Asymmetric Risk and CEO Compensation

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This paper aims to understand how firms' asymmetric risk environment affects the CEO compensation structure. I investigate how firm's downside risk and upside potential differentially affect the choice between cash and equity compensation and the choice between stock options and restricted stock compensation. First, I show that, as downside risk (upside potential) increases, boards grant more cash compensation (more equity compensation) and less equity compensation (less cash compensation). Second, I show that the proportion of CEO option compensation in total equity compensation increases with downside risk and decreases with upside potential. My findings support the idea that boards respond to changes in their firms' risk environments by adjusting the structure of CEO compensation to reflect risk-averse CEOs' risk preferences.

Keywords: executive compensation, executive stock options, equity incentives, asymmetric risk

INTRODUCTION

To mitigate agency problems, a significant portion of CEO compensation is normally tied to the firm's uncertain future outcome. Prior research suggests that the CEO pay-setting process is a negotiation between the board and the CEO (Hermalin and Weisbach 1998; Bebchuk, Fried, and Walker 2002), which suggests that CEOs influence both the amount and structure of the compensation package. Since a risk-averse CEO demands a risk premium for bearing risk associated with such compensation, firms offer compensation contingent on firm's performance only if the benefit (e.g., minimizing CEO's rent seeking behavior, inducing optimal incentive and risk-taking, etc.) is greater than the cost (i.e., risk premium). The benefit and cost of contingent compensation depends on the firm's investment opportunities and the firm's risk environment (Guay 1999; Del Viva, Kasanen, and Trigeorgis 2017). Therefore, firm risk is an important determinant of CEO compensation. Prior studies focus the relation between *symmetric* risk and CEO compensation (e.g., Aggarwal and Samwick 1999; Guay 1999; Jin 2002). In this paper, I examine the impact of *asymmetric* risk on CEO compensation. Specifically, I investigate the differential impact of downside risk versus upside potential on compensation structure, i.e., the choice between cash and equity compensation and the choice between stock options and restricted stock.

Traditional option pricing models, e.g., Black-Scholes (1973), use symmetric volatility as an input. Similarly, the vast majority of prior studies examine the relation between *symmetric* risk and CEO compensation (e.g., Guay 1999; Jin 2002). The key findings of these studies suggest that the CEO's valuation of stock options differs from the valuation of risk-neutral shareholders because of the CEO's risk-aversion and lack of diversification (e.g., Lambert, Larcker, and Verrecchia 1991; Hall and Murphy 2002; Jin 2002; Tian 2004). An important aspect of a stock option is that its payoff is piece-wise linear to its underlying stock price (i.e., asymmetric payoff). Consistent with this idea, Hall (1998) documents that CEOs view at-the-money or out-of-the-money options as near worthless, confirming that there exists a wedge between the Black-Scholes option pricing model and CEOs' valuation of stock options.

When downside risk increases, a CEO requires a higher risk premium for equity compensation. Thus, as downside risk increases, granting equity incentives will be more costly. Consequently, the board could shift compensation away from equity compensation to cash compensation. Researchers suggest, e.g., Lambert and Larcker (2004) and Dittman, Yu, and Zhang (2017), that the optimal contract protects the CEO from losses for bad outcomes. Thus, I predict that, as downside risk increases, the observed compensation contract will contain more cash and less equity compensation.

With regard to the choice between restricted stock and options, the probability of a stock option finishing out of the money (i.e., zero intrinsic value) increases as downside risk increases. In contrast, restricted stock has value as long as the stock price is positive (i.e., positive intrinsic value). Thus, I predict a risk-averse CEO will increase his or her preference for restricted stock to stock options as downside risk increases since restricted stock offers some downside protection. In contrast, when upside potential increases, there is no upper limit to the payoff of equity compensation (i.e., the leverage effect of equity compensation). Thus, I predict that a CEO would prefer equity compensation to cash compensation when upside potential increases. In addition, because of stock options' leverage effect (i.e., steeper slope in the in-the-money price range), a CEO will prefer stock options to restricted stock when upside potential increases. Thus, I predict that the proportion of CEO option compensation (the proportion of stock option over total equity compensation) decreases with downside risk and increases with upside potential.

This paper is organized as follows. Section 2 discusses the related literature and develops my hypotheses. Section 3 describes data and variable measurement. Section 4 describes research design. The primary results are presented in Section 5. Section 6 concludes.

RELATED LITERATURE AND HYPOTHESES DEVELOPMENT

Cash Versus Equity Compensation

In addition to the sorting and retention of employees (e.g., Oyer and Schaefer 2005), stock and option grants are used to incentivize the CEO to maximize shareholder wealth. However, since equity compensation is risky (i.e., dependent on uncertain future outcomes), a risk-averse CEO requires a risk premium for bearing risk associated with equity compensation (Lambert, Larcker, and Verrecchia 1991; Hall and Murphy 2002). The marginal benefit and cost of equity compensation depend on the firm's risk environment as well as the CEO's risk-aversion. Prior studies argue that firms set higher levels of cash compensation for executives who are exposed to higher levels of compensation risk (Antle and Smith 1985; Lambert, Larcker, and Verrecchia 1991). Furthermore, Lambert and Larcker (2004) and Dittman, Yu, and Zhang (2017) show that the optimal contract protects the CEO from losses for bad outcomes. Consistent with this idea, I predict that a CEO would require higher risk premium for equity compensation as downside risk increases. Thus, the board is likely to shift CEO compensation away from equity compensation to cash compensation as downside risk increases. In contrast, as upside potential increase, the board need not pay as much risk premium. In addition, from the CEO's perspective, there is no upper limit for the payoff of equity compensation increases. Thus, I predict that a CEO would prefer cash compensation (equity compensation) to equity compensation (cash compensation) when downside risk (upside potential) increases. Thus, I posit my first hypothesis:

H1: *As downside risk (upside potential) increases, the percentage of cash compensation will increase (decrease).*

Stock Versus Option Grants

The payoffs from stock and option grants are directly linked to the firm's stock price – a fundamental reason for granting equity incentives. However, a distinguishing feature between the two types of equity incentives is how their payoff relates to stock price. The payoff to a share of stock is linear in the firm's stock price as long as that price is greater than zero, whereas the payoff to a stock option is linear above the exercise price and zero otherwise (i.e., piecewise linear or convex payoff)[1]. Prior literature predicts and finds that option grants, but not stock grants, increase the convexity of the CEO wealth and firm performance relation, and CEO's risk-taking behavior (Guay 1999).

