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Can Equity Incentives Help Explain the Low Share of Females in Top Management?

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Executive Summary

Despite the increased gender equality in higher education and the growing participation of women in the labor market, the share of female top executives remains low. At the same time, the increased focus on shareholder value creation has resulted in a growth of equity-based compensation. The aim of this thesis is to assess whether there is an association between the use of equity incentives in top management and the low share of female top executives. The study is based on a sample of 13,410 firm-year observations from 1808 US-listed firms in the period 2007 - 2016.

Following previous literature, we use vega and delta to measure equity incentives. Vega measures the sensitivity of an executives' wealth to stock return volatility and delta the sensitivity of an executives' wealth to stock price. Previous research shows that women are inherently more risk averse and less competitive than men and thus prefer "safe" compensation packages that do not rely on performance. Therefore, we expected female top executives to have lower vega and delta than men and shy away from top management of firms that rely strongly on equity incentives to reward their top executives.

We find that female top executives have significantly lower vega and delta compared to males and that a higher management team vega associates with reduced probability of observing a female top executive. We argue that the association between vega and firm risk might explain this association. Our main conclusion is however that each executive's incentives matter more than the average across the top management team. Vega is associated with reduced probability of observing female lower executives, while delta is associated with reduced probability of observing female CEOs. We further show that the level of salary compensation the female executive receives for holding equity risk cannot help explain women's representation in different top executive positions. Moreover, the fact that female CEOs can hold higher delta compared to males without it having a negative impact on firm performance implies that females in the highest top executive positions are not more averse to equity risk than their male counterparts. We discuss the possibility that the female risk aversion observed in the lay population does not apply to female CEOs. However, for women holding other top executive positions delta, is associated with reduced firm performance. This might indicate an aversion to equity risk and that incentivizing female top executives with equity might not be beneficial. We find that the presence of women in top management is negatively associated with the probability of observing an increase in the number of female top executives. We discuss how this might indicate that firms are only willing to employ a limited number of female top executives.

Our results imply that in setting compensation policy, one should consider how the average vega across the management team might make females reluctant to top executive positions. Further, each individual position should be considered by itself when determining delta for top executives.

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Introduction

The increased focus on shareholder value creation has resulted in a growing usage of equity-based incentives. During the 1970s executive compensation consisted primarily of salary and bonuses. Consequently, executives had limited incentive to boost the share price. As the US stock market had experienced a sustained depression beginning in 1965, the use of equity incentives was almost non-existent (Jensen et al., 2004). As managers' wealth was not tied to firm performance, the focus was primarily on size, prestige, and growth. Beginning in the mid-1980s, the pressure for stricter corporate control increased and so did the focus on shareholder value. This resulted in an increase in shares and options as a way to incentivize and compensate top management.

In the same period, women have made considerable advancements in the labor market. In 1970, only 12 percent of executives in private firms in the US were women. In 1991 this number had reached 39 percent. The increased gender equality in higher education can explain some of this change (Altonji and Blank, 1999). However, in recent years the positive growth in female executives have stagnated, despite the continued focus on gender equality in top management (Haveman and Beresford, 2012).

Our motivation for conducting this research is to shed light on possible explanations as to why we observe a gender gap in top management. More specifically we want to investigate the link between top management compensation structures and the low share of female top executives. Despite the increased attention on women in top management there is no consensus in literature on what drives the gender gap among top executives. One of the challenges researchers face is the possibility that men and women differ in personality traits that are difficult to observe and that these traits impact labor market outcomes (Bertrand, 2011).

The purpose of this thesis is to contribute to the existing literature on gender differences in top management and the use of equity incentives as a way to compensate and incentivize executives. In the search for possible explanations for the observed gender gap in top management, psychology and behavioral theory have received increased attention in labor market research. Psychological attributes that have been used to explain gender differences in the labor market are, among others, risk aversion and competitiveness. However, due to the difficulty of observing psychological attributes in field studies, most of these studies have been conducted in controlled environments. There has been limited research able to demonstrate the relevance of the findings from the lab on real labor market outcomes (Bertrand, 2011). Our objective is to test the validity of these findings through empirical evidence. Our aspiration is to inspire and encourage further research to shed light on different perspectives on the gender gap in top management.

Research Question

Based on a review of the literature and our motivational background for conducting this study we have formulated the following research question:

"Can equity incentives help explain the low share of females in top management?"

By narrowing our research to this question, we will attempt to explain the persistent gender gap in top management and how the use of equity incentives relates to this. To be able to provide an answer to our research question we will focus our research on three main topics. First, we will analyze the differences in equity incentives between male and female top executives and assess whether the use of equity incentives is associated with the probability of observing female top executives. Second, we will look further into why equity incentives might explain the share of female executives by looking at how females respond to such incentives and whether they require compensation in the form of "safe" pay to hold equity incentives. Third, we will analyze the impact of having females in top management on the future acceleration of gender equality.

Our thesis is structured into eight main sections. After introducing our problem statement and related background information, we will start off by reviewing the literature related to gender inequality in management. We will first present traditional drivers, such as discrimination, social norms, and human capital accumulation. Further, as psychology has had an increased influence on labor market research, we will review literature related to gender differences in risk aversion and competitiveness, and how these might explain differences in compensation structures between men and women in the labor market. Based on the reviewed literature we will develop four hypotheses that will guide our analysis. The next section will explain our methodological approach and different statistical considerations related to our research. Following this, we will explain our data collection and variable construction. We will put extra emphasis on the calculation of vega and delta, as these will be our primary variables of interest throughout the report. Following, in the descriptive statistics section, we will present the main characteristics of our data. In the analysis section, we will present and interpret the results from our regression analysis and relate our findings to existing research. Further, we will summarize and discuss our findings and explain the related implications, before we lastly will conclude on the entire research.

Delimitations

This thesis is limited to top management compensation structures. This constitutes only a small fraction of the total labor market. However, it is plausible that the issues we discuss relate to lower level employees as well. Especially as the use of equity incentives is increasingly observed in lower levels of the organizational hierarchy as well (Jensen et al., 2004). Our findings might therefore also be helpful when considering compensation structures for other employees. Further, this study is limited to publicly listed firms in the US, more specifically firms on the S&P 1500 index. The reason for this is the relatively easy access to compensation data on these firms through the Compustat and ExecuComp databases. Publicly listed firms in the US are required by the federal securities law to disclose information about the amount and type of compensation paid to top executives within a firm (SEC, 2014). As the S&P 1500 index covers approximately 90 percent of the US market capitalization (S&P Dow Jones Indices, 2018), we believe that we cover a representative selection of US listed firms. Our sample period is limited to the ten-year period from 2007 to 2016. This choice was made to ensure that all reported numbers follow the reporting standards introduced by FAS 123R in 2006.

Central Concepts and Definitions

Throughout our thesis, we will refer to concepts and definitions related to compensation and top executives. For the ease of the reader, the most central definitions will be defined.

Vega

The change in the dollar value of an executive's wealth for a 0.01 change in the annualized standard deviation of stock return (Coles et al., 2006). Wealth refers to the portfolio of stock options granted to the executive by the company. Vega measures an executive's risk-taking incentives.

Delta

The change in the dollar value of an executive's wealth for a one percentage point change in stock price (Coles et al., 2006). Wealth refers to the portfolio of stocks and stock options granted to the executive by the company. Delta measures an executive's pay-performance sensitivity.

Equity Incentives

Equity incentives refers to the level of stocks and stock options granted to the executive. We measure the level of equity incentives through vega and delta.

Compensation Risk

Compensation or earnings risk is defined as compensation structures that rely on factors that are highly variable and hence result in uncertain payments (Jensen et al., 2014). In line with Carter et al. (2017), we use vega and delta as measures of compensation risk.

Top Management/Top Executives

We refer to top management or top executives as the top five to top nine executives in a company. These positions include CEOs, CFOs, COOs and other high ranking executives. The definition of top management is based on each company's own classification and the executives they report in their proxy statement.

Lower Executives

Executives that hold other non-CEO/CFO/COO positions, such as divisional executives.

Background Information

This study will complement the wide field of research within corporate governance. Corporate governance covers the mechanisms and processes that are used to govern and monitor the relationship between shareholders and managers. Shleifer and Vishny (1997) describe corporate governance as “the ways in which suppliers of finance to corporations assure themselves of getting a return on their investment”.

The separation of ownership and control in the modern corporation requires mechanisms that can be used to govern the relationship between owners and executives. Executives might have other objectives that are not aligned with the wealth maximization objective of shareholders. The costs that follow from the separation of ownership and control is referred to as agency costs. Governance mechanisms are used to reduce agency costs by aligning the interest of shareholders and executives.

In their well-acknowledged book, *The Modern Corporation and Private Property,* Berle and Means (1932) shed light on the issues that follow from the separation of ownership and control; managers can use the resources of a company to pursue their own interests. For owners, this means a possible loss in economic rents. Jensen and Meckling (1976) refer to this cost as agency cost and argue that the principal (owner) can limit these costs by “establishing appropriate incentives for the agent”.

This perspective on agency costs has been widely discussed in the pay-performance literature. Among others by Jensen et al. (2004). They argue that the most efficient governance mechanism is the use of compensation, of which they define the purpose as “attracting, retaining and motivating executives”. In top management teams, compensation often consists of equity-based incentives. As top executives often can impact stock prices, this has shown to be an effective way of aligning the interests of shareholders and executives.

The use of equity incentives in top management has been studied from different angles in the literature. One major concern often discussed is how to balance the slope that determines the relation between executives' wealth and stock price, with the convexity of a managers' equity portfolio, i.e., the non-linearity of the pay-performance relationship (Guay, 1999). The slope refers to the sensitivity of a manager's wealth to changes in stock price while the convexity refers to the sensitivity of a manager's wealth to stock price volatility.

Guay (1999) was the first to quantify how stock return volatility impacts the value of a manager's equity portfolio. He argues that it is the convexity of stock options that generate the sensitivity of a manager's wealth to equity risk. He finds that the volatility in stock return is positively related to a manager's compensation convexity. This has in literature been referred to as vega. The slope between an executive's wealth and stock price is referred to as delta.

Delta ties a manager's wealth to firm performance and will therefore motivate managers to increase the stock price. However, as high values of delta often are associated with manager's risk aversion, Guay (1999) argues that in combination with delta, the convexity of the pay-performance relation (vega) is necessary to provide managers with the optimal level of incentives. Including vega in a manager's compensation structure is related to increased risk-taking by managers, such as higher leverage and investments in R&D (Gormley et al., 2013).

For this study we will look at the attracting purpose of compensation and assess whether compensation practices used in publicly listed companies work to attract female top executives. Further, we will look at the motivating purpose of compensation and examine if female and male top executives respond differently to the compensation practices used.

As a stream of literature before us, we will use vega and delta as measures of equity compensation. An advantage of using delta and vega as equity compensation measures, compared to, e.g., ownership share or the number of options held, is that these measures capture the effect of different characteristics of equity incentives. The convexity of an executive's wealth-performance relation varies extensively with the measures that underlie the equity instruments, for example an option's exercise price and time-to-maturity (Guay, 1999).

Consistent with previous research (Carter et al., 2017) we will use vega and delta to measure compensation risk. Stocks and option-based remuneration are volatile and place an undiversifiable risk on the executive (Jensen et al., 2004). A consequence of this might be that the attracting and motivating purpose of compensation does not work optimally, in particular for risk averse agents.

As shares and options often are used to incentivize managers, it is relevant to assess the impacts that this has on top management teams. The use of equity-based compensation in the US has increased over the past 30 years (Gormley et al., 2013), while the share of females in management has stagnated in recent years. This is despite women's increased participation in the labor market (Haveman and Beresford, 2012). Whether the risk associated with management compensation can help explain this relation, is an issue that has gotten limited attention among scholars. Previous studies on the relation between gender and compensation risk are often experimental studies (Gneezy et al., 2003; Gupta et al., 2005; Niederle and Vesterlund, 2007; Flory et al., 2015). This study will, therefore, contribute to existing literature by examining the implications of compensation risk on the gender gap in top management using empirical data.

Methodology

Research Approach

This study is based on a deductive research approach, which implies that we will use previous research to develop theories on what we expect to observe. These theories will then be tested through the collection and analysis of data. The purpose of the analysis will be to either confirm our hypothesis and existing theory, or based on our findings modify existing theories (Saunders et al., 2009). Due to the significant amount of research that exists within the field of compensation and females in management, and due to the nature of our data, the deductive approach is well suited for our research.

Statistical Methodology

To estimate the different models in our study, we will use pooled OLS models, linear probability models, and fixed effect models. The following section will describe the intuition behind the different models and possible drawbacks of each.

Pooled OLS Model

When estimating models on panel data by ordinary least squares, a pooled OLS model is used. Applying a pooled OLS estimation to panel data, will pool the observations across time and across sectional units. A pooled OLS model will not take into account the unobserved individual characteristics, and the estimates might, therefore, be biased (Wooldridge, 2012). Due to the longitudinal nature of our data, we will include year dummies in all OLS models estimated to control for possible time effects. We also include 1-digit SIC-code dummies to control for industry.

Linear Probability Model

For regressions with a binary dependent variable, we use the linear probability model and estimate the coefficients using pooled OLS. The OLS estimates are interpreted as the change in the probability of the independent variable being 1 when the explanatory variable changes, holding all other explanatory variables constant. The advantage of using the linear probability model compared to a logit or probit regression is that the model can be estimated using OLS and that the coefficients are easy to interpret. The linear probability model provides reasonable estimates when there are not too many extreme values. In our research, both vega and delta have outliers that possibly could cause the model to estimate probabilities outside the range of 0 to 1. As will be discussed later, outliers of vega and delta will be dealt with through winsorizing. Furthermore, the residuals of the linear probability model are always heteroscedastic (Stock and Watson, 2012) and the assumption of homoscedasticity is also violated if the errors are serially correlated. Because of this, HAC standard errors will be applied when estimating the models.

Goodness of Fit

To measure the goodness of fit of our linear probability models, we calculate the percentage correctly predicted. The usual prediction threshold is 0.5, meaning that predicted probabilities higher than 0.5 are set to 1, and 0 otherwise. This threshold is used for regressions where the dependent variable is the probability of observing a female in top management (*Table 5* and *Table 6*). The threshold of 0.5 has been criticized, especially when one outcome is very unlikely (Wooldridge, 2012). For example, if the share of female CEOs is particularly low, we could end up never predicting y = 1, because the estimated probability of observing a female CEO is never higher than 0.5. This is the case for the regressions where we estimate the probability of observing a female CEO/CFO/etc. (*Table 7, 8)* and for the regressions where we estimate the probability of observing a positive change in the number of female top executives (*Table 11 and 12*). The percentage of female executives is below 11 percent for all executive positions, while we observe a positive change in 15 percent of the observations. Consequently, we follow Wooldridge (2012) and set the threshold to the percentage of females in the sample or the percentage of observations with a positive change. The goodness of fit of each linear probability model are reported in their respective tables.

Unobserved Heterogeneity in Panel Data

The pooled OLS and the linear probability model estimated by pooled OLS does not take into consideration the unobserved heterogeneity between firms (Wooldridge, 2012). The advantage of using panel data is that one can control for the unobserved effects that differ between firms, but remain constant over time. To be able to control for unobserved heterogeneity, one can use panel data models, such as random or fixed effects.

The random effects model assumes that there is no correlation between the unobserved individual variables and the explanatory variables included in the model (Wooldridge, 2002). The unobserved heterogeneity can be treated as a random effect when the variable is completely random in contrast to fixed effect where the unobserved heterogeneity is treated as a variable to be estimated for each individual (firm) (Wooldridge, 2002).

To test if our models are better to run as random effects or fixed effects we run a Hausman test (see appendix 1). The null hypothesis is that the unique errors are uncorrelated with the explanatory variables. With a p-value approximately equal to zero for all regressions we can reject the null of no correlation. Hence, the Hausman test suggests fixed effects as a better option than random effects for our regressions.

To check whether we should use time fixed effects and/or individual fixed effects we run a pFtest in R (see appendix 2). The test compares the pooled model with the within model when using time fixed effect, individual effects or both. The null hypothesis is that there is no individual/time fixed effect. Based on the low p-value we can reject the null of no individual effects and no time effects. The results indicate that we should include both year fixed effect and firm fixed effect in our models.

Fixed Effect Regression

When using the linear probability model, we implicitly assume that there is no unobserved heterogeneity in the data. As this is a fairly restrictive assumption and as the Hausman test and pFtest suggests that we should control for both year and firm fixed effects, we estimate fixed effects models as a robustness check.

When using panel data, fixed effects regression allows one to control for omitted variables bias caused by unobserved variables that differ across entities, but are constant over time (Stock and Watson, 2012). Fixed effects regression uses a transformation to remove the unobserved effect. Explanatory variables that are time-constant are also removed. Consequently, we estimate the model without including dummies for industry. The logic behind fixed effects regression is that a variable that is constant from period to period will not cause any change in the dependent variable. Consequently, observed changes must be determined by other sources.

The fixed effect transformation or the within-transformation subtracts the average of each variable within a firm from each firm observation, this is illustrated in the equation below. Thus, the fixed effect model requires time variation in X and Y within each cross-sectional observation. If not, the X and Y will be zero. A pooled OLS model is run on the time-demeaned data to estimate our models. As the within-variation in some of our variables are relatively small, these variables will provide limited information in the fixed effect estimation.

For the fixed effect models with a continuous dependent variable, the R-squared will be used to measure the goodness of fit. The R-squared is interpreted as the time variation in Y that can be explained by the time variation in the explanatory variables (Wooldridge, 2012).

$$y_{it} - \bar{y}_i = \beta_1(x_{it} - \bar{x}_i) + u_{it} - \bar{u}_i, \quad t = 1, 2, \ldots, T,$$

Wooldridge (2012)

Similar to previous research (Coles et al., 2006; Carter et al., 2017), we include firm fixed effects in our model to control for time-invariant unobservable firm characteristics that might affect the presence of females in top management. Examples of such characteristics could be company culture or firm structure that can be viewed as being approximately constant over the time period studied (Wooldridge, 2002). Additionally, we also include year fixed effects to control for omitted variables that differ from year to year but are constant across entities. Such variables could be changes in gender norms on a national level or changes in the share of female graduates.

Probit Model

As the linear probability model does not allow for nonlinear effects of X on Y, the probability will exceed 1 or go below 0 for high or low values of the explanatory variables (Stock and Watson, 2012). Due to this limitation of the linear probability model, probit models could be estimated as a robustness check. Probit regressions are estimated by the maximum likelihood method and uses the standard normal cumulative distribution function. However, a limitation of the probit model is that under heteroscedasticity the estimates will be inconsistent, even though we cluster the standard errors. Contrary to the probit model, linear models make it possible to estimate consistent parameters in spite of heteroscedasticity in the error term

(Wooldridge, 2012). Because of this, the researchers have chosen not to estimate probit models for this research.

Statistical Considerations

As panel data includes both cross-sectional and time series observations, special considerations related to the error term need to be adjusted for. Additionally, the effect of outliers and possible multicollinearity between the explanatory variables needs to be considered.

Heteroscedasticity

One of the assumptions related to the error term in our models is that the variance is homoscedastic or in other words, constant. If the variance of the error term depends on the value of our explanatory variables the variance is said to be heteroskedastic. This implies that our standard errors, and hence t and F statistics, are invalid if we do not correct for the non-constant variance (Wooldridge, 2012). As it is unlikely that for example, the variance in ROA or salary is constant at all values of size, risk or gender, we will assume heteroscedasticity and consequently correct for this.

Autocorrelation

Autocorrelation in the error term defines a situation where the regression errors are correlated over time within an entity (Stock and Watson, 2010). Autocorrelation in the error term affects the variance of the estimated coefficients and hence the computation of standard errors. If the unobserved variables that affect the probability of observing a female top manager in one period is correlated with the unobserved variables in subsequent periods, our errors are serially correlated. As this is common when using longitudinal data, we will also correct for this.

Clustered Standard Errors

When the regression errors are heteroskedastic, and the errors are correlated over time, we need to use standard errors that are robust to both situations. To adjust for autocorrelation and heteroscedasticity, we use HAC standard errors when estimating all the models. We cluster the standard errors at the firm level. This allows for the standard errors to be serially correlated and have varying variance within the same firm (cluster) but assumes that the residuals are not correlated across different firms (Stock and Watson, 2012).

Outliers

One of the assumptions when estimating ordinary least squares models is that large outliers are unlikely (Stock and Watson, 2012). OLS estimation is sensitive to extreme outliers, and as a consequence, the estimated coefficients might be misleading (Stock and Watson, 2012). To deal with outliers, we have winsorized the variables when necessary. This will be explained further in the variable construction section.

Multicollinearity

One of the least squares assumptions is no perfect multicollinearity between the explanatory variables (Stock and Watson, 2012). This implies that none of the variables are a perfect linear combination of some of the other variables. Perfect multicollinearity between the explanatory variables will prevent estimation of the model. In contrast, imperfect multicollinearity might result in imprecise estimates of some coefficients. To ensure that our models do not suffer from multicollinearity we assess the variance inflation factor (VIF). The VIF might give indications as to how much each explanatory variable included in the model is affected by multicollinearity and can be interpreted as how much the variance of the estimated coefficient is "inflated" due to multicollinearity.

Appendix 3 gives the VIF for each explanatory variable in our models. Following Wooldridge (2012) we flag VIF values larger than 10. As none of our variables are affected by multicollinearity, we will leave all variables in the models.

Endogeneity

The assumption of endogeneity applies to both the OLS and fixed effect models. For the models estimated by OLS, endogeneity implies that there is no correlation between the error term and the explanatory variables. For the fixed effect model, the assumption implies no correlation between the explanatory variables and the remaining error after we have controlled for the time-invariant heterogeneity. Violation of the endogeneity assumption results in biased estimates (Wooldridge, 2012).

As corporate governance research often suffer from endogeneity one cannot claim causality, but only associations between variables. Endogeneity in corporate governance research might arise due to omitted variables, simultaneity, or the fact that past values of our outcome variable impact future values of our explanatory variables. There are several different techniques one can use to limit the consequences of endogeneity, some of which we will discuss in suggestions for further research.

Literature Review

A well-known trait of top management across firms and industries is the underrepresentation of women. Based on the sample we collected from the ExecuComp database, we see that in 2007 women accounted for 7.26 percent of top executives in S&P 1500 firms. This number has increased somewhat up until 2014 but has decreased in 2015 and 2016. At the end of our sample years, the share of women in our sample was 6.42 percent. Even though women have increased their representation in top executive positions as compared to their share of 1.92 percent in 1992 (Bertrand and Hallock, 2001), their share remains low.

