBINSQ* CRISIS	-0.0052	0.013*	0.0018	0.0003	0.99***	0.019**	0.015*	-0.025***	0.013**
LN(ASSETS)	0.32***	0.25***	0.013*	-0.0010	0.044***	0.32***	0.25***	-0.069***	0.57***
MTOB	0.014*	-0.010	-0.0019	0.0003	-0.0004	-0.014	-0.012	0.0020	-0.024***
LN(EMPL)	0.34***	0.26***	-0.010	0.0033	0.026***	0.34***	0.27***	-0.041***	0.49***
LN(SALES)	0.35***	0.25***	0.046***	0.0035	0.012***	0.34***	0.25***	-0.085***	0.50***
LAG(ASSETS)	0.056***	0.046***	0.024***	-0.0026	0.0014	0.060***	0.048***	-0.0050	0.29***
LN(R&D)* SPHIGHTECH	0.18***	0.15***	0.029***	-0.011	0.047***	0.178***	0.15***	-0.019*	0.46***
R&D/ASSETS* SPHIGHTECH	0.017	-0.013	-0.018*	-0.0059	0.0087	0.0117	-0.019	0.66***	0.18***
YEARS	-0.0012	0.0028	0.014**	0.0002	-0.0080**	0.0021	-0.0036	0.012**	0.45***
AGE	0.066***	0.024*	0.0091	-0.0034	0.0046	0.081***	0.037***	-0.014	0.22***

APPENDIX I. Correlation matrix 4

	ROA	ROE	DIVIDENDYIELD	TSR	TOBINSQ	LAG(ROA)	LAG(ROE)	R&D/ASSETS	LN(R&D)* CRISIS
CEOOWN	0.069***	0.013	-0.0037	-0.0051	0.0041	0.061***	0.0096	0.0056	-0.064***
LAG(CEOOWN)	0.053***	0.0079	-0.0015	-0.0060	0.0045	0.074***	0.022	0.0044	-0.059***
MALE	-0.0067	-0.0087	-0.0055	0.0032	-0.0023	-0.0050	-0.0065	0.025***	-0.059***
LN(R&D)* HIGHTECH	0.085***	0.060***	-0.025**	-0.0041	0.0054	0.088***	0.065***	-0.010*	0.31***
R&D/ASSETS* HIGHTECH	-0.063***	-0.054***	-0.011	-0.0012	-0.0000	-0.099***	-0.069***	0.059***	-0.0094*
ROE* HIGHTECH	0.28***	0.43***	-0.011	0.0016	0.0050	0.18***	0.18***	-0.047***	0.049***
ROA* HIGHTECH	0.42***	0.31***	-0.036***	0.0013	-0.0002	0.26***	0.18***	-0.021**	0.078***
TSR* HIGHTECH	-0.0032	-0.0019	-0.0017	0.55***	0.0002	-0.025*	-0.025*	0.0046	-0.0057
TOBINSQ* HIGHTECH	0.0082	0.015**	0.0015	0.0007	0.21***	-0.0095	-0.0052	0.0001	0.026***
DIVIDENDYIELD *HIGHTECH	-0.023*	-0.0083	0.53***	-0.0008	0.0005	-0.025*	-0.0084	0.0027	0.0018
LAG(ROE)* HIGHTECH	0.17***	0.17***	-0.012	-0.0030	-0.0011	0.29***	0.42***	-0.0044	0.053***
LAG(ROA)* HIGHTECH	0.25***	0.20***	-0.04***	-0.0048	-0.0012	0.42***	0.32***	-0.026**	0.089***
RESTRICTED	No obs	No obs	-0.0025	-0.0015	0.0012	No obs	No obs	-0.0136	-0.10***
OPTIONS	No obs	No obs	-0.0080	-0.0022	0.0016	No obs	No obs	-0.0041	-0.15***
MTOB* HIGHTECH	-0.0057	0.0057	-0.0014	0.0005	-0.0007	-0.017*	-0.0116	0.0007	-0.0049
SHORT	0.013***	0.0093	-0.0074	0.0098	0.0054	0.0024	-0.0036	-0.050***	-0.042***
LONG	No obs	No obs	-0.018**	0.0082	0.0051	No obs	No obs	-0.015	-0.17***
FIXED	0.061***	0.085***	0.15***	-0.0036	0.034***	0.057***	0.082***	-0.18***	0.26***
RD	0.074	0.071***	0.15***	-0.0065	0.031***	0.076***	0.073***	-0.041***	0.34***
PATENTS	0.052***	0.044***	0.077***	-0.0072	0.016***	0.053***	0.045***	-0.036***	0.21***
RDCRISIS	0.061***	0.060***	0.12***	0.025***	0.024***	0.069***	0.067***	-0.034***	0.45***
ASSETS	0.060***	0.061***	0.17***	-0.0081	0.022***	0.067***	0.067***	-0.071***	0.28***
EMPL	0.071***	0.067***	0.089***	-0.010	0.033***	0.071***	0.066***	-0.080***	0.31***
SALES	0.073***	0.071***	0.13***	-0.0044	0.033***	0.074***	0.071***	-0.073***	0.27***
RDHIGHTECH	0.059***	0.045***	0.036***	0.00010	0.017***	0.062***	0.048***	-0.020***	0.20***