Nonetheless, because of the complex nature of equity incentives, prior literature is mixed on the consequences of stock options and the circumstances in which either form of equity incentive is preferred over the other. For example, Guay (1999), Coles, Daniel, and Naveen (2006), and Low (2009) present evidence of a positive relation between vega and risk-taking. In contrast, Aggarwal and Samwick (1999) and Milidonis and Stathopoulos (2014) find a negative relation between firm risk and pay-performance sensitivity. In addition, studies that model the choice between stock options and restricted stock provide different predictions about the preference for stock versus option grants from the shareholders' perspective due to the different assumptions in the models, and model and parameter choices (e.g., Feltham and Wu 2001; Hall and Murphy 2002; Lambert and Larcker 2004; Dittmann and Maug 2007; Dittmann, Yu, and Zhang 2017). Feltham and Wu (2001) show stock is optimal when the agent can influence only the mean of the outcome, and options are optimal when the agent can influence both the mean and variance of the outcome. Hall and Murphy (2002) suggest granting at-the-money options maximizes incentives when grants are an add-on to existing pay packages, while stock grants are preferred when grants are accompanied by reductions in cash compensation. Dittmann and Maug (2007) predicts that most CEOs should not hold any stock options and, instead, receive lower base salaries and receive additional stock. They interpret their findings contradicting current practice as evidence of rent extraction. In contrast, Lambert and Larcker (2004) argue that prior studies ignore incentive effects of option-based contracts and show that stock options generally dominate stock grants in the optimal compensation contract.

The mixed results in the literature suggests that it is not clear that the incentives created by equity compensation are understood by academics, practitioners or CEOs (Hall 1998). In addition, the assumptions embedded in the Black-Scholes model are not completely applicable to employee stock options. For example, the Black-Scholes model assumes that the riskiness of the option's payoff can be perfectly hedged by continuously and costlessly revising a portfolio of call options, stock, and riskless bonds. However, a risk-averse CEO who cannot freely trade stock options and is prohibited from hedging his compensation risk, would request risk premiums for bearing risks associated with option and stock grants. This suggests that the CEO's valuation of equity compensation is different from the market valuation/cost to the firm (e.g., Lambert, Larcker, and Verrecchia 1991; Hall and Murphy 2002; Jin 2002; Tian 2004). In practice, the utility function of an individual CEO is not observable, creating a wedge between theory and practice. Guay (1999) states that there is no clear method of determining the value of an employee stock option from the employee's perspective, as opposed to the firm's perspective.

In addition to the difficulty in valuing equity incentives from the perspective of CEOs, there is disagreement about the asymmetric incentive effects of stock options even to academics. That is, some researchers argue that stock options limit downside risk (e.g., Bryan, Hwang, and Lilien 2000; Ryan and Wiggins 2001). For example, Bryan et al. (2000) claim that "stock options protect risk-averse CEOs from downside risk and simultaneously provide a high upside potential". In contrast, Carter, Lynch, and Tuna (2007) argues that "If executives are more risk-averse, then I might see more restricted stock because it always provides some positive intrinsic value to the executive".

To illustrate the latter, consider the following case (see Appendix A). A CEO is granted $1,000,000 worth of either at-the-money stock options or restricted stock, but not both. Assuming a current stock price of $30, the CEO will receive 90,467 stock options or 33,333 shares of restricted stock. The parameters are $\sigma = 0.2$, maturity = 10 years, $r_f = 0.03$ in yearly terms.

If stock price increases by 90%, at maturity the final payoffs to stock options and restricted stock are $2,442,614 and $1,900,000, respectively. In contrast, if the stock price decreases by 90%, the final payoffs to the stock options and restricted stock will be $0 and $100,000, respectively. This numerical example demonstrates that stock options do not provide downside protection.

Motivated by this observation, I examine how asymmetry in risk, i.e., downside risk versus upside potential, affects the use of stock option and stock grants. To develop predictions on the differential impact of downside versus upside risk on CEO equity compensation grants, I assume that stock options are granted at-the-money, consistent with real world practices. When downside risk increases, the probability of a stock option finishing out of the money (i.e., zero intrinsic value) increases. In contrast, stock grants have value as long as the stock price is positive (i.e., positive intrinsic value). Consistent with this idea, Hall (1998) documents that CEOs view at-the-money or out-of-the-money options as near worthless. Thus, I predict a risk-averse CEO prefers stock over stock options as downside risk increases.

In contrast, when upside potential increases, a CEO would want to take advantage of the leverage effect of stock options. The value of a stock option is always less than one unit of stock because of the positive exercise price of a stock option. That is, a share of stock is worth multiple stock options. Therefore, for the equivalent value, once they are in-the-money, stock options have a steeper slope than stock – the leverage effect of stock options. Thus, when upside potential is more likely, a CEO will prefer stock options to stock grants.

The above predictions are related to the CEO's preference as to the form of equity incentives when facing downside risk versus upside potential. Prior research suggests that CEOs influence their own compensation (Hermalin and Weisbach 1998; Bebchuk et al. 2002). Thus, I posit that the CEO's preference over a particular type of compensation with downside risk versus upside potential would be reflected in the actual compensation. The second hypothesis is:

H2: *As downside risk (upside potential) increases, the percentage of stock options relative to stock grants will decrease (increase).*

DATA AND VARIABLE MEASUREMENT

Data

The initial sample consists of firm-year observations in the ExecuComp database during the period 1993-2015. Since I lag independent variables by one year in the regression models, my sample starts in 1993 even though ExecuComp began in 1992. I then merge the dataset with Compustat and Center for Research in Security Prices (CRSP) datasets. I exclude financial (SIC 6000-6999) and utilities (4000-4999) firms. My initial sample consists of 1,700 unique firms, with a total of 17,570 firm-year observations (see Table 1). My sample is well distributed across industries and the top 5 industries in my sample are retail, electronic equipment, computer software, business services, and machinery industries which jointly represent about 34% of my sample.

TABLE 1
SAMPLE SELECTION

Sample Selection Procedure	Firm-year observations
Execucomp from 1993 to 2015	41,010
Less:	
Financial (SIC 6000 - 9000) and utilities (SIC 4000 - 4999) firms	(9,010)
Missing data for Execucomp variables	(4,454)
Missing data for Compustat variables	(7,143)
Missing data for CRSP variables	(928)
Missing data for Thomson Reuters Institutional (13f) Holdings variable	(1,906)
Total	**17,569**

Measures of Downside Risk and Upside Potential

To measure asymmetric risk, I first use downside and upside market betas (denoted by β^- and β^+, respectively) – introduced by Bawa and Lindenberg (1997):

$$\beta_{i,t}^{-} = \frac{cov(r_{i,d}, r_m | r_m < \mu_m)}{var(r_m | r_m < \mu_m)}, \beta_{i,t}^{+} = \frac{cov(r_{i,d}, r_m | r_m > \mu_m)}{var(r_m | r_m > \mu_m)}, \quad (1)$$

where $r_{i,d}$ (r_m) is firm *i*'s (the market's) daily excess return, and μ_m is the average daily market excess return during the fiscal year *t*. Thus, β^- (β^+) measures how strongly a firm's stock returns covary with the market over periods when the excess market is below (above) its yearly mean. Regular, downside, and upside betas are, by construction, not independent of each other. To examine the incremental effects of downside risk and upside potential, following Ang, Chen, and Xing (2006), I compute a relative downside beta (β^- - β) and a relative upside beta (β^+ - β). I also control for the "regular" beta and idiosyncratic volatility, as measured in the market model, as well as other proxies for symmetric risk to examine the incremental effects of asymmetric risk on compensation. In addition, to examine the effect of downside risk relative to upside potential, I compute the difference between downside beta and upside beta (β^- - β^+) as a combined asymmetric risk measure.