For the purpose of this thesis, previous literature has been reviewed in order to find an explanation for the gender gap in top management. The reasons traditionally discussed in the literature for the low share of female top executives are discrimination and social norms on the demand side and gender differences in human capital accumulation on the supply side. Literature shows that these factors are still relevant, but perhaps not as much as before. Therefore, we have looked into other causes of the gender gap that are more related to psychological attributes, such as risk aversion and competitiveness. These are factors that will influence how people respond to different compensation and incentive schemes, and consequently how attractive certain positions are to men and women. As literature suggests that female risk aversion and competitiveness are associated with preferences for compensation structure, we will further review the literature related to compensation practices in management. Building on this literature, we propose that the low share of females in top management might be, in part, explained by the structure of executive pay. However, the traditional explanations and why they no longer might be of importance will be discussed first.

Discrimination

Merton (1972) defines discrimination as the treatment of a functionally irrelevant status (such as gender or race) as relevant for the distribution of a reward or penalty. There is no doubt that gender discrimination does happen in workplaces across the world. Nonetheless, it is hard to prove the existence and the extent of gender-based discrimination, particularly because it may happen in many different and very subtle ways. Thus, it is difficult to say how much of the gender gap in top management can be attributed to discrimination. Nevertheless, previous research has in different ways and to different extents managed to find evidence of gender discrimination (Neumark et al., 1996; Goldin and Rouse, 2000; Roth, 2004). Neumark et al. (1996) found gender discrimination in restaurant hiring by conducting an audit study where all aspects of the applicants were the same except gender. More evidence of gender discrimination in hiring was found in a study by Goldin and Rouse (2000). They looked at what effect the introduction of blind auditions had for female musicians. These studies have thus been able to disentangle the relevance of gender from other individual characteristics and show how it, in turn, defines the hiring for executive positions.

Several attempts at explaining the prevalence of gender discrimination have been made. Some researchers argue that gender ideology and in particular stereotypes is one of the primary causes of gender discrimination (Gorman, 2005; Ridgeway and England, 2007). According to Fiske (1998) stereotypes about gender are socially constructed and describe how men and women typically are known and expected to behave. Because stereotypes can alter your view of someone, this will likely affect employers' decisions in the hiring process. Gorman (2005) tested this by looking at data from large US law firms in the mid-1990s. Her findings show that, when the selection criterias are dominated by stereotypically male characteristics, women constitute a smaller share of new hires. However, when the selection criterias for the most part are stereotypically female characteristics, women are better represented among those hired.

Another explanation for the persistence of gender discrimination is the gender composition of the workplace. Gorman (2005) find that the gender of the decision maker matter for the gender of the individual hired. Firms with female hiring partners hired a larger share of women. Furthermore, they found that, when hiring for entry-level positions, female partners were more likely to hire a woman than a man if women were a minority among the company's leaders. This effect diminished as the proportion of women in top management increased. Overall, they found that, in hiring, employers tend to favor candidates of their own gender. If this propensity to hire someone of your own gender is also found outside law firms, this can help explain the low share of women in top executive positions, as the top management of companies generally are male-dominated (Bertrand and Hallock, 2001).

Roth (2004) also argue that the gender composition of the workplace matter, but somewhat suggests a different mechanism related to networking and co-worker support. She conducted in-depth interviews with MBA graduates who began their careers in major Wall Street securities firm. She found that both subtle and obvious discrimination led to 11 of the 44 women finding different jobs or leaving the industry. Furthermore, some of the women stated that, because the majority of the managers, co-workers, and clients were men who often preferred to associate with other men, it was difficult for them to succeed in areas that were dominated by men. This proves that gender composition does matter for discrimination and women's role in the labor market.

Further studies on the impact of gender composition of a workplace also suggest that the presence of females in a firm associates positively with the hiring of new females. Cohen and Broschak (2013) revealed a positive association between new management positions filled by women and the proportion of existing female managers in a firm. Similarly, Huffman et al. (2010) showed that in organizations with a higher share of female managers, gender integration is better at all levels compared to organizations with a lower percentage of female managers. McGinn and Milkman (2013) revealed that a higher share of female employees in an organization positively affects women's probability of being hired and promoted. Similarly, Elvira and Cohen (2001) found that a higher proportion of females in executive positions decreased the likelihood that women at the same organizational level left the firm. These results indicate that a higher proportion of female executives might accelerate gender equality in top management.

Overall, the literature provides evidence that part of the gender gap in top management can be attributed to gender discrimination. However, as discrimination is not quantifiable, it is difficult to measure how much of the gender gap can be attributed to that. Thus, it is difficult to say whether the increase in female top executives observed up until 2014 is related to a reduction in gender discrimination. Thus far, we did not identify any study linking the increased share of women in top management to changes in discriminatory behavior and practices in corporations.

Social Norms

Social norms influence what is deemed appropriate for males and females (Bertrand, 2011). Related to social norms is the concept of identity. Akerlof and Kranton (2000) describe identity as one's sense of self and sense of belonging in social groups. Social norms define the expectations of behavior that follows when an individual is part of a particular social category. They further argue that an individual's utility is affected by how his or her behavior aligns with these expectations. Males and females belong to their own social categories and, with this, certain expectations about behavior will follow. Being a woman has traditionally been associated with roles involving care-taking, housekeeping and childbearing. If women's utility decreases, when they deviate from these activities, it might explain why there is a gender gap in top management (Bertrand, 2011).

The findings of research on changes in social norms and gender roles are somewhat divided. Fortin (2005, 2015) find that social norms have not changed notably, whereas a study conducted by Families and Work Institute (2011) find a decrease in people who hold conservative views on gender roles. Fortin (2005) find that social norms related to females as "homemakers" are persistent over the 10-year period from 1990 to 1999. This expectation of women has a significant impact on their positions in the labor market. In a later study, Fortin (2015) attempts to explain this persistence by looking at the US labor market. She argues that some of the explanation as to why we still see a gender gap, despite women's increased participation in higher education, was a reversal of the gender role expectations in the mid-1990s. Up until then gender norms had become less and less conservative, and women had steadily been increasing their participation in the corporate world. However, in mid-1990s, the trend reversed. Fortin (2015) argue that the HIV crisis can be associated with a shift towards more conservative social norms and gender roles as the fear of AIDS made the lifestyle of the single career women less attractive. These findings support the fact that social norms related to gender roles affect women's position in the labor market. On the contrary, the Families and Work Institute (2011) find that the perception of women has changed. The percentage of respondents believing that women should take care of children while the men earn the money, dropped by 25 percentage points from 1977 to 2008. Despite this development, they still find that two in five employees still hold conservative opinions about gender roles.

Regardless of the contradicting findings above, it is plausible to believe that women are underrepresented in workplaces where employees hold conservative gender norms. Experimental studies have shown that behavior that deviates from gender norms will harm women's outcome in the labor market (Rudman, 1998; Bowles et al., 2007). Rudman (1998) argue that social norms related to self-promotion have affected women's outcome in the labor market. As a tool to manage impression, self-promotion is positively associated with promotions and hiring decisions. However, if a female promotes herself, it might violate gender expectations to act modestly. In Rudman's (1998) experimental study, the effect of this social norm is tested through different interview situations. The results revealed that women are negatively affected when acting in a self-promoting way. They were perceived as lacking social competence which further decreased their hireability. Bowles et al.'s (2007) study conclude along the same lines; they find that women who initiate negotiations in an interview setting are more strongly penalized than men who do the same. Females who initiate negotiations are less likely to be hired. As self-promotion is positively associated with the interviewer's perception of the candidate and how well the candidate fits the job (Kristof-Brown et al., 2002), women might be disadvantaged vis-a-vis men in an interview setting if they are penalized for self-promotion.

Human Capital Accumulation

Productivity differences related to human capital accumulation has traditionally been one of the leading supply-side explanations for gender differences in the labor market (Azmat and Petrongolo, 2014). Altonji and Blank (1999) point at differences in education and accumulated experience as traditional drivers of women's role in the corporate world.

In his 1981 paper, Polachek looked at how differences in human capital investments between genders affected outcomes in the labor market. His results show how women's lifetime labor market participation and occupational choice are related to each other. More home-time will negatively impact women's accumulated experience and decrease their probability of entering managerial and professional occupations. Newer research indicates that the negative effect of women's home-time, e.g., in relation to maternity leave, has decreased (Blau and Winkler, 2017). Additionally, women's continuity of employment has improved; in the US the share of full-time employed women working year-round has increased from 41 percent to 61 percent in the period from 1970 to 2013 (U.S. Bureau of Labor Statistics, 2015). However, the gender gap in accumulated experience is still present and might, therefore, help explain the gender gap in top management (Blau and Winkler, 2017).

Altonji and Blank (1999) argue that there is no longer any gender difference in the level of education and that the gender difference in area of study also has declined sharply. This suggests that education alone does not play an important role in explaining gender differences in the labor market anymore. Women graduating with bachelor and master degrees have increased considerably over the last decades. In 2008-09 women earned 60 percent of master degrees as opposed to 40 percent in 1970-71 (Haveman and Beresford, 2012). Up until the mid-1990s, women have increased their share in management, indicating that the closing gender gap in education has played an important role in attaining gender equality in management. Despite this remarkable change, women's share in management has decreased in recent years (Haveman and Beresford, 2012).

New Explanations for the Gender Gap

As mentioned previously, the share of female top executives increased from 1992 to 2014. This trend could, in part, be explained by a convergence in human capital accumulation between men and women (Altonji and Blank, 1999; Blau and Winkler, 2017) as well as changing gender norms (Families and Work Institute, 2011). As mentioned above, the development in gender equality in top management has tempered in recent years (Haveman and Beresford, 2012; OECD, 2017). This reversal in the trend might indicate that there are other factors that contribute to the persistent gender gap in top management.

In more recent years there has been a growing influence of psychology and behavioral theory on labor market research. This has resulted in an increased focus on psychological factors and differences in preferences when explaining the gender gap in management (Bertrand, 2011; Azmat and Petrongolo, 2014). In particular, gender differences in risk aversion and competitiveness are recurring themes in the literature. These factors can also be relevant in explaining the low representation of women in top executive positions. Management positions are associated with high competitiveness and risk, among others, due to higher reliance on performance pay (Lemieux et al., 2009). Top executive positions are also those with the lowest share of females (Haveman and Beresford, 2012). Thus, women's perception of competitive situations and risk might be particularly relevant in explaining the low representation of women in the upper echelons of firms.

Risk Aversion and Competitiveness

Previous research has demonstrated that women and men differ related to several psychological attributes. Research within this field has received considerable attention, and the number of existing studies is therefore extensive. Personality traits that are recurring in these studies are, among others, risk aversion and competitiveness.

Experimental studies that use samples of both men and women often find that women are significantly more risk averse than men (Eckel and Grossmann, 2002; Niederle and Yestrumskas, 2008; Dohmen et al., 2011). Eckel and Grossman (2002) use the variance in possible payoffs from different gambles as a measure of risk. They find that women are consistently more risk averse than men in their gamble choices and for the most part prefer the risk-free gambles. Niederle and Yestrumskas (2008) also find a significant gender difference in risk aversion. Their experimental study shows that the implication of this is that women seek less challenging tasks than men, despite having the same abilities and beliefs about their own abilities.

The observed gender gap in risk aversion differs across domains (Johnson and Powell, 1994; Croson and Gneezy, 2009; Dohmen et al., 2011; Graham et al., 2013). Dohmen et al. (2011) show that women tend to be more risk averse with regards to driving, career choices and financial matters. The gender gap in risk aversion is, however, smallest in the career domain.

In addition to females being more risk averse, literature on the topic of competitiveness finds that men are more competitive than women (Gneezy and Rustichini, 2004; Gupta et al., 2005; Niederle and Vesterlund, 2007; Buser et al., 2014; Flory et al., 2015). Additionally, some studies also find that the performance of men improves in competitive environments, while the performance of women remains the same (Gneezy et al., 2003; Gneezy and Rustichini, 2004; Gupta et al., 2005).

Buser et al. (2014) find that competitiveness can help explain secondary school students choices of study profiles. They find that boys are more likely to choose the most prestigious study profiles and that this, in part, is due to boys' higher competitiveness and confidence. Competitiveness is measured by whether the candidates choose a tournament based incentive scheme.

Risk and Competitiveness in Top Executive Positions

The observed gender difference in risk aversion and competitiveness might be relevant when explaining the representation of females in top management, as top executive positions often are associated with higher risk and competition.

Compensation in top management usually consists of a larger share of variable pay as opposed to lower level management (Lemieux et al., 2009). The variable pay is made up of stocks, options and, bonuses used to incentivize executives and align their interests with shareholders. A company's stock price and stock return volatility might reflect how well the company is performing, but can just as well reflect general trends in the market that are outside the executive`s control. Thus, Bertrand and Mullainathan (2001) argue that CEOs often are paid for luck. Therefore, taking on a role as an executive will entail a considerable amount of risk as the level of your compensation will partly be dependent upon factors that are outside your control. Furthermore, studies have shown that the turnover in top management often is highly linked to firm performance (Fee and Hadlock, 2004). Hence, risk averse agents might find top management positions risky because they are held accountable for firm performance and thus risk being laid off in times of poor firm performance.

When discussing the impacts of different compensation systems, literature identifies competitiveness as another relevant psychological factor. Many high-profile top executive positions take place in highly competitive environments (Bertrand, 2011). One factor that has proved to increase the perceived competitiveness of these environments is the structure of executive compensation. Manning and Saidi (2010) argue that all performance-related pay schemes create competitive work environments. They claim that as people do not work in isolation, differences in pay that might occur under performance-related schemes will typically be quite visible, and "winners" and "losers" will emerge. Furthermore, some researchers argue that gender differences in compensation choices are due to gender differences in competitiveness (Niederle and Vesterlund, 2007).

The Link Between Risk Aversion, Competitiveness and the Gender Gap in Top Management

Several studies have investigated the impact gender differences in risk aversion and competitiveness have on labor market outcomes. Studies using field data show a positive association between individual's risk attitudes and their corresponding compensation risk (Bonin et al., 2007; Grund and Sliwka, 2010; Bandiera et al., 2011; Graham et al., 2013; Carter et al., 2017). In their representative selection of the German population, Bonin et al. (2007) reveal a highly significant and positive correlation between occupational risk, as measured by earnings variation, and willingness to take on risk. This indicates that more risk averse individuals are drawn to occupations where earnings variation is lower. Grund and Sliwka

(2010) also find, in the same selection of the German population, that individual risk aversion has a negative effect on the probability that the individual's wage depends on performance. Similarly, using a sample of 600 Italian top executives, Bandiera et al. (2011) show that risk averse top managers are employed in firms offering low-powered incentives and that risk-tolerant executives are drawn to firms where compensation are more closely tied to performance.

Experimental studies further support this relation between risk aversion and earnings risk. Gupta et al. (2005), for example, find that while men are not affected by risk in their choice of compensation scheme, women who choose the least risky scheme (piece-rate) are significantly more risk averse than those who choose the riskiest compensation scheme (tournament scheme). They conclude that women are driven by risk aversion in their compensation choices and therefore choose low-risk schemes.

If women are more risk averse, one can expect that empirical studies will show that women will have lower earnings variation and less performance pay. Studies show that women are less represented in jobs with performance pay. Both Grund and Sliwka (2010) and Manning and Saidi (2010) find that women are less likely to have jobs where their compensation is tied to performance. Similarly, Flory et al. (2015) find that women are less likely to apply for jobs with variable pay and that this gender gap increases as compensation becomes more dependent on performance. Graham et al. (2013) find that more risk averse CEOs and female CEOs are both less likely to accept performance-based compensation packages with a greater share of stocks, options, and bonuses. Carter et al. (2017) show that female executives, on average, are more averse towards compensation risk and consequently hold lower equity incentives. Further, the study finds that female top executives require higher salary premium for bearing compensation risk compared to male top executives. Female executive's aversion to holding compensation risk might be due to them being more risk averse than their male counterparts.

Previous studies have also demonstrated that gender differences in competitiveness have implications in the labor market. Literature has found that women have a stronger aversion to competitive workplaces than men (Flory et al., 2015). Further, the perceived competitiveness of a situation has shown to negatively impact female performance (Gneezy et al., 2003; Gneezy and Rustichini, 2004; Gupta et al., 2005).

Flory et al. (2015) find that women are less likely than men to apply for jobs in which compensation is not fixed. They use real-world data to test whether men and women respond differently to employment contracts characterized by competition and uncertainty. The more the compensation schemes rely on individual performance, the more significantly dominant the proportion of men among applicants becomes. They find that the gap between men and women is not due to men being more attracted to competition than women, but rather women showing a significantly stronger aversion to competitive workplaces than men.

Several laboratory experiments investigate the consequences of gender differences in competitiveness (Niederle and Vesterlund, 2007; Gneezy et al., 2003). In these experiments, researchers usually ask the subjects to perform a relatively simple task, both under a piece rate compensation scheme and a competitive winner-takes-all compensation scheme. Experiments like this try to replicate a real-world situation where one, for example, have to choose between a high-risk, but potentially high paid job and a low-risk job where pay is fixed, but lower. The difference between these studies and the studies discussed under risk aversion is that the researchers argue that gender differences in competitiveness are the primary reason as to why we see gender differences in compensation choices.

Niederle and Vesterlund (2007) find that gender differences in competitiveness impact preferences for certain compensation schemes. They find that the gender differences related to aversion to risky payment schemes are driven primarily by men’s overconfidence and competitiveness, while female risk aversion only plays a minor role. Gneezy et al. (2003) support this conclusion, thereby suggesting that it is not risk aversion but differences in competitiveness and confidence that explain the gender differences in individuals’ preferences towards risky performance-related pay. Gupta et al. (2005) obtain similar results with their experimental study; they find that substantially more men than women choose the tournament compensation scheme. While risk aversion plays a role in women’s decision to compete, it is does not play a role in men’s decision. The researchers argue that social norms and external factors influence men’s higher propensity to compete.

Previous studies indicate that the gender difference in competitiveness discussed above is not constant. Some studies suggests that the gender composition of a group might impact male and female propensity to compete (Gneezy et al., 2003; Gneezy and Rustichini, 2004; Gupta et al., 2005; Antonovics et al., 2009) as well as their performance in competitive environments

(Gneezy et al., 2003; Gupta et al., 2005). Gneezy et al. (2003) find that under a competitive incentive scheme, men perform better than females. They further find that the performance of women increases when in an all-female group as compared to a mixed gender group. Suggesting that men and women have different beliefs about their relative abilities compared to their fellow participants and that this influences their willingness to compete. The findings of Gupta et al. (2005) support this. They find that men are more likely to compete in the tournament when matched with a man than with a woman. They further find that the performance of men increased with the tournament scheme while the performance of women remained the same.

Assessment of Studies

Based on the reviewed literature it is reasonable to believe that risk aversion plays a crucial role in agency theory, however, risk aversion is not directly observable. This makes it difficult to assess whether risk aversion has an impact on gender differences in preferences towards type of compensation structure. The studies discussed above either use survey questions (Bonin et al., 2007; Grund and Sliwka, 2010; Dohmen et al., 2011; Graham et al., 2013), variance in payoffs associated with gamble choices (Eckel and Grossman, 2002) or type of betting decision (Johnson and Powell, 1994), to measure degree of risk aversion among participants. It is impossible to know if subjects' behavior in real life is in line with what they reply in surveys or choose in hypothetical gambles and betting situations, consequently, these measures of risk aversion might be ambiguous.

Another limitation is that risk aversion often is studied as part of an experimental research. A possible difference between a real-world situation and these experimental studies is the payoff at stake. In a laboratory experiment where the researchers are able to manipulate the payoffs and the probabilities, the situation might be unrealistic compared to a real-world situation. It has been found that the gender differences in risk aversion do not apply under high payoff situations (Holt and Laury, 2002). This is due to men's risk seeking behavior disappearing when they face a higher payoff at stake. This result might imply that the level of risk aversion among males and females do not differ in real-world situations where the stakes are higher, and consequences often are more severe.

The studies by Gneezy et al. (2003), Gupta et al. (2005) and Niederle and Vesterlund (2007) are based on university students and not actual managers. The studies by Bonin et al. (2007), Grund and Sliwka (2010) and Manning and Saidi (2010) are based on employees but do not provide any information about the managerial level of the subjects. Flory et al. (2015) also study employees, but only candidates applying for lower-level positions, and not those applying for top management jobs. Employees at different levels in an organization might differ in terms of their risk aversion. Thus, these findings might not apply to top executives. In fact, it has previously been suggested that top executives differ from the general population in particular traits. For example, it has been argued that the gender difference in risk aversion that are observed in the general population might not transfer to top executives (Johnson and Powell, 1994; Croson and Gneezy, 2009; Adams and Funk, 2011; Graham et al., 2013).

Thus, based on existing studies, one cannot conclude that female risk aversion can help explain the lower representation of women in top management. We could identify only three studies (Graham et al., 2013; Baixauli-Soler et al., 2015; Carter et al., 2017) that investigate the gender differences in compensation in top management.

As discussed in relation to risk aversion, competitiveness is also a psychological factor that is difficult to directly observe. The studies reviewed measure competitiveness using likelihood of tournament entry (Gupta et al., 2005; Niederle and Vesterlund, 2007; Buser et al., 2014), difference in performance in competitive environments (Gneezy and Rustichini, 2004), and propensity to apply for positions with higher degree of relative performance evaluations (Flory et al., 2010). As there is no accurate measure of competitiveness, the researchers' interpretation of competitiveness might vary and so can the results.

Another drawback of the studies on competitiveness is that they define a piece-rate compensation scheme as a low-risk and non-competitive incentive scheme (Gneezy et al., 2003). Manning and Saidi (2010) define a competitive incentive scheme as one that is based on performance pay. This includes both piece-rate incentive schemes where individuals are paid relative to an objective measure of individual output or pay determined by relative performance. One can argue that a non-competitive compensation scheme would be one were compensation is fixed. In a piece-rate system, one gets compensated based on the number of tasks one manages to solve, and thus it will depend on performance. Because the literature reviewed, for the most part, use these two compensation schemes to measure competitiveness and risk aversion, the results should be interpreted carefully. An alternative way to more accurately measure competitiveness and risk aversion would be to include one option where compensation is fixed and therefore not dependent on performance.

Concluding that men are more competitive than women may be a too simple conclusion. One should look at the underlying reasons behind men's higher propensity to compete. The literature does this to some extent, but perhaps not sufficiently. Niederle and Vesterlund (2007) state that both overconfidence and men's higher willingness to compete are the main explanations of the gender gap in top management. However, these results must be interpreted with caution. If men are relatively more optimistic about their future performance and this affects their decision to enter competition, the gender differences in propensity to compete may be overestimated. Some of these differences should perhaps be attributed to overconfidence.