APPENDIX J. Correlation matrix 5

	R&D/ASSETS* CRISIS	LAG(R&D)* CRISIS	TSR*CRISIS	DIVIDENDYIELD *CRISIS	TOBINSQ* CRISIS	LN(ASSETS)	MTOB	LN(EMPL	LN(SALES)
R&D/ASSETS* CRISIS	1.00								
LAG(R&D)* CRISIS	-0.0026	1.00							
TSR*CRISIS	0.0050	0.0035	1.00						
DIVIDENDYIELD *CRISIS	0.0014	0.020**	-0.0014	1.00					
TOBINSQ* CRISIS	-0.025***	0.0020	0.0003	0.0012	1.00				
LN(ASSETS)	-0.060***	0.29***	0.0017	0.016**	0.040***	1.00			
MTOB	0.0019	-0.0026	-0.0002	-0.0009	-0.0004	-0.035***	1.00		
LN(EMPL)	-0.035***	0.26***	0.0051	-0.0077	0.024***	0.84***	-0.026***	1.00	
LN(SALES)	-0.058***	0.27***	0.0041	0.040***	0.011***	0.90***	-0.023***	0.90***	1.00
LAG(ASSETS)	-0.0042	0.50***	-0.0016	0.024***	0.0013	0.26***	-0.0018	0.21***	0.23***
LN(R&D)* SPHIGHTECH	0.042***	0.49***	-0.01	0.030	0.047***	0.68***	-0.011	0.60***	0.63***
R&D/ASSETS* SPHIGHTECH	0.37***	0.21***	-0.0061	-0.0087	0.0087	0.025***	0.0033	-0.082***	-0.038***
YEARS	0.019***	0.10***	0.0074	0.073***	-0.0097***	0.020***	0.0096***	0.0010	0.031***
AGE	0.067***	0.045***	-0.0024	0.020***	0.0044	0.084***	0.0018	0.072***	0.085***
CEOOWN	0.017*	-0.027***	-0.0043	-0.0033	0.0041	-0.14***	-0.0020	-0.064***	-0.12***
LAG(CEOOWN)	0.021**	-0.021**	-0.0051	-0.0029	0.0045	-0.14***	-0.0026	-0.062***	-0.12***
MALE	0.027***	-0.027***	0.0026	-0.0053	-0.0023	-0.012	0.0032	-0.037***	-0.021***
LN(R&D)* HIGHTECH	-0.0085	0.16***	-0.0067	-0.013	0.0043	0.29***	-0.0061	0.27***	0.26***
R&D/ASSETS* HIGHTECH	0.055***	-0.0028	-0.0022	-0.0064	0.0005	-0.059***	0.0076	-0.035***	-0.11***

