CEO incentives for risk-taking and compensation duration

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Abstract:
We hypothesize that corporate boards structure CEO compensation contracts to offset contrasting managerial incentives from compensation risk incentives (vega) versus contract horizon (duration). We find that compensation contracts with greater sensitivity to stock return volatility have longer durations and cross-sectional tests show an even stronger association for certain firm and CEO characteristics. We support the causal implications of our results using quasi-exogenous shocks: the adoptions of the Sarbanes-Oxley Act (SOX) and the Financial Accounting Standard (FAS) 123R. Our results suggest that boards are less willing to grant short duration compensation contracts in the presence of greater compensation risk incentives.

JEL codes: J33; M52

Keywords: boards; CEOs; compensation; vega; duration; executives; delta

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1. Introduction

Equity-based compensation is widely recognized as a key incentive device that encourages managers to act in ways that increase firm value (e.g., Jensen and Meckling 1976; Jensen and Murphy 1990; Mehran 1995; Hall and Liebman 1998). However, certain forms of equity-based compensation can provide managers with incentives to take excessive risks (e.g., Coles et al. 2006; Armstrong et al. 2013; Gormley et al. 2013) or focus on short-term results (e.g., Stein, 1998, 1999; Bolton, Scheinkman and Xiong, 2006; Bebchuk and Fried, 2010). In addition, prior empirical evidence suggests that compensation contracts affect managerial horizons and thus, their decisions. For example, the evidence shows that compensation contract duration (the time required for vesting of stock and option grants) is related to managerial decisions (Gopalan, et al., 2014) and that when vesting is imminent, equity compensation can lead CEOs to reduce real investment (Edmans et al., 2016).[1]

These issues lead to the fundamental question of how boards consider executives' risk incentives in designing compensation contracts, specifically in determining the contracts' duration. We address this question by examining the relation between the duration of executive compensation contracts and the equity incentives embedded in those contracts. Duration is often considered an important component of compensation contracting due to its potential effects on managerial incentives. For example, longer duration contracts are argued to be effective in creating incentives to increase firm value without engaging in excessive risk. However, Edmans and Gabaix (2015) point out that

[1] Edmans, Gonclaves-Pinto, Groen-Xu, and Wang (2018) find that imminent equity investing also affects disclosure. For reviews of the executive compensation literature see Murphy (1999, 2012), Frydman and Jenter (2010) and Edmans and Gabaix (2016).

although extending managers' incentive horizons may be valuable in overcoming moral hazard, it is not costless because of the additional risks it can impose on the manager. Thus, we focus on the design of compensation contracts in light of duration and the determination of how compensation-induced incentives for risk-taking, particularly the convexity of the compensation contract (i.e., *vega*) influence those contracts.

We develop hypotheses about the design of the compensation contracts. We first hypothesize that due to concerns over excessive risk-taking, a board of directors would be more likely to structure the CEO's risk incentives over a longer duration to discourage that risk taking. If the CEO's incentives are more dependent on stock price, it indicates that the CEO has more skin in the game (i.e., the CEO's wealth is more sensitive to stock price), thereby sending a credible signal of effort (Harris and Raviv 1978; Holmstrom 1979; Shavell 1979). At the same time, we expect that directors often include risk incentives in CEO compensation contracts to mitigate effects from CEO risk aversion (Amihud and Lev 1981; Smith and Stulz 1985). Thus, our first testable hypothesis is that we should observe a positive association between the duration of CEO contracts and CEO's equity risk incentives.[2] To test this hypothesis, we examine the relation between compensation duration and a CEO's compensation sensitivity to changes in stock volatility (*vega*) while controlling for the CEO's sensitivity to changes in stock price (*delta*).

Using a sample of over 11,000 firm-years with requisite data on vesting schedules over the period 1998-2014, we measure duration as the weighted average number of

[2] Equity risk incentives are represented by *vega* which captures the change in value of a manager's stock option portfolio for a given change in stock return volatility. In contrast, stock price incentives are represented by *delta* which captures the change in value of a manager's stock option portfolio for a given change in stock price. See Guay (1999) for additional discussion.

years for a CEO's compensation to vest, explicitly including the following components of pay: salary, bonus, performance-based awards, stock options, and restricted stock (Gopalan et al., 2014).[3] Controlling for CEO compensation delta, we find evidence consistent with our hypothesis in that we observe a strong positive relationship between the duration of CEO compensation and *vega* suggesting that boards lengthen vesting periods of new equity grants when the CEO's compensation is characterized with higher *vega*. In other words, boards appear to be less willing to approve short-term vesting periods when a CEO's compensation is more sensitive to stock volatility (vega). These results are robust to using different measures of duration (constructed explicitly from stock or options), as well as firm and CEO-firm fixed effects to control for latent time-invariant factors that could be correlated with both duration and equity incentives.

In testing our hypotheses, we consider how other factors would be expected to influence CEO pay duration. First, for the board and CEO of a firm with higher stock return volatility, we expect board's concerns over excessive risk-taking to be more acute, thus making it more likely for the board to lengthen pay duration due to the presence of greater compensation sensitivity to volatility. Consistent with our primary results, we find that the pattern of pay duration (positive association with vega) is stronger for firms with high volatility.

In supplementary tests of the relation between pay duration and risk-taking, we consider the CEO's age as a proxy for the CEO's experience and ability. We hypothesize that when boards have less information on a CEO's ability, they will prefer a longer vesting period, particularly in the presence of greater compensation-induced incentives

[3] Although we use the Gopalan et al. (2014) measure for much of our analysis, we also develop an extended measure in which we include the duration of the executive's pension and deferred compensation claims.

for risk-taking. Consistent with this hypothesis, we find that boards impose longer vesting periods for their younger CEOs. Overall, these results are consistent with corporate boards using vesting periods in order to more effectively bond a manager to act in ways that increase firm value while being cognizant of the possibility that CEOs may have incentives to take excessive risk.

We employ multiple methods to address the empirical challenges associated with analyzing executive contracts. First, to ensure that the board has knowledge of current vega at the time new grants are issued, we examine the relation between lagged vega and the duration of new equity grants. Second, because option incentives vary across firms, we include option intensity in our regressions to control for the proportion of options in a CEO's current compensation. Finally, to eliminate any mechanical relation between vega sensitivity and option duration, we also estimate the duration of restricted stock grants (which by construction have zero vega) and evaluate the extent to which lagged option vega leads to longer vesting schedules for new stock grants.

To sharpen identification, we consider two quasi-shocks to the contracting relationship between a corporate board and its CEO. The first shock derives from the enactment of SOX in 2002, which significantly increased boards' concerns about excessive risk-taking (Bargeron, Lehn, and Zutter 2010).[4] The second shock relates to the Financial Accounting Standards Board (FASB) issuance of FAS 123R in December 2004, which addresses the valuation of equity-based payments, in our case, stock or option payments to CEOs. With the issuance of FAS 123R, companies had to recognize the fair value of their option grants on the date of the grant, which changed the

[4] Bargeron et al. (2010) explain that SOX influenced risk-taking by requiring more independent directors, expanded liability exposure for executives and directors, and requiring formal evaluations of the adequacy of internal controls over financial reporting.

accounting treatment and made options more expensive to grant than previously. Testing the effects of both of these shocks, we find results consistent with our previous findings. The association between pay duration and vega is particularly prominent in the firm-years shortly after SOX and after the issuance of FAS 123R.