As another proxy for asymmetric risk, I use the down-to-up volatility of firm-specific daily returns (*DUVOL*), which captures asymmetric volatilities between above- and below-mean firm-specific returns (Chen, Hong, and Stein 2001; Kim, Li, and Zhang 2011). A higher value of DUVOL indicates greater downside risk

$$DUVOL_{i,t} = \log\{((n_{up} - 1)\sum_{down} R_{i,t}^2)/((n_{down} - 1)\sum_{up} R_{i,t}^2)\} \quad (2)$$

For each firm *i* over fiscal-year t, firm-specific weekly returns are separated into two groups: "down" days when the returns are below the annual mean, and "up" days when the returns are above the annual mean. The standard deviation of firm-specific daily returns is calculated separately for each of these two groups. DUVOL is the natural logarithm of the ratio of the standard deviation of firm-specific daily returns in the "down" days to the standard deviation of firm-specific daily returns in the "up" days.

Measures of CEO Compensation

To investigate the impact of asymmetric risk on CEO compensation structure, I focus on *annual* CEO compensation *awards*. While the cumulative CEO compensation portfolio is likely to slowly adjust, boards can adjust new compensation quickly. For the first set of regression models, I examine the impact of asymmetric risk on the *level* of cash, value of stock option, or value of restricted stock *awards*.[2] Thus, the dependent variable is either the natural logarithm of one plus cash, stock option, or restricted stock awards. For the second set of regression models, I examine the impact of asymmetric risk on the *proportion* of each form of compensation award. The dependent variable is either the percentage of cash, stock option, or restricted stock awards over the sum of the three components – cash, stock option, and restricted stock. Using these dependent variables, I focus on the choice among the three types of compensation components.

EMPIRICAL MODELS

Level Analysis

To examine the impact of firms' downside risk versus upside potential environment on CEO compensation structure, I estimate regressions that take the following forms:

$$Compensation\ Component_{i,t} = \alpha + \beta_1\ \boldsymbol{rel\beta_{it-1}^{-}} + \beta_2\ \boldsymbol{rel\beta_{it-1}^{+}} + \boldsymbol{\gamma\ Symmetric\ Risk_{it-1}} + \boldsymbol{\delta\ Controls_{it-1}} + Year\ Fixed\ Effects + Firm\ Fixed\ Effects + u_{it} \quad (3a)$$

For the first set of regression models, I examine the impact of β^-- β (*rel* β^-) and β^+- β (*rel* β^+) on the levels of cash, stock option, and restricted stock awards.[3] Thus, the dependent variable is either the natural logarithm of one plus cash, stock option, or restricted stock awards. To understand the impact of asymmetric risk on CEO compensation structure in addition to that of symmetric risk, I control for symmetric risk proxies such as market beta (β), idiosyncratic risk (*IR*) and the standard deviation of net income (σNI). I also control for the factors that are found to be related with compensation structure in the prior studies. *Controls* is a vector of control variables: firm size (*MVE*), past stock performance (*Annret*), past accounting performance (*ROA*), change in net income (Δ*NI*), growth opportunities (*BM*), financial leverage (*Leverage*), big N (*BigN*), institutional investor ownership (*Instown*), Herfindahl-Hirschman Index (*HHI*), free cashflows (*Free_cf*), R&D expenditures (*R&D*), *PP&E*, CEO age (*Age*), CEO tenure (Tenure), CEO share ownership (*Shrown*), CEO duality (*Dual*), and CEO gender (*Male*). All independent variables are lagged by one year. I also include fixed effects to capture time variation and to control for unobserved time-invariant firm-level heterogeneity. My inferences are based on firm-level clustered standard errors.

To examine the effect of downside risk relative to upside potential, I compute the difference between downside beta and upside beta as a combined asymmetric risk measure (β^{-} - β^{+}) and estimate the following regression models:

$$Compensation\ Component_{i,t} = \alpha_0 + \alpha_1\ \beta^- - \beta^+{}_{it-1} + \boldsymbol{\gamma\ Symmetric\ Risk_{it-1}} + \boldsymbol{\delta\ Controls_{it-1}} + Year\ Fixed\ Effects + Firm\ Fixed\ Effects + u_{it} \quad (3b)$$

To investigate the impact of *DUVOL* on CEO compensation structure, I replace $\beta^- - \beta^+$ with *DUVOL* and estimate the following regression models:

$$Compensation\ Component_{i,t} = \alpha + \beta\ DUVOL_{it-1} + \boldsymbol{\gamma\ Symmetric\ Risk_{it-1}} + \boldsymbol{\delta\ Controls_{it-1}} + Year\ Fixed\ Effects + Firm\ Fixed\ Effects + u_{it} \quad (4)$$

Ratio Analysis

Since I am interested in understanding the impact of asymmetric risk on the choice among cash, stock, and option compensation, I also use the proportion of cash, stock, or option awards over the sum of cash, stock, and option compensation. Thus, the dependent variable is alternatively is either the proportion of cash, stock option, or restricted stock awards over the sum of cash, stock, and option compensation. I estimate regressions that take the following forms:

$$Proportion\ of\ Compensation\ Component_{i,t} = \alpha + \boldsymbol{\beta\ Asymmetric\ Risk_{it-1}} + +\boldsymbol{\gamma\ Symmetric\ Risk_{it-1}} + \boldsymbol{\delta\ Controls_{it-1}} + Year\ Fixed\ Effects + Firm\ Fixed\ Effects + u_{it} \quad (5)$$

Asymmetric Risk is alternatively either β^- and β^+, $\beta^- - \beta^+$, or *DUVOL*. I control for symmetric risk proxies and the factors that are found to be related with compensation structure in the prior studies. *Controls* is a vector of control variables: firm size (*MVE*), past stock performance (*Return*), past accounting performance (*ROA*), change in net income (Δ*NI*), growth opportunities (*BM*), financial leverage (*Lev*), big N (*BigN*), institutional investor ownership (*Instown*), Herfindahl-Hirschman Index (*HHI*), free cashflows (*Free_CF*), R&D expenditures (*R&D*), *PP&E*, CEO age (*CEO_Age*), CEO tenure (*CEO_Tenure*), CEO share ownership (*CEO_Shrown*), CEO duality (*Duality*), and CEO gender (*Male*). All independent variables are lagged by one year. I also include fixed effects to capture time variation and to control for unobserved time-invariant firm-level heterogeneity. My inferences are based on firm-level clustered standard errors.

In addition, to focus on the impact of asymmetric risk on the choice between equity compensation components (i.e., stock versus option), I use the proportion of option awards over the sum of stock and option awards as the dependent variable. When a firm does not grant any stock or option compensation, I set the dependent variable to 0.5. I estimate the following regression model.

$$Proportion\ of\ Option\ Awards_{i,t} = \alpha + \boldsymbol{\beta\ Asymmetric\ Risk_{it-1}} + +\boldsymbol{\gamma\ Symmetric\ Risk_{it-1}} + \boldsymbol{\delta\ Controls_{it-1}} + Year\ Fixed\ Effects + Firm\ Fixed\ Effects + u_{it} \quad (6)$$

RESULTS

Descriptive Statistics

Table 2 presents the descriptive statistics. Panel A shows that the means of cash, option, and restricted stock compensation are \$1.7 million, \$1.5 million, and \$1.1 million, representing 35.3%, 31.5%, and 24.4% of mean total compensation, respectively. The average ratio of option awards to the sum of option and restricted stock awards is 0.6, suggesting that the option compensation slightly dominates stock compensation in my sample. Panel B reports the descriptive statistics for asymmetric risk measures. The negative mean value of $Rel\beta^{-}$, -0.08, indicates that firms' undiversifiable risk is less sensitive to the market risk, and the positive mean value of $Rel\beta^{+}$, 0.05, indicates that firms' undiversifiable risk is more sensitive to the market risk. The mean of *DUVOL*, 0.94, indicates that, on average, the volatility of stock returns during "down" days when the returns are below the annual mean is slightly higher than the volatility of stock returns during "up" days when the returns are above the annual mean.