APPENDIX K. Correlation matrix 6

	R&D/ASSETS* CRISIS	LAG(R&D)* CRISIS	TSR*CRISIS	DIVIDENDYIELD *CRISIS	TOBINSQ* CRISIS	LN(ASSETS)	MTOB	LN(EMPL)	LN(SALES)
ROE* HIGHTECH	-0.037***	0.035***	-0.0042	-0.012	0.0020	0.098***	0.0016	0.082***	0.086***
ROA* HIGHTECH	-0.013	0.065***	-0.0087	-0.039***	-0.0000	0.14***	-0.0004	0.12***	0.13***
TSR* HIGHTECH	0.0009	-0.0005	0.58***	-0.0012	0.0002	-0.0080	0.0009	-0.0067	-0.0055
TOBINSQ* HIGHTECH	0.0001	0.0029	0.0006	0.0014	0.21***	0.024***	-0.0002	0.026***	0.040***
DIVIDENDYIELD *HIGHTECH	0.0082	0.013	-0.0007	0.58***	0.0004	-0.0085	-0.0012	-0.015**	-0.015**
LAG(ROE)* HIGHTECH	-0.0033	0.040***	-0.0043	-0.012	-0.0013	0.10***	-0.0027	0.084***	0.091***
LAG(ROA)* HIGHTECH	-0.018*	0.075***	-0.0062	-0.042***	-0.0013	0.15***	-0.0059	0.12***	0.14***
RESTRICTED	-0.048***	-0.015	-0.0020	-0.010	0.0012	0.067***	-0.0018	0.058***	0.069***
OPTIONS	-0.068***	-0.015	-0.0025	-0.013*	0.0015	0.068***	-0.0023	0.071***	0.070***
MTOB* HIGHTECH	-0.0002	-0.0015	-0.0002	-0.0009	-0.0007	-0.020***	0.21***	-0.012***	-0.013***
SHORT	-0.067***	0.086***	0.0076	-0.0086	0.0021	0.12***	-0.0026	0.072***	0.10***
LONG	-0.076***	-0.018*	-0.0028	-0.014*	0.0017	0.082***	-0.0049	0.080***	0.085***
FIXED	-0.12***	0.23***	0.0032	0.012	0.019**	0.53***	0.0096	0.47***	0.53***
RD	-0.0035	0.86***	0.0019	0.021**	0.0026	0.33***	-0.027***	0.31***	0.31***
PATENTS	-0.0029	0.41***	0.0015	0.010	0.0015	0.15***	-0.014**	0.16***	0.16***
RDCRISIS	-0.0025	0.99***	0.0039	0.034***	0.0021	0.27***	-0.021***	0.25***	0.25***
ASSETS	-0.0042	0.51***	-0.0015	0.024***	0.0015	0.24***	-0.018***	0.22***	0.24***
EMPL	-0.0044	0.31***	-0.00050	0.0093	0.0025	0.31***	-0.030***	0.39***	0.34***
SALES	-0.0043	0.40***	-0.0007	0.028***	0.0022	0.33***	-0.028***	0.35***	0.36***
R&D* HIGHTECH	-0.0019	0.48***	-0.0019	0.0078	0.0015	0.17***	-0.016***	0.16***	0.16***

APPENDIX L. Correlation matrix 7

	LAG(ASSETS)	LN(R&D)* SPHIGHTECH	R&D/ASSETS* SPHIGHTECH	YEARS	AGE	CEOOWN	LAG(CEOOWN)	MALE
LAG(ASSETS)	1.00							
LN(R&D)* SPHIGHTECH	0.40***	1.00						
R&D/ASSETS* SPHIGHTECH	0.021**	0.46***	1.00					
YEARS	0.018***	0.17***	0.026***	1.00				
AGE	0.034***	0.042***	0.0055	0.26***	1.00			
CEOOWN	-0.057***	-0.084***	-0.0078	-0.0038	0.16***	1.00		
LAG(CEOOWN)	-0.055***	-0.082***	-0.0072	0.0007	0.16***	0.87***	1.00	
MALE	-0.018**	-0.055***	0.040***	-0.037***	0.023***	0.019**	0.019**	1.00
LN(R&D)* HIGHTECH	0.075***	0.30***	0.38***	0.019***	-0.033***	0.049***	0.052***	0.012
R&D/ASSETS* HIGHTECH	-0.0080	0.019*	0.60***	0.0061	-0.010	0.010	0.0094	0.015
ROE* HIGHTECH	0.023***	0.11***	0.058***	0.010	0.022*	0.0078	0.0066	0.0072
ROA* HIGHTECH	0.038***	0.20***	0.20***	0.0046	0.0029	0.027**	0.0088	0.020
TSR* HIGHTECH	-0.0028	-0.0042	0.0032	0.0068	-0.0015	-0.0033	-0.0035	0.0020
TOBINSQ* HIGHTECH	0.0024	0.042***	0.0087	-0.0034	-0.017**	0.018**	0.0214***	-0.0029
DIVIDENDYIELD* HIGHTECH	0.0096	0.0048	0.0086	0.018**	-0.0039	-0.0026	-0.0032	-0.0025
LAG(ROE)* HIGHTECH	0.021**	0.11***	0.056***	0.0075	0.032**	0.0086	0.0097	0.0065
LAG(ROA)* HIGHTECH	0.039***	0.20***	0.20***	0.0048	0.016	0.024*	0.029**	0.019
RESTRICTED	0.0055	0.034***	-0.010	-0.15***	-0.023***	-0.033***	-0.016**	0.014*
OPTIONS	0.0051	0.078***	0.021**	-0.19***	-0.022***	-0.042***	-0.014*	0.014*
MTOB* HIGHTECH	-0.0013	-0.0082	0.0051	0.0008	-0.0020	-0.0030	-0.0032	0.0016
SHORT	0.11***	0.13***	-0.0059	-0.10***	0.030***	0.0067	0.025***	0.020***
LONG	0.0062	0.079***	0.013	-0.22***	-0.027***	-0.057***	-0.017**	0.017**
FIXED	0.38***	0.42***	-0.023**	0.054***	0.20***	0.017**	0.0024	-0.0096
RD	0.56***	0.56***	0.26***	0.035	0.012	-0.032***	-0.028***	-0.017*
PATENTS	0.38***	0.37***	0.091***	0.0045	0.011	-0.056***	-0.049***	-0.070***
R&D*CRISIS	0.49***	0.48***	0.20***	0.11***	0.049***	-0.015	-0.016	-0.026***
ASSETS	0.99***	0.41***	0.021**	0.020***	0.025***	-0.064***	-0.056***	-0.016**
EMPL	0.29***	0.49***	-0.033***	0.015***	0.029***	-0.037***	-0.029***	-0.020***
SALES	0.51***	0.43***	-0.0065	0.024***	0.025***	-0.065***	-0.056***	-0.019**
R&D*HIGHTECH	0.20***	0.37***	0.21***	0.031***	0.015	0.039***	0.027***	-0.017*