Few studies assess the implications of the observed gender gap in risk aversion and competitiveness on real-world outcomes or outcomes in top executive positions. Furthermore, due to the difficulty of measuring risk aversion and competitiveness, it is difficult to know to which extent the observed gender gap in risk aversion and competitiveness can be applied to the general population, and especially top executives. Consequently, the results from the reviewed literature should be interpreted with caution and future studies on risk aversion and competitiveness should try to replicate real-world situations better.

Compensation Structure in Top Management

Compensation structure in top management has received a lot of attention in literature, however, few of the empirical studies we identified looked at whether incentive systems impact men and women differently and how it might explain the lack of gender diversity in top management. A possible reason for this is that the psychological attributes that drive preferences for compensation structures, such as risk aversion and competitiveness, are challenging to observe.

When top executive compensation is discussed in the literature, vega and delta are often used as measures of equity incentives. Most studies look at how vega and delta impact firm policies. Several studies find a positive association between vega and manager's risk-taking (Coles et al., 2006; Low, 2009; Bulan et al., 2010; Gormley et al., 2010; Baixauli-Soler et al., 2015). Specifically, vega is often associated with higher investment in research and development and higher leverage (Coles et al., 2006; Gormley et al., 2013). Vega and increased firm risk is further associated with higher firm performance (Coles et al., 2006; Low, 2009; Bulan et al., 2010). However, the association between vega and firm performance is somewhat ambiguous as previous studies find both positive and negative associations. Coles and Li (2013) find a positive association with Tobin's Q and negative with ROA.

Contrary to the literature discussed above, Hayes et al. (2012) and Milidonis and Stathopoulos (2014) find no significant relation between vega and risk related policies. An explanation for this might be that risk averse managers do not increase firm risk even if they are incentivized with a high vega. Milidonis and Stathopoulos (2014) argue that the effect of vega will depend on the manager's utility function. For managers, there will be a trade-off between the expected increased wealth resulting from an increase in firm risk and the decreased utility resulting from managerial risk aversion. Hence, if managers are highly risk averse the reduced utility from increased firm risk might be higher than their increase in wealth resulting from higher stock return volatility. This finding is illustrated by both Milidonis and Stathopoulos (2014), Carpenter (2000) and Hall and Murphy (2002).

Previous studies also show evidence of a positive association between delta and firm risk, but the relationship is somewhat different. Literature shows evidence of an inverse U-shaped relationship between delta and firm productivity (Bulan et al., 2010) and delta and firm risk (Baixauli-Soler et al., 2015). Delta induces managers to increase firm risk so as to improve firm performance, but only up to certain values of delta. When delta gets higher, managerial risk aversion increase as the manager will have more of his or her wealth tied to firm performance. Incentivizing managers with a higher vega will mitigate the problems that follow from managerial risk-aversion (Core and Guay, 1999; Bulan et al., 2010).

Previous studies provide evidence of a negative association between delta and R&D expenditure and leverage (Coles et al., 2006). Core and Guay (1999) further show that delta is negatively associated with firm performance measured as market-to-book ratio. On the contrary, Coles and Li (2013) find that larger CEO delta is positively associated with firm performance when measured in ROA.

Among the identified studies there were only a few who looked at whether male and female executives hold different vega and delta or whether their response to equity incentives differ. Previous studies show evidence of significantly lower vega and delta values among female top executives compared to male top executives (Baixauli-Soler et al., 2015; Carter et al., 2017). Baixauli-Soler et al. (2015) further show that female managers implement risk-reducing policies at lower values of delta compared to male managers, providing evidence of a stronger risk aversion among female managers.

Hypotheses

In an attempt to find out whether there is a link between the low percentage of women in top executive positions and the type of incentive schemes offered in top management, existing literature has been reviewed. Existing literature shows several attempts at explaining the gender gap in the labor market, but none of the identified studies sheds light on the direct link between the gender gap in top management and the use of certain incentive systems.

As illustrated, due to individual risk aversion, the design of incentive systems in top management might impact the perceived risk of these positions. Despite there often being higher total remuneration in top executive positions, these positions often lead to increased earnings volatility and might therefore be regarded as riskier by certain individuals. If, as discussed, top management positions entail riskier compensation schemes, risk averse people will likely shy away from these positions. As women have been shown to be more risk averse one can, therefore, expect to see fewer women in top management. Additionally, literature has also identified competitiveness as a factor that might influence how agents respond to different compensation structures. Compensation schemes used in management are often based on performance and might therefore increase the perceived competitiveness associated with these positions (Lemieux et al., 2009). If, as literature suggests, men have a higher propensity to compete and perform better in competition relative to women, compensation schemes relying on performance will discourage gender equality, as males are more drawn to these positions. These arguments lead to our first hypothesis,

Hypothesis one: Women are likely to hold lower vega and delta than men and are also less likely to be present in the top management team of firms that use a high level of equity compensation (measured through vega and delta) to incentivize their executives

As traditional agency theory assumes that agents are risk averse, executives that are incentivized with risky pay-packages will require compensation, in the form of “safe” pay for bearing equity risk (Jensen et al., 2004). Furthermore, females have been found to require higher salary premium than men for bearing compensation risk (Carter et al., 2017). Therefore, we will assume that female top executives will be highest represented in those positions where the salary is highest for a given level of vega and delta. Our second hypothesis is thus,

Hypothesis two: We expect women to be higher represented in positions where the salary premium for compensation risk is the highest

As discussed, the gender difference in risk aversion and competitiveness is not constant. Gender composition of groups has shown to impact the performance of women and women's propensity to compete. If these results are transferred to top management groups one can assume that in corporations where the majority of top executives are men, it is less likely that women will fill these positions when management is replaced over time. The findings in the literature might indicate that females' aversion to work in top management will diminish when there are other women already employed in the top management team. One might, therefore, assume that the association between vega and delta and the probability of observing a positive change in the number of females in top management will depend on the presence of female top managers within the firm. These arguments lead to our third hypothesis,

Hypothesis three: Women are more likely to be present in top management teams of firms that have been previously employing a higher share of females in top management.

Compensation schemes relying on performance measures have shown to increase the perceived competitiveness of a workplace (Manning and Saidi, 2010). Further, studies have revealed that females perform worse than men in competitive environments (Gneezy et al., 2003; Gupta et al., 2005). As executive compensation often uses stock price as a performance measure, one might assume that those female executives who have compensation closely tied to stock price, perform worse than their male counterparts. Further, as females have been found to be inherently more risk averse, one might assume that for a given level of equity incentives they will implement risk-reducing policies. As risk-reducing policies are associated with reduced firm performance and decline in shareholder value (Jensen and Meckling, 1976), we will therefore expect that delta and vega of female top executives will be negatively associated with firm performance. However, as vega is used to incentivize managers to implement risky policies, we will assume that for a given level of delta, women will need higher vega for it to have an effect on firm performance. Our fourth hypothesis is thus,

Hypothesis four: Firms with female top managers perform better when vega and delta are lower

Based on these four hypotheses, we aim to assess whether there is an association between executive compensation and representation of women in top management. Following, our method used to test these hypotheses will be explained.

Data Collection

Data Source

The data used in this study is provided by Standard and Poor's databases and collected through Wharton Research Data Services. The necessary data has been gathered and combined from ExecuComp - Annual Compensation and Outstanding Equity Awards, and Compustat - Fundamental Annuals and Security Monthly. Each dataset includes companies' ticker symbol. The ticker symbols for companies in ExecuComp is used to identify the corresponding companies in Compustat. ExecuComp provides data on the top five to ten executives in the S&P 500, S&P Midcap 400 and S&P Smallcap 600 beginning in 1992. The data in ExecuComp is collected through the companies' annual proxy statements and include several different compensation measures. Compustat provides information on firm-specific characteristics from year to year.

In 2006 ExecuComp changed its reporting standard related to several key variables as a result of FAS 123R. The new standard introduced by the Financial Accounting Standard Board requires companies to expense all stock options granted to employees. This resulted in several changes related to the variables reported in ExecuComp. Among others, several new variables measuring the value of stock and option awards granted to employees were introduced. As a consequence, several of the variables reported prior to 2006 are not directly comparable to the values reported after 2006. To obtain consistency and reduce the possibility of wrongly interpreting the variables this study will focus on data post FAS 123R. In the fiscal year of 2006 there is still 16 percent of the companies in ExecuComp that use the old reporting format, while in 2007 all firms report compensation in line with the new format. This study will, therefore, focus on the 10-year period from 2007 to 2016. 2017 is excluded as the data is still not collected for a majority of the companies in the database.

Data Collection

Following Guay (1999) we exclude executives that own more than one-third of the corporation's shares, as their compensation structure doubtfully is designed for contracting purposes. In line with previous research (Coles et al., 2006; Hayes et al., 2012) we also exclude companies operating in the financial industry (SIC codes 6000 – 6999). Furthermore, we delete executive observations that are missing information on the number of shares and options owned, exercise price and stock price, as these variables are crucial for the calculation of vega and delta. As age fields are not consistently reported for all executives, we backfill the missing age fields for all executives reporting at least one age field over the sample period. To avoid reducing the already low number of female observations, we hand-collect age for the remaining female executives that do not have a single age observation. We delete 460 observations with no reported age in any of the years. This method of dealing with missing age fields is in line with Carter et al. (2017). The field of Annual Title is not consistently reported either. Knowing the executives` position in the firm is crucial for our analysis, and we, therefore, choose to delete those observations that report no information on Annual Title.

Our final dataset can be defined as an unbalanced panel dataset. Panel data consist of observations at different time periods related to seperate entities. When the dataset is unbalanced there are missing time periods for some of the entities studied (Stock and Watson, 2012). Our datasets consist of yearly observations on firm characteristics and annual observations on individual executives. Several of the firms studied are only present in some of the years for the period of interest, and some observations have been deleted due to missing values. *Table 1* shows the distribution of observations over the years and how the share of female top managers has evolved. The number of firms and executive observations have remained quite steady, but have decreased somewhat in recent years.

Table 1

Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
# of firms	1676	1628	1616	1582	1550	1516	1490	1468	1418	1358
# of executive observations	8178	7891	8574	8130	7993	7864	7761	7613	7434	7041
% female executives each year	7.26	7.56	7.81	8.00	8.04	8.33	8.36	8.70	7.28	6.42

An unbalanced panel requires a formal explanation of why the dataset is unbalanced and might lead to issues related to sample selection. To ensure that estimators are consistent, attrition and missing values need to be appropriately exogenous (Wooldridge, 2002). By deleting observations with missing values, there is a probability that we systematically have deleted firms with similar characteristics from our sample. However, as the number of missing values have been relatively low and we have followed methods from previous literature, this issue is not regarded as critical for our results.

Variable Construction

Vega and delta

As mentioned initially and in line with previous research (Coles et al., 2006; Hayes et al., 2012; Carter et al., 2017), vega and delta will be used to measure the level of equity compensation for each executive, and thus the level of equity incentives. Vega measures the sensitivity of an executive's wealth to stock return volatility and is defined as the change in the dollar value of an executive's wealth for a 0.01 change in the annualized standard deviation of stock returns. Wealth refers to the value of the stock options granted to the executive by the company. Delta measures the sensitivity of an executive's wealth to stock price and is defined as the change in the dollar value of an executive's wealth for a one percentage point change in stock price (Coles et al., 2006). In the definition of delta, wealth refers to the value of the stock options and restricted and unrestricted stocks granted to the executive by the company.

Option Valuation

To calculate the vega and delta of options, we need the value of the executives' options. The two leading models used to price options are the Cox-Rubinstein Binomial Option Pricing Model and the Black-Scholes Option Valuation Model. We follow Core and Guay (2002) and Coles et al. (2013) and use the Black-Scholes Model, as modified by Merton (1973) to account for dividends. As our dataset consists of observations from 2007 and on, we mainly focus on the method by Coles et al. (2013) which is a modification of Core and Guay (2002) to account for the new reporting standards from 2006. The Black-Scholes formula for valuing options can be seen below:

$$\textbf{Option value} = \left[Se^{-dT}N(Z) - Xe^{-rT}N\left(Z - \sigma T^{(1/2)}\right)\right]$$

where

$$Z = [\ln(S/X) + T(r - d + \sigma^2/2)]/\sigma \ T^{(1/2)}$$

N = cumulative probability function for the normal distribution

S = price of the underlying stock

T = time to maturity of the option in years

X = exercise price of the option

σ = expected stock-return volatility over the life of the option

r = natural logarithm of risk-free interest rate

d = natural logarithm of expected dividend yield over the life of the option

The variables needed to value an option using Black-Scholes are listed above. As several of these variables are not readily available from ExecuComp or Compustat, a description of how the variables are constructed follows.

Stock Price

Stock prices are downloaded from Compustat and correspond to the closing price for the fiscal year. This is in with Coles et al. (2013).

Time to Maturity

ExecuComp does not provide a separate variable measuring time to maturity, this variable is therefore calculated based on option expiration date as reported in Outstanding Equity Award (OEA) in ExecuComp. OEA provides information on each executive's outstanding option holdings and the corresponding option characteristics. From 2007 to 2016, 579,803 observations are identified. 3145 of these miss information on the expiration date and are therefore excluded from our analysis. If the option matures in the first six months of the following fiscal year, the maturity is set to six months. Options that expire within the current fiscal year is also set to six months. For options expiring in the following fiscal year from six months and later the maturity is set to the nearest number of fiscal years.

Exercise Price

ExecuComp (Outstanding Equity Awards) provides exercise price for each outstanding option, however, several of the observations does not contain information on exercise price. In his 1999 paper, Guay explains how he uses the average of the stock prices for the beginning and end of the fiscal year the option was granted, as a substitute for exercise price. As the data used in this study does not provide information on the time of option grants, we were not able to use this method. Consequently, those observations not reporting information on exercise price were deleted from our sample.

Stock Return Volatility (σ)

To calculate the volatility that is used in the Black Scholes model we replicate the variable BS_Volatility that were provided by ExecuComp before 2006. We follow ExecuComp and Coles et al. (2013) in the calculation. We use the monthly total return from Compustat (TRT1M) to calculate the standard deviation of stock returns over the 60 months prior to the beginning of the fiscal year. This volatility is annualized. For companies where Compustat does not provide enough data to calculate the annualized standard deviation over 60 months prior to the beginning of the fiscal year, we use the annualized standard deviation for the prior months available, as long as there is data for at least 12 months. For companies where there are less than 12 months of data before the beginning of the fiscal year, the mean volatility across all firms are used.

Risk-free Rate

The risk-free rate used in the Black Scholes model is downloaded from historical data provided by the Federal Reserve. Similar to Coles et al. (2013) we use the market yield on US Treasury securities downloaded from the homepage under “Treasury constant maturities” using the “annual” series. The data provided is for Treasury securities with 1, 2, 3, 5, 7, and 10-year maturity. To get the rates for the remaining years, we interpolate the rates by using linear interpolation. If the maturity is longer than 10 years, the 10-year rate is used.

When interpolating we implicitly assume that the interest rates increases or decreases with a constant rate between the two periods. The following formula is used to interpolate:

F1: r(a) + ((r(b)-r(a))((d-a)/(b-a))*

- r(a) = interest rate for the nearest prior period
- r(b) = interest rate for the nearest period forward in time
- d = the period we want to calculate interest rate for
- a = the period prior in time
- b = the period forward in time

"Treasury Constant Maturity" provides data on historical interest rate each day for different maturities. To find the interest rate for year X for Y years of maturity, we use the average interest rate over the year.

Dividend Yield

Before 2006 Compustat provided the variable BS_YIELD which is the dividend yield used in the Black Scholes formula. As this variable does no longer exist, we follow the method provided by ExecuComp as closely as possible, to replicate the variable. We first calculate the dividend yield for each company-year observation by dividing "Dividends per Share by Ex-Date" by close price for the fiscal year. The BS_YIELD is then calculated by taking the average of the current year and the two prior years. To exclude extreme outliers, the values are winsorized at the 5th and 95th levels. For company-year observations where there is no dividend yield in the previous year (e.g., for companies in their first year after IPO) the BS_YIELD is set equal to the dividend yield for the year.

Calculating the Value of Option Vega and Option Delta

Vega of Options

$$[\partial(\text{option value})/\partial(\text{stock volatility})] * 0.01 = e^{-dT} N'(Z) S T^{(1/2)} * (0.01)$$

Core and Guay (2002)

Delta of Options

$$[\partial(\text{option value})/\partial(\text{price})] * (\text{price}/100) = e^{-dT} N(Z) * (\text{price}/100)$$

Core and Guay (2002)

Once the option values are calculated, the formulas above are used to calculate the vega and delta of each option. The total number of vested and unvested options an executive holds are multiplied with their respective vega and delta, to get the total vega and delta of the executive's option portfolio. This calculation is illustrated in the formula below.

Option Vega = Vega of option 1 * # of option 1 + Vega of option 2 * # of option 2 + ..
Option Delta = Delta of option 1 * # of option 1 + Delta of option 2 * # of option 2 + ..

Following Coles et al. (2013) we use both vested and unvested options to get the total number of options. The number of unearned options is not used, as the data required to calculate delta and vega for these options are not available through Compustat or ExecuComp. ExecuComp provides the number of vested and unvested options.

Several executive-year observations in ExecuComp does not have data on options owned in OEA, however, as all data downloaded from OEA belongs to companies in the ExecuComp database we assume that these executives are not listed in OEA because they do not own options in the indicated fiscal year.

Calculating Vega and Delta of the Equity Portfolio

The vega of the equity portfolio is set equal to the vega of the option portfolio. This is consistent with Guay's (1999) method that is based on the assumption that vega of shares is zero.

To get the overall delta of the equity portfolio, we sum up delta of shares and delta of options. Delta of shares is calculated using the number of restricted and unrestricted shares. Consistent with Coles et al. (2013) the following formula is used:

*F2: (Sum of restricted and unrestricted shares) * (stock price at fiscal year-end) * 0.01*

There are 2783 observations in ExecuComp missing information on the number of shares owned (SHROWN_OPTS_EX). However, as these executives have reported information on other compensation variables in ExecuComp we also assume that the number of shares owned is zero.

Vega and Delta Used in Regressions

As some of our regressions are estimated using the firm-level values of delta and vega, the top management team vega and delta are calculated by taking the average vega and delta for the employees in each company, each year. In line with Coles et al. (2006), we winsorize vega and delta at the 1^{st} and 99^{th} percentile. As the resulting distribution of vega and delta is highly skewed to the right, the values were winsorized twice.

Critique of Black Scholes

As outlined, option values are calculated using the Black-Scholes Option Valuation Method. This is in line with all previous studies we have identified (Coles et al., 2006; Adams and Ferreira, 2009; Bulan et al., 2010; Hayes et al., 2012; Gormley et al., 2013). Despite Black-Scholes being acknowledged as a valid option pricing method, several issues have been discussed in the literature. First of all, the option value calculated is based on the perspective of a diversified investor. An executive does not have a diversified portfolio and will, therefore, value the option lower than what the Black Scholes method does (Hall and Murphy, 2002). Further, the Black-Scholes model calculates the option value of a European call option, i.e., an option that can be exercised at the option expiration date. Also, the Black Scholes Model assumes that the option is fully transferable. Options given to managers are likely to deviate from these assumptions. However, as Guay (1999) argue, adjusting Black-Scholes is not straightforward.

In line with Guay (1999), we set the vega of shares equal to zero. However, Guay (1999) argues that stocks also provide convexity to the manager's wealth-performance relation in levered firms. If the firm value increase by one USD for a levered firm this is shared between debtholders and shareholders. Additionally, a levered firm with the probability of default might motivate managers with ownership shares to take on risky projects if these offer a higher expected payoff than the payoff under default. In this way, shares might also provide managers with incentives to increase stock price volatility. However, as this convexity is small relative to the payoff from an option, we follow previous literature (Coles et al., 2006) and set vega of shares equal to zero.

Categorizing Job Titles

Previous studies have shown that females who work in top management teams are more likely to have lower level titles than males (Bertrand and Hallock, 2001). Consequently, we create different executive categories to, among other things, test if the effect of vega and delta varies between executive positions. The variable "Annual Title" in ExecuComp gives the title the executive has in the indicated fiscal year. The method used by companies to report this variable is not consistent across firms and several of the reported titles are up to 30 characters long. In the final dataset, there are 18,124 unique descriptions used in the "Annual Title" field. Additionally, some executives report more than one title for the same year. To simplify this variable, we construct a new variable called "Title".

Executives that are missing values in "Annual Title", but have a positive value in the variable "CEO flag", are given a CEO title. 5660 of the observations do not have a title or a CEO flag and are therefore deleted from the sample. For executives reporting more than one title during the year we follow the method used by Carter et al. (2017). In contrast to Bertrand and Hallock (2001), they extrapolate an executive's title based on the entire description reported in "Annual Title" and not just the two first titles reported. We mark each executive using a selection of the same titles as Carter et al. (2017), i.e., CEO, CFO, COO, Other Chief, President, Vice-President, Chairman, Vice-Chairman, Divisional President, and Any Other Title. Additionally, we also include a title for executives listed as advisors and divisional vice-presidents. For executives holding several of these titles in the same fiscal year, the title representing the highest responsibility is flagged. Further, consistent with Carter et al. (2017) we follow Aggarwal and

Samwick (2003). They argue that the distinction between corporate and divisional executives affect differences in pay and therefore group executives further into six unique categories distinguished by corporate or divisional responsibilities. These are; CEO, CFO, COO, and Other Executives (executives covering other non-CEO/CFO/COO positions), Divisional Executives, and Other Lower Executives. To simplify our regression analysis, we choose to combine Other Executives, Divisional Executives and Other Lower Executives into one group which we label Lower Executives. We also create two dummies for whether or not the executive is a chairman. For a complete list of the titles see appendix 4.

A drawback of the final list of titles is that it is affected by a subjective opinion that might wrongly categorize some of the executives. The grouping of executives based on their corporate or divisional responsibilities is based on our intuitive judgement. There might, therefore, be a possibility that some executives, based on their company title, have been categorized wrong. For instance, an executive might hold a divisional title, while his real responsibility would better match the category representing COOs. *Table 3* in descriptive statistics shows the distribution of executives across the different categories of positions as well as the average vega and delta for each position.

Control Variables

In addition to vega, delta and dummies for title, we include additional controls in our regressions. The firm-specific variables included in the regression models are based on variables used in prior empirical research related to our topic. We control for variables that might affect the share of women in top management and compensation structure. The purpose of introducing control variables is to account for drivers of both vega and delta together with the presence of female top executives. As mentioned in section two and consistent with the models used in previous research (Bertrand and Hallock, 2001; Coles et al., 2006; Carter et al., 2017), we run separate regressions where we control for firm fixed effects. This is to account for the possibility that there might be other omitted firm characteristics that might be correlated with vega and delta or the allocation of females in top management positions.