TABLE 2
DESCRIPTIVE STATISTICS

Panel A: CEO incentive variables					
Variable	Mean	Std Dev	25th	Median	75th
Cash (in thousands)	1,653.9	1,456.0	701.4	1,200.0	2,086.5
Option Awards (in thousands)	1,476.3	2,626.5	0.0	495.2	1,725.4
Stock Awards	1,144.2	2,215.1	0.0	0.0	1,298.7
Option/Equity	0.60	0.37	0.34	0.50	1.00
Total Compensation	4,685.4	5,081.5	1,369.0	2,944.7	5,988.1
Panel B: Risk variables					
Variable	Mean	Std Dev	25th	Median	75th
β	1.28	0.60	0.86	1.21	1.61
$Rel\beta^{-}$	-0.08	0.39	-0.28	-0.06	0.13
$Rel\beta^{+}$	0.05	0.50	-0.19	0.06	0.31
β^{-}-β^{+}	-0.13	0.75	-0.51	-0.12	0.25
DUVOL	0.94	0.24	0.78	0.91	1.06
σRet	0.03	0.01	0.02	0.02	0.03
σIR	0.02	0.01	0.02	0.02	0.03
σNI	0.05	0.06	0.02	0.03	0.06

Panel C: Control variables

Variable	Mean	Std Dev	25th	Median	75th
MVE (in millions)	6,595.6	16,837.1	519.9	1,410.3	4,477.9
Annret	0.17	0.49	-0.13	0.11	0.36
ROA	0.05	0.09	0.02	0.06	0.09
BTM	0.48	0.36	0.25	0.41	0.62
Lev	0.50	0.21	0.35	0.51	0.64
BigN	0.95	0.23	1.00	1.00	1.00
Instown	0.70	0.20	0.57	0.72	0.84
HHI	0.09	0.08	0.05	0.07	0.10
Free_CF	0.03	0.10	0.01	0.04	0.07
R&D	0.03	0.05	0.00	0.01	0.04
PP&E	0.28	0.21	0.12	0.23	0.39
CEO_Age	55.8	7.3	51.0	56.0	61.0
CEO_Tenure	8.62	7.61	3.00	6.00	11.00
CEO_Shrown	0.03	0.06	0.00	0.01	0.02
Duality	0.59	0.49	0.00	1.00	1.00
Male	0.98	0.16	1.00	1.00	1.00

This table presents descriptive statistics for firms in my sample. My sample is constructed from the intersection of Execucomp (compensation), Compustat (accounting data), CRSP (stock price data), and Thomson Reuters Institutional (13f) Holdings (institutional ownership) for the time period 1993 to 2015 and covers a total of 17,570 firm-years (1,700 firms). Panel A reports descriptive statistics for measures of CEO incentives. Panel B reports descriptive statistics for measures of risk. Panel C reports descriptive statistics for control variables. All variables are winsorized at the 1 and 99 percent levels. All dependent variables are measured at year t and all dependent variables are measured at year t-1. All variables are as defined in Appendix B.

Correlation Matrix of Risk Measures

Table 3 presents the correlation coefficients between risk measures used in this study. The correlation coefficients between β_t and $Rel\beta_t^-$ and between β_t and $Rel\beta_t^+$ are -0.24 and 0.16, which are relatively low in magnitude. In addition, the correlation coefficient between *DUVOL* and σRet_t is -0.14. This implies that symmetric and asymmetric risk measures capture different information about firms' risk environment. Thus, it is important to consider both symmetric and asymmetric risk when studying the impact of risk on firm decisions. Another observation is that the autocorrelation coefficients of $Rel\beta^-$, $Rel\beta^+$, $DUVOL$ are 0.13, -0.36, and -0.14, respectively. These statistics suggest that the asymmetric risk measures used in this study keep changing over time and that they capture the changes in firms' asymmetric risk environment.

TABLE 3
CORRELATION MATRIX FOR RISK VARIABLES

	β_t	β_{t-1}	$rel\beta^-_t$	$rel\beta^-_{t-1}$	$rel\beta^+_t$	$rel\beta^+_{t-1}$	$\beta^- - \beta^+_t$	$\beta^- - \beta^+_{t-1}$	$DUVOL_t$	$DUVOL_{t-1}$	σRet_t	σRet_{t-1}	σIR_t	σIR_{t-1}	σNI_t
β_t	**1**														
β_{t-1}	**0.71**	**1**													
$rel\beta^-_t$	**-0.24**	**-0.26**	**1**												
$rel\beta^-_{t-1}$	**-0.18**	**-0.23**	**0.13**	**1**											
$rel\beta^+_t$	**0.16**	**0.13**	**-0.37**	**-0.07**	**1**										
$rel\beta^+_{t-1}$	**0.05**	**0.14**	**-0.07**	**-0.36**	**0.06**	**1**									
$\beta^- - \beta^+_t$	**-0.24**	**-0.23**	**0.78**	**0.12**	**-0.86**	**-0.08**	**1**								
$\beta^- - \beta^+_{t-1}$	**-0.13**	**-0.22**	**0.12**	**0.77**	**-0.07**	**-0.87**	**0.11**	**1**							
$DUVOL_t$	**-0.06**	**-0.06**	**0.09**	**0.04**	**-0.08**	-0.01	**0.10**	**0.02**	**1**						
$DUVOL_{t-1}$	**-0.06**	**-0.07**	**0.01**	**0.10**	-0.01	**-0.08**	0.01	**0.11**	**0.05**	**1**					
σRet_t	**0.48**	**0.39**	**-0.13**	**-0.08**	0.00	**-0.04**	**-0.06**	**-0.02**	**-0.14**	**-0.10**	**1**				
σRet_{t-1}	**0.47**	**0.49**	**-0.13**	**-0.14**	**0.02**	-0.01	**-0.08**	**-0.06**	**-0.16**	**-0.14**	**0.71**	**1**			
σIR_t	**0.37**	**0.31**	**-0.10**	**-0.07**	**-0.03**	**-0.05**	**-0.03**	-0.01	**-0.15**	**-0.12**	**0.96**	**0.69**	**1**		
σIR_{t-1}	**0.39**	**0.39**	**-0.11**	**-0.11**	0.00	**-0.03**	**-0.05**	**-0.03**	**-0.17**	**-0.15**	**0.73**	**0.96**	**0.75**	**1**	
σNI_t	**0.33**	**0.32**	**-0.07**	**-0.07**	-0.01	**-0.02**	**-0.03**	**-0.02**	**-0.09**	**-0.09**	**0.44**	**0.45**	**0.44**	**0.45**	**1**
σNI_{t-1}	**0.30**	**0.33**	**-0.07**	**-0.07**	-0.01	**-0.02**	**-0.03**	**-0.02**	**-0.09**	**-0.09**	**0.37**	**0.43**	**0.37**	**0.43**	**0.87**

This table presents Pearson correlations among risk variables. Correlations significant at the $p < 0.05$ level are reported in bold.