Finally, we examine whether a fuller measure of duration would yield the same qualitative results. Specifically, in lieu of the Gopalan et al. (2014) measure that uses options and restricted stock, we develop a measure of compensation duration that includes executives' pensions and deferred compensation. We find that our inferences hold using this expanded measure of duration indicating a robust relation between compensation sensitivity to risk (vega) and duration.

Our study contributes to several literature streams. First, we incorporate compensation sensitivities to stock volatility (vega) into the determinants of pay duration. In this way, we advance the influential stream of literature that argues that compensation mix matters in establishing appropriate incentives (see, for example, Bebchuk and Fried 2010 and Jensen and Murphy 1990, among others). We find strong evidence of a positive association between compensation incentives for risk-taking and duration.

Second, although our study uses the innovative duration measure developed by Gopalan et al. (2014), we provide a distinct contribution beyond their analysis by showing a rich set of relations between compensation sensitivities and duration. Our results suggest that boards consider the potential drawbacks associated with excessive risk-taking, particularly in the short-term. Although our focus is on the relation between compensation sensitivities for risk-taking and duration, our analysis should prove useful to future researchers in examining incentives for managers.

Finally, our results should be informative to a number of parties involved in public policy debates over the level and form of executive compensation. Our results are consistent with boards encouraging executives to take a long-term perspective by structuring longer duration compensation packages with heightened sensitivities for risk-taking. In this way, our results may generate a more nuanced discussion among various stakeholder groups.

2. Hypothesis development, sample and methodology

2.1. Incentives for risk-taking

It has long been argued that due to agency problems managers need compensation incentives to act in ways that increase shareholder value rather than pursue their own self-interested agendas. For example, equity-based compensation, primarily stock and stock options, is commonly used to mitigate managers' risk aversion.[5] Coles et al. (2006) suggest that a board will choose a mixture of equity-based incentives depending on their investment and financial objectives. However, beyond determining the composition of management compensation, the board of directors must also consider the duration of the vesting schedule for equity-based compensation.

In their study of the effects of financial reporting on equity vesting schedules, Cadman et al. (2013) argue that both costs and benefits must be weighed when determining the vesting period. Shareholders benefit from longer vesting schedules because longer duration helps extend the relatively short horizon of managers and increases the likelihood of retaining successful managers. Extending the duration of equity compensation also provides the board with more information for evaluating

[5] See for example, Jensen and Meckling (1976), Harris and Raviv (1978), Holmstrom (1979), and Shavell (1979).

management performance and reduces the opportunity for managers to manipulate information releases or engage in other activities that can produce short-lived results. However, extending the duration of vesting schedules may not be costless.[6] Beyond the additional risk pointed out by Edmans and Gabaix (2015), others have studied the additional effects on managers such as reduced pay-for-performance sensitivities and increased management turnover (Kleymenova and Tuna, 2016) and managers' preferences for shorter duration vesting schedules because of reduced forfeiture risk. Gomez-Mejia et al., 2010). These results indicate a tradeoff between additional compensation costs and additional risk taking.

There also exists the more basic question of the relation between equity compensation and excessive risk taking and whether stock ownership works to align the executives' incentives with that of the shareholders (e.g., Coles, 2006; Gormley, et al., 2013; Armstrong et al., 2013). Moreover, beyond stock compensation, CEOs can be compensated with stock options, which create convexity in the compensation contract. Given that the value of the CEO's option holdings directly relate to the firm's stock price volatility, a CEO being compensated through a contract with a high vega will be more willing to engage in a risky project than a CEO with a low vega, all else equal.

Taking these considerations into account, our first hypothesis states that if boards take the CEO's risk-taking incentives into account while determining the duration of the compensation contract, then the length of the vesting schedule should be positively associated with vega. A related hypothesis is that duration should be more positively

[6] In addition to these costs and benefits, the choice of a time horizon for equity compensation is likely to generate controversy. A short-term vesting schedule is often viewed as promoting a short-term focus and inducing managerial myopia (Zimmerman, 2015) despite the notion that an extended duration vesting schedule could be described as inefficient (Roe, 2015).

associated with vega in the cross section under conditions in which excessive risk taking is a concern or when the benefits of extending duration is likely to be greater. In subsequent tests, we examine two such conditions. First, firms with greater stock volatility are more likely to be concerned with excessive risk-taking, particularly if the CEO's decision horizon is shorter. Thus, we expect these firms to exhibit a stronger relation between vega and duration of new grants. Second, we propose that boards might be more concerned about excessive risk-taking for younger CEOs, as the board has relatively less information about the ability of younger CEOs.

2.*2. Sample*

Our sample derives primarily from the Incentive Lab database, which collects detailed compensation data disclosed in proxy filings from the largest 750 publicly-traded U.S. companies each year. The sample period is 1998-2014. We begin our sample in 1998, as that is the earliest year in which detailed vesting data required to construct our dependent variable (*Duration*) is available through Incentive Lab. We also obtain firm-level financial information from the Compustat database, and various other features of executive compensation from the ExecuComp database.

Table 1 reports the distribution of firms whose data is available by year (Panel A) and by industry (Panel B). In Panel A we observe around 500-800 firms per year that have adequate data coverage to be included in our empirical analysis. In Panel B, we show that the sample has broad Standard Industrial Classification (SIC) industry representation (which also closely mirrors that of the larger Compustat population).

2.3. Variable measurements

2.3.1. Duration of executive compensation

We use detailed data on compensation vesting periods provided by the Incentive Lab database to construct our primary measure of duration. The database tracks vesting periods for the following components of pay: options, restricted stock, long-term and short-term cash awards, phantom stock and options, and various cash and equity-based awards. We adapt the Gopalan et al. (2014) measure of duration as the weighted average number of years a CEO must wait in order to receive their compensation from each of the sources:

$$\begin{aligned} Duration = \; & [(Salary + Bonus)\times 0 + \Sigma Restricted\ stock_i \times t_i + \Sigma Option_j \times t_j] \\ & / [(Salary + Bonus) + \Sigma Restricted\ stock_i + \Sigma Option_j]. \end{aligned} \quad (1)$$

Because Incentive Lab tracks all components of compensation grants with data available on vesting periods, we differ from Gopalan et al. and measure duration using all available data on vesting periods (not just options and restricted stock).[7] However, in supplemental tests, we confirm that our results are unchanged if we strictly follow Gopalan et al. (2014) and construct duration using only salary, bonus, stock options, and restricted stock.[8]

2.3.2. Delta and vega

Our independent variables of interest reflect the price sensitivities of the executive's option portfolio. Specifically, *delta* captures the change in the value of the executive's option portfolio given a 1% increase in the underlying stock price, and *vega*

[7] In untabulated tests, we confirm that the majority of vesting periods correspond to options and restricted stock.