Firm Size

As previous literature has found that women in top management positions tend to work for smaller firms and as salary has been found to be positively associated with firm size (Bertrand

and Hallock, 2001), we need to control for firm size. Consistent with prior literature we measure firm size using the logarithm of sales (Bertrand and Hallock, 2001; Coles et al., 2006) and the logarithm of assets and employees (Bertrand and Hallock, 2001).

Firm Risk

In line with Coles et al. (2006), we use stock return volatility, investment in R&D, capital expenditures and leverage as proxies for firm risk. As higher leverage, increased investment in R&D and lower investment in capital expenditure are associated with higher firm risk, it is important to control for these measures to account for the possibility that females shy away from riskier firms, not because of their compensation structure, but because of risky firm characteristics. Consistent with Coles et al. (2006) we define R&D as research and development expenditure scaled by assets, CapEx as capital expenditure (the amount spent on construction and/or acquisition of PPE) scaled by assets and leverage as the debt-to-equity ratio.

Growth (Market-to-book ratio)

Market-to-book ratio is often used to measure whether a company is expected to grow. A ratio higher than one indicates that the expectations about the future are positive. Consistent with Carter et al. (2017), we use the market value of equity to the book value of equity as a proxy for investment opportunities. Future investment opportunities might have an impact on the value of vega as the board would want to incentivize managers to take on risk (Coles et al., 2006).

Industry Segment

As gender composition in top management is not equally distributed across industry segments we also include controls for industry. Women tend to manage health care and social services companies and companies specializing in trade within wholesale or retail (Bertrand and Hallock, 2001). We therefore control for industry by including 1-digit SIC-code dummies.

Lagged Vega and Delta

To assess whether vega and delta in one period might predict the gender composition of the top management team in the next period, it is necessary to introduce a time lag in the data. Doing this implies losing those firm-year observations where there are no observations in the previous year. Running our regressions using a one period lag in vega and delta reduces our dataset from 15,302 firm-year observations to 13,410.

Descriptive Statistics

The purpose of the following section is to get an overview of our sample and the variables used for our regressions. Getting an insight into the different variables and an understanding of how they behave, will help us better interpret the results of our regressions.

Table 2

(Values in thousands USD)	**Mean**	**25th percentile**	**50th percentile**	**75th percentile**	**Women**	**Men**	**p-Value**
N	78 479				6114	72 365	
Part A: Executive Characteristics							
Vega	25 (59)	0	4	20	17	25	0.0000
Delta	163 (372)	24	54	126	121	167	0.0000
Salary	500 (327)	304	420	606	448	505	0.0000
Age	53 (7.33)	48	53	58	51	53	0.0000
Part B: Top management team compensation							
Vega	26 (46)	1.45	8.35	27	25	26	0.0000
Delta	207 (389)	55	91	185	201	210	0.0000
Part C: Firm characteristics							
Employees	20.70 (72)	1.60	6.14	15.14	23.70	19.30	0.0000
D/E	1.03 (39)	0.01	0.40	0.94	0.92	1.07	0.0255
CapEx	0.05 (0.05)	0.02	0.03	0.06	0.046	0.05	0.0000
R&D	0.03 (0.14)	0.00	0.00	0.04	0.03	0.04	0.0000
Volatility	0.42 (0.17)	0.30	0.41	0.49	0.41	0.42	0.0000
Market-to-book	3.11 (32.38)	1.36	2.17	3.57	2.78	3.14	0.0000
ROA	0.03 (0.37)	0.01	0.05	0.09	0.032	0.031	0.0000
Stock Return	0.90 (10.28)	-0.17	0.08	0.32	0.98	0.86	0.0000

Table 2 shows the mean, standard deviation, and distribution of our dependent and independent variables. *Part A: Executive characteristics* is based on individual executives while *Part B: Top management team compensation* is based on the averages for each company's top management team. The reported p-values correspond to a mean comparison test between individual women and men (*Part A*), and between firms with at least one female executive and firms with no female executives (*Part B and C*). Standard deviations are reported in parentheses. CapEx and R&D expenditure are scaled by assets.

Data Distribution

The first summary statistics for vega and delta showed several extreme outliers which gave a highly skewed distribution, even though the values had been winsorized at the 1st and 99th percentile (see appendix 5). A consequence of extreme outliers is biased estimates of mean, standard deviation and regression coefficients, which in turn could hurt the significance and interpretation of the regressions. Furthermore, as one of the least squares assumptions is that extreme outliers are unlikely, we winsorize vega and delta at the 1st and 99th percentile a second time. The new distribution of vega and delta is reported in *Table 2.* In line with Coles et al. (2006), we also winsorize market-to-book ratio at the 1st and 99th percentile.

Despite being winsorized, the values of vega and delta still show quite the span. Delta has a mean of 163,000 USD, whereas the median is much lower at 54,000 USD. This indicates that some of the executives in our sample have a very high delta, and that these affect the mean delta quite a lot. This is also the case for vega, as the mean is 25,000 USD and the median is 4,000 USD. With the exception of employees, market-to-book ratio, and ROA, our control variables are not as widely spread as vega and delta. The average number of employees (20,700) is considerably higher than the median number of employees (6,140). This means that some companies have a very high number of employees compared to the majority of the firms in our dataset. Market-to-book ratio has a mean of 3.11 and a standard deviation of 32.38, indicating that the ratio has values in a broad range and the reliability of the mean is uncertain. Hence, some firms are very overvalued while other are very undervalued. Furthermore, the wide range of the market-to-book ratio indicates that the growth opportunities of the firms in our sample vary substantially. The standard deviation of ROA shows that it also displays a wide range of values. With a mean of 0.03 and a standard deviation of 0.37, it indicates that the performance of firms varies substantially.

Mean Comparison Test

The mean comparison test shows that firms with at least one female top executive report significantly lower vega and delta than firms with no female executives. At the individual level, the results are the same. As reported in *Part A* of *Table 2*, female executives have significantly lower delta and vega than men, and they also receive a significantly lower salary.

As women have been found to be more risk averse than men (Eckel and Grossmann, 2002; Niederle and Yestrumskas, 2008; Dohmen et al., 2011), we expect women to work for less risky firms. The average firm characteristics of firms with no women in top management and firms with a least one woman in top management are presented in *Part C* of *Table 2*. The results show that firms with female top executives have, on average, significantly lower debt-to-equity ratio, volatility, and research and development expenditures. This supports our expectation that firms with female top executives are, on average, less risky. Market-to-book ratio is an indication of growth opportunities for the company. Judging by the market-to-book ratio, companies with female top executives have significantly lower growth opportunities than what companies with only male executives have. We also see that firms employing female top executives have significantly higher performance (ROA) than those with only men in top management.

Executive Positions

Table 3 shows the distribution of executive observations across positions as well as the percentage of female executives in each position. The reported vega and delta are the average across the different executive categories. The mean vega and delta for CEOs are 54,000 USD and 272,000 USD, respectively. This is much lower than what Carter et al. (2017) reported, who also used the ExecuComp database. Their sample had an average vega of 80,000 USD and delta of 600,000 USD. One explanation for this gap is that while we have winsorized at the 1st and 99th percentile twice, they have only winsorized at the same percentiles once. Another explanation could be the sample years, as our sample is from 2007 to 2016 whereas their sample is from 1992 to 2002.

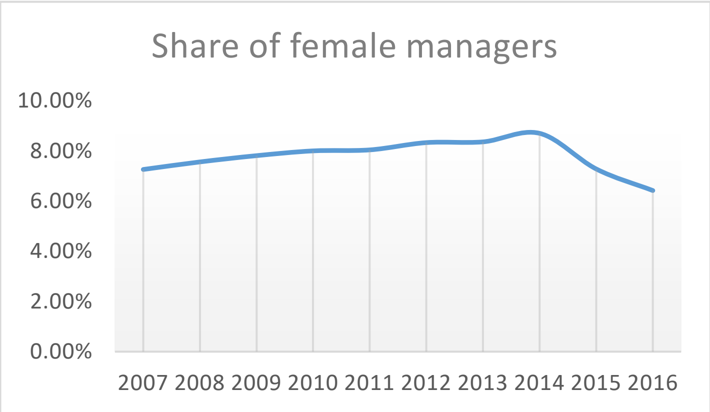
Table 3

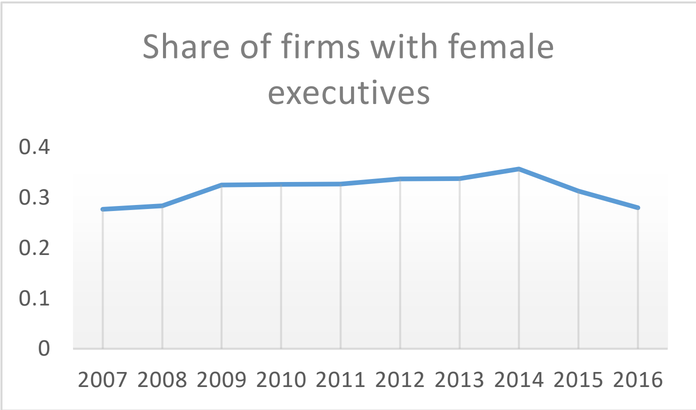
Position	# in occupation	% female in occupation	Vega	Delta	Salary
			(1000 USD)		
CEO	17,834	3.63	54	272	763
COO	5704	3.74	21	123	519
CFO	15,791	9.02	15	106	413
Lower executives	37,908	10.00	14	120	403
Chairman	10,116	2.85	73	442	835

Women are the highest represented in the positions of CFO and lower executives. This is somewhat in line with what Bertrand and Hallock (2001) found, as females in their sample were the highest represented in the position of CFO. As anticipated, CFO and lower executives are also the positions that hold the lowest equity incentives. Furthermore, women are least represented in the positions with highest compensation risk – CEO and chairman.

The Representation of Female Executives

Figure 1 & 2

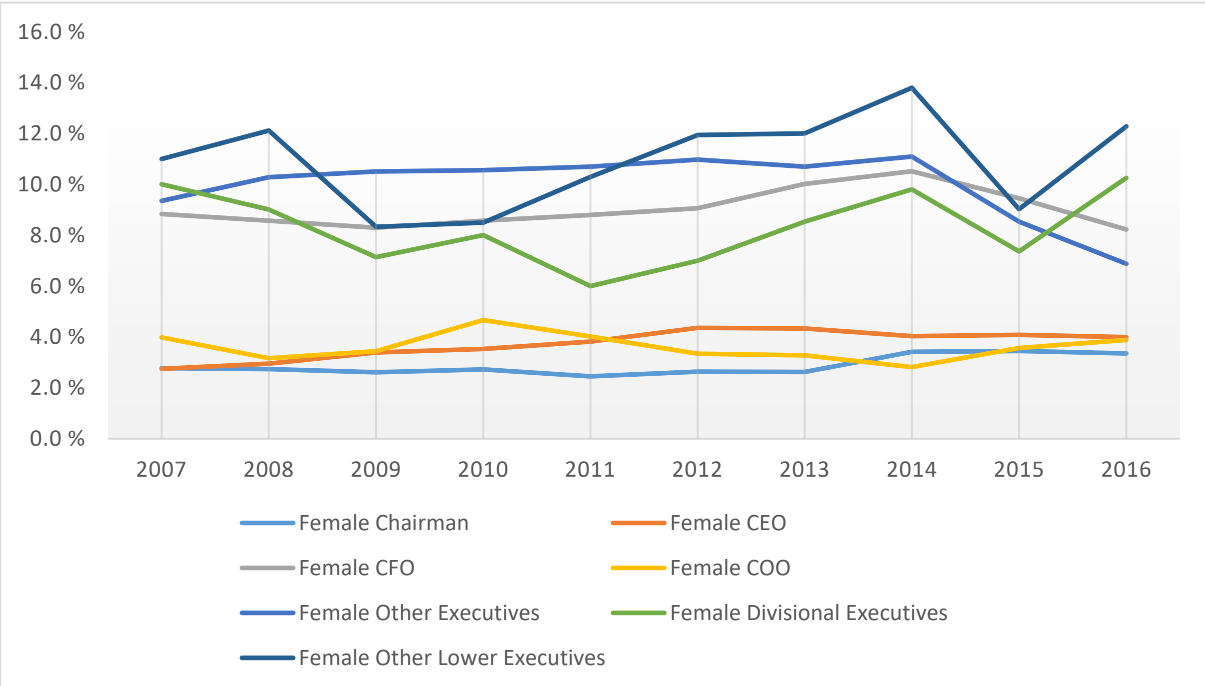




As mentioned initially the share of females in top executive positions has steadily increased in our sample years up until 2014, and since then the proportion has declined. This is illustrated in *Figure 1*. From *Figure 2* we also see that the share of firms with at least one female executive follow the same trend, indicating that the increase in the share of female top executives is mainly coming from more companies employing female top executives rather than companies already employing women increasing their share of female top executives. At the end of our sample period, the share of companies employing at least one woman in top management was about one-third of our sample.

A countertrend in the share of female executives was also observed by Haveman and Beresford (2012). They state that the positive development seen before the countertrend is not seen at all ranks of management as women remain the highest represented in lower levels of management and constitute only a small share at the top. To examine if this is the case for different levels of top executives we look at the share of females in different executive positions and how these proportions have developed over our sample years. Each line in *Figure 3* represents the share of females in that position over the sample years. We consider the ranking of the positions to be in the following order: Chairman/CEO, COO, CFO, other executives, divisional executives and other lower executives. As expected, the share of females is highest in the lowest ranking positions. Their share in the highest positions remains steadily low and has not increased particularly. Consequently, the observed increase in female top executives up until 2014 must mainly come from more women entering into the lower levels of top management.

Figure 3



To examine what may have caused the growth of female executives to stop and even decline in 2015 and 2016 we look at the development of vega and delta of each position (see appendix 6). The equity incentives of both CFO and lower executives have increased in 2015 and 2016.

However, equity incentives have increased for most positions. Nevertheless, this might indicate that the effect of an increase in vega and delta is strongest for positions where the proportion of females are highest. An explanation for this could be that the position of CFO and lower executive have less power to influence the stock price, and consequently their wealth, than what CEO, COO and Chairman have.

Multicollinearity

Table 4 shows the correlation between the different variables used in our regressions. According to Lind et al. (2008), the upper limit of a correlation is 0.7, a correlation higher than this might bias the results. As seen in the correlation matrix, none of our variables are correlated at that level, except the control variables for size and salary. Employees, assets, and sales are included to control for the size of the firm. Due to the high correlation between these three variables, we only include the log of employees to control for size in the regression models, as employees displayed the highest significance when running our regressions. As anticipated, the correlation between volatility and vega is high.

Table 4: Correlation matrix

Correlation	Vega	Delta	Employees	Assets	Sales	R&D	CapEx	M/B	D/E	Volatility	Gender	Salary	ROA	Stock return
Vega	1													
Delta	0,148	1												
Employees	0,355	0,11	1											
Assets	0,443	0,125	0,745	1										
Sales	0,316	0,091	0,728	0,732	1									
R&D	0,004	0,017	-0,19	-0,177	-0,149	1								
CapEx	-0,048	0,049	-0,064	0,039	0,015	-0,059	1							
M/B	0,005	0,008	0,023	0,015	0,015	-0,001	-0,003	1						
D/E	-0,005	-0,002	0,014	0,007	0,004	-0,002	-0,001	0,341	1					
Volatility	-0,255	-0,046	-0,367	-0,422	-0,33	0,103	0,012	-0,022	0,003	1				
Gender	-0,015	-0,012	0,044	0,044	0,061	-0,043	-0,036	-0,008	-0,002	-0,034	1			
Salary	0,424	0,152	0,602	0,64	0,54	-0,096	-0,037	0,016	0,008	-0,275	0,086	1		
ROA	0,046	0,008	0,098	0,06	0,031	-0,371	-0,024	0,012	-0,002	-0,082	0,016	0,038	1	

As mentioned previously, we use variance inflation factors to assess if multicollinearity cause problems for our estimated models, in addition to the correlation matrix. The results show that our estimates are not severely affected by multicollinearity (Appendix 3).

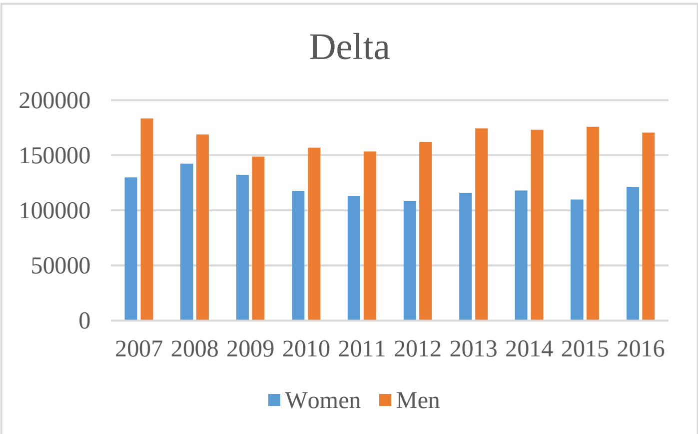
Analysis

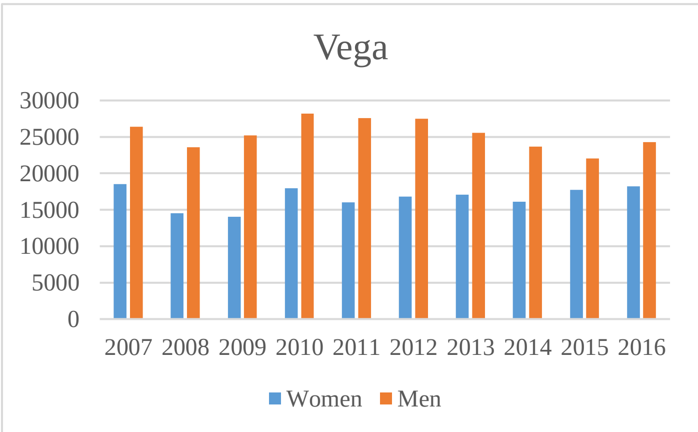
Hypothesis One: The Role of Equity Incentives

Hypothesis one: *Women are likely to hold lower vega and delta than men and are also less likely to be present in the top management team of firms that use a high level of equity compensation (measured through vega and delta) to incentivize their executives.*

As discussed earlier, previous literature has argued that gender differences in risk aversion and competitiveness can explain females' position in the labor market. In contrast to several previous studies that have studied the link between risk aversion and compensation risk (Bonin et al., 2007; Grund and Sliwka, 2010; Graham et al., 2013), this study does not include any direct measure of risk aversion. However, Graham et al. (2013) found that more risk averse CEOs are less likely to accept pay packages with a greater proportion of bonus pay, stock, and stock options. Furthermore, studies have demonstrated that women, on average, display greater aversion towards equity incentives, as shown through lower vega and delta (Goel and Thakor 2008; Coles and Li 2013; Baixauli-Soler et al., 2015).

Figure 3 & 4





As we can see in *Figure 3* and *4*, men have higher vega and delta than women throughout all the sample years of our analysis, which is in line with the findings of previous literature (Goel and Thakor 2008; Coles and Li 2013; Baixauli-Soler et al., 2015). To test if this difference is significant we run a mean comparison test (see Descriptive Statistics, *Table 2*), and find that men indeed have higher vega and delta than women. This suggests that women might be less attracted to equity incentives than men.

Regression Specification

To assess the validity of hypothesis one, we run two different sets of regressions, both using an unbalanced panel of firm-level data with 13,410 firm-year observations from 1808 unique firms. In the first set of regressions we will look at the association between vega and delta and the probability of observing a female in top management, by running the following regressions using both pooled OLS and fixed effects (*Table 5 and 6*):

$$\text{Female} = \beta_1 + \beta_2 * \text{Vega}_{t-1} + \beta_3 * \text{Delta}_{t-1} + \lambda_{1,\text{Year}} + \lambda_{1,\text{Industry}}$$

$$\text{Female} = \beta_1 + \beta_2 * \text{Vega}_{t-1} + \beta_3 * \text{Delta}_{t-1} + \beta_4 * \text{Employees}_{t-1} + \beta_5 * \text{CapEx}_{t-1} + \beta_6 * \text{R\&D}_{t-1} + \beta_7 * \text{Volatility}_{t-1} + \beta_8 * \text{D/E}_{t-1} + \beta_9 * \text{Market/Book}_{t-1} + \lambda_{1,\text{Year}} + \lambda_{1,\text{Industry}}$$

The dependent variable is a dummy taking the value 1 if there are one or more female top executives in the company that year, and 0 otherwise. The vega and delta are the yearly averages for each top management team with a one-year lag. We expect that higher vega and delta will lower the probability of observing a female in top management, so we expect negative coefficients on vega and delta. Log of employees is included to control for size. Due to the high correlation between employees, sales, and assets, employees are the only measure of size we control for. This is to avoid multicollinearity. In line with previous literature, we expect the coefficients on employees to be negative as female top executives have been found to work for smaller companies (Bertrand and Hallock, 2001). To control for firm risk, we include the following variables: capital expenditures, R&D, volatility and debt-to-equity ratio. If women are more risk averse than men and this plays a role in their choice of workplace, we expect volatility, R&D and debt-to-equity ratio to have a negative correlation with the probability of observing a woman in top management, and capital expenditures to be positively correlated with this probability. Market-to-book ratio is included to control for growth opportunities. This is expected to have a negative relationship with our dependent variable as growth opportunities are associated with higher vega (Coles et al., 2006). In the OLS regressions, we control for the effect of time trends and industry by adding dummies for year and the 1-digit SIC-code.

In the second set of regressions (*Table 7 and 8*) we look at the association between vega and delta and the likelihood that a certain executive position in the firm is held by a woman. To test this, we run one regression on each of the executive categories. The regression is presented below and is run using both OLS and fixed effects:

$$\text{Female Executive} = \beta_1 + \beta_2 * \text{Vega}_{t-1} + \beta_3 * \text{Delta}_{t-1} + \lambda_{1,\text{Year}} + \lambda_{1,\text{Industry}}$$

$$\text{Female Executive} = \beta_1 + \beta_2 * \text{Vega}_{t-1} + \beta_3 * \text{Delta}_{t-1} + \beta_4 * \text{Employees}_{t-1} + \beta_5 * \text{CapEx}_{t-1} + \beta_6 * \text{R\&D}_{t-1} + \beta_7 * \text{Volatility}_{t-1} + \beta_8 * \text{D/E}_{t-1} + \beta_9 * \text{Market/Book}_{t-1} + \lambda_{1,\text{Year}} + \lambda_{1,\text{Industry}}$$

The dependent variable is a dummy variable taking the value 1 if the executive position (CEO, CFO, COO or lower executive) is held by a woman, and 0 if not. As the position of lower executive can be held by several executives each year, the value of 1 on this dummy variable indicates that at least one of the lower executives is female. The vega and delta reported are the lagged values of vega and delta for each executive category. As several executives will fall into the category of lower executives, we use the average vega and delta of those executives. We also include the same control variables as used in the first set of regressions.