TABLE 4
INDUSTRY DISTRIBUTION OF THE SAMPLE

Industry	Nobs.	%	Industry	Nobs.	%
Agriculture	53	0.3	Automobiles and Trucks	491	2.79
Food Products	432	2.46	Aircraft	222	1.26
Candy & Soda	57	0.32	Shipbuilding, Railroad Equipment	66	0.38
Beer & Liquor	69	0.39	Defense	73	0.42
Tobacco Products	37	0.21	Precious Metals	102	0.58
Recreation	145	0.83	Mines	71	0.4
Entertainment	179	1.02	Coal	8	0.05
Printing and Publishing	192	1.09	Petroleum and Natural Gas	745	4.24
Consumer Goods	426	2.42	Communication	307	1.75
Apparel	347	1.97	Personal Services	295	1.68
Healthcare	218	1.24	Business Services	978	5.57
Medical Equipment	608	3.46	Computers	431	2.45
Pharmaceutical Products	718	4.09	Computer Software	1,154	6.57
Chemicals	705	4.01	Electronic Equipment	1,327	7.55
Rubber and Plastic Products	134	0.76	Measuring and Control Equipment	513	2.92
Textiles	128	0.73	Business Supplies	425	2.42
Construction Materials	524	2.98	Shipping Containers	135	0.77
Construction	237	1.35	Transportation	634	3.61
Steel Works Etc	450	2.56	Wholesale	667	3.8
Fabricated Products	35	0.2	Retail	1,515	8.62
Machinery	977	5.56	Restaurants, Hotels, Motels	375	2.13
Electrical Equipment	237	1.35	Almost Nothing	128	0.73

This table presents industry distribution of my sample based on the Fama and French 49 industry classification.

Level Analysis

Table 5 represents the results of the OLS regression models that examine the effects of $Rel\beta^-$ and $Rel\beta^+$ on the levels of CEO annual cash, option, and stock awards. All compensation measures are measured in year *t* and all independent variables are measured in year *t-1* to mitigate the simultaneity concern. As noted in the previous section, my asymmetric risk measures are time-sensitive. In addition, I include firm-fixed effects in all my regression models, which allow me to examine within-firm variation and mitigate the concern that the observed findings reflect the mere correlation between dependent variables and unobservable time-invariant factors.

TABLE 5
LEVEL ANALYSIS – *Relβ⁻* AND *Relβ⁺*

	(1) *Cash_Awards*	(2) *Equity_Awards*	(3) *Option_Awards*	(4) *Stock_Awards*
$Rel\beta^-$	0.0318**	0.0347	-0.106	0.241***
$Rel\beta^+$	0.00531	0.0563	0.152***	-0.0738
β	0.0236*	0.0946	-0.0960	0.201**
σIR	-3.907***	0.844	39.26***	-54.67***
σNI	0.182	-0.593	0.641	0.0548
MVE	0.232***	0.767***	0.241***	1.132***
Annret	0.0908***	0.0399	0.00817	-0.0138
ROA	-0.173*	-0.240	0.0815	-1.762***
ΔNI	0.000980***	-0.00225	-0.00168	0.00196
BTM	0.278***	0.491***	-0.569***	1.952***
Lev	0.621***	0.926***	-1.236***	3.713***
BigN	-0.105*	0.137	0.808***	-0.587*
Instown	0.434***	1.191***	0.192	2.585***
HHI	1.498***	3.086***	-2.990**	10.97***
Free_CF	0.347***	0.321	-0.263	1.304***
R&D	0.0661	2.038	-2.651	6.310***
PP&E	-0.644***	-1.627***	0.392	-5.549***
CEO_Age	0.0817	-1.048***	-2.032***	-0.118
CEO_Tenure	0.0390***	0.0298	-0.0174	-0.0227
CEO_Shrown	-0.852***	-6.350***	-4.173***	-2.092*
Duality	-0.0541***	-0.106	0.106	-0.286**
Male	-0.117*	-0.267	0.790*	-1.099***
Intercept	4.577***	3.429**	9.726***	-5.862***
Firm Fixed Effects	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes
N	17,570	17,570	17,570	17,570
Adj. R-sq	0.691	0.397	0.389	0.443

This table presents results from OLS regressions that estimate the effects of $Rel\beta^-$ and $Rel\beta^+$ on the levels of CEO cash, option, and stock awards. All dependent variables are measured in year *t* and all independent variables are measured in year *t-1*. All variables are winsorized at the 1 and 99 percent levels. All variables are as defined in Appendix B. All models include firm and year fixed effects and firm-level clustered standard errors are used. ***, **, and * denote statistical significance at the 0.01, 0.05, and 0.10 levels (two-tail), respectively. t-values are reported in parentheses.

The positive coefficient on $Rel\beta^-$ in model (1) where I examine the impact of asymmetric risk on the level of annual cash compensation indicates that, as downside risk increases, boards grant more cash compensation. In contrast, the coefficient on $Rel\beta^-$ in model (2) where I examine the impact of asymmetric risk on the level of the sum of stock and option awards is insignificant. This indicates that, although boards do not reduce the level of equity compensation, they increase cash compensation to compensate for the increase in downside risk, which CEOs dislike. Interestingly, the coefficient on $Rel\beta^+$ in model (2) is insignificant, implying that boards do not decrease cash compensation as upside potential increases. This suggests that the boards' adjustment of cash compensation is asymmetric to downside risk versus upside potential.

Now, to better understand the choice between stock and option awards, I investigate the impact of *Relβ*$^-$ and *Relβ*$^+$ on option awards and stock awards in model (3) and (4), respectively. The positive coefficient on *Relβ*$^+$ in model (3) indicates that boards increases option awards as upside potential increases and the positive coefficient on *Relβ*$^-$ in model (4) indicates that boards increases stock as downside risk increases. Similar to the asymmetric effects of *Relβ*$^-$ and *Relβ*$^+$ on cash awards in model (1), only upside potential, but not downside risk, affects option awards and only downside risk, but not upside potential, affects stock awards. This result is consistent with the idea that, as upside potential increases, the leverage effects of option dominate and, thus, that boards grant more stock compensation to the CEOs. In contrast, as downside risk increases, boards provide more stock awards to protect the CEOs from downside risk since stock has positive value as long as the stock price is positive (i.e., positive intrinsic value).

The above findings in Table 5, however, are interesting since I test the impact of asymmetric risk on CEO compensation after controlling for symmetric risk, including market risk (β), idiosyncratic risk (σIR), and the volatility of accounting performance (σNI).