[8] In supplemental tests, we find our results are unchanged if we include pensions and deferred compensation (with reasonable assumptions about vesting periods) in our measure of duration.

captures the change in the value of the executive's option portfolio given a 0.01 unit increase in the underlying stock volatility. These measures are the partial derivatives of the executive's option portfolio value with respect to the underlying stock price and volatility, respectively, using the option pricing model of Black and Scholes (1973), adjusted for dividends (Merton 1973):

$$V = \quad Se^{-dT} N(Z) - Xe^{-rT} N(Z - \sigma T^{(1/2)}). \tag{2}$$

Where $Z = [ln(S/X) + T(r-d+\sigma^2/2]/\sigma T^{(1/2)}$, N is the cumulative normal distribution function, S is the stock price, X is the option strike price, σ is the expected volatility during the option life, r is the risk-free rate, T is the time to maturity in years, and d is the expected dividend yield during the option's life. Hence,

$$delta = \partial V/\partial S = e^{-dT} N(Z) S/100, \text{ and} \tag{3}$$

$$vega = \partial V/\partial \sigma = e^{-dT} N'(Z) S T^{(1/2)}/100, \tag{4}$$

Where $N'(Z)$ is the normal density function of Z. We use the "one-year approximation" method outlined in Core and Guay (2002) to estimate *delta* and *vega*.[9]

2.4. Empirical design

We test our hypotheses using variations of the following regression model:

$$Duration_{i,t} = \alpha + \beta_1 vega_{i,t-1} + \beta_2 delta_{i,t-1} + Controls + fixed\ effects + \varepsilon. \tag{5}$$

We lag delta and vega to ensure that the compensation risk (through delta and vega) are known at the time in which new vesting periods are approved by the board. To mitigate the influence of outliers, we log-transform delta and vega in all regressions. Because compensation contracting depends on board, firm and industry characteristics,

[9] Detailed descriptions are provided in Section 2 of Core and Guay (2002), as well as the appendix of Brockman et al. (2010). In 2005, ExecuComp changed the reporting of several of the data items required to compute delta and vega. We follow the procedures outlined in Hayes, Lemmon, and Qiu (2012) to construct delta and vega for post-2005 observations.

we use a number of control variables in an attempt to isolate the effects of our variable of interest (vega) on duration.[10] Specifically, we control for the sensitivity of the CEO's stock and option compensation to stock price (delta), as boards may be less concerned about excessive risk-taking when the compensation is more closely tied to stock price. To control for the differences associated with stock option usage, we also include option intensity, defined as the proportion of current-year compensation that is comprised of option grants.

We control for firm characteristics that have been shown to influence pay duration in previous research, such as firm size, growth opportunities, asset duration, R&D, leverage, profitability, stock return, stock volatility (e.g., Gopalan et al. 2014). We also control for several CEO characteristics, including tenure, age, and whether the CEO holds the dual role of chair of the board. We include several board characteristics, including board size, proportion of the board comprised of independent directors, the percentage of independent directors who are busy, and number of board members who are financial experts (e.g., have a CPA license, accounting or finance background). Finally, we include a lagged measure of duration (*Lagged duration*) in our regression models to capture the persistence of duration over time. Thus, we are capturing the board's changes in compensation duration. Depending on the specification, combinations of fiscal year, industry (two-digit SIC), industry-by-year, firm and CEO-firm fixed effects are modeled in the regressions, and standard errors are clustered by firm (Petersen 2009).

[10] All variables are defined in the appendix.

3. Results

3.1. Summary statistics

Panel A of Table 2 reports descriptive statistics for the variables used in the empirical analyses. On average, when we weight by compensation received at each duration, the CEOs in our sample receive their compensation in 1.34 years, which is consistent with the Gopalan et al. (2014) sample. The means (medians) for the compensation contracts' vega and delta are large, which is not surprising given that our sample primarily contains large firms.[11,12] Approximately 27% of the average CEO's total annual compensation is comprised of option grants.

Along with the firm characteristics, we also include a number of CEO and board-related characteristics. CEO tenure on average is 8.4 years, the average CEO is almost 56 years old, and approximately 66% of our sample firms do not separate the roles of CEO and Chair of the Board. On average, the boards are comprised of around eleven members. Nearly 72% of directors are classified as independent. Among those, nearly half hold more than two other (public or private) board positions. For descriptive purposes, we report raw dollar values (in thousands) of CEO total compensation, as well as major components of compensation. The average CEO earns $895,000 in salary, $620,000 in bonus, $1 million in new option awards, and $2 million in new restricted stock awards.

In Panel B of Table 2 we report the pairwise correlation coefficients for the variables used in our primary analyses. Other than the relationship between delta and

[11] Incentive Lab tracks the largest 750 firms (by market cap) each year. Once Incentive Lab begins to track a firm, they continue to track that firm even if it later falls out of the top 750 firms.

[12] In untabulated additional robustness tests, rather than log-transforming delta and vega to mitigate the influence of outliers, we remove outliers from the regression using the DFITS and r-student statistics of Belsley, Kuh, and Welch (1980) and find consistent results.

vega, most of the correlations are small.[13] Notably, we observe a positive correlation between *ln(vega)* and *Duration* (*p*-value < 0.05), which suggests the two variables interact in board compensation considerations, consistent with our primary hypothesis.

3.2. Univariate differences

We first examine whether duration is associated with systematic differences in primary compensation contract dimensions. In Table 3 we report the mean characteristics for the firms with short (bottom tercile) and long (top tercile) duration along with the results of univariate tests for differences in these means for the two types of firms.[14] The differences are all significantly different from zero.

We observe that short-duration CEOs have an average duration of less than one year while long-duration CEOs have an average duration of more than two years. Long-duration CEOs have on average less delta exposure but more vega exposure (*p*-value < 0.01), providing support for our primary hypothesis. Specifically, the difference in delta (vega) exposure is approximately $243,500 ($113,500) which is economically significant. We note that these univariate patterns are also consistent with the correlations reported in Panel B of Table 2 where *ln(delta)* is negatively correlated with *Duration*, and *ln(vega)* is positively correlated with *Duration*. These pairwise correlations are also statistically significant (*p*-value < 0.05). We also observe that option usage differs between CEOs with short and long duration. CEOs with short duration schemes typically work at firms where options comprise a smaller percentage of total annual compensation.

[13] In untabulated tests, we examine variance inflation factors ("VIFs") and confirm that the VIFs for our variable of interest is less than 2.2 which is well below thresholds of concern (Kennedy 2008).

[14] Terciles are formed by industry (two-digit SIC) and fiscal year.