Regression Analysis

The first set of regressions using OLS are presented in *Table 5*. In line with our expectations, the coefficients on vega and delta are negative in both regressions. This indicates that, when holding all other variables constant, a higher vega and delta will be negatively associated with the probability of a female being in top management. However, this effect of vega and delta is not significant. Thus, we cannot conclude that equity incentives impact the probability of a female being in top management.

Table 5

Model	(1)	(2)
Dependent	*Female in top management*	*Female in top management*
	OLS	
Vega $_{t-1}$ **(in millions)**	-0.023 (0.181)	-0.244 (0.195)
Delta $_{t-1}$ **(in millions)**	-0.019 (0.021)	-0.019 (0.021)
Employees $_{t-1}$		0.012** (0.006)
CapEx $_{t-1}$		-0.166 (0.146)
R&D $_{t-1}$		-0.061 (0.045)
Volatility $_{t-1}$		-0.042 (0.053)
D/E $_{t-1}$		3e-05 (1e-04)
Market/Book $_{t-1}$		-1e-04 (2e-04)
Industry control	YES	YES
Year control	YES	YES
Constant	0.168*** (0.032)	0.207*** (0.048)
Goodness-of-fit	0.671	0.678

*Statistically significant at the .10 level; **at the .05 level; ***at the .01 level.

Size (log of employees) is positive and significant at the five percent level, indicating that larger firms have a higher probability of having a female top executive. This is in contrast to what Bertrand and Hallock (2001) found. However, their sample period was ten years prior to ours; from 1992 to 1997. Another explanation might be that larger companies are more visible in the media and consequently are held accountable for their actions to a larger extent. Thus, they might be more concerned about their reputation. How companies address the issue of gender inequality and, more precisely, how large the proportion of females is, might impact their reputation. Previous studies have found that having females represented on the board can be positive for firm reputation (Brammer et al., 2009). This might explain why our findings differ from previous studies (Bertrand and Hallock, 2001).

When controlling for size and firm risk, we observe that none of the variables are significant, suggesting that firm size and risk are not significantly associated with the probability of observing a female in top management. When controlling for industry, we find that the SIC-codes for firms in the health and trade industries are positive and statistically significant at the

1 percent level. This implies that firms in those industries have a higher probability of employing female top executives, which is consistent with the findings of Bertrand and Hallock (2001). All the year dummies are significant. 2016 is the only year where we observe a negative coefficient, this is in line with the negative development in share of female executives observed in 2015 and 2016.

Table 6

Model	(1)	(2)
Dependent	*Female in top management*	*Female in top management*
	Fixed Effects	
Vega $_{t-1}$ (in millions)	-0.225 (0.142)	-0.243* (0.143)
Delta $_{t-1}$ (in millions)	-0.018 (0.013)	-0.018 (0.014)
Employees $_{t-1}$		0.021 (0.015)
CapEx $_{t-1}$		4e-03 (0.122)
R&D $_{t-1}$		-3e-03 (0.011)
Volatility $_{t-1}$		-0.023 (0.045)
D/E $_{t-1}$		4e-05 (5e-05)
Market/Book $_{t-1}$		-8e-05 (1e-04)
Goodness of fit	0.678	0.678

*Statistically significant at the .10 level; **at the .05 level; ***at the .01 level.

As a robustness check, the regressions in *Table 5* are also run with fixed effects. The results of the fixed effect models are presented in *Table 6*. As in the pooled OLS, vega and delta are negatively associated with the probability of observing females in top management. Firm risk and growth opportunities are not significantly associated with the dependent variable. Contrary to the pooled OLS, the coefficient for vega is statistically significant in the fixed effect regression (*Table 6*, *Model 2*).

A requirement for the efficiency of the fixed effects model is that there is a certain level of within-firm variation in the variables. In our dataset the dependent variable changes in 8.1 percent of the observations, so the result of the fixed effect model should be considered with caution. Yet, given that in all regression specifications the coefficient for vega is negative (and in the fixed effects regression also statistically significant), we conclude that, indeed, firms that rely more strongly on vega to reward their executives are less likely to have women in their top management. An explanation for this might be that the average vega in a top management team has a greater impact on how females perceive the firm than the average delta. If an executive with high vega implements risky firm policies, this will have an impact on all executives in the firm. If females are averse towards higher firm risk, this might explain why a higher vega is associated with a lower probability of observing a female top manager.

As mentioned initially, we also look at the association between vega and delta and the likelihood of a certain executive position being held by a female. The regression results are presented in *Table 7* (OLS) and *Table 8* (fixed effects).

Table 7

Model	(1)	(2)	(3)	(4)
Dependent	*CEO*	*CFO*	*COO*	*Lower Executives*
		OLS		
Vega $_{t-1}$ (in millions)	-0.056 (0.046)	0.159 (0.207)	-0.126 (0.086)	-0.363** (0.168)
Delta $_{t-1}$ (in millions)	-0.019*** (0.006)	-0.008 (0.017)	0.063 (0.048)	-0.023 (0.022)
Employees $_{t-1}$	0.007** (0.003)	-3e-04 (0.004)	-0.003 (0.005)	1e-05 (0.005)
CapEx $_{t-1}$	0.114* (0.068)	-0.249*** (0.093)	0.007 (0.073)	0.053 (0.148)
R&D $_{t-1}$	-0.006 (0.011)	-0.120* (0.064)	0.154 (0.191)	-0.247** (0.098)
Volatility $_{t-1}$	-0.001 (0.023)	2e-04 (0.037)	0.020 (0.043)	5e-04 (0.049)
D/E $_{t-1}$	-5e-05* (3e-05)	2e-05 (3e-05)	-2e-05* (1e-05)	3e-05 (8e-05)
Market/Book $_{t-1}$	2e-04 (1e-04)	-2e-04* (9e-05)	-6e-06 (2e-05)	-6e-05 (1e-04)
Industry control	YES	YES	YES	YES
Year control	YES	YES	YES	YES
Constant	-0.02 (0.01)	0.093*** (0.02)	-0.017 (0.028)	0.158*** (0.044)
Goodness of fit	0.670	0.690	0.930	0.650

*Statistically significant at the .10 level; **at the .05 level; ***at the .01 level.

Contrary to the first set of regressions, delta is now significant, but only in the position of CEO. This indicates that delta does not have a significant association with the likelihood of observing a female CFO, COO or lower executive, but does have a significant negative association with the probability that the CEO of the firm is female. The fact that CEO is the only position with a negative and significant delta is surprising, as one can assume that they have the most power to influence the stock price. Lower executives is a merging of the lowest ranking executive positions and is the category where females are the highest represented. This is also the only executive category where vega is significantly negative, which is in line with our expectations as it is plausible to assume that they have the least power to influence the stock price.

A possible explanation as to why delta is significantly associated with the probability of observing a female CEO, while vega is not, might be that female CEOs find it more risky to own shares than options. When owning shares, a top executive's wealth will be affected by both positive and negative movements in stock price. When owning options the executive's wealth is not affected by decreases in share price. The fact that vega is only significant for the probability of observing a female lower executive, might be explained by women's perception of stock and stock options as compensation. Being compensated with unrestricted stock might be perceived as safer as the value of an option as compensation is not realized before it is exercised. Further, being compensated with options might imply a lower base salary. As salary is lower for lower executives compared to CEOs, they might be less willing to replace salary for options.

The control variables for risk display the greatest significance for CEOs and CFOs. For CEOs, both CapEx and debt-to-equity ratio are significant. The coefficient of CapEx is positive, while the coefficient for the debt-to-equity ratio is negative. This indicates that females are less likely to manage risky firms considering that higher debt-to-equity ratio implies higher risk, while higher capital expenditures implies lower risk. This is in line with our expectations. The control variables for CFO gives somewhat ambiguous results, as both CapEx and R&D are negative. These results suggest that firm risk matters most for the likelihood of a female CEO. This is reasonable as the CEO position usually contains highest pay-performance sensitivity and the most responsibility. Furthermore, this is consistent with the findings of Khan and Vieito (2013), who found that firm risk is smaller if the firm is managed by a female CEO.

As a further robustness check, we next re-run the regressions from *Table 4* where we control for firm-fixed and year-fixed effects. The results can be seen in *Table 5*. Contrary to the pooled OLS, the coefficient for vega is only significantly negative in the CEO regression, while the coefficients for delta are only significantly negative in the CEO and CFO regressions. The significant association between equity incentives and the probability of having a female CEO as opposed to the other positions could be because the CEO position contains the highest earnings risk. This indicates that for the other positions other factors play a larger role in the likelihood of a female holding these positions, which will be addressed later.

Table 8

Model	(1)	(2)	(3)	(4)
Dependent	*CEO*	*CFO*	*COO*	*Lower Executives*
		Fixed Effects		
Vega $_{t-1}$ (in millions)	-0.103** (0.051)	-0.152 (0.102)	-0.042 (0.173)	0.212 (0.189)
Delta $_{t-1}$ (in millions)	-0.012** (0.013)	-0.030*** (0.011)	-0.004 (0.012)	0.028 (0.023)
Employees $_{t-1}$	-3e-03 (0.018)	0.017 (0.015)	-7e-04 (0.014)	-1e-03 (0.022)
CapEx $_{t-1}$	0.014 (0.048)	-0.113 (0.089)	0.062* (0.041)	-0.097 (0.140)
R&D $_{t-1}$	-0.011 (0.017)	0.072 (0.076)	-0.059 (0.050)	-0.123 (0.147)
Volatility $_{t-1}$	-0.033* (0.021)	-0.043 (0.029)	0.010 (0.042)	-0.043 (0.051)
D/E $_{t-1}$	-2e-05 (1e-05)	-2e-04 (8e-04)	5e-04 (6e-04)	7e-05 (1e-04)
Market/Book $_{t-1}$	4e-05 (4e-05)	-9e-05 (6e-05)	-2e-05 (3e-05)	5e-05 (5e-05)
Goodness of fit	0.941	0.901	0.932	0.767

*Statistically significant at the .10 level; **at the .05 level; ***at the .01 level.

Conclusion Hypothesis One

Our analysis showed that women, on average, hold lower vega and delta than men and are also less likely to be present in top management of firms that reward their executives through higher vega. However, the probability of observing a female top manager is not significantly associated with top management team delta. Based on these findings we find some support for our hypothesis, and we can therefore not reject it. However, it is difficult to make an ultimate conclusion in this regard, as our regression does not allow us to control for reverse causality. That is, we do not know whether women, once hired, are the ones that might be able to reduce the strength of incentives because of risk-aversion or whether they are simply less likely to accept a position in firms that rely more strongly on incentives.

When testing the association vega and delta have with the probability that women hold certain executive positions, we find some further support for our hypothesis. A higher CEO delta is associated with a reduced probability of observing a female CEO, while for lower executives, a higher vega is associated with a reduced probability of observing a female lower executive. This indicates that the effect of equity incentives depends on the type of position.

Hypothesis Two: Risk Premium

Hypothesis two: *We expect women to be higher represented in positions where the salary premium for compensation risk is higher*

Traditional agency theory assumes that agents are risk averse and need to be compensated for holding equity risk. Compared to shareholders, executives are undiversified as their wealth and human capital are disproportionately invested in their company. If managers are incentivized with risky pay-packages, they will often demand higher levels of "safe" pay (Jensen et al., 2004). Carter et al. (2017) show that for a given level of incentives women will require higher risk premium through higher salary, as compared to men. To test if this holds for our sample as well, we first calculate the ratios in *Table 9*, which is vega divided by salary and delta divided by salary.

Table 9

	Vega/Salary	Delta/Salary
Female	0.10	1.31
Male	0.12	11.54

The ratios are the means for those executives with vega and delta over the 75th percentile. As shown in the table, vega is 10 percent of salary for women and 12 percent for men. Furthermore, the delta of women is only 1.31 times larger than salary while for men it is 11.54 times larger. Both of these findings suggest that for every dollar increase in vega and delta, salary increases more for women than it does for men. This is in line with what Carter et al. (2017) found.

As previous literature has found that women are significantly more risk averse than men (Eckel and Grossmann, 2002; Niederle and Yestrumskas, 2008; Dohmen et al., 2011) and demand higher salary premiums for compensation risk (Jensen et al., 2004; Carter et al., 2017), we expect that women are least represented in positions where the salary premium for compensation risk is the lowest. To measure compensation risk, we use the vega and delta of the executive position.

Regression Specification

To test if hypothesis two holds we look at the association between salary and vega and delta and how this differs between male and female executives. The regressions are run on an unbalanced panel of firm-level data with 13,410 firm-year observations from 1808 unique firms. The regression is presented below. We run the same regression on all the executive categories (*Table 10*).

$$\text{Salary} = \beta_1 + \beta_2 * \text{Vega}_{t-1} + \beta_3 * \text{Delta}_{t-1} + \beta_4 * \text{Employees}_{t-1} + \beta_5 * \text{CapEx}_{t-1} + \beta_6 * \text{R\&D}_{t-1} + \beta_7 * \text{Volatility}_{t-1} + \beta_8 * \text{D/E}_{t-1} + \beta_9 * \text{Market/Book}_{t-1} + \beta_9 * \text{ROA}_{t-1} + \lambda_{1,\text{Year}} + \lambda_{1,\text{Industry}}$$

The dependent variable is the salary for each executive category measured at the firm level. As several executives fall into the category of lower executives we will use the average salary for lower executives measured in each firm-year observation. The reported vega and delta is also based on the individual executive category. Contrary to the regressions in hypothesis one, we do not use lagged values of vega and delta, as we assume that vega, delta, and salary is set in the same year. This is also in line with Carter et al. (2017). To check if the salary premium for vega and delta differs between men and women in the different executive positions we interact vega and delta with gender.

As previous literature has found a positive association between salary and firm size (Bertrand and Hallock, 2001), we control for firm size using log of employees. Consistent with Carter et al. (2017), we also control for firm risk, growth opportunities and firm performance by including CapEx, R&D expenditures, volatility, debt-to-equity ratio, market-to-book ratio and ROA. In the OLS regressions, we also control for year and industry by including year dummies and dummies for 1-digit SIC-codes.

As the largest share of women is found in the positions of lower executives and CFO, we expect these positions to display the highest coefficients on vega and delta. A higher coefficient indicates that the salary for these positions increase more for each dollar vega and delta increase, or vice versa, as we do not know the direction of the causality. Furthermore, we expect the coefficients on the interaction terms between vega and delta and gender to be positive, as women have been found to receive higher salary premium for compensation risk (Carter et al., 2017).

Regression Analysis

Table 10

Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent	Salary (in 1000)		Salary (in 1000)		Salary (in 1000)		Salary (in 1000)	
Subset	*CEOs*		*CFOs*		*COOs*		*Lower Executives*	
	OLS	*Fixed Effect*	*OLS*	*Fixed Effect*	*OLS*	*Fixed Effect*	*OLS*	*Fixed Effect*
Female	8.30 (21.36)	-41.20 (25.70)	-13.87** (8.91)	-48.75*** (8.45)	29.27 (47.53)	39.88 (52.17)	-6.87 (6.51)	-19.31*** (3.81)
Vega $_{t-1}$ (in 1000)	1.04*** (0.12)	2.48*** (5.86)	1.21*** (0.15)	0.41*** (0.09)	2.74*** (0.67)	1.42 (1.10)	1.30*** (0.19)	0.12* (0.07)
Female* Vega $_{t-1}$	-0.53** (0.24)	-0.35 (0.33)	-0.31*** (0.25)	-0.38** (0.18)	-0.01 (1.55)	-0.30 (1.12)	0.33* (0.24)	0.04 (0.14)
Delta $_{t-1}$ (in 1000)	0.01 (0.03)	0.01 (0.02)	-0.01 (0.03)	0.01 (0.01)	0.025 (0.03)	-0.01 (0.03)	-0.01 (0.02)	-0.01 (0.01)
Female* Delta $_{t-1}$	0.01 (0.05)	-0.03 (0.04)	-0.01 (0.02)	0.01 (0.01)	0.057 (0.10)	0.088 (0.10)	0.02 (0.02)	0.01 (0.01)
Employees$_{t-1}$	104.23*** (5.07)	62.20*** (9.60)	58.02*** (2.59)	28.27*** (4.59)	60.72*** (7.26)	79.94*** (19.47)	57.75*** (2.45)	30.38*** (5.33)
CapEx$_{t-1}$	-339.60*** (119.50)	-287.70*** (76.90)	-276.91*** (66.45)	-98.12 (61.84)	-260.90 (162.20)	115.64 (74.33)	-87.54 (62.51)	-69.57 (43.98)
R&D$_{t-1}$	-26.41 (20.74)	-18.90*** (5.30)	108.01*** (38.83)	-66.25** (30.94)	-241.90* (134.70)	48.72 (214.64)	158.23*** (39.32)	-6.14 (25.16)
D/E$_{t-1}$	0.11 (0.11)	-0.01 (0.05)	22.08 (0.04)	0.00 (0.02)	-0.020 (0.034)	0.01 (0.02)	0.02 (0.06)	0.01 (0.03)
Volatility $_{t-1}$	26.59 (37.09)	50.00** (23.30)	-20.01** (16.96)	-4.62 (12.94)	70.86 (58.00)	9.98 (37.48)	0.09 (17.61)	-4.60 (10.23)
ROA $_{t-1}$	18.52 (16.60)	63.60*** (15.43)	2.64 (8.51)	12.35 (9.64)	2.54 (2.33)	19.51 (17.84)	21.66 (14.09)	7.38 (5.53)
Industry Control	YES				YES		YES	
Year Control	YES				YES		YES	
Constant	685.20*** (16.80)		373.50*** (8.80)		435.90*** (36.60)		310.50*** (15.60)	
R^2	0.381	0.023	0.386	0.025	0.249	0.067	0.404	0.018
Adj-R^2	0.380	-0.134	0.385	-0.138	0.244	-0.273	0.403	-0.147

*Statistically significant at the .10 level; **at the .05 level; ***at the .01 level

The association between vega and salary is positive and significant across all OLS models. The coefficient is smallest for CEOs, as was expected (*Table 10, Model 1)*. This indicates that the position where women constitute the smallest share is also the position were executives are compensated the least for bearing compensation risk, as measured through vega. However, when controlling for fixed effects, the results are the opposite; CEO is the position that shows the strongest association between vega and salary, whereas lower executives show the weakest association. The coefficient on vega is still significant for all models when we control for fixed effect, except for COOs. As the share of females is lowest among the CEOs in our data, these results imply that women are least represented in the executive group that receives the highest compensation for vega. As fixed effect models use the within variation to estimate the coefficients, we will rely mostly on the fixed effect estimates for variables that vary, and therefore we conclude that female top executives are not higher represented in those positions where the compensation for vega is highest.

As the fixed effect estimates also are reliable when a time-invariant variable is interacted with a varying variable (Wooldridge, 2012), we will rely on fixed effects also for the interaction terms. When we interact vega with the female dummy, the results show that the association between vega and salary is significantly different only between male and female CFOs when we measure the model with fixed effects (*Table 10, Model 4).* As the coefficient is negative, this implies that female CFOs are compensated less than men, in the form of salary, for holding compensation risk as measured by vega. As the CFO position has the second largest share of women in our sample, this finding also contradicts our expectations. If female executives are more risk averse one would assume that they would receive a higher salary for a given level of vega. Further, this result also contradicts Carter et al. (2017). An explanation for this difference might be that we look at each position separately, while Carter et al. (2017) look at all positions combined. Additionally, the sample period is larger than ours (1996 - 2010).

Even though the interaction term between vega and the female dummy is not significant for any of the other executive positions (*Model 2, Model 6, Model 8)* when measured with fixed effect, the sign of the estimates might give us some indications about the direction of the association. The coefficient on the interaction between vega and the female dummy is negative for CEOs and COOs and positive for lower executives when we include fixed effect. This indicates that females, compared to males, are compensated less for vega when they are CEOs and COOs. For lower executives, the association between vega and salary is stronger for females, which implies that female lower executives are compensated more than their male counterparts. If we only consider the size and not the significance of the estimates, the results imply that females are compensated the most for vega in CEO positions. As females are least represented in CEO positions, these results contradict with our expectations.

The association between delta and salary is not significant across any of the models or executive positions. Neither is the coefficient on the interaction term between female and delta. However, if we only look at the size and not the significance of the delta coefficients, the results imply that female executives are compensated the most for delta in the COO position.

The insignificant delta coefficients suggest that salary is not dependent on the level of delta, or vice versa. The lack of association between delta and salary, might be because unrestricted stock can be regarded as more safe pay whereas the value of an option as compensation is not realized before it is exercised. Our findings contradict Carter et al. (2017) who found a positive and significant association between delta and salary and a significant difference in the strength of association between male and female executives. The different results could be due to the fact that while they use option delta, we use total delta, which consists of delta of both options and shares. By only controlling for delta of options and not of shares, Carter et al. (2017) do not control for the level of stocks the executive own. Furthermore, they only run one regression on all of the executives together.

Among our control variables, size is significant across all our models. Log of employees is positively associated with salary for all the executive positions. This positive association between size and salary indicates that executives working for the largest firms are paid more in salary. The significance and sign of the other control variables vary across model and position and hence do not give us any clear indication of their association with salary.

Conclusion Hypothesis Two

When we use vega and delta as measures of compensation risk, only vega is significantly associated with salary. However, this significance only applies to CEOs, CFOs, and lower executives. The association is positive, which can imply that executives are compensated in the form of salary for bearing compensation risk, measured by vega. This premium is, however, only significantly different between male and female executives in the position of CFO. Surprisingly, female CFOs receive less in salary for a given level of vega compared to male CFOs. These findings contradict our expectations. Based on the higher risk aversion among females and the assumption that agents need to be compensation for holding compensation risk, one would expect to see the opposite. Our findings do not allow us to confirm our hypothesis. Possible explanations might be that our results are driven by men receiving a higher salary than women. If men earn more than women in management, our results might reflect this. Another possible explanation might be that female top executives are not any more risk averse than their male counterparts and therefore do not require salary premiums. By and large, we cannot conclude that the level of salary premium can help explain the share of women in an executive category.

Hypothesis Three: The Role of Female Role Models in Top Management

Hypothesis three: *Women are more likely to be present in top management teams of firms that have been previously employing a higher share of females in top management.*

Previous research has shown that the gender composition of a group might impact women's aversion towards risk and competition (Gneezy et al., 2003; Gneezy and Rustichini, 2004; Gupta et al., 2005; Antonovics et al., 2009). We therefore hypothesized that the presence of female top executives in a firm would be positively associated with an increase of females in top management within the same firm. Further, having a female executive might change the impact of vega and delta on observing new female executives.