In Table 6, I used a combined asymmetric risk measure – β^- - β^+. Higher values of β^- - β^+ indicates greater downside risk. Thus, using this asymmetric risk proxy measures, I test how the magnitude of β^- relative to that of β^+ affect CEO compensation. The insignificant coefficient on β^- - β^+ in model (2) implies that boards do not adjust the total value of equity compensation. The positive coefficients in model (1) and (4) and the negative coefficient in model (3) indicate that, as downside risk relative to upside potential increases, boards increase cash and stock compensation but decrease option compensation, consistent with the findings from Table 5. To summarize, although boards do not adjust the total value of equity compensation, they shift away from option compensation to stock compensation as downside risk relative to upside potential increases.

TABLE 6
LEVEL ANALYSIS – β^- - β^+

	(1) *Cash_Awards*	(2) *Equity_Awards*	(3) *Option_Awards*	(4) *Stock_Awards*
β^--β^+	0.00952*	-0.0255	-0.136***	0.138***
β	0.0237*	0.0930	-0.0972	0.201**
σIR	-3.977***	0.685	39.20***	-55.00***
σNI	0.181	-0.593	0.645	0.0476
MVE	0.233***	0.769***	0.241***	1.135***
Annret	0.0918***	0.0434	0.0107	-0.00978
ROA	-0.171*	-0.235	0.0837	-1.754***
ΔNI	0.000984***	-0.00225	-0.00168	0.00198
BTM	0.279***	0.494***	-0.567***	1.957***
Lev	0.623***	0.931***	-1.234***	3.721***
BigN	-0.104*	0.139	0.809***	-0.585*
Instown	0.435***	1.191***	0.190	2.587***
HHI	1.493***	3.079***	-2.987**	10.94***
Free_CF	0.348***	0.324	-0.262	1.308***
R&D	0.0662	2.042	-2.647	6.310***
PP&E	-0.643***	-1.627***	0.390	-5.545***
CEO_Age	0.0816	-1.049***	-2.033***	-0.119

	(1) *Cash_Awards*	(2) *Equity_Awards*	(3) *Option_Awards*	(4) *Stock_Awards*
CEO_Tenure	0.0389***	0.0295	-0.0174	-0.0232
CEO_Shrown	-0.847***	-6.335***	-4.165***	-2.070*
Duality	-0.0540***	-0.106	0.106	-0.285**
Male	-0.117*	-0.266	0.791*	-1.097**
Intercept	4.571***	3.417**	9.723***	-5.888***
Firm Fixed Effects	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes
N	17,570	17,570	17,570	17,570
Adj. R-sq	0.691	0.397	0.389	0.442

This table presents results from OLS regressions that estimate the effects of β^{-} - β^{+} on the levels of CEO cash, option, and cash awards. All dependent variables are measured in year *t* and all independent variables are measured in year *t-1*. All variables are winsorized at the 1 and 99 percent levels. All variables are as defined in Appendix B. All models include firm and year fixed effects and firm-level clustered standard errors are used. ***, **, and * denote statistical significance at the 0.01, 0.05, and 0.10 levels (two-tail), respectively. t-values are reported in parentheses.

In Table 7, I use *DUVOL* as an asymmetric risk measure. Unlike $Rel\beta^{-}$, $Rel\beta^{+}$, and β^{-} - β^{+}, which measure the asymmetric sensitivity to the market risk, this asymmetric risk proxy measures asymmetry in a firm's total risk. Higher value of *DUVOL* indicates that firm's stock return is more volatile during "down" days than during "up" days. In these models, I control for the standard deviation of stock returns instead of market beta and idiosyncratic risk. The positive coefficient on DUVOL in model (4) indicates that boards increase stock compensation when downside risk increases to protect CEOs from bad outcomes.

TABLE 7
LEVEL ANALYSIS – *DUVOL*

	(1) *Cash_Awards*	(2) *Equity_Awards*	(3) *Option_Awards*	(4) *Stock_Awards*
DUVOL	0.0296	0.0608	-0.132	0.342***
σRet	-1.064*	6.468**	29.53***	-29.48***
σNI	0.134	-0.690	0.489	-0.170
MVE	0.243***	0.787***	0.198**	1.231***
Annret	0.0937***	0.0464	-0.00565	0.0202
ROA	-0.162*	-0.218	0.154	-1.755***
ΔNI	0.00107***	-0.00195	-0.00176	0.00259
BTM	0.269***	0.443***	-0.603***	1.920***
Lev	0.612***	0.876***	-1.259***	3.673***
BigN	-0.108*	0.133	0.827***	-0.626*
Instown	0.465***	1.220***	-0.0427	2.951***
HHI	1.534***	3.078***	-3.369**	11.47***
Free_CF	0.343***	0.273	-0.341	1.339***
R&D	0.0981	2.000	-2.847	6.597***
PP&E	-0.674***	-1.676***	0.554	-5.844***
CEO_Age	0.0951	-1.023***	-2.049***	-0.0257

	(1) *Cash_Awards*	(2) *Equity_Awards*	(3) *Option_Awards*	(4) *Stock_Awards*
CEO_Tenure	0.0391***	0.0305	-0.0202	-0.0194
CEO_Shrown	-0.861***	-6.385***	-4.193***	-2.145*
Duality	-0.0561***	-0.109	0.112	-0.303***
Male	-0.121*	-0.272	0.817*	-1.143***
Intercept	4.412***	3.214*	10.27***	-7.284***
Firm Fixed Effects	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes
N	17,569	17,569	17,569	17,569
Adj. R-sq	0.690	0.398	0.387	0.436

This table presents results from OLS regressions that estimate the effects of *DUVOL* on the levels of CEO cash, option, and stock awards. All dependent variables are measured in year *t* and all independent variables are measured in year *t-1*. All variables are winsorized at the 1 and 99 percent levels. All variables are as defined in Appendix B. All models include firm and year fixed effects and firm-level clustered standard errors are used. ***, **, and * denote statistical significance at the 0.01, 0.05, and 0.10 levels (two-tail), respectively. t-values are reported in parentheses.

Ratio Analysis

In the previous section, I regress asymmetric risk measures on the level of each compensation component. However, I acknowledge that the CEO compensation is provided as one package and the compensation components are not determined independent to each other. Thus, to examine the choice among compensation components, I perform ratio analysis in this section. In Table 8, model (1) through model (3), the dependent variables are the percentage of cash awards, option awards, and stock awards over the total compensation, respectively. In untabulated analysis, I replace the denominator in model (1) through (3), total compensation, with the sum of cash, option, and stock awards to examine the choice strictly among the three components. The results are similar. One potential explanation for the similar results is that cash, option, and stock compensation comprise significant portion of total compensation (see Table 3) and, thus, that it does not make a big difference if the total compensation or the sum of cash, option, and stock compensation is used. The negative coefficient of $Rel\beta^-$ in model (2) and the positive coefficient in model (3) indicates boards decrease the proportion of option awards and increase the proportion of stock awards as downside risk increases. In contrast, the positive coefficient of $Rel\beta^+$ in model (2) and the negative coefficient in model (3) indicates boards increase the proportion of option awards and decrease the proportion of stock awards as upside potential increases.

The dependent variable in model (4) is the value of option awards over the value of option and stock awards. Thus, in this specification, I examine how asymmetric risk affect the choice between option versus stock awards. Similar to results from model (2) and (3), as downside risk (upside potential) increases, boards shift away from option awards (stock awards) to stock awards (option awards).