3.3. Baseline regressions

We next examine the relation between duration and vega while controlling for other firm and compensation contract characteristics. Table 4 reports the results from ordinary least squares (OLS) regressions of Equation (5) with fixed effects.[15] Column 1 includes only lagged duration and fiscal year and industry fixed effects as controls, while Column 2 and 3 include the full set of control variables.

The results reveal a striking pattern consistent with our hypotheses. Results from Column 1 confirm the univariate patterns observed in Table 3, specifically that duration is positively associated with *vega* (Estimate = 0.037, *p*-value < 0.01). We also find that duration is negatively associated with *delta*. Notably, the coefficient estimates for vega maintain their statistical significance as control variables and additional restrictions (via firm fixed effects) are added (Estimate = 0.017, *p*-value < 0.01). Results from Column 3 with firm fixed effects, in particular, help dispel concerns that innate, unobserved firm characteristics (e.g., firm culture) may be driving the patterns we observe (Estimate = 0.030, *p*-value < 0.01).[16] Further, the use of CEO-firm fixed effects in Column 4 helps alleviate concerns that our results might be affected by an unobservable, time-invariant matching process between the CEO and firm (Estimate = 0.028, *p*-value < 0.01). Finally, we control for industry-year shocks to compensation contracting by including industry-by-year fixed effects in Column 5 (Estimate = 0.015, *p*-value < 0.01). Economically, a one-standard deviation in lagged vega is associated with a 4-8% increase in duration,

[15] Because we include a lagged measure of duration as a right-hand-side variable, we omit this term in firm fixed effects specifications to avoid the well-known Nickell bias associated with using firm fixed effects with lagged dependent variables (Nickell 1985). In untabulated tests, we confirm our inferences are unchanged if we estimate these regressions using Blundell-Bond dynamic panel GMM.

[16] Results are also robust to estimating regressions with CEO fixed effects (in lieu of firm fixed effects), and this alleviates the concern that innate, unobserved executive characteristics (e.g., ability, risk tolerance) explain the patterns we find.

depending on the specification. As would be expected, the coefficient estimate on *Lagged duration* is positive and significant, suggesting persistence in the length of compensation contracts across time.

Overall, we interpret these results as consistent with our primary hypothesis that longer duration contracts are associated with CEO compensation incentives for risk-taking. In particular, the results suggest that boards are more willing to grant shorter duration contracts in the presence of less vega exposure, and we find some evidence that boards are more willing to grant shorter duration in the presence of more delta exposure.

3.4. Cross-sectional tests

In our next set of tests, we examine settings where we expect variation in the relation between vega and contract duration. Specifically, we test how vega and duration vary for firms with high volatility, young CEOs, and across time. If compensation duration is selected by the board in consideration of compensation sensitivities toward risk, then these settings should provide more powerful tests of our predictions.

3.4.1. Volatility

Table 5 reports results from estimating regressions with year and CEO-firm fixed effects (Columns 1 and 2) for firms with high (*High Vol*) and low (*Low Vol*) stock return volatility. We define high (low) stock return volatility if the firm's annualized daily stock return volatility over the prior fiscal year is above (below) the median for that particular industry and fiscal year. Our hypotheses suggest that boards should prefer that CEOs commit to a longer-term horizon when risk is more prominent. Consequently, we test whether under conditions of high stock return volatility, boards are less willing to grant their CEOs shorter-duration compensation contracts in the presence of greater existing

vega exposure.

The results displayed in Table 5 are consistent with this expectation. The coefficient estimate on vega in the low volatility subsample is positive but insignificant at conventional levels (Estimate = 0.006, *p*-value > 0.10), whereas the coefficient estimate on vega in the high volatility subsample is positive and highly significant (Estimate = 0.034, *p*-value < 0.01). We conduct a Welch test of differences in coefficients on vega across regression subsamples (reported near the bottom of the table) and confirm these differences are statistically significant (*p*-value < 0.05). Results suggest that the effect of prior-year vega exposure on compensation duration is stronger when prior-year volatility is high.

3.4.2. CEO age

Table 5 also reports results from estimating regressions with year and CEO-firm fixed effects (Columns 3 and 4) for firms led by younger (*Younger CEO*) and older (*Older CEO*) CEOs. We identify younger (older) CEOs if the CEO's age is below (above) the median for that particular industry and fiscal year. Our hypotheses imply that age should have a moderating effect on compensation duration for two reasons. First, there is generally less information available about the ability of a younger CEO; therefore, boards may be less willing to grant short duration contracts to younger CEOs in the presence of greater vega exposure. Second, the relatively younger CEOs are generally less experienced and face greater career concerns and therefore may be more willing to accept longer incentive horizons.

Results reveal an interesting pattern. Specifically, restricting the subsample to the set of younger CEOs appears to strengthen the observed relations between vega exposure

and compensation duration. The coefficient estimate on vega for the younger CEO subsample is positive and highly significant (Estimate = 0.041, *p*-value < 0.01), while the coefficient estimate on vega in the older CEO subsample is still positive but smaller in magnitude and marginally significant (Estimate = 0.016, *p*-value < 0.10). We conduct a Welch test of differences in coefficients on vega across regression subsamples (reported near the bottom of the table) and confirm these differences are statistically significant (*p*-value < 0.10). We interpret these results as reflecting boards' preference for longer duration compensation contracts when the CEO is young and has greater vega exposure. This result also bears some similarity to Gillan, Hartzell, and Parrino (2009) who find that when contracting uncertainty between the firm and CEO is high, the compensation contract is more likely to be governed by an explicitly longer employment agreement.

3.5. Time trends

Our sample covers a seventeen year period in which there existed a number of changes in corporate governance, accounting rules and financial markets. Figures 1a through 1c show the time trends in the CEO compensation variables of interest. The level of compensation illustrated in Figure 1a reaches a peak just before the dotcom market crash in the early 2000's, after which it falls, before building again. just before the Financial Crisis of 2007-2008 after which it again falls and then begins to climb once more. The time trend in option awards shown in Figure 1b reflects the rising popularity of executive option grants until the dotcom market crash, after which the amount of option grants to CEOs has been decreasing over time. In contrast, Figure 1c shows that the amount of stock awards has been steadily increasing over time. These figures indicate to some extent a substitution between grants of options and grants of stock.

Figures 1d and 1e show the time trends in the duration of CEO compensation and vega, respectively. Figure 1d shows that duration has been increasing over time indicating that, on average, corporate boards have been lengthening their CEOs' compensation contracts. Vega increased in the early part of the sample period (as option awards were increasing and creating more convexity in the compensation contracts) and then vega began to decrease until the financial crisis and there has been little change in vega since that time. Given these variations over time we adapt our regression to include a linear and quadratic time trend, defined as the fiscal year minus 1999 (the first fiscal year in our sample), and interact it with vega. This specification allows us to examine whether the relation between vega and duration has changed significantly over time, particularly considering the emergence of restricted stock grants (as depicted in Figure 1c).