APPENDIX M. Correlation matrix 8

	LN(R&D)* HIGHTECH	R&D/ASSETS *HIGHTECH	ROE* HIGHTECH	ROA* HIGHTECH	TSR* HIGHTECH	TOBINSQ* HIGHTECH	DIVIDENDYIELD* HIGHTECH	LAG(ROE)* HIGHTECH
LN(R&D)* HIGHTECH	1.00							
R&D/ASSETS* HIGHTECH	0.037***	1.00						
ROE* HIGHTECH	-0.0019	-0.14***	1.00					
ROA* HIGHTECH	0.061***	-0.14***	**0.68*****	1.00				
TSR* HIGHTECH	0.023**	0.0081	0.0034	0.0058	1.00			
TOBINSQ* HIGHTECH	0.032***	-0.0012	0.037***	0.019**	0.0015	1.00		
DIVIDENDYIELD* HIGHTECH	0.033***	0.0086	-0.0061	-0.024*	-0.0005	0.0046	1.00	
LAG(ROE)* HIGHTECH	0.0079	-0.18***	0.40***	0.41***	-0.0074	-0.011	-0.0067	1.00
LAG(ROA)* HIGHTECH	0.077***	-0.21***	0.44***	0.61***	0.033**	-0.021***	-0.028**	0.70***
RESTRICTED	0.0031	-0.0053	No obs	No obs	-0.0011	0.0010	-0.0001	No obs
OPTIONS	0.045***	0.0018	No obs	No obs	-0.0013	0.013*	-0.0027	No obs
MTOB* HIGHTECH	-0.0042	0.040***	0.012	-0.013	0.0011	-0.0014	-0.0004	-0.029***
SHORT	-0.00060	-0.035***	0.0011	-0.0020	-0.00010	0.0032	-0.0060	0.0041
LONG	0.037***	0.0018	No obs	No obs	-0.00060	0.011	-0.0041	No obs
FIXED	-0.11***	-0.17***	0.0074	-0.013	-0.036***	0.0012	0.0088	-0.0057
RD	0.16***	-0.0064	0.043***	0.090***	0.038***	0.034***	0.23***	0.086***
PATENTS	0.11***	-0.0046	0.025***	0.059***	0.014	0.018***	0.13***	0.049***
R&D*CRISIS	0.14***	-0.0033	0.036***	0.079***	0.055***	0.028***	0.23***	0.080***
ASSETS	0.067***	-0.051***	0.022***	0.044***	0.00060	0.017***	0.12***	0.045***
EMPL	0.089***	-0.058***	0.010	0.022***	-0.012*	0.028***	0.041***	0.019**
SALES	0.040***	-0.053***	0.018**	0.031***	-0.0059	0.026***	0.072***	0.032***
R&D*HIGHTECH	0.42***	0.073***	0.050***	0.12***	0.084***	0.032***	0.37***	0.11***