TABLE 8
RATIO ANALYSIS – *Relβ⁻* AND *Relβ⁺*

	(1) *Cash_Awards (%)*	(2) *Option_Awards (%)*	(3) *Stock_Awards (%)*	(4) *Option/Equity (%)*
$Rel\beta^-$	-0.00124	-0.0150**	0.0159***	-0.0224***
$Rel\beta^+$	-0.00989**	0.0135***	-0.00593**	0.0150***
β	-0.00190	0.000922	0.0108**	-0.0322***
σIR	-1.111***	5.278***	-3.952***	6.152***
σNI	0.102	0.0364	-0.0966	0.0447
MVE	-0.0725***	0.0125**	0.0682***	-0.0770***
Annret	0.00507	-0.00433	-0.00276	-0.00248
ROA	-0.0488	0.101**	-0.0659**	0.139***
ΔNI	0.000407***	-0.000331**	-0.0000407	-0.000205
BTM	-0.0279**	-0.0975***	0.122***	-0.185***
Lev	-0.0459*	-0.186***	0.245***	-0.351***
BigN	-0.0267	0.0627***	-0.0241	0.124***
Instown	-0.0636***	-0.0434**	0.118***	-0.202***
HHI	-0.106	-0.404***	0.610***	-0.963***
Free_CF	0.0188	-0.0880***	0.0712***	-0.125***
R&D	-0.266	-0.152	0.416***	-0.642***
PP&E	0.101**	0.152***	-0.292***	0.411***
CEO_Age	0.0603*	-0.121***	0.0115	-0.136***
CEO_Tenure	-0.000879	-0.00148	-0.000121	0.000998
CEO_Shrown	0.424***	-0.338***	-0.101	-0.155
Duality	-0.00296	0.0175**	-0.0224***	0.0323***
Male	-0.00373	0.0550*	-0.0743**	0.142***
Intercept	0.913***	0.586***	-0.435***	1.730***
Firm Fixed Effects	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes
N	17,563	17,563	17,563	17,570
Adj. R-sq	0.381	0.364	0.427	0.409

This table presents results from OLS regressions that estimate the effects of $Rel\beta^-$ and $Rel\beta^+$ on the percentages of CEO cash, option, and stock awards over total compensation, and the ratio of option over equity awards. All dependent variables are measured in year *t* and all independent variables are measured in year *t-1*. All variables are winsorized at the 1 and 99 percent levels. All variables are as defined in Appendix B. All models include firm and year fixed effects and firm-level clustered standard errors are used. ***, **, and * denote statistical significance at the 0.01, 0.05, and 0.10 levels (two-tail), respectively. t-values are reported in parentheses.

In Table 9 and Table 10, I perform similar analysis as in Table 8 with replacing $Rel\beta^-$ and $Rel\beta^+$ with β^- - β^+ and *DUVOL*, respectively. The results generally confirm the inference that, as firms' downside risk relative to upside potential increases, boards grant more annual cash and stock compensation, and less annual option compensation.

TABLE 9
RATIO ANALYSIS – β^{-} - β^{+}

	(1) *Cash_Awards (%)*	(2) *Option_Awards*	(3) *Stock_Awards*	(4) *Option/Equity*
β^{-}-β^{+}	0.00553**	-0.0144***	0.00976***	-0.0181***
β	-0.00187	0.000777	0.0108**	-0.0323***
σIR	-1.092***	5.284***	-3.972***	6.169***
σNI	0.102	0.0369	-0.0970	0.0454
MVE	-0.0726***	0.0125**	0.0683***	-0.0771***
Annret	0.00471	-0.00423	-0.00253	-0.00254
ROA	-0.0493	0.101**	-0.0654**	0.138***
ΔNI	0.000406***	-0.000331**	-0.0000398	-0.000206
BTM	-0.0282**	-0.0975***	0.123***	-0.185***
Lev	-0.0464*	-0.186***	0.245***	-0.351***
BigN	-0.0269	0.0627***	-0.0240	0.124***
Instown	-0.0636***	-0.0436**	0.118***	-0.202***
HHI	-0.105	-0.403***	0.608***	-0.961***
Free_CF	0.0185	-0.0880***	0.0714***	-0.125***
R&D	-0.266	-0.152	0.416***	-0.642***
PP&E	0.101**	0.152***	-0.291***	0.410***
CEO_Age	0.0603*	-0.121***	0.0115	-0.136***
CEO_Tenure	-0.000864	-0.00147	-0.000151	0.00103
CEO_Shrown	0.423***	-0.338***	-0.0995	-0.156
Duality	-0.00299	0.0175**	-0.0223***	0.0322***
Male	-0.00395	0.0550*	-0.0741**	0.142***
Intercept	0.915***	0.586***	-0.437***	1.731***
Firm Fixed Effects	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes
N	17,563	17,563	17,563	17,570
Adj. R-sq	0.381	0.365	0.427	0.409

This table presents results from OLS regressions that estimate the effects of β^{-} - β^{+} on the percentages of CEO cash, option, and stock awards over total compensation, and the ratio of option over equity awards. All dependent variables are measured in year *t* and all independent variables are measured in year *t-1*. All variables are winsorized at the 1 and 99 percent levels. All variables are as defined in Appendix B. All models include firm and year fixed effects and firm-level clustered standard errors are used. ***, **, and * denote statistical significance at the 0.01, 0.05, and 0.10 levels (two-tail), respectively. t-values are reported in parentheses.

TABLE 10
RATIO ANALYSIS – *DUVOL*

	(1) *Cash_Awards (%)*	(2) *Option_Awards*	(3) *Stock_Awards*	(4) *Option/Equity*
DUVOL	0.000720	-0.0187**	0.0194***	-0.0330***
σRet	-0.984***	3.923***	-2.474***	3.526***
σNI	0.105	0.0448	-0.103*	0.0423
MVE	-0.0720***	0.00671	0.0743***	-0.0875***
Annret	0.00496	-0.00551	-0.00102	-0.00594
ROA	-0.0500	0.103**	-0.0679**	0.146***
ΔNI	0.000396***	-0.000336**	-0.00000974	-0.000274
BTM	-0.0254**	-0.103***	0.123***	-0.181***
Lev	-0.0435*	-0.191***	0.244***	-0.345***
BigN	-0.0272	0.0658***	-0.0266	0.128***
Instown	-0.0586***	-0.0724***	0.143***	-0.244***
HHI	-0.0935	-0.450***	0.645***	-1.023***
Free_CF	0.0226	-0.100***	0.0759***	-0.129***
R&D	-0.255	-0.188	0.436***	-0.662***
PP&E	0.0978**	0.170***	-0.310***	0.445***
CEO_Age	0.0606*	-0.126***	0.0164	-0.143***
CEO_Tenure	-0.000874	-0.00167	0.000130	0.000427
CEO_Shrown	0.425***	-0.339***	-0.102	-0.151
Duality	-0.00315	0.0186**	-0.0234***	0.0338***
Male	-0.00444	0.0581*	-0.0771**	0.148***
Intercept	0.900***	0.687***	-0.523***	1.858***
Firm Fixed Effects	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes
N	17,562	17,562	17,562	17,569
Adj. R-sq	0.381	0.358	0.420	0.401

This table presents results from OLS regressions that estimate the effects of β^{-} - β^{+} on the percentages of CEO cash, option, and stock awards over total compensation, and the ratio of option over equity awards. All dependent variables are measured in year *t* and all independent variables are measured in year *t-1*. All variables are winsorized at the 1 and 99 percent levels. All variables are as defined in Appendix B. All models include firm and year fixed effects and firm-level clustered standard errors are used. ***, **, and * denote statistical significance at the 0.01, 0.05, and 0.10 levels (two-tail), respectively. t-values are reported in parentheses.