Consistent with the illustrations in the figures, the regression coefficient estimates in Table 6 show that duration is significantly increasing over time. Notably, the interaction term, $ln(vega) \times Time$, is also positive and significant indicating that the relation between vega and duration has been strengthening over time (Estimate = 0.002, p-value < 0.05). This result is consistent with the hypothesis that boards' concerns about excessive risk-taking have become stronger over our sample period. We explore this result further in the next section by examining two significant changes affecting compensation contracting during our sample.

4. Shocks to compensation contracting

Shocks to compensation contracting between the board and the CEO provide an opportunity for stronger identification of the relation between compensation risk and

duration. In this section, we first examine CEO contracting during the immediate years surrounding the 2002 enactment of SOX. We then examine CEO contracting before and after a shock to the accounting regulatory system, the issuance of FAS123R.

4.1. CEO contracting before and after the enactment of SOX

The enactment of SOX provides a valuable setting for identifying the relation between vega and duration because of the effects SOX had on U.S. firms' corporate governance. Specifically, SOX imposes more stringent requirements for director independence, expands liability exposure for executives and directors, and requires CEO and CFO certification of the financial statements and internal controls, all of which were designed to affect corporate risk-taking. Consistent with this view, Bargeron et al. (2010) predict and find that SOX led to a general reduction in firm risk. We hypothesize that corporate board concerns over vega-induced excessive risk-taking were heightened following SOX. Thus, we expect the relation between vega and duration to be stronger in the years after the SOX passage.

We estimate our baseline regression for two subsamples. The Pre SOX (Post SOX) is defined as fiscal years 1999 through 2002 (2003 through 2005). We restrict the analysis to the years immediately surrounding SOX to better capture the effects from SOX.

The results reported in Table 7 show that the relation between vega and duration was indeed stronger in the years following SOX. Specifically, the coefficient estimate on *ln(vega)* is insignificant in the pre-SOX years (Estimate = -0.009, p-value > 0.10) and positive and highly significant in the post-SOX years (Estimate = 0.055, p-value < 0.01). An untabulated Welch test of differences in coefficients across regression models

confirms the difference is statistically significant (p-value < 0.05). Overall, results from this test support our hypothesis that board concerns over vega-induced excessive risk-taking became more prominent in the years immediately following SOX and resulted in a lengthening of the compensation duration.

4.2. CEO contracting before and after the issuance of FAS 123R

The issuance of FAS 123R in December 2004 changed the accounting for executive stock options. Prior to this time firms that granted stock options with an exercise price equal to the current stock price did not have to record the option grant as an expense because the intrinsic value would be zero. FAS 123R requires that firms recognize the fair value of the options on the date it was granted. Firms can use the Black-Scholes model or some other model for estimating the fair value. Hayes, Lemmon and Qiu (2012) argue that the issuance of FAS 123R serves as an exogenous change because although it affects the accounting for stock options, it does not affect the economic costs and benefits of using stock options to provide managerial incentives. They show that firms reduced the dollar value of option grants after FAS 123R relative to the years just before FAS 123R.[17] The issuance of FAS 123R gives us a quasi-natural experiment to examine whether boards changed the way in which they considered compensation duration and the risk from compensation incentives.[18]

FAS 123R would have most affected those firms that did not expense stock options prior to the adoption of FAS 123R. Thus, we partition the sample by the years

[17] Hayes, Lemmon and Qiu (2012) provide evidence supporting their hypothesis that the accounting rule change should not affect managerial decisions. In contrast, Chava and Purnanandam (2010) provide evidence that the rule change did affect managerial decisions. We take a different track by examining board decisions regarding the relation between duration and compensation risk incentives.

[18] Bakke et al. (2016) find a significant reduction in vega after FAS 123R and connect this reduction to a subsequent decrease in firm risk for a small sample of oil and gas firms.

immediately before and after FAS 123Rand include a new variable, *Affected firm*, which consistent with Bakke et al. (2016), are those firms that were not expensing stock options prior to the accounting rule change.[19] We estimate our regression for two subsamples, the before (after) FAS 123R subsamples consisting of theyears 2002 through 2004 (2005 through 2007).

The results, reported in Table 8, show that in the period after the implementation of FAS 123R duration significantly changes as does the relation between duration and compensation risk incentives. In Columns (1) and (2) in which duration is the dependent variable, the coefficient estimate on lagged vega (*ln(vega)*) is positive and highly significant, suggesting that compensation contracts characterized with greater vega in general lengthened in duration following the rule change. Notably, the coefficient estimates on *Affected firm* indicate that the firms most affected by the accounting rule change decreased the duration of CEO compensation in the years following FAS 123R. Similar to Bakke et al. (2016), we observe a sharp reduction in vega for these firms following the enactment of FAS 123R. Taken together, these results provide interesting insights into the relation between vega and duration by examining how duration changes (i.e., decreases) following an exogenous decrease in vega for affected firms. These results are consistent with our hypothesis that boards consider compensation risk incentives when determining compensation duration.

[19] Although the treated would also technically include firms that had no stock options (and thus no need to expense them), Hayes, Lemmon and Qiu (2012) found only 16 firms in their sample that had no outstanding stock options pre and post FAS 123R introduction.

5. Additional Analyses

We perform additional analyses to determine whether our results are robust to alternative measures of duration. We also examine whether our results are affected by different types of grants.

5.1. Alternative measures of duration

As described earlier, our primary measure of duration includes all components of compensation that have a vesting schedule to construct the weighted-average number of years a CEO must wait to receive her compensation. These components include options, restricted stock, as well as other less frequent items such as phantom stock and deferred cash and equity awards. In this section, we consider alternative measures of duration and re-estimate our main tests.

Table 9 reports regressions using two alternative measures of duration. *Duration (stock + options)* is the primary measure of Gopalan et al. (2014) which considers only restricted stock and options in determining duration. *Duration (including pensions)* is our primary measure of duration augmented with pensions and non-qualified deferred compensation. To estimate the vesting schedule associated with pensions and deferred compensation, we use the number of years before CEOs reach the age of 65. This admittedly naïve approach roughly approximates the time in which CEOs would begin to have unfettered access to their pensions. However, we recognize that some CEOs may wait much later to begin drawing from their pension in which case our alternative measure of duration would represent a lower-bound estimate.

Results from Table 9 support our primary results, namely that compensation sensitivity to volatility is associated with longer duration compensation contracts.

Specifically, our results hold whether we use a measure of duration that captures only restricted stock and options as in Gopalan et al. (2014) (Column 1) or if we use a measure that explicitly considers pensions and deferred compensation (Column 2).

5.2. Examining different types of grants

In this section, we examine the extent to which our results are sensitive to different types of equity grants to the CEOs. Table 10 reports the results where in , Column 1 we consider only stock grants and in Columns 2 (3) considers only time-based (performance-based) awards. The results in all columns show that the relationship between duration and vega is not confined to option grants. In other words, the level of compensation sensitivity toward risk can also impact the duration of stock awards. Further, we find that boards alter the timing of awards (Column 2) as well as the nature of the vesting schedule (Column 3).