APPENDIX N. Correlation matrix 9

	LAG(ROA)* HIGHTECH	RESTRICTED	OPTIONS	MTOB* HIGHTECH	SHORT	LONG	FIXED	R&D	PATENTS	R&D*CRISIS
LAG(ROA)* HIGHTECH	1.00									
RESTRICTED	No obs	1.00								
OPTIONS	No obs	0.30***	1.00							
MTOB* HIGHTECH	-0.037***	-0.0008	-0.0011	1.00						
SHORT	-0.00020	0.14***	0.16***	-0.0015	1.00					
LONG	No obs	0.66***	0.91***	-0.0012	0.19***	1.00				
FIXED	-0.025*	0.096***	0.073***	-0.0082	0.17***	0.098***	1.00			
R&D	0.098***	0.0094	0.051***	-0.0019	0.11***	0.046***	0.27***	1.00		
PATENTS	0.063***	No obs	No obs	-0.0019	0.061***	No obs	0.20***	0.46***	1.00	
R&D*CRISIS	0.092***	-0.021**	-0.030***	-0.0015	0.068***	-0.034***	0.22***	0.84***	0.40***	1.00

APPENDIX O. Correlation matrix 10

	LAG(ROA)* HIGHTECH	RESTRICTED	OPTIONS	MTOB* HIGHTECH	SHORT	LONG	FIXED	R&D	PATENTS	R&D*CRISIS
ASSETS	0.048***	0.044***	0.028***	-0.0013	0.12***	0.041***	0.38***	0.57***	0.37***	0.49***
EMPL	0.021**	0.031***	0.037***	-0.0023	0.038***	0.042***	0.25***	0.37***	0.22***	0.30***
SALES	0.031***	0.066***	0.041***	-0.0020	0.078***	0.061***	0.34***	0.47***	0.30***	0.39***
R&D*HIGHTECH	0.13***	-0.0025	0.035***	-0.0011	0.074***	0.028***	0.025***	0.52***	0.34***	0.50***

APPENDIX P. Correlation matrix 11

	ASSETS	EMPL	SALES	R&D*HIGHTECH
ASSETS	1.00			
EMPL	0.30***	1.00		
SALES	0.53***	0.66***	1.00	
R&D*HIGHTECH	0.21***	0.16***	0.17***	1.00

APPENDIX Q. White test for heteroscedasticity

Dependent variables	White test p-value	Homoscedasticity or heteroscedasticity
LN(SHORT)	0.040	Heteroscedasticity
LN(LONG)	0.00	Heteroscedasticity
LN(FIXED)	0.00	Heteroscedasticity
ROA	0.00	Heteroscedasticity
ROE	0.00	Heteroscedasticity
TSR	0.016	Heteroscedasticity
TOBINSQ	0.00	Heteroscedasticity
DIVIDENDYIELD	0.41	Homoscedasticity
LN(R&D)	0.55	Homoscedasticity
R&D/ASSETS	0.00	Heteroscedasticity
RESTRICTED	0.00	Heteroscedasticity
OPTIONS	0.034	Heteroscedasticity

APPENDIX R. Wooldridge test for autocorrelation

Dependent variables	Wooldridge p-value	First-order autocorrelation or no first-order autocorrelation
LN(SHORT)	0.98	No first-order autocorrelation
LN(LONG)	0.00	First-order autocorrelation
LN(FIXED)	0.00	First-order autocorrelation
ROA	0.00	First-order autocorrelation
ROE	0.18	No first-order autocorrelation
TSR	0.68	No first-order autocorrelation
TOBINSQ	0.00	First-order autocorrelation
DIVIDENDYIELD	0.0035	First-order autocorrelation
LN(R&D)	0.0002	First-order autocorrelation
R&D/ASSETS	0.00	First-order autocorrelation
RESTRICTED	0.00	First-order autocorrelation
OPTIONS	0.00	First-order autocorrelation

APPENDIX S. xtoverid test

Dependent variables	P-value of xtoverid test	Fixed- or random effects model
LN(SHORT)	0 62	Random effects model
LN(LONG)	0.97	Random effects model
LN(FIXED)	0.00	Fixed effects model
ROA	0.17	Random effects model
ROE	0.056	Random effects model
TSR	0.24	Random effects model
TOBINSQ	0.19	Random effects model
DIVIDENDYIELD	0.00	Fixed effects model
LN(R&D)	0.18	Random effects model
R&D/ASSETS	0.072	Random effects model
RESTRICTED	0.00	Fixed effects model
OPTIONS	0.00	Fixed effects model

APPENDIX T. Robustness check. Hypothesis 2.