CONCLUSIONS

Stock-based compensation for CEOs has grown significantly over the past 30 years. Since the value of stock-based compensation is linked to firms' uncertain future performance and risk-averse CEOs demand a risk-premium for bearing risk associated with stock-based compensation, firms risk environment is an important consideration. However, less is known about how boards adjust CEOs' incentives in light of firms' risk environments.

Because of the complex nature of equity incentives, prior literature is mixed on the circumstances in which either form of equity incentive is preferred over the other. Guay (1999) states that there is no clear method of determining the value of an employee stock option from the employee's perspective, as opposed to the firm's perspective. For example, the assumptions embedded in the Black-Scholes model are not completely applicable to employee stock options.

Furthermore, there is disagreement about the asymmetric incentive effects of stock options. Some researchers argue that options encourage risk since they limit downside risk (e.g., Bryan, Hwang, and Lilien 2000; Ryan and Wiggins 2001). In contrast, another stream of researchers argue that restricted stock provides greater downside protection because the value of stock is always positive. Thus, providing empirical evidence is important.

In this paper, I study how boards adjust CEO compensation package in response to firms' risk. First, regarding the choice between cash and equity compensation, I provide evidence that firms increase the value of cash awards but do not change the value of equity awards (i.e., the sum of the value of option and stock compensation) as downside risk increases. This finding is consistent with the idea that, although boards do not adjust the total value of equity compensation, they increase the cash compensation to compensate for increased risk. Second, I find that, as downside risk increases, firms grant more stock compensation but less option compensation. This finding implies that, although boards do not change the value of the total compensation, they shift the equity compensation away from option compensation to stock compensation as downside risk increases. This is consistent with the idea that providing option compensation becomes more expensive since risk-averse managers demand a higher risk premium for option compensation as downside risk increases.

The findings in this study contribute to the literature by providing evidence that boards respond to changes in their firms' risk environments by adjusting the structure of CEO compensation to reflect risk-averse CEOs' risk preferences. Lastly, my findings shed light on the importance of considering asymmetric risk when studying the impact of risk on CEO compensation and other corporate decisions such as investment.

ENDNOTES

1. A share of stock is an extreme case of a stock option with exercise price of zero. Guay (1999) describes stock in a levered firm as a European call option to buy the firm with an exercise price equal to the face value of debt.
2. Cash award is the sum of salary and bonus.
3. Cash award is the sum of salary bonus, and non-equity incentive compensation.

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APPENDIX A: ASYMMETRIC PAYOFF OF STOCK OPTIONS

The following illustrate the point that stock options do not provide downside protection. Consider the following case. A CEO is granted $1,000,000 worth of either at-the-money stock options or restricted stock. I assume that the exercise price equals the stock price at grant = $30, estimated volatility = 0.2, maturity = 10 years, the risk-free rate = 0.03, and dividend yield = 0%. Assuming the company uses the Black-Scholes model, the CEO will receive either 90,467 shares of stock options or 33,333 shares of restricted stock. If stock price increases by 90% at maturity, the final payoffs of stock options and restricted stock are $2,442,614 and $1,900,000, respectively. In contrast, if stock price decreases by 90% at maturity, the final payoffs of stock options and restricted stock are $0 and $100,000, respectively. This numerical example demonstrates the asymmetric payoff of stock options with respect to downside risk versus upside potential.

Annual increase/decrease in stock price	Value of options after 10 years ($)	Value of shares after 10 years ($)
-6.6%	0	100,000
0%	0	1,000,000
6.6%	2,442,614	1,900,000

APPENDIX B: VARIABLE DEFINITIONS

Dependent variables	
Cash_Awards	Natural logarithm of one plus the cash compensation received by the CEO during the fiscal year.
Option_Awards	Natural logarithm of one plus the option compensation received by the CEO during the fiscal year.
Stock_Awards	Natural logarithm of one plus the restricted stock compensation received by the CEO during the fiscal year.
Equity_Awards	Natural logarithm of one plus the restricted stock and option compensation received by the CEO during the fiscal year.
Cash_Awards (%)	Percentage of the cash compensation over the total compensation received by the CEO during the fiscal year.
Option_Awards (%)	Percentage of the option compensation over the total compensation received by the CEO during the fiscal year.
Stock_Awards (%)	Percentage of the restricted stock compensation over the total compensation received by the CEO during the fiscal year.
Equity_Awards (%)	Percentage of the restricted stock and option compensation over the total compensation received by the CEO during the fiscal year.
Option/Equity	Option compensation over the sum of option and restricted stock compensation.
Asymmetric risk variables	
$Rel\beta^-$	Downside beta minus beta (Ang, Cheng, and Xing 2006; see Eq. (1)).
$Rel\beta^+$	Upside beta minus beta (Ang, Cheng, and Xing 2006; see Eq. (1)).
$\beta^- - \beta^+$	Downside beta minus upside beta (Ang, Cheng, and Xing 2006; see Eq. (1)).
DUVOL	Natural logarithm of the ratio of the standard deviation of firm-specific daily returns in the “down” days to the standard deviation of firm-specific daily returns in the “up” days (Chen, Hong, and Stein 2001; Kim, Li, and Zhang 2011; see Eq. (2)).

Control variables	
β	Market beta estimated from the market model.
σIR	Standard deviation of the residuals of the market model, estimated with daily returns, over the year.
σRet	Standard deviation of daily returns over the year.
σNI	Standard deviation of net income before extraordinary items over the prior five years ending in year *t*. Minimum of 3 observations required.
MVE	Natural logarithm of market value of equity.
Annret	Buy-and-hold annual return.
ROA	Net income before extraordinary items scaled by total assets.
ΔNI	Change in net income before extraordinary items divided by fiscal year-end stock price.
BTM	Book-to-market value of equity.
Leverage	Total liabilities divided by total assets.
BigN	An indicator for big N auditor.
Instown	The percentage of total intuitional ownership over common shares outstanding.
HHI	Herfindahl-Hirschman Index. Sum of the squares of the net sales of each firm in an industry.
Free_CF	Operating cash flow minus capital expenditures divided by market value of equity
R&D	Research and development expenses scaled by total assets.
PP&E	Net property, plant, and equipment scaled by total assets.
CEO_Age	Natural logarithm of one plus CEO age.
CEO_Tenure	Natural logarithm of one plus CEO tenure.
CEO_Shrown	The number of shares of the firm owned by the CEO divided by the total number of shares of the firm.
Duality	An indicator for CEO-Chairman duality.
Male	One if the CEO is male, zero otherwise.