6. Conclusion

Contracting between corporate boards and their CEOs is a fundamental aspect of incentive alignment for the CEO's decision-making and in particular, it is important to understand how the structuring of these contracts affects managers' investment horizons. We examine how boards design CEO compensation contracts and document a relation between the sensitivity of compensation to firm volatility and the duration of that compensation. Specifically, compensation contracts with greater sensitivity to a firm's stock return volatility, i.e., greater vega, have longer durations. We also find this relationship to be stronger in firms with greater return volatility, firms led by relatively younger and newer CEOs.

By examining shocks to the contracting environment, we are able to provide better

identification strategies. After SOX, which we consider as an exogenous shock to the strength of board monitoring, we find a stronger association between compensation contracts with greater sensitivity to firm volatility and duration. After passage of FAS 123R, which significantly raised the cost of options, we find that compensation contracts have a greater association between vega and duration. Overall, our results suggest that boards consider the compensation risk that their CEOs face in setting the vesting schedules. Boards appear less willing to grant shorter vesting periods in the presence of greater compensation risk.

Finally, our empirical results suggest a need for further theoretical analysis of the optimal form of compensation in structuring appropriate incentives for executives. Current theoretical explanations of CEO compensation do not explicitly consider how duration interacts with other components of pay, such as vega. For example, Laux (2012) and Manso (2011) develop theories that acknowledge that long-term vesting periods may discourage long-term investments, particularly when job security is threatened, but they also suggest that compensation contracts allow for early vesting or provide other forms of job security, respectively. In other models, Bolton et al. (2006), Peng and Roell (2014), and Edmans et al. (2015) generally prescribe longer vesting schedules to effectively curb short-term behavior. However, these models could be expanded to consider the interaction between duration and compensation incentives for risk-taking.

Appendix: Variable Definitions

Firm characteristics	
Firm size	the natural logarithm of total assets (Compustat AT)
Market-to-book ratio	the market value of equity, plus book value of total debt, divided by total assets (Compustat (PRCC_F*CSHO + DLC + DLTT)/AT).
Long-term assets	net property, plant, and equipment plus goodwill, divided by total non-cash assets (Compustat (PPENT + GDWL)/(AT-CHE)).
R&D	research and development expense divided by total assets (Compustat XRD/AT)
Leverage	total debt divided by total assets (Compustat (DLC+DLTT)/AT)
ROA	net income divided by total assets (Compustat NI/AT)
Stock return	the annual stock return (including dividends) computed during the fiscal year
Stock return volatility	the annualized daily stock return volatility over the fiscal year
CEO and board characteristics	
CEO age	the age of the CEO at the end of the fiscal year
CEO tenure	the number of years the executive has held the title of CEO at the firm (using ExecuComp data item BECAMECEO)
CEO chair	equals one if the CEO holds the dual role of Chair of the Board[20]
Ln (board size)	the natural logarithm of the number of board members at the end of the fiscal year
Board independence	the percentage of board members that are classified as independent directors
Num financial experts	the number of financial experts serving on the board

[20] We use the executive's title reported in ExecuComp to identify whether a CEO also holds the dual role as Chair of the Board. Our search procedure captures variations of "chairman" or "chair", and we specifically exclude any instances in which the title includes "former."

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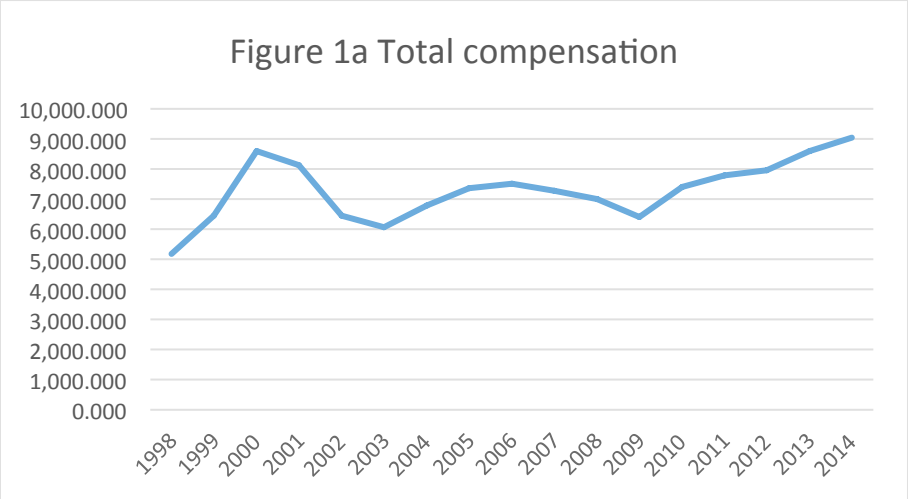
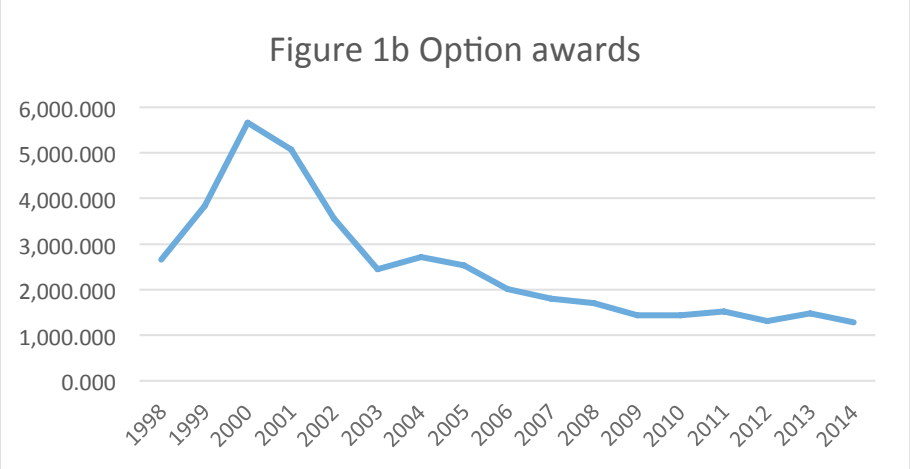
Figure 1 Time trends in variables