Variables	LN(SHORT)=Bonus	LN(FIXED)=Salary
LN(PATENTS)	-0.089 (0.081)	-0.0040 (0.0095)
PATENTS/ASSETS	0.32 (0.63)	-0.00059 (0.0048)
LN(PATENTS)*HIGHTECH	-0.044 (0.076)	-0.033*** (0.010)
PATENTS/ASSETS*HIGHTECH	-0.25 (0.78)	0.060 (0.051)
ROA	-0.031** (0.012)	0.0030* (0.0014)
LAG(ROA)	0.0014 (0.01)	-0.0017 (0.0014)
ROE	0.013*** (0.0047)	-0.00018 (0.00053)
LAG(ROE)	-0.0029 (0.0044)	0.00022 (0.00049)
TOBINSQ	-0.00057 (0.0037)	0.000047 (0.00028)
DIVIDENDYIELD	-0.026 (0.021)	0.0065 (0.0080)
TSR	0.0018** (0.021)	-0.000031 (0.00018)
LN(ASSETS)	0.44*** (0.092)	0.20*** (0.015)
CEOOWN	0.027 (0.029)	0.012** (0.0026)
MTOB	-0.0029 (0.0028)	0.0028* (0.00017)
AGE	0.020* (0.010)	0.0013 (0.0026)
MALE	-0.48** (0.24)	-0.036 (0.070)
YEARS; (2008 is base year)		
-2009	-0.11 (0.12)	0.043** (0.020)
-2010	0.078 (0.14)	0.039 (0.024)
-2011	-0.30* (0.16)	0.059** (0.025)
-2012	-0.011 (0.18)	0.030 (0.031)
-2013	-0.22 (0.17)	0.051 (0.033)
-2014	-0.068 (0.21)	0.067* (0.035)
-2015	0.63** (0.26)	0.12** (0.060)
Constant	1.63** (0.77)	4.73*** (0.19)
Adjusted R-squared		0.031
Within R-squared	0.18	
Number of observations	410	2,808

*** , ** and * indicate statistical significance at the one, five and ten percent levels, respectively ($p < 0.01$; $p < 0.05$; $p < 0.1$). Robust standard deviations are in parentheses.

APPENDIX U. Robustness check. Hypothesis 3

Variables	LN(SHORT)=Bonus	LN(FIXED)=Salary
ROA*HIGHTECH	-0.018 (0.014)	0.0022 (0.0031)
LAG(ROA)*HIGHTECH	-0.021 (0.029)	0.00045 (0.0054)
ROE*HIGHTECH	0.00078 (0.0019)	-0.000046 (0.00050)
LAG(ROE)*HIGHTECH	0.022 (0.014)	-0.0016 (0.0023)
TOBINSQ*HIGHTECH	0.019 (0.020)	-0.0045 (0.0045)
DIVIDENDYIELD*HIGHTECH	-0.27* (0.16)	-0.015 (0.038)
TSR*HIGHTECH	0.0023 (0.0028)	-0.00052 (0.00057)
LN(PATENTS)	-0.098 (0.070)	-0.015* (0.0082)
PATENTS/ASSETS	0.12 (0.44)	0.0036 (0.0047)
ROA	-0.027* (0.014)	0.0022 (0.0017)
LAG(ROA)	-0.0045 (0.013)	-0.00085 (0.0015)
ROE	0.013** (0.0056)	-0.00010 (0.00056)
LAG(ROE)	-0.0026 (0.0047)	0.00022 (0.00051)
TOBINSQ	-0.0017 (0.0027)	0.00013 (0.00032)
DIVIDENDYIELD	-0.018 (0.020)	0.0092 (0.0083)
TSR	0.0015 (0.0010)	0.000078 (0.00020)
LN(ASSETS)	0.43*** (0.091)	0.20*** (0.016)
CEOOWN	0.025 (0.030)	0.012* (0.0060)
MTOB	-0.0033 (0.0035)	0.00027* (0.00016)
AGE	0.018* (0.011)	0.0017 (0.0027)
MALE	-0.95** (0.39)	-0.041 (0.072)
YEARS; (2008 is base year)		
-2009	-0.11 (0.12)	0.044** (0.019)
-2010	0.080 (0.14)	0.041* (0.023)
-2011	-0.26* (0.15)	0.059** (0.025)
-2012	0.033 (0.18)	0.028 (0.031)
-2013	-0.17 (0.17)	0.051 (0.033)
-2014	-0.025 (0.20)	0.068** (0.035)
-2015	0.65** (0.27)	0.12** (0.060)
Constant	3.04 (2.40)	4.73*** (0.19)
Adjusted R-squared		0.057
Within R-squared	0.34	
Number of observations	410	2,808

*** , ** and * indicate statistical significance at the one, five and ten percent levels, respectively ($p < 0.01$; $p < 0.05$; $p < 0.1$). Robust standard deviations are in parentheses.