Regression Specification

To assess the validity of hypothesis three, we look at the association between the presence of females in top management and the subsequent change in the number of females employed in top management the three following years. The dependent variable is a dummy taking the value 1 if there has been a positive change in the number of women in top management. The change is measured over a three year period within each firm. If there has been no or a negative change the dependent variable takes the value 0. We include control variables for size (log of employees), risk (R&D, CapEx, volatility and debt-to-equity ratio) and growth opportunities (market-to-book ratio). We use the 3-year lag for all independent variables. Additionally, we include a variable measuring the 3-year lag of the number of women in the top management team within each firm. All firms with less than four years of observations are naturally excluded from the dataset. The resulting number of firm-year observations is 9861.

To test whether having a female CEO or chairman is associated with the probability of observing a positive change in female top executives within a firm, we create three new dummies. We create a dummy for female CEOs, female chairmen, and a dummy indicating that both the CEO and chairman are females. To exclude a situation of perfect multicollinearity between these dummies, the variables are coded such that an executive only fits in one of the groups. For example, the dummy of female CEO takes the value 1 if the CEO of the company is female and if the chairman is male, and 0 otherwise. This means that firms with a female CEO and a female chairman will not be included in the other two dummies. Even though this makes the sample of female CEOs and chairmen smaller than what it truly is, it allows us to assess the impact of having one versus two powerful positions filled by women. To test whether the association between vega and delta and our dependent variable is affected by the presence of a female we interact vega and delta with all the variables indicating the presence of a female top manager within a firm. The complete regression with all control variables is:

ΔFemale = β_1 + β_2 * Vega$_{t-3}$ + β_3 * Delta$_{t-3}$ + β_4 * Employees$_{t-3}$ + β_5 * CapEx$_{t-3}$ + β_6 * R&D$_{t-3}$ + β_7 * D/E$_{t-3}$ + β_8 * Market/Book$_{t-3}$ + β_9 * Volatility$_{t-3}$ + β_{10} * #F$_{t-3}$ + β_{11} * Vega$_{t-3}$ *#F$_{t-3}$ + β_{12} * Delta$_{t-3}$* #F$_{t-3}$ + β_{13} * F_CEO$_{t-3}$ + β_{14} * F_Chairman$_{t-3}$ + β_{15} * F_Chairman & CEO$_{t-3}$ + β_{16} * Vega$_{t-3}$ * F_CEO$_{t-3}$ + β_{17} * Vega$_{t-3}$ * F_Chairman$_{t-3}$ + β_{18} * Vega$_{t-3}$ * F_Chairman & CEO$_{t-3}$ + β_{19} * Delta$_{t-3}$ * F_CEO$_{t-3}$ + β_{20} * Delta$_{t-3}$ * F_Chairman$_{t-3}$ + β_{21} * Delta$_{t-3}$ * F_Chairman & CEO$_{t-3}$ + $\lambda_{1,Year}$ + $\lambda_{1,Industry}$

(F = female)

The regression results from hypothesis three are presented in *Table 11* (OLS) and *Table 12* (fixed effect). Dummies for industry and year are not included in the fixed effect regressions. The regressions are run on an unbalanced panel of firm-level data with 9861 firm-year observations from 1664 unique firms.

Regression Analysis

Table 11

Model	(1)	(2)	(3)	(4)	(5)	(6)
Dependent			**Positive change in female executives**			
			OLS			
Vega$_{t-3}$ (in millions)	0.100 (0.094)	0.042 (0.102)	0.030 (0.105)	0.036 (0.083)	-0.021 (0.121)	0.031 (0.105)
Delta$_{t-3}$ (in millions)	-0.010 (0.011)	-0.013 (0.011)	-0.014 (0.012)	-0.013 (0.009)	-0.010 (0.014)	-0.010 (0.012)
Employees$_{t-3}$		0.008*** (0.003)	0.008** (0.004)	0.008** (0.002)	0.008** (0.003)	0.008** (0.003)
CapEx$_{t-3}$		0.063 (0.086)	0.060 (0.074)	0.069 (0.067)	0.059 (0.088)	0.067 (0.086)
R&D$_{t-3}$		-0.014 (0.065)	-0.028 (0.068)	-0.011 (0.056)	-0.030 (0.068)	-0.011 (0.065)
D/E$_{t-3}$		2e-06 (5e-05)	-1e-06 (5e-05)	7e-07 (1e-04)	3e-07 (5e-05)	1e-06 (5e-05)
Market/ Book $_{t-3}$		1e-04 (1e-04)	-1e-04 (1e-04)	-1e-04 (1e-04)	-1e-04 (1e-04)	-1e-04 (1e-04)
Volatility$_{t-3}$		0.049 (0.034)	0.052 (0.035)	0.051 (0.023)	0.053 (0.035)	0.052 (0.034)
# Female $_{t-3}$			-0.043*** (0.006)		-0.044*** (0.008)	
Vega $_{t-3}$* #Female $_{t-3}$					0.140 (0.124)	
Delta $_{t-3}$* #Female $_{t-3}$					-0.013 (0.011)	
Female CEO$_{t-3}$				-0.069*** (0.019)		-0.060** (0.024)
Female Chairman$_{t-3}$				-0.112* (0.052)		-0.063 (0.119)
Female Chairman& CEO$_{t-3}$				0.073** (0.039)		0.105** (0.052)
Vega $_{t-3}$*Female CEO$_{t-3}$						-0.052 (0.579)
Vega $_{t-3}$*Female Chairman$_{t-3}$						-0.392 (0.453)
Vega$_{t-3}$*Female Chairman& CEO$_{t-3}$						0.143 (0.555)
Delta $_{t-3}$*Female CEO$_{t-3}$						-0.040** (0.019)
Delta $_{t-3}$*Female Chairman$_{t-3}$						-0.028 (0.051)
Delta$_{t-3}$*Female Chairman& CEO$_{t-3}$						-0.203**
Industry Control	YES	YES	YES	YES	YES	YES
Year Control	YES	YES	YES	YES	YES	YES
Constant	0.111*** (0.017)	0.075*** (0.028)	0.081*** (0.028)	0.072** (0.027)	0.081*** (0.029)	0.072*** (0.028)
Goodness of fit	0.788	0.778	0.726	0.818	0.752	0.732

*Statistically significant at the .10 level; **at the .05 level; ***at the .01 level.

Table 12

Model	(1)	(2)	(3)	(4)	(5)	(6)
Dependent		**Positive change in female executives**				
			Fixed Effect			
Vega$_{t-3}$ (in millions)	0.281* (0.166)	0.265* (0.149)	-0.053 (0.148)	0.218 (0.148)	-0.115 (0.160)	0.226 (0.158)
Delta$_{t-3}$ (in millions)	-0.012 (0.015)	-0.012 (0.015)	-0.010 (0.014)	-0.011 (0.015)	-0.016 (0.016)	-0.009 (0.016)
Employees$_{t-3}$		0.032 (0.019)	0.026* (0.016)	0.029 (0.019)	0.026* (0.016)	0.029 (0.019)
CapEx$_{t-3}$		-0.018 (0.180)	-0.079 (0.143)	-0.009 (0.179)	-0.077 (0.144)	-0.008 (0.179)
R&D$_{t-3}$		0.037 (0.104)	-0.077 (0.123)	0.034 (0.104)	-0.074 (0.126)	0.035 (0.104)
D/E$_{t-3}$		4e-05 (5e-05)	2e-05 (5e-05)	3e05 (5e-05)	2e-05 (5e-05)	3e-05 (5e-05)
Market/ Book $_{t-3}$		-2e-04 (2e-04)	-1e-04 (1e-04)	-1e-04 (1e-04)	-1e04 (1e-04)	-1e04 (1e-04)
Volatility$_{t-3}$		-0.011 (0.063)	-0.063 (0.056)	-0.017 (0.063)	-0.062 (0.056)	-0.020 (0.063)
# Female $_{t-3}$			-0.378*** (0.013)		-0.386*** (0.014)	
Vega $_{t-3}$* # Female $_{t-3}$					0.118 (0.199)	
Delta $_{t-3}$* # Female $_{t-3}$					0.016 (0.024)	
Female $_{t-3}$ CEO$_{t-3}$				-0.215*** (0.044)		-0.195*** (0.045)
Female $_{t-3}$ Chairman$_{t-3}$				-0.230** (0.116)		-0.229* (0.133)
Female Chairman& CEO$_{t-3}$				0.083 (0.062)		0.108* (0.060)
Vega $_{t-3}$* Female CEO$_{t-3}$						-1.247 (1.270)
Vega $_{t-3}$* Female Chairman$_{t-3}$						-0.553 (0.494)
Vega $_{t-3}$* Female Chairman& CEO$_{t-3}$						0.107 (0.798)
Delta $_{t-3}$* Female CEO$_{t-3}$						0.033 (0.041)
Delta $_{t-3}$* Female Chairman$_{t-3}$						0.027 (0.137)
Delta $_{t-3}$* Female Chairman& CEO$_{t-3}$						-0.183* (0.106)
Goodness of fit	0.871	0.923	0.901	0.889	0.931	0.0.904

*Statistically significant at the .10 level; **at the .05 level; ***at the .01 level.

Contrary to the reviewed literature (Elvira and Cohen, 2001; Huffman et al., 2010; Cohen and Broschak, 2013; McGinn and Milkman, 2013), our results indicate that there is a significant negative association between the number of females in top management and the appointment of new female executives in the following years. This result holds across both OLS (*Table 11, Model 3 and 5*) and fixed effects (*Table 12, Model 3 and 5*). However, the size of the coefficient measuring the three-year lag of the number of women is somewhat different depending on the estimator used, i.e., regular OLS or the firm fixed effect regressions. As the pooled OLS model does not take into consideration the unobserved heterogeneity that is related to the firm characteristics, the fixed effect estimates might be more reliable. On the other side, little within-firm variation in the variable measuring the number of women (the three-year lag) might reduce the reliability of the fixed effect estimates. Nevertheless, we find that in both cases the coefficients are negative and statistically significant. This allows us to conclude that, indeed, the number of females in top management is associated with a decrease in the number of females in top management in subsequent years.

The size of the sample studied might be some of the explanation as to why our results differ from the previous literature discussed. Elvira and Cohen (2001) look at a single Fortune 500 firm, while McGinn and Milkman (2013) look at a single law firm, and Cohen and Broschak (2013) use a sample of New York advertising agencies. The only study that has a sample size comparable to ours is Huffman et al. (2010) which study observations from 68,269 US firms in the period 1975 to 2005. The difference might be that firms in their sample are present for a longer period which makes it possible to observe changes in gender inequality that develops more slowly. Using the change over a three-year period, as in our study, limits our sample size to those firms observed for at least three years and the sample period are reduced to seven years.

An explanation of the observed relationship in this study is what has been called the Queen Bee Syndrome (Kanter, 1977). Women in powerful positions might have a negative effect on other women’s way to power. The Queen Bee Syndrome describes how a woman in authority more critically judges female subordinates compared to male subordinates. This might explain why having a female in top management does not increase the likelihood of additional females obtaining top executive positions.

The result of the regressions when including a dummy for female CEOs, chairmen, and instances where both positions are filled by a woman are reported in *Table 11, model 4 and 6* and *Table 12, model 4 and 6.* If the Queen Bee Syndrome holds one could expect that when the position of highest authority within a company is held by a woman, the probability of observing an increase in the number of women in the top management team is lower. On the other side, if there is no Queen Bee Syndrome among female executives one could expect that when the highest position is held by a woman, she is more likely to have a positive view on other female executives and therefore promote them. As seen from the regression results, a female CEO associates with a negative and significant change in the number of women in the top management team for the following years. For both the OLS and fixed effect regression the coefficients are negative and statistically significant. The association between having a female chairman and the subsequent change in the number of female executives is also negative and statistically significant. On the contrary, having both a female CEO and chairman is positively and significantly associated with an increase in female executives.

These findings imply that the Queen Bee syndrome holds, however not when both the CEO and chairman positions are filled by women. As boards are normally male-dominated (Adams and Ferreira, 2009), a female chairman might not be able to influence the hiring of new female executives if she does not have support from a female CEO or other females on the board. This could be a possible explanation as to why the association is positive only when both the CEO and chairman are females. Previous research has indeed shown an association with the number of females on board and the impact they have. MSCI (2015) found that boards need at least three women to increase the likelihood of women's opinion being heard. This might explain why we do not see any positive association between a female chairman and a positive increase.

Even though our findings contradict most of the reviewed literature we can draw similarities to Gorman (2005), who found that female partners at law firms were more likely to hire a woman than a man if women were a minority among the company's leaders. This effect diminished as the proportion of women in top management increased. These findings suggest that the effect of having females in top management on the hiring of new female top managers is positive up until a certain point. Perhaps when top management reaches this point, there is no "room" for more women. While some further research and more observations with both female CEOs and chairmen are required to conclude this, this explanation might also apply to our results.

The regressions run (*Table 11 and 12*) might also say something about how the level of vega and delta associates with the growth/decline in female executives within a firm. As discussed in the literature, compensation risk might increase the perceived competitiveness of a workplace (Manning and Saidi, 2010). Further, it has been proved that women shy away from competitive workplaces (Flory et al., 2015). If earnings risk truly increases competitiveness and this increase women's aversion to top management positions, one could expect that an increase in vega and/or delta within a top management team will negatively affect the change in the number of females in the following years. However, if there are women already in top management one might expect this association to be weaker.

The results show that neither vega nor delta is significantly associated with our dependent variable when we include all control variables. Based on these findings it is plausible that compensation risk does not influence the change in the number of female executives within a firm. Vega and delta are interacted with the number of females in top management to assess whether the impact of compensation risk on the change in the number of female executives, decreases in the presence of other female executives. The interaction terms are not significant for neither the OLS model (*Table 11, Model 6)* or fixed effects (*Table 12, Model 6*). When we interact vega and delta with the position dummies some of them are significant. In the OLS model, the association between delta and our dependent variable is significantly dependent on the presence of a female CEO or the presence of both a female CEO and chairman. As the estimates are negative, this implies that when there is a female CEO or female CEO and chairman an increase in delta is associated with a more negative change in the probability of observing a positive change in the number of female managers. This contradicts our expectations and implies that the presence of a female manager does not decrease other females' aversion towards risk and competitiveness.

As expected, the coefficients for the 2015 and 2016 year dummies are negative and significant. This is in line with the negative change in the share of female executives observed in 2015 and 2016 (see Descriptive Statistics, *Figure 1*).

The remaining control variables in the regressions might give indications of what other factors are associated with the increase/decrease in female managers. The coefficient for size (log of employees) is positive and statistically significant in all the OLS models. Namely, an increase in firm size is associated with a higher probability of observing a positive change in the number of female managers. This contradicts with our expectations as previous findings show that female managers often work for smaller firms (Bertrand and Hallock, 2001). However, it is consistent with our previous findings, which suggest that larger firms are more likely to employ women in top management. None of the remaining control variables are significantly associated with the probability of observing a positive change in the number of female top executives. This implies that neither risk or investment opportunities play an important role in predicting the change in female top executives.

Conclusion Hypothesis Three

We hypothesized that women are more likely to be present in management teams of firms that have been previously employing a higher share of females in top management, and that the presence of females in top management will make females less averse towards vega and delta. Our analysis shows the opposite; the number of females three years prior as well as the presence of a female CEO or chairman is negatively associated with the probability of observing a positive change in the number of females in a top management team. However, this is not the case when both the CEO and chairman are female. Their presence is positively associated with the subsequent change in the number of women in top management. Furthermore, we found that the presence of a female CEO or chairman does not decrease the negative association of vega and delta with the change in the number of female executives. Our results somewhat suggest that a female executive with high authority, such as CEO or chairman, might have some influence in promoting new females to management, while this is less likely to be the case for other women in management. Based on these results we cannot confirm our hypothesis.

Hypothesis Four: Firm Performance

Hypothesis four: *Firms with female managers will perform better when vega and delta are lower.*

The ultimate goal of corporate governance is to align the interest of managers and shareholders. As shareholders' interest is to maximize return on their invested capital, the compensation structures should also be designed with this aim. As discussed in the literature review, previous studies have found a relationship between performance-based compensation schemes and the perceived competitiveness of a workplace (Manning and Saidi, 2010). Further, studies have also found that men perform better in competitive environments (Gneezy et al., 2003; Gupta et al., 2005). Executives' equity compensation (stocks and options) depends on the performance of the firm. The sensitivity of this compensation to firm performance is measured through the level of vega and delta. Based on these findings it is plausible that, in firms where there are female top executives, there is a negative association between firm performance and vega and delta. To test hypothesis four, we look at the association between vega and delta and firm performance. As vega and delta are used to induce managers to make optimal investment and financing decisions (Guay, 1999), one can assume that vega and delta, after controlling for firm characteristics, are positively associated with firm performance.

Regression Specifications

In line with Carter et al. (2017), we measure firm performance using the annual stock return. To validate our findings, we also include the market-to-book ratio and return on asset (ROA) as additional measures of firm performance. This is in line with previous corporate governance research where market-to-book ratio has been used as a proxy for Tobin's Q (Adams and Ferreira, 2009) and ROA used as an accounting measure of firm performance (Adams and Ferreira, 2009; Coles and Li, 2013). ROA is calculated as the ratio of net income before discontinued operations and extraordinary items to the book value of assets.

As previous research has shown, the effect of delta on firm performance is non-linear. Normally delta has an inverted U-shaped relationship with firm performance, i.e., for values of delta up to a certain level, firm performance will increase. However, due to managers' risk aversion, high values of delta might make the manager reluctant to take on risky projects and as a result of this firm performance might decrease. Further, the effect of vega on firm performance has shown to be dependent on the level of delta. For values of delta that result in decreased firm performance the risk-taking effect of vega might be different than for lower values of delta (Bulan et al., 2010). Due to these complex relationships between vega/delta and firm performance we will follow Bulan et al. (2010) and include the quadratic term of delta to capture possible non-linear effects, and we interact vega with delta to capture their interdependence.

To account for the fact that vega and delta might differ across firms and that performance will depend on certain firm characteristics we include various control variables. We control for firm risk, size, industry, firm fixed and time fixed effects using our previously described control variables.

Including an interaction term and an exponential variable causes multicollinearity among the regressors. As our statistical software, R, are not able to estimate fixed effect models when the explanatory variables are strongly collinear, we will report the model with the interaction and exponential term using only an OLS model. In R, the command for the linear model automatically replaces NAs in the beta vector for the coefficients not estimated, while the command for fixed effect estimation fails to estimate the model.

We run two sets of different regressions which are both run on an unbalanced panel of firm-level data with 13,410 firm-year observations from 1808 unique firms. In the first set of regressions (*Table 13*) we measure the association between vega and delta and different performance measures. As the analysis will show, ROA displayed the strongest significance with our explanatory variables. Therefore, in our second set of regressions (*Table 14*), where we look at how the association between vega and delta and firm performance differ between executive positions, we use ROA as the dependent variable.

Our final model is specified below:

Firm performance = $\beta_1 + \beta_2 * Vega_{t-1} + \beta_3 * Delta_{t-1} + \beta_4 * Delta_{t-1}\text{^}2 + \beta_5 * Female_{t-1} + \beta_6 * Employees_{t-1} + \beta_7 * CapEx_{t-1} + \beta_8 * R\&D_{t-1} + \beta_9 * D/E_{t-1} + \beta_{10} * Volatility_{t-1} + \beta_{11} * Vega_{t-1} * Female_{t-1} + \beta_{12} * Delta_{t-1} * Female_{t-1} + \beta_{13} * Delta_{t-1}\text{^}2 * Female_{t-1} + \beta_{14} * Vega_{t-1} * Delta_{t-1} + \beta_{15} * Vega_{t-1} * Delta_{t-1} * Female_{t-1} + \lambda_{1,Year} + \lambda_{1,Industry}$

Regression Analysis

Table 13

Model	(1)	(2)	(3)	(4)	(5)	(6)
Dependent	Annual Stock Return		ROA		Market to Book	
	OLS	*Fixed Effect*	*OLS*	*Fixed Effect*	*OLS*	*Fixed Effect*
Vega$_{t-1}$ (in millions)	-14.652** (5.752)	-10.571 (5.694)	0.303*** (0.039)	-0.033* (0.043)	-14.799* (8.219)	-12.825 (13.7)
Delta$_{t-1}$ (in millions)	1.442 (2.517)	-0.373 (1.404)	0.041 (0.026)	0.008 (0.009)	-1.203 (2.736)	-1.771 (1.108)
Delta$_{t-1}$^2 (in millions)	-0.632 (0.877)		-0.010 (0.009)		0.243 (0.883)	
Female $_{t-1}$	0.552 (1.689)	0.459 (2.235)	0.002 (0.004)	0.005 (0.005)	-2.111** (0.927)	-2.925** (1.473)
Employees$_{t-1}$	0.253 (0.296)	0.118 (0.829)	-0.002 (0.002)	-0.024*** (0.009)	0.211 (0.177)	-0.258 (0.983)
CapEx$_{t-1}$	0.529 (5.436)	5.412 (9.067)	0.089 (0.073)	0.510*** (0.157)	-0.246 (2.539)	0.257 (8.289)
R&D$_{t-1}$	0.471 (0.837)	-0.104 (0.317)	-0.982*** (0.047)	-1.128*** (0.008)	1.310 (1.325)	0.554 (0.69)
D/E$_{t-1}$	-0.001 (0.001)	0.001 (0.002)	-5e-05*** (1e-05)	-2e-05** (1e-05)	-0.006 (0.008)	-0.044*** (0.011)
Volatility	0.603 (0.500)	-1.658 (2.122)	-0.111*** (0.013)	0.092*** (0.021)	-5.119** (2.476)	-6.780 (5.494)
Vega$_{t-1}$* Female $_{t-1}$	-1.606 (10.167)	-0.754 (13.143)	-0.118** (0.058)	-0.047 (0.064)	44.079 (28.725)	12.691 (32.126)
Delta$_{t-1}$* Female $_{t-1}$	-3.198 (5.384)	-1.378 (2.016)	0.021 (0.034)	-0.002 (0.010)	-0.739 (6.221)	3.463 (4.515)
Delta$_{t-1}$^2 *Female$_{t-1}$	1.080 (1.824)		-0.008 (0.013)		3.056 (5.902)	
Vega$_{t-1}$* Delta$_{t-1}$	4.447 (2.766)		-0.065 (0.054)		7.226 (4.486)	
Vega$_{t-1}$* Delta$_{t-1}$ *Female $_{t-1}$	1.649 (4.094)		0.062 (0.063)		-62.750 (47.807)	
Industry Control	YES		YES		YES	
Year Control	YES		YES		YES	
Constant	-0.304 (1.487)		-0.027* (0.014)		3.262** (1.272)	
R^2	0.001	0.000	0.388	0.476	0.004	0.005
Adj-R^2	0.000	-0.157	0.387	0.394	0.002	-0.153

As can be seen in *Table 13*, the association between vega and delta and firm performance differs depending on the different performance measures used. Vega has a significant and negative association with annual stock return which only holds for the OLS regression (*Model 1*). The association between vega and ROA is negative and significant in both the OLS and the fixed effect model (*Model 3 and 4*). Market-to-book ratio is only significantly associated with vega when the model is estimated with OLS (*Model 5*). The negative association between vega and firm performance, measured as ROA, is consistent with Coles and Li (2013), but it also contradicts several previous studies. Both Coles et al. (2006), Low (2009) and Bulan et al.