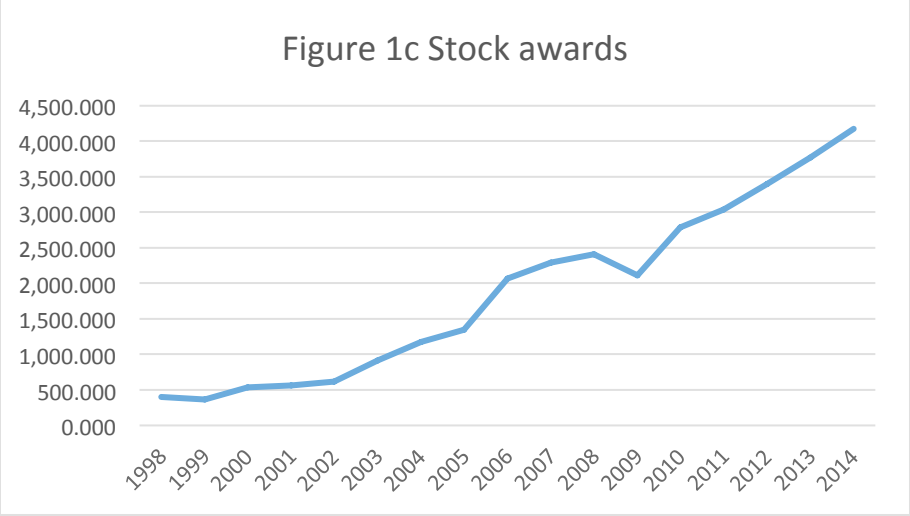
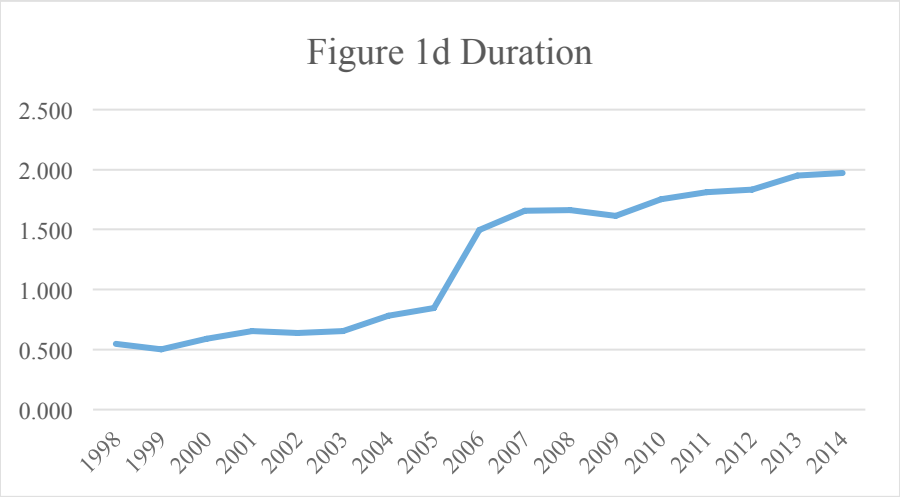


Figure 1 (continued)



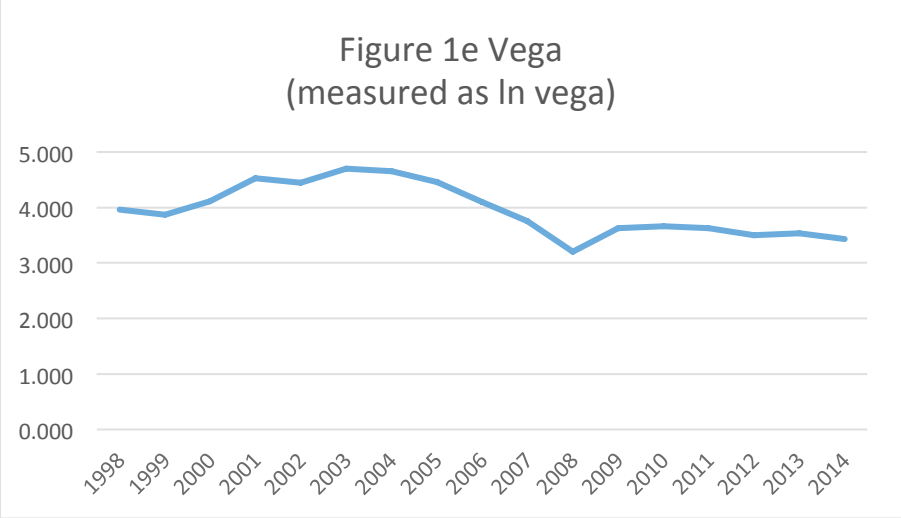


Table 1
Sample composition

The table provides descriptions of the sample composition. In Panel A, the sample distribution is reported in number and percentage by the firms' fiscal years. In Panel B, the sample distribution is reported by two-digit SIC industry.

Panel A: Distribution by fiscal year

Fiscal year	N	%
1999	524	4.59
2000	610	5.35
2001	649	5.69
2002	710	6.22
2003	717	6.28
2004	710	6.22
2005	683	5.99
2006	597	5.23
2007	730	6.40
2008	802	7.03
2009	813	7.13
2010	814	7.13
2011	785	6.88
2012	767	6.72
2013	756	6.63
2014	743	6.51
Total	11,410	

Panel B: Distribution by industry

Two-digit SIC	Industry	N	%
73	Business services	1,056	9.26
36	Electronic and other electrical equipment and components, except computer equipment	852	7.47
49	Electric, gas, and sanitary services	785	6.88
28	Chemicals and allied products	759	6.65
35	Industrial and commercial machinery and computer equipment	707	6.20
63	Insurance carriers	597	5.23
60	Depository institutions	593	5.20
38	Measuring, analyzing, and controlling instruments; photographic, medical and optical goods; watches	442	3.87
13	Oil and gas extraction	384	3.37
67	Holding and other investment offices	379	3.32
20	Tobacco products	349	3.06
48	Communications	289	2.53
37	Transportation equipment	276	2.42
62	Security and commodity brokers, dealers, and exchanges	254	2.23
other	Various	3,688	32.31
Total		11,410	

Table 2
Descriptive Statistics

This table reports the descriptive statistics and correlations for the compensation, firm characteristic, and CEO and board characteristic variables used in the analysis. All variables are defined in the appendix. To mitigate the influence of outliers, all continuous measures have been winsorized at the 1% and 99% levels. Panel A provides the mean, standard deviation, and 10^{th}, 50^{th}, and 90^{th} percentile observations. Panel B provides the Pearson correlation coefficients among the primary variables of interest. Bolded coefficients denote significance at the 5% level or less using a two-sided test.

Panel A. Sample statistics

Variable	N	Mean	Std	10th Pctl	50th Pctl	90th Pctl
Duration	11,410	1.340	1.042	0.000	1.537	2.496
Vega ($$$)	11,410	227.97	349.42	0.00	103.93	580.54
Delta ($$$)	11,410	1,141.72	2,982.40	35.20	365.44	2,282.84
ln(vega)	11,410	4.080	2.169	0.000	4.653	6.366
ln(delta)	11,410	5.691	1.898	3.589	5.904	7.734
Option intensity	11,410	0.272	0.267	0.000	0.224	0.683
Size	11,410	8.610	1.520	6.720	8.466	10.592
Market-to-book	11,410	1.630	1.528	0.502	1.227	3.144
LT assets	11,410	0.426	0.253	0.026	0.446	0.759
R&D	11,410	0.024	0.047	0.000	0.000	0.091
Leverage	11,410	0.248	0.185	0.006	0.232	0.493
ROA	11,410	0.047	0.096	-0.013	0.047	0.134
Stock return	11,410	0.186	0.566	-0.330	0.119	0.700
Stock vol	11,410	0.390	0.218	0.186	0.332	0.670
CEO tenure	11,410	8.471	6.525	3.000	7.000	17.000
CEO age	11,410	55.999	6.691	47.000	56.000	64.000
CEO chair	11,410	0.659	0.474	0.000	1.000	1.000
Board size	11,410	10.707	2.935	7.000	11.000	14.000
Indpct	11,410	0.722	0.189	0.444	0.778	0.909
Indbusy	11,410	0.508	0.268	0.000	0.538	0.833
Num fin experts	11,410	2.028	1.473	0.000	2.000	4.000
Salary ($$$)	11,410	895.72	375.79	475.00	882.87	1,300.00
Bonus ($$$)	11,410	620.31	1,343.93	0.00	0.00	1,800.00
Option awards ($$$)	11,410	1,049.09	1,857.66	0.00	275.00	3,010.21
Stock awards ($$$)	11,410	2,086.77	3,049.75	0.00	885.89	5,835.96