APPENDIX V. Robustness check. Hypothesis 5

Variables	LN(SHORT)=Bonus Pre-crisis	LN(SHORT)=Bonus Post-crisis	LN(FIXED)=Salary Pre-crisis	LN(FIXED)=Salary Post-crisis
LAG(SHORT)	0.00012*** (0.000040)	0.00031*** (0.000073)		
LAG(FIXED)			0.00081*** (0.000076)	0.00083*** (0.000062)
LN(PATENTS)	0.018 (0.047)	-0.068* (0.037)	-0.0051 (0.0049)	-0.0017 (0.0035)
PATENTS/ASSETS	-0.61** (0.27)	0.080 (0.20)	0.0017 (0.0040)	-0.00063 (0.0048)
TOBINSQ	0.0071 (0.014)	-0.00035 (0.0014)	-0.00038*** (0.00013)	-0.00011 (0.00013)
DIVIDENDYIELD	-0.0090 (0.043)	0.012 (0.025)	0.0022 (0.0056)	0.00070 (0.0042)
TSR	0.00029 (0.0012)	0.00090 (0.00074)	-0.00059*** (0.00025)	-0.000021 (0.00012)
LN(ASSETS)	0.32*** (0.065)	0.36*** (0.050)	0.11*** (0.014)	0.086*** (0.013)
CEOOWN	0.012 (0.012)	0.032* (0.016)	0.0045* (0.0027)	0.00029 (0.0049)
MTOB	-0.0021 (0.013)	0.000018 ($7.18*10^{-6}$)	$4.21*10^{-6}$ ($2.58*10^{-6}$)	$-8.38*10^{-6}$ (0.000013)
AGE	0.021*** (0.0075)	0.0060 (0.0077)	0.0016 (0.0016)	0.00023 (0.0013)
MALE	0.34 (0.48)	0.33 (0.37)	-0.050 (0.10)	0.043 (0.037)
Constant	1.49** (0.67)	1.87*** (0.62)	4.95*** (0.15)	5.08*** (0.11)
Adjusted R-squared			0.066	0.090
Within R-squared	0.0013	0.025		
Number of observations	392	913	1,884	5,409

*** , ** and * indicate statistical significance at the one, five and ten percent levels, respectively ($p < 0.01$; $p < 0.05$; $p < 0.1$). Robust standard deviations are in parentheses.

APPENDIX W. Robustness check. Hypothesis 8

Variables	LN(SHORT)=Bonus	LN(FIXED)=Salary
LAG(SHORT)	0.000096*** (0.000031)	
LAG(FIXED)		0.0011*** (0.000076)
LN(PATENTS)*S&PHIGHTECH(=0)	-0.13 (0.082)	-0.0022 (0.0060)
LN(PATENTS)*S&PHIGHTECH(=1)	-0.079 (0.082)	0.0056 (0.0074)
LN(PATENTS)*S&PHIGHTECH(=2)	0.0058 (0.081)	0.0057 (0.0098)
LN(PATENTS)*S&PHIGHTECH(=3)	-0.086 (0.26)	-0.049 (0.042)
LN(PATENTS)*S&PHIGHTECH(=4)	-0.37 (0.26)	0.016* (0.0088)
LN(PATENTS)*S&PHIGHTECH(=5)	-0.024 (0.14)	-0.00075 (0.0079)
LN(PATENTS)*S&PHIGHTECH(=6)	-0.23 (0.18)	-0.0050 (0.0091)
LN(PATENTS)*S&PHIGHTECH(=7)	-0.058 (0.072)	-0.0089 (0.020)
PATENTS /ASSETS* S&PHIGHTECH(=0)	0.87 (0.58)	0.0017 (0.0013)
PATENTS /ASSETS* S&PHIGHTECH(=1)	-0.61 (1.31)	-0.036 (0.055)
PATENTS /ASSETS* S&PHIGHTECH(=2)	-0.61 (0.57)	-0.048 (0.051)
PATENTS /ASSETS* S&PHIGHTECH(=3)	-0.84 (2.41)	0.29 (0.41)
PATENTS /ASSETS* S&PHIGHTECH(=4)	2.31*** (0.80)	-0.073 (0.080)
PATENTS /ASSETS* S&PHIGHTECH(=5)	0.19 (0.80)	-0.0059 (0.031)
PATENTS /ASSETS* S&PHIGHTECH(=6)	7.85 (5.42)	-0.11 (0.21)
PATENTS /ASSETS* S&PHIGHTECH(=7)	-2.73 (2.23)	0.065 (0.21)
ROA	-0.033** (0.013)	0.0033** (0.0015)
LAG(ROA)	0.0047 (0.0098)	-0.0028* (0.0015)
ROE	0.014*** (0.0051)	-0.00016 (0.00048)
LAG(ROE)	-0.0045 (0.0041)	0.00046 (0.00054)
DIVIDENDYIELD	-0.0079 (0.019)	0.0048 (0.0053)
TOBINSQ	-0.0061** (0.0031)	0.00033 (0.00053)
TSR	0.0019** (0.00087)	0.000089 (0.00019)
LN(ASSETS)	0.42*** (0.10)	0.061*** (0.017)
MTOB	-0.0022 (0.0021)	0.00090*** (0.00017)
AGE	0.021** (0.0095)	-0.00096 (0.0017)
CEOOWN	0.024 (0.028)	-0.000068 (0.0056)
MALE	-0.48* (0.27)	-0.052 (0.044)
Constant	1.63* (0.86)	5.26*** (0.14)
Adjusted R-squared		0.11
Within R-squared	0.44	
Number of observations	410	2,806