(2010) show that vega is positively associated with firm performance. Our result further show that risky firm policies, as investment in R&D and more aggressive debt policies, is significantly and negatively associated with ROA. If vega induces managers to implement risky firm policies, this might explain the negative association we see between vega and ROA.

The coefficient of delta is not significant for any of the performance measures. These findings imply that the relationship between incentives and performance is somewhat ambiguous, and differ between different performance measures. Further, if we rely on fixed effect, the association between vega and delta and firm performance does not differ depending on whether or not there is a female in top management. This implies that the effect of incentives does not depend on gender.

An explanation for the results might be that the regressions are based on the average vega and delta for each top management team in our sample. This might give a misleading picture of how incentives affect performance as the vega and delta might differ substantially between the top executive positions within a firm. Using the mean might also be misleading as managers most likely are more affected by their own delta and vega than by their colleagues. It is also reasonable to assume that managers differ in how much they are able to impact firm performance. As CEOs often have a more direct impact on firm performance (Coles et al., 2006; Bulan et al., 2010; Coles and Li, 2013) one might assume that vega and delta of male and female CEOs are more strongly associated with firm performance compared to other top management positions.

To test whether this is the case, we run the same regressions as reported in *Table 13*. However, we replace the average management team vega and delta with the vega and delta corresponding to the different positions. The unit of analysis is still the firm, i.e., the regressions are run on firm level. The gender dummy takes the value 1 if the firm has a female in the executive position the regression refers to. The vega and delta used in the regressions are the vega and delta of that executive position in the firm the year before.

Table 14

Model	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent	ROA		ROA		ROA		ROA	
	CEOs		*CFOs*		*COOs*		*Lower Executives*	
	OLS	*Fixed Effect*	*OLS*	*Fixed Effect*	*OLS*	*Fixed Effect*	*OLS*	*Fixed Effect*
$Vega_{t-1}$ (in millions)	0.116*** (0.018)	-0.043* (0.023)	0.257*** (0.058)	-0.024 (0.044)	0.179*** (0.068)	-0.122* (0.074)	0.310*** (0.042)	0.006 (0.053)
$Delta_{t-1}$ (in millions)	0.044** (0.02)	0.014** (0.005)	0.047** (0.022)	0.009 (0.008)	-0.077 (0.09)	0.171* (0.087)	0.050*** (0.016)	0.010 (0.012)
$Delta_{t-1}$^2 (in millions)	-0.008 (0.007)		-0.022** (0.009)		0.119 (0.091)		-0.038*** (0.012)	
$Female_{t-1}$	-0.015** (0.007)	-0.002 (0.01)	0.019*** (0.006)	0.015* (0.008)	0.016 (0.019)	0.056* (0.034)	0.008 (0.005)	0.009* (0.005)
$Employees_{t-1}$	-0.002 (0.002)	-0.023*** (0.008)	0.001 (0.002)	-0.024*** (0.009)	0.003* (0.002)	-0.054*** (0.014)	-2e-04 (0.001)	-0.032*** (0.009)
$CapEx_{t-1}$	0.065 (0.075)	0.504*** (0.161)	0.110 (0.086)	0.510*** (0.188)	0.110 (0.147)	0.645* (0.388)	0.122 (0.081)	0.502*** (0.189)
$R\&D_{t-1}$	-0.984*** (0.048)	-1.128*** (0.008)	-0.858*** (0.272)	-1.022*** (0.105)	-0.274*** (0.097)	-1.275*** (0.202)	-0.614*** (0.056)	-1.016*** (0.105)
D/E_{t-1}	-5e-05*** (2e-05)	-2e-05** (1e-05)	-5e-05*** (2e-05)	-2e-05* (1e-05)	-2e-05*** (5e-06)	-8e-06 (1e-05)	-4e-05*** (1e-05)	-2e-05** (1e-05)
$Volatility_{t-1}$	-0.109*** (0.014)	0.089*** (0.021)	-0.123*** (0.010)	0.077*** (0.017)	-0.089*** (0.013)	0.099*** (0.034)	-0.129*** (0.009)	0.007*** (0.017)
$Vega_{t-1}$* $Female_{t-1}$	0.049 (0.052)	0.050 (0.043)	-0.305*** (0.105)	-0.016 (0.119)	-0.691** (0.280)	0.181 (0.273)	-0.141* (0.080)	-0.065 (0.075)
$Delta_{t-1}$* $Female_{t-1}$	0.055** (0.027)	-0.005 (0.01)	-0.031 (0.067)	-0.049 (0.038)	0.100 (0.140)	-0.291* (0.165)	-0.055 (0.037)	-0.045** (0.021)
$Delta_{t-1}$^2 *$Female_{t-1}$	-0.027** (0.012)		-0.036 (0.034)		-0.128 (0.099)		0.027 (0.032)	
$Vega_{t-1}$* $Delta_{t-1}$	-0.045** (0.018)		0.199 (0.148)		-0.255* (0.142)		0.105 (0.084)	
$Vega_{t-1}$* $Delta_{t-1}$ *$Female_{t-1}$	0.014 (0.064)		0.597 (0.613)		0.705*** (0.216)		0.277 (0.218)	
Industry Control	YES				YES		YES	
Year Control	YES				YES		YES	
Constant	-0.027* (0.014)		-0.019 (0.013)		-0.029 (0.019)		-0.024** (0.012)	
R^2	0.393	0.484	0.127	0.060	0.102	0.099	0.140	0.064
Adj-R^2	0.391	0.402	0.125	-0.097	0.095	-0.227	0.138	-0.093

*Statistically significant at the .10 level; **at the .05 level; ***at the .01 level.

As our explanatory variables display the highest significance when ROA is used to measure firm performance, we will use ROA as the dependent variable in the following regressions (*Table 14*). In contrast to annual stock return and market-to-book ratio, ROA is a purely accounting-based measure of performance. A disadvantage of using ROA as a performance measure is that it might vary considerably from industry to industry. Some industries are more asset-intensive than others and would therefore have other levels of ROA compared to, e.g,. a software company where the asset base is considerably lower. Despite these drawbacks, we will follow Coles and Li (2013) and rely on ROA as a reliable performance measure. As in our previous regressions, we will control for industry using the 1-digit SIC code. The regression results are presented in *Table 14.*

CEOs

For CEOs the association between females and ROA is negative, i.e., having a female CEO is associated with lower firm performance relative to a male CEO. This finding is significant in the OLS model (*Table 14*, *Model 1*). The size of the coefficient implies that, on average, a female CEO is associated with a decrease in ROA of 1.5 percent, when holding all other variables constant. This association is not significant when we control for fixed effect. As gender does not vary much within the firms, using the fixed effect model might not be appropriate, so we therefore rely on the OLS estimate of gender and conclude that, indeed, there is a negative association between female CEOs and ROA. This is in contrast with the findings of Khan and Vieito (2013), who found that firms perform better when managed by a female CEO as opposed to a male CEO.

Both vega and delta of CEOs are significantly associated with firm performance, this holds for both the OLS and the fixed effect model. The coefficient estimate for delta is positive for both models, while vega is positive in the OLS model and negative in the fixed effect model. As vega varies in our sample, we will rely on the fixed effect estimate and conclude that CEOs vega has a negative association with the firm's ROA. These findings are consistent with Coles and Li (2013), who also find a positive association between executive delta and ROA and a negative association between vega and ROA.

There is no evidence of a non-linear relationship between delta and firm performance as the estimate of delta squared is insignificant. However, the coefficient is negative which implies that the relationship is inversely U-shaped. This is consistent with prior literature (Bulan et al., 2010).

Our primary interest is how the effect of delta and vega differs between men and women. If we only rely on fixed effects, the results show that the association between vega and delta and firm performance is not significantly different between male and female CEOs. However, the results show that the coefficient on delta squared interacted with gender is negative and significant. The squared term indicates when the observed relationship between delta and firm performance wears off. Surprisingly, the result indicates that the positive association between CEO delta and ROA has its turning point at a lower value of delta for male CEOs than for female CEOs. Based on the estimated coefficients the positive relationship will on average turn into negative for female CEOs when delta has a value of 650,000 USD, while for male CEOs for a delta value of 365,000 USD (appendix 7). These findings contradict with prior studies (Baixauli-Soler et al., 2015), and can imply that the increased risk from holding a high delta affects women less negatively than men. This is in line with previous research (Adams and Funk, 2009) who find that, while the average woman might be more risk averse than the average man, the women who hold management positions are actually more risk-loving than their male counterparts. Further, our results imply that female CEOs does not perform better when vega and delta are lower.

As the estimate of the interaction between vega and delta is significant and negative, it is plausible to assume that the association between vega and ROA changes as the level of delta changes. The estimated negative coefficient on the interaction term shows that, for higher values of CEO delta, vega has a less positive association with ROA than for lower levels of delta. This is contrary to the findings of Bulan et al. (2010) which gets a positive coefficient on the interaction term. Their result indicates that, for higher values of delta, vega has a more positive impact on firm performance. They argue that this is logical considering that higher deltas might increase risk aversion among managers and that they therefore are willing to take on risky, but value-added projects when vega increase. The interaction between vega and delta is not significantly different for male and female CEOs.

For high values of delta, vega does not mitigate the negative effect that follows from holding large equity shares. Therefore, a possible explanation as to why our results differ from Bulan et al. (2010), might be that the CEOs in our sample are more risk averse compared to those in their sample. While our sample only excludes financial firms, Bulan et al. (2010) only look at manufacturing firms and their sample period is the ten-year period from 1992 to 2003, while our sample period starts four year later.

CFOs

The association between gender and ROA is positive and significant and holds across both the OLS and the fixed effect model. This suggests that firms perform better with a female CFO than with a male CFO. Holding all other variables constant, the firms with a female CFO have a ROA that is higher on average by 1.9 or 1.5 percent, depending on the model. We find that measures of risk (R&D, D/E, and volatility) are negatively and significantly associated with firm performance for both OLS and fixed effect.

The association between equity incentives and firm performance (ROA) gives somewhat ambiguous results. Neither vega nor delta has a significant association with ROA. If we rely on fixed effects, the association between vega and delta and firm performance does not differ between female CFOs and male CFOs. This suggests that incentivising CFOs with equity incentives does not have any impact on firm performance. An explanation for this might be that the CFOs, in our sample, are not that involved in the operational side of the firm and might therefore not be able to influence stock prices in the same way as a CEO or COO.

For CEOs, we found that the inverse U-shaped relationship between delta and ROA had a lower turning point for female CEOs than for male CEOs. For CFOs the turning point of delta is not significantly different between males and females. If female CFOs are more risk averse than their male counterparts one would expect to see a significant difference in the coefficient estimate on delta-squared. As the interaction between delta/vega and gender also is insignificant in the fixed effect model, we will conclude that there is no difference between female or male CFOs in how they respond to equity incentives.

COOs

If we only rely on OLS for the estimate of the female dummy, the association between gender and firm performance is not significant, suggesting the gender of the COO might not matter for firm performance. As for CEOs, vega has a significantly negative association with ROA while delta a significantly positive association with ROA, when controlling for fixed effects. As the size of the coefficients of delta and vega are larger for COOs than CEOs, it is plausible that incentivizing COOs with vega and delta has a stronger impact on firm performance.

If we continue to rely on fixed effects, the results indicate that the association between vega and firm performance is not significantly different for female and male COOs. However, the association between delta and ROA is significantly lower for female COOs. This implies that for an increase in delta, a female COO will be associated with reduced firm performance, while a male COO will associate with increased firm performance. This is consistent with our assumption that incentivizing female COOs with a high delta has a negative association with firm performance as opposed to a positive association for male COOs.

The results show that the association between vega and ROA significantly depends on the value of delta. In contrast to the other executive positions, COOs are the only position where this association is significantly different for women and men. As the coefficient on the interaction term between female, vega, and delta is positive, higher values of delta will associate with a stronger association between vega and ROA. In contrast, for male COOs, the coefficient on the interaction term between vega and delta is significantly negative. This means that for men, vega will have a negative association with ROA for high values of delta, while for women vega will have a positive association with ROA for high delta values. These findings indicate that using vega to incentivise female COOs, might cancel out the negative performance effect that follows from incentivising female COOs with delta.

Lower Executives

In contrast to CEOs and COOs, firm performance does not vary between having a female executive or not, nor is vega and delta significantly associated with firm performance. The interaction between vega and female is not significant. However, the interaction between delta and female is significant and negative. This implies that the association between delta and firm performance is weaker for female lower executives compared to males. These results suggest that the use of equity incentives on female lower executives might harm firm performance. This is consistent with what we found for female COOs and implies that firm with female top executives perform worse when their compensation is partly relying on performance. As we do not know to what extent the lower executives are able to influence firm performance, these results should be interpreted with some caution.

Conclusion Hypothesis Four

We find that the average vega and delta across the top management team does not associate differently with any of our performance measures, for firms with female top executive versus firms with no female top executive. However, for individual positions, the association between incentives and firm performance depend on gender.

Our results show some support for our hypothesis. Incentivising female COOs and female lower executives with ownership shares (delta) is significantly and negatively associated with ROA. This confirms our hypothesis. Furthermore, the findings indicate that female CEOs are not more risk averse than their male counterparts, the fact that they can hold higher delta without negatively affecting performance proves the opposite. This relates to the findings of Adams and Funk (2011), who found that male directors are slightly more risk averse than female directors. Female CFOs do not respond differently to compensation risk than their male counterparts. To conclude, we find some support for our hypothesis as our results suggest that firms with female executives perform worse when the female executives are incentivized with equity. However, this does not apply to female CEOs and CFOs.

The association between vega/delta and firm performance is only significant for CEOs and COOs. This makes sense as these positions often are strongly involved in operations and have the highest operating authority (Zhang, 2006).

Discussion and Implications

The purpose of this thesis was to examine if equity incentives can help explain the low share of women in top management. In the literature review we outlined gender differences in risk aversion and competitiveness as reasons for why equity incentives might be relevant in explaining the representation of females in management.

We expected women to have lower vega and delta, and that they were less likely to be present in top management teams of firms that use strong equity incentives, as measured through a high vega and delta. We can conclude that female executives hold equity portfolios with significantly lower delta and vega than their male counterparts and that there is a significant negative association between vega and the probability of observing a woman in top management. The fact that our hypothesis does not hold for delta implies that it is not the level of stock compensation but rather the level of stock option compensation that might deter women from entering top management. Furthermore, we can conclude that equity incentives have a significant negative association with the probability of observing women in certain executive positions, particularly the position of CEO. Lower executives is the only position were vega is negatively and significantly associated with the probability of observing a woman, despite being the position holding the lowest vega. An explanation for this could be that these positions have the lowest ability to influence the performance of the firm and thus, the value of their option portfolio.

Even though we find an association between the equity incentives and the presence of female executives, there is still the issue of causality. Studies looking at the relationship between vega and delta and different firm characteristics have shown that causality runs in both directions (Coles et al., 2006). This issue is likely to be relevant for studies looking at the relationship between vega, delta and gender composition in top management. Vega and delta might impact the number of female managers, however the opposite might also be the case; firms might set vega and delta in order to adjust the compensation schemes to female managers. However, according to Khan and Vieito (2013), the latter might not be true. They find that boards do not consider female risk aversion when designing the compensation packages; female CEOs are awarded about the same proportion of equity incentives as their male counterparts. As we do not know how and when the compensation structure is determined and thus, what the direction of the causality is, we cannot conclude that the level equity incentives help explain the low share of females in top management, only that there is a negative association.

Our analysis does not allow us to conclude that women are higher represented in positions where the salary premium for compensation risk is higher. Therefore, we cannot conclude that the level of salary premium an executive receive for holding equity compensation, can help explain the proportion of females in an executive category. We hypothesized that females would receive a higher premium for holding equity compensation due to their stronger risk aversion found by previous literature. Consequently, an explanation as to why our hypothesis does not hold could be that the gender differences in risk aversion found in the general population does not apply to top executives, as argued by previous literature (Johnson and Powell, 1994; Croson and Gneezy, 2009; Adams and Funk, 2011; Graham et al., 2013).

As our results indicate that females are not that averse to compensation risk, it might be that the higher risk aversion among females affects the proportion of females in other ways. Studies have shown that the turnover in top management often is highly linked to firm performance (Fee and Hadlock, 2004). Females might find top management positions risky due to the fact that they are held accountable for firm performance and thus risk being laid off in times of poor firm performance. If this is the case, it might explain why we do not observe more female top managers.

We expected that women were more likely to be present in management teams of firms that have been previously employing a higher share of females in top management. Our analysis shows that this hypothesis does not hold. On the contrary, we find the opposite. The fact that our findings differ from previous literature could be because their findings cannot be applied to top executives. What we observe may be an implicit quota on the number of females in top management, as found by Dezso et al. (2016). They found that while firms attempt to have a small number of female top executives, they make less of an effort to or even resists having a larger number of women in top management. Further, the probability of a woman entering into an executive position was 51 percent lower if another woman already held a position in that firm. If those firms already employing a woman in top management does not have "room" for any more women, there will only be a limited number of firms that are willing to hire a new female executive. Thus, this can to some extent explain the low share of females in top management and the slow increase of this proportion. Consequently, for women to increase their representation in top management, there needs to be, among other things, a change in the attitude towards both hiring a female executive and hiring a larger number of women in top management. This is further supported by our findings from descriptive statistics; the increase in the share of female executives are mainly coming from more firms employing women in top management, rather than firms already employing female top executives increasing their share of them.

Making an explicit effort to obtain gender equality in top management is important for the legitimacy of the firm (Meyer and Rowan, 1977). Furthermore, negative publicity, especially from sex discrimination lawsuits, can evoke pressure to hire women into positions that are highly visible (Skaggs, 2008; Williams et al., 2014). As bad press about gender equality can harm a firm’s reputation, and as larger firms usually are subject to more scrutiny for their actions, this can explain why we find that larger firms have a higher probability of employing a woman in top management.

The analysis showed that hypothesis four does not hold as we cannot conclude that firms with female managers perform better when vega and delta are lower. Consequently, we cannot conclude that women’s aversion to competitive environments can help explain why they constitute such a low share in top management. The level of vega and delta is only significantly associated with firm performance for CEOs and COOs. Thus, one might argue that vega and delta are only useful for firm performance in those positions that have the highest operating authority, and hence are the most able to influence share price.

Our analysis shows that incentivizing executives with stocks and stocks options does not necessarily have the desired impact on all executive positions. Further, literature finds negative, positive and no association between firm performance and the use of stock options as incentives. Accordingly, further research should be conducted to assess the usefulness of equity incentives.

As discussed in our literature review, discrimination, human capital accumulation, and social norms are some of the factors that literature has used to explain the low share of females in top executive positions. As three of our hypotheses did not hold, some or all of these factors may still be very relevant. However, discrimination is difficult to prove and may happen in very subtle ways, and social norms are not directly quantifiable. Consequently, it would be difficult to prove that these might still be an obstacle for women to overcome.

Implications

There are several different implications related to our findings that could be relevant to corporate boards and top management. Even though our findings and conclusions are based on data from publicly listed companies in the US, the implications discussed are nevertheless relevant for all firms using equity incentives to reward and incentivise their executives.

As the main purpose of governance mechanisms is to align the interest of shareholders and managers, compensation structures and the use of equity incentives should have a positive effect on firm performance. Shareholders' primary objective is to maximize the return on their invested capital. If compensation structures are not able to do this one might need to reconsider compensation as a governance mechanism.

As the level of equity incentive across the top management team does not have a positive significant association with firm performance, our results might imply that the relationship between incentives and firm performance might not work as intended. If this is the case in our sample, the boards of other firms might experience the same. This implies that it might be necessary with tighter monitoring of the pay-performance relationship to assure its effectiveness.

On the other hand, our results might also imply that it is not the average vega or delta across the management team that matters, but rather each executive's individual incentives. As revealed, each position responds differently to vega and delta, which implies that the board needs to consider the individual when determining compensation structure. CEOs and COOs respond positively to delta, i.e., incentivizing CEOs and COOs with equity ownership is positive for firm performance. Out of the four occupational categories used in our regressions, one might assume that CEOs and COOs are the positions which are mostly involved in operations as these management positions often have the highest operating authority (Zhang, 2006). If these positions are those most able to implement strategic changes it is reasonable that when they own shares in their companies, they will be motivated to make changes that are positive for performance. This implies that equity ownership should be used to incentivize those managers that are able to impact firm performance.

Another consideration that might be of importance when determining compensation policies is the usefulness of vega to increase firm performance. As none of the positions revealed a significant positive association between vega and firm performance, one might question if boards use vega correctly. Vega is normally used to induce managers to take on risky projects. As a risk-taking incentive vega has shown to be effective (Coles et al., 2006; Gormley et al., 2013), however, if it does not work to increase firm performance one might question the purpose. One possible explanation as to why CEO and COO vega reduce firm performance might be that these positions are also those that hold highest equity ownership. When a manager has large exposure to stock price movements, vega should reduce the risk aversion that might follow from such exposure. However, if risky projects reduce firm performance (as is evidenced in our results), it might imply that the boards should use other mechanisms to combat the risk aversion that follows from large ownership positions.

A higher vega is associated with an increase in research and development expenditure and more aggressive debt policy (Coles et al., 2006). In our study these two firm characteristics were significantly and negatively associated with firm performance, however, stock return volatility has a significant positive association. Previous research has also found that risk-reducing policies are value-destroying (Low, 2009). This might imply that boards should focus on a risk inducing incentive that does not have a substantial impact on R&D or debt, but still work to increase stock return volatility.

The main purpose of this thesis has been to assess whether there is an association between compensation risk, measured by vega and delta, and the low share of females in management. With this, our intention was to point out aspects of management compensation that keeps women away from these positions. Our results imply that females are significantly associated with firm performance when they hold specific positions. A female CEO is associated with a significant reduction in firm performance. In contrast, a female CFO is associated with a significant increase in firm performance. This implies that for firms it should be a goal to appoint more female managers, however, firms might perform better with females in certain positions compared to others.

If firms want to adjust their compensation policy to attract more female managers, our results indicate that this might be the most challenging for female CEOs. The reason why this might be challenging for boards is that firm performance increase with CEO delta, and for female CEOs the association between delta and firm performance is even stronger. However, CEO delta is negatively associated with the probability of observing a female CEO. For firms, this means that one must balance the two effects of delta. A positive aspect of delta is however that female CEOs will not require a higher salary premium than men for a given level of delta. Hence firms can incentivize female CEOs with shares without this having an extra cost for them.

Despite the fact that the probability of observing a female CEO decrease with delta our results also imply that female CEOs might manage higher values of delta than what they currently have. If boards increase the value of female CEOs' delta our results indicate that firm performance will increase. Furthermore, our results showed that female CEOs will manage higher delta than males. As our descriptive statistics showed that female CEOs have significantly lower deltas than male CEOs, boards might benefit from increasing delta for female CEOs.

To increase the overall share of females in management, firms should decrease the level of stock options as we have concluded that vega is negatively associated with the probability of observing females in top management. If firms want to appoint a female CEO, CFO or COO, vega might not be of any particular relevance. However, for lower executives in top management, a lower vega might help attract females. Setting the level of stock compensation, as measured through delta, to increase female representation in the positions of CFO, COO, and lower executive, is more challenging as our results do not provide a definite solution to this. However, female COOs and lower executives might reduce firm performance if they are incentivized with delta, and thus delta might make females shy away from these positions.

Limitations of Research

Even though our findings give indications of associations, we cannot claim causality. One of the reasons for this is, as we have discussed before, the issue of reversed causality. The hiring of a female top executive and compensation structure might be jointly determined, which makes it challenging to conclude in which way causality runs.

Literature shows several examples of how one can address endogeneity. Coles et al. (2006) and DeYong (2013) both use a simultaneous equations approach. This approach is used to take account of the fact that the system of equations is jointly determined. Hence, to increase the reliability of our conclusions, an alternative would be to use a simultaneous equations approach. However, as this method is out of the scope of an introductory econometrics class, we have resolved to other methods, e.g., using the lagged values of incentives. We have further controlled for time-invariant firm characteristics that might affect the demand for female executives and time-varying trends in the labor market that affects all firms. Despite this, endogeneity caused by reverse causality will most likely still be present, which means that our estimates might be biased (Wooldridge, 2012).

Another alternative could have been to include an instrumental variable in our regressions. Instruments are variables that are included to replace the endogenous variable. As the requirements of an instrument is that it needs to be correlated with our endogenous variable while at the same time exogenous it is challenging to use this approach. In research related to compensation, it is normally difficult to find valid instruments as variables that are correlated with the endogenous variables most likely also have an impact on the outcome variable (Carter et al., 2017). Further, finding an instrument often implies that one needs to collect additional data. As we were not able to identify any valid instruments and collecting additional data was considered too time-consuming we chose to exclude this approach.

If we had had more time, we could have extended our sample period to include the years prior to the introduction of FAS 123R and use the introduction of this new accounting rule to control for endogeneity. This has previously been used by Hayes et al. (2012). The introduction of FAS 123R in 2005 changed the accounting requirements for stock options and lead to a dramatic reduction in the use of stock options to incentivize managers. Before the introduction of FAS

123R, companies could expense stock options at their intrinsic value. For companies, this meant that options granted at-the-money did not cause any reported expense. After FAS 123R was introduced, this advantage was eliminated as companies had to report options at their fair value. Hayes et al. (2012) argue that this "shock" is valid as an instrument as it is exogenous and correlated with vega. In our study, this shock can also be considered exogenous as one can assume that it is not related to the probability of observing a female manager. However, as this new requirement was known and repeatedly discussed in the years before its introduction one can question how effective this would have been as an instrument (Gormley et al., 2013).

Another limitation is that our sample only consists of listed firms. If women are higher represented in smaller companies, our sample might not be a good representation of women working in top management positions.

Our research and the conclusions we make are to a large extent dependent on our calculation of vega and delta. This might cause another limitation as small errors can mean significant changes in our results. Further, vega and delta are the only compensation variables we include in our regressions, and we are therefore dependent on the usefulness of these measures in truly capturing earnings risk.

Carter et al. (2017) argue that the total equity delta as a measure of incentives is inappropriate as restricted shares are included in the calculation. Restricted shares have no tangible value for an executive before the stock has vested and might therefore be valued below its true value by managers. Further, stock holdings are often determined by salary, i.e., ownership shares are higher for managers with higher salaries (Core and Larcker, 2002), and might therefore be a poor reflection of risk aversion. Due to these limitations, Carter et al. (2017) only use the option delta and vega as measures of incentives. An additional limitation of delta is that both increases in share price and increases in stock holdings will increase the value of delta. Over our sample period, it has, on average, been an increase in share prices. A corresponding increase in delta will therefore not imply that managers increase their ownership shares.

Conclusion

The aim of this thesis has been to analyze whether the use of equity incentives can help explain the low share of women in top management. We find that female top executives, on average, holds significantly lower equity compensation than their male counterparts, measured by vega and delta. This is in line with what previous literature has found (Coles and Li 2013; Carter et al., 2017). Furthermore, we examined if the level of equity incentives used in the firm were associated with the presence of a women in top management. Based on our analysis, we can conclude that only vega is negatively associated with the probability of observing a woman in top management. Moreover, we find that the level of equity incentives matters for the likelihood of women holding certain executive positions. Delta is negatively associated with observing a female CEO, while vega is negatively associated with observing a female lower executive.

Our findings imply that it is the individual incentives of each executive position that deter women from entering top management rather than the average vega and delta across the top management team. This was further supported when we found that the association between incentives and firm performance depends on executive position. Our results show that incentivizing CEOs and COOs with equity ownership (measured through a high delta) has a positive association with performance. We argue that this is due to CEOs and COOs having the most operating authority and thus, are the most able to influence their compensation through the stock price. As vega and delta only showed a significant association with firm performance for CEOs and COOs and as a higher vega displayed a negative association with firm performance, boards might reconsider whether incentivizing managers through stock and stock options serve its full purpose.

Furthermore, we found that incentivising females with delta negatively associates with firm performance when they hold a COO or lower executive position, indicating that incentivising females with equity incentives might not work as intended. However, this does not apply for female CEOs, as firm performance is positively associated with delta for female CEOs. Further, female CEOs can hold higher values of delta without this having a negative impact on performance. We argue that female CEOs differ from females holding lower executive positions.

The intention of our research has been to point out factors that keep women from entering into top executive positions. Our analysis shows that the number of female executives and the presence of a female CEO or a female chairman is negatively associated with the change in female executives the following three years. Suggesting that there is a “limit” as to how many women there can be in top management. This is line with what Gorman (2005), and Dezso, Ross and Uribe (2016) found, but in contrast to what other literature have found (Cohen and Broschak, 2013; McGinn and Milkman, 2013). We argue that the contrasting finds can be due to the sample studied. Furthermore, we found that the level of salary premium an executive receives for bearing compensation risk, cannot help explain the gender gap in top management or why females are higher represented in certain top executive positions. This might suggest that higher female risk aversion found in the general population does not apply to top executives, as previous literature has argued (Johnson and Powell, 1994; Croson and Gneezy, 2009; Graham et al., 2013; Adams and Funk, 2011).

Our results are relevant as they give some insight into what factors might and might not explain the low share of female top executives, as well as the usefulness of equity incentives. However, they are indicative as causality might run both ways. To be able to claim causality, additional research is thus necessary.

Suggestions for Further Research

In addition to using the introduction of FAS 123R as an exogenous shock, future research on the topic of equity incentives and gender composition in management might benefit from including qualitative methods in addition to quantitative analysis. A challenge with this research or any other research relying solely on quantitative data has been the difficulty in observing risk aversion as well knowing how different compensation structures are determined. Additionally, there might be other gender differences that affect the share of female top executives that are not observable without qualitative methods. Interviews with female managers and lower level employees could help detect motivation and different views on the risks that follow a manager position.

In our study, we have focused on compensation risk as the primary risk that follows from a top executive position. However, there might be several other aspects of a top management position that females find risky. It might well be that females are averse to risk related to tenure, accountability or exposure. Qualitative methods could help detect this possibility.

Our assumption prior to conducting this research was that females are more risk averse than males and will therefore shy away from top management positions due to compensation risk. If females really are more risk averse it would be relevant to study whether this has implications for other areas of the labor market. For instance, if females are more risk-averse than men, one can assume that their representation in start-ups is rather low. If this is true and what implications this have for the society would be relevant topics for future research.

Further, for future research to draw more reliable conclusions, individual executive characteristics such as age, education, marital status, tenure, etc. could be relevant to include as control variables. It is reasonable that these are factors that affect women's propensity to work in top management as well as firms willingness to hire them. Additionally, conducting the study on a different sample could also provide valuable results. Our sample consisted of only listed US firms. If women tend to manage smaller companies (Bertrand and Hallock, 2001) studying non-listed firms would probably increase the number of women in the sample and therefore give more representative results.

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Appendix

Appendix 1: Hausman Test for random or fixed effects

```
> ##---------Hausman_Test-------##
> #Hyp1_Reg3 with fixed effect versus random effects.
> fe13_H <- plm(Gender ~ Vega_lagged + Delta_lagged + log_employees_lag + lagCapExPPE_to_Assets +
+              lagRD_to_Assets + volatility + lagDE_ratio + lagMarket_to_book, data = pfirmcomp_lagged
,
+            effect = "twoways", model = "within")
> re13_H <- plm(Gender ~ Vega_lagged + Delta_lagged + log_employees_lag + lagCapExPPE_to_Assets +
+              lagRD_to_Assets + volatility + lagDE_ratio + lagMarket_to_book, data = pfirmcomp_lagged
,
+            model = "random")
>
> phtest(fe13_H, re13_H) #Test comparing fixed versus random effect

        Hausman Test

data:  Gender ~ Vega_lagged + Delta_lagged + log_employees_lag + lagCapExPPE_to_Assets +  ...
chisq = 18.869, df = 8, p-value = 0.01557
alternative hypothesis: one model is inconsistent

>
> #Hyp2_Reg 3 with fixed effect versus random effects.
> fe23_H <- plm(Three_year_diff ~ Vega_lag3 + Delta_lag3 + Nr_women_lag3 + log_employees_lag3 + CapExPP
E_to_Assets_lag3 +
+               RD_to_Assets_lag3 + volatility + DE_ratio_lag3 + Market_to_book_lag3, data = pfirm_lagg
ed_hyp2, effect = "twoways", model = "within")
> re23_H <- plm(Three_year_diff ~ Vega_lag3 + Delta_lag3 + Nr_women_lag3 + log_employees_lag3 + CapExPP
E_to_Assets_lag3 +
+                 RD_to_Assets_lag3 + volatility + DE_ratio_lag3 + Market_to_book_lag3, data = pfirm_la
gged_hyp2, model = "within")
> phtest(fe23_H, re23_H)

        Hausman Test

data:  Three_year_diff ~ Vega_lag3 + Delta_lag3 + Nr_women_lag3 + log_employees_lag3 +  ...
chisq = 87.874, df = 9, p-value = 4.343e-15
alternative hypothesis: one model is inconsistent

> |
```

Appendix 2: pFtest – for individual and/or time fixed effects

```
> pFtest(ind, p)

        F test for individual effects

data:  Gender ~ Vega_lagged + Delta_lagged + log_employees_lag + lagCapExPPE_to_Assets +  ...
F = 12.483, df1 = 1807, df2 = 11594, p-value < 2.2e-16
alternative hypothesis: significant effects

> pFtest(time, p)

        F test for time effects

data:  Gender ~ Vega_lagged + Delta_lagged + log_employees_lag + lagCapExPPE_to_Assets +  ...
F = 4.7357, df1 = 8, df2 = 13393, p-value = 8.055e-06
alternative hypothesis: significant effects
```

```
> pFtest(two, p)

        F test for twoways effects

data:  Gender ~ Vega_lagged + Delta_lagged + log_employees_lag + lagCapExPPE_to_Assets +  ...
F = 12.536, df1 = 1815, df2 = 11586, p-value < 2.2e-16
alternative hypothesis: significant effects
```

Appendix 3: VIF test for multicollinearity

```
> vif(hyp1.reg2)
                          GVIF Df GVIF^(1/(2*Df))
vegath                1.260774  1        1.122842
deltath               1.043328  1        1.021434
log_employees_lag     1.434441  1        1.197681
lagCapExPPE_to_Assets 1.309365  1        1.144275
lagRD_to_Assets       1.667861  1        1.291457
volatility            1.288029  1        1.134913
lagDE_ratio           1.165013  1        1.079358
lagMarket_to_book     1.166670  1        1.080125
ROA                   1.635739  1        1.278960
as.factor(year)       1.102557  8        1.006121
as.factor(SIC2)       1.540196  7        1.031332
```

Appendix 4: Categorizing job titles

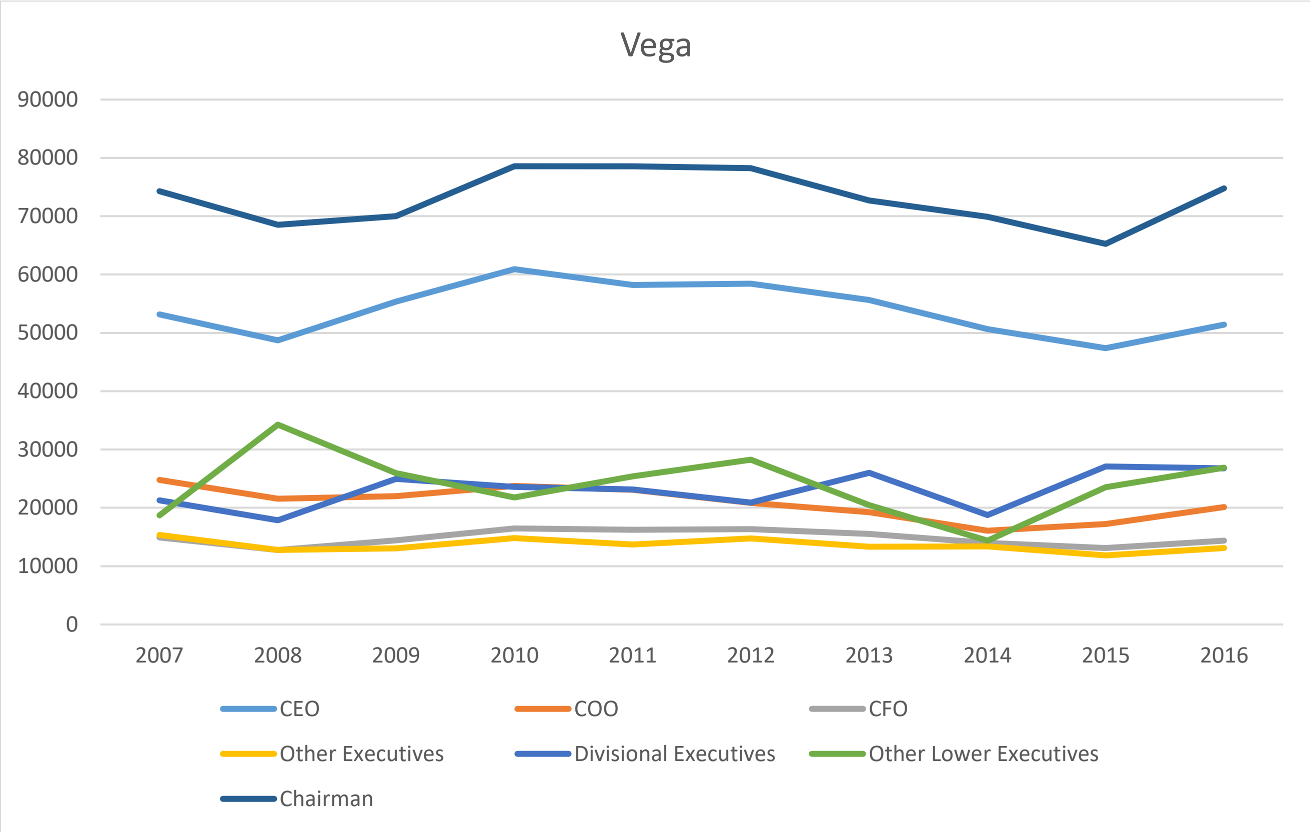
<table>
<tr><th>First set of positions</th><th>Second set of positions</th><th>Final set of positions</th></tr>
<tr><td>CEO</td><td>CEO</td><td>CEO</td></tr>
<tr><td>CFO</td><td>CFO</td><td>CFO</td></tr>
<tr><td>COO</td><td rowspan="2">COO</td><td rowspan="2">COO</td></tr>
<tr><td>President</td></tr>
<tr><td>Other Chief</td><td rowspan="2">Other Executives</td><td rowspan="6">Lower Executives</td></tr>
<tr><td>Vice-President</td></tr>
<tr><td>Divisional President</td><td rowspan="2">Divisional Executives</td></tr>
<tr><td>Divisional Vice-President</td></tr>
<tr><td>Any Other Title</td><td rowspan="2">Other Lower Executives</td></tr>
<tr><td>Advisors</td></tr>
<tr><td>Chairman</td><td>Chairman</td><td>Chairman</td></tr>
<tr><td>Vice-Chairman</td><td rowspan="2">Board member</td><td rowspan="2">Board member</td></tr>
<tr><td>Board member</td></tr>
</table>

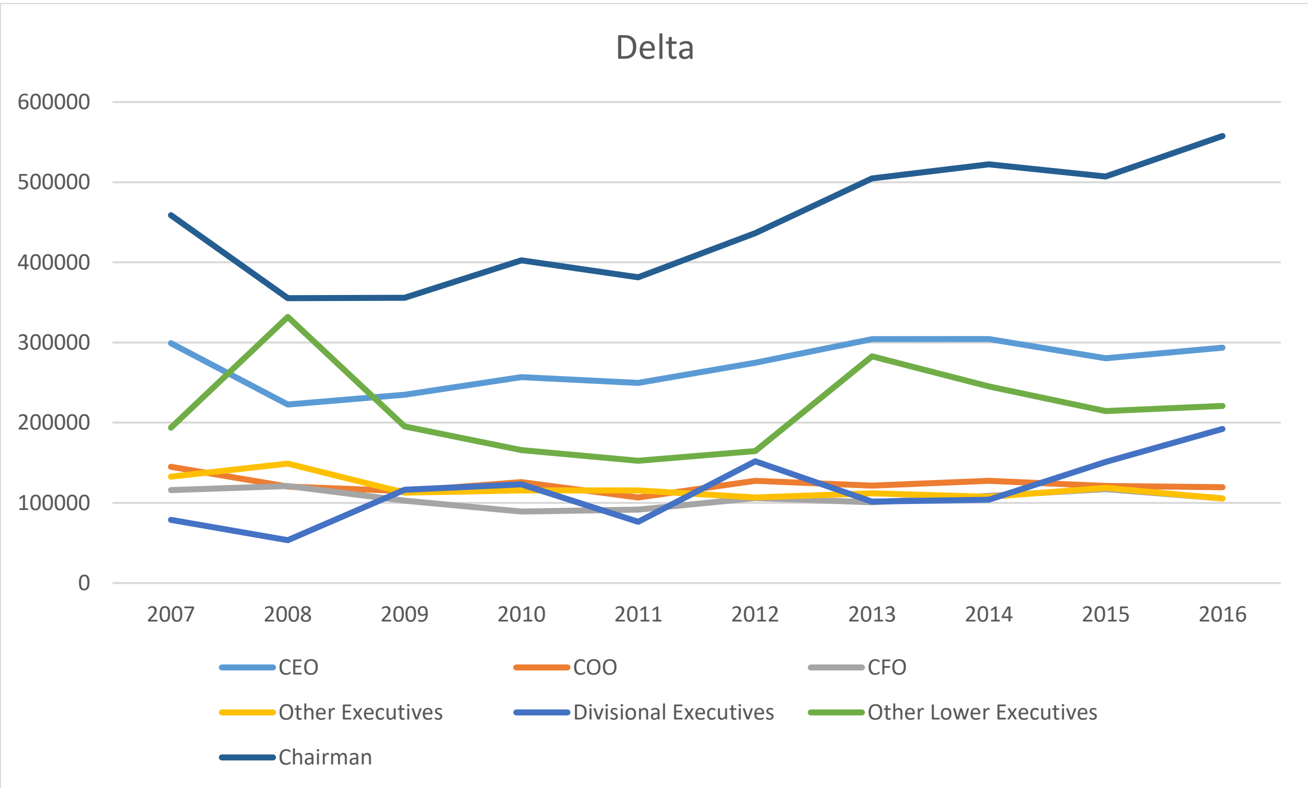
Appendix 5: First winsorizing of vega and delta

The table below corresponds to *Table 2* in Descriptive Statistics and shows the values of delta and vega before winsorizing at the 1st and 99th percentile a second time.

(Values in thousands)	**All Managers**	**25th percentile**	**50th percentile**	**75th percentile**	**Women**	**Men**	**p-Value**
N	78 479				6114	72 365	
Executive Characteristics							
Vega	28 (107)	0	4	20	23	29	0.0000
Delta	385 (7360)	24	54	126	130	406	0.0000
Cash compensation	568 (404)	324	453	680	510	573	0.0000
Age	53 (7.33)	48	53	58	51	53	0.0000
Management team compensation							
Vega	28 (79)	1.45	8.35	27	29	28	0.0000
Delta	377 (3305)	55	91	185	486	326	0.0000
Total cash compensation	568 (308)	377	496	664	572	567	0.0000
Firm characteristics							
Employees	20.70 (72)	1.60	6.14	15.14	23.70	19.30	0.0000
D/E	1.03 (39)	0.01	0.40	0.94	0.92	1.07	0.0255
Sales/Assets	1.06 (0.77)	0.55	0.87	1.37	1.12	1.04	0.0000
CapEx (PPE)/Assets	0.05 (0.05)	0.02	0.03	0.06	0.046	0.05	0.0000
RD/Assets	0.03 (0.14)	0.00	0.00	0.04	0.03	0.04	0.0000

Appendix 6: Development of vega and delta per position





Appendix 7: Calculation of turning point for vega and delta

Male CEOs:

$\Delta ROA \div \Delta Delta = 0.044 - 2 * 0.008 * Delta$

$0.016\ Delta = 0.044$

$Delta = 0.3636$

Female CEOs:

$\Delta ROA \div \Delta Delta = 0.044 - 2*0.008 + 0.055 - 2 * 0.027 * Delta$

$0.083\ Delta = 0.054$

$Delta = 0.6506$