*** , ** and * indicate statistical significance at the one, five and ten percent levels, respectively

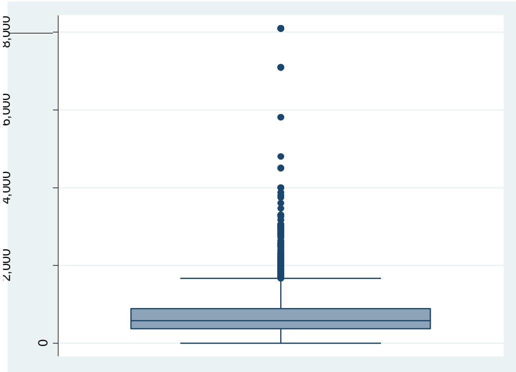
(p < 0.01; p < 0.05; p< 0.1). Robust standard deviations are in parentheses.

APPENDIX X. Robustness check. Hypothesis 9

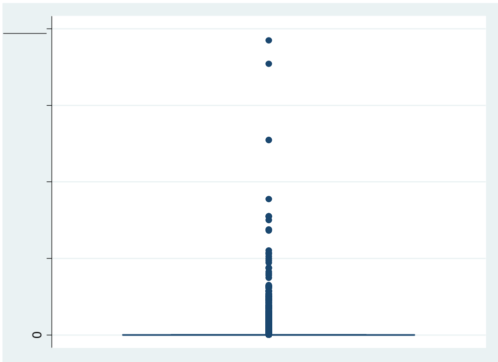
Variables	LN(SHORT)=Bonus	LN(FIXED)=Salary
LAG(SHORT)	0.00010*** (0.000031)	
LAG(FIXED)		0.0011***
MTOB*HIGHTECH	0.0041 (0.038)	0.0028 (0.0029)
LN(PATENTS)	-0.087 (0.063)	-0.0042 (0.0042)
PATENTS/ASSETS	0.024 (0.39)	0.00098 (0.0033)
ROA	-0.036*** (0.013)	0.0033** (0.0015)
LAG(ROA)	0.0029 (0.010)	-0.0027* (0.0015)
ROE	0.014** (0.0057)	-0.00016 (0.00048)
LAG(ROE)	-0.0042 (0.0044)	0.00042 (0.00054)
DIVIDENDYIELD	-0.0079 (0.020)	0.0052 (0.0051)
TOBINSQ	-0.0028 (0.0023)	0.00058 (0.00045)
TSR	0.0019** (0.00085)	0.000089 (0.00019)
LN(ASSETS)	0.37*** (0.088)	0.058*** (0.018)
MTOB	-0.0017 (0.0025)	0.00089 (0.00015)
AGE	0.019* (0.0099)	-0.00099 (0.0017)
CEOOWN	0.026 (0.027)	0.000043 (0.0059)
MALE	-0.41 (0.25)	-0.063 (0.039)
Constant	1.96** (0.77)	5.30*** (0.14)
Adjusted R-squared		0.17
Within R-squared	0.13	
Number of observations	410	2,806

*** , ** and * indicate statistical significance at the one, five and ten percent levels, respectively (p < 0.01; p < 0.05; p< 0.1). Robust standard deviations are in parentheses.

APPENDIX Y. Box plot FIXED



APPENDIX Z. Box plot SHORT



APPENDIX AA. Box plot LONG