Panel B. Correlations among primary variables

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Duration																		
ln(vega)	**0.10**																	
ln(delta)	**-0.02**	**0.60**																
Option intensity	**-0.10**	**0.32**	**0.16**															
Size	**0.26**	**0.23**	**0.18**	**-0.08**														
Market-to-book	**-0.09**	**0.03**	**0.16**	**0.22**	**-0.36**													
LT assets	**0.09**	0.00	**-0.05**	**-0.02**	**-0.14**	**0.04**												
R&D	**-0.06**	**0.05**	**0.04**	**0.22**	**-0.32**	**0.33**	**-0.07**											
Leverage	**0.04**	**-0.05**	**-0.09**	**-0.11**	**0.13**	**-0.14**	**0.13**	**-0.22**										
ROA	**0.09**	**0.10**	**0.12**	**-0.02**	**-0.05**	**0.32**	**0.07**	**-0.14**	**-0.17**									
Stock return	**-0.06**	**-0.10**	**-0.11**	0.01	**-0.07**	**0.31**	-0.01	**0.02**	**-0.03**	**0.10**								
Stock vol	**-0.21**	**-0.19**	**-0.11**	**0.18**	**-0.28**	**0.08**	**-0.09**	**0.23**	-0.01	**-0.36**	0.01							
CEO tenure	**-0.10**	**0.00**	**0.31**	**-0.05**	**-0.07**	**0.07**	**-0.05**	**0.02**	**-0.04**	**0.04**	0.01	0.00						
CEO age	0.01	**0.03**	**0.14**	**-0.09**	**0.16**	**-0.09**	**0.03**	**-0.14**	**0.02**	**0.06**	-0.01	**-0.15**	**0.41**					
CEO chair	**-0.05**	**0.12**	**0.16**	**0.06**	**0.12**	**-0.05**	**0.03**	**-0.10**	0.01	0.00	**-0.02**	**-0.04**	**0.21**	**0.23**				
Board size	**0.16**	**0.18**	**0.06**	**-0.06**	**0.56**	**-0.26**	**-0.03**	**-0.25**	**0.07**	-0.01	**-0.08**	**-0.25**	**-0.13**	**0.11**	**0.09**			
Indpct	**0.38**	**0.05**	**-0.04**	**-0.23**	**0.14**	**-0.10**	**0.08**	0.01	0.01	**0.09**	**-0.04**	**-0.21**	**-0.04**	**0.04**	**0.02**	**0.10**		
Indbusy	**0.18**	**0.11**	**0.03**	**-0.06**	**0.24**	**-0.09**	**0.05**	**0.02**	**0.05**	**-0.02**	**-0.07**	**-0.14**	**-0.13**	**-0.03**	0.00	**0.20**	**0.31**	
Num fin experts	**0.23**	**0.03**	-0.01	**-0.16**	**0.24**	**-0.12**	0.00	**-0.06**	**0.07**	**0.04**	**-0.04**	**-0.12**	**-0.06**	**0.05**	0.01	**0.24**	**0.40**	**0.22**

Table 3

Short vs Long Duration: Univariate Differences

This table divides the sample firms for duration and reports the mean characteristics and the univariate differences between the means for the firms in each group. Firms are classified in short (long) duration categories if the firm-year observation for duration is in the bottom (top) tercile, ranked by fiscal year and two-digit SIC industry. The variables are defined in the Appendix. To mitigate the influence of outliers, all continuous measures have been winsorized at the 1% and 99% levels. The right column reports two-sided *p*-values for *t*-tests of whether the differences between the mean characteristics for each group are significantly different from zero. between the short and long duration groups.

Variable	Short duration	Long duration	Difference (short-long)	*p*-value
Duration	0.561	2.250	-1.688	<.0001
Vega ($$$)	179.622	293.093	-113.500	<.0001
Delta ($$$)	1,278.500	1,035.030	243.500	0.000
ln(vega)	3.674	4.466	-0.792	<.0001
ln(delta)	5.628	5.819	-0.192	<.0001
Option intensity	0.228	0.294	-0.066	<.0001

Table 4

The effect of compensation risk on duration: baseline regressions

This table reports regressions examining the relation between compensation sensitivity to risk and duration. The variable definitions are provided in the Appendix. Robust standard errors, clustered by firm, are reported below each coefficient estimate. ***, **, * denotes significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)	(4)	(5)
Variable	*Duration*	*Duration*	*Duration*	*Duration*	*Duration*
ln(vega)	0.037***	0.017***	0.030***	0.028***	0.015***
	(0.005)	(0.006)	(0.006)	(0.007)	(0.005)
ln(delta)	-0.016***	-0.012*	-0.004	0.001	-0.011**
	(0.006)	(0.006)	(0.007)	(0.008)	(0.005)
Option intensity	0.393***	0.431***	0.403***	0.505***	0.455***
	(0.045)	(0.045)	(0.037)	(0.039)	(0.032)
Size		0.056***	0.134***	0.071***	0.057***
		(0.010)	(0.021)	(0.028)	(0.007)
Market-to-book		0.004	-0.006	0.003	0.006
		(0.006)	(0.008)	(0.008)	(0.006)
LT assets		-0.002	0.150*	0.143	0.011
		(0.049)	(0.088)	(0.106)	(0.046)
R&D		-0.112	1.587***	0.565	-0.203
		(0.242)	(0.496)	(0.580)	(0.208)
Leverage		0.036	-0.033	-0.030	0.032
		(0.051)	(0.079)	(0.094)	(0.047)
ROA		0.054	0.241**	0.032	0.030
		(0.083)	(0.101)	(0.107)	(0.092)
Stock return		-0.011	-0.007	0.003	-0.017
		(0.013)	(0.015)	(0.015)	(0.015)
Stock vol		-0.379***	-0.434***	-0.290***	-0.315***
		(0.048)	(0.057)	(0.062)	(0.054)
CEO tenure		-0.005***	-0.009***	0.015	-0.004***
		(0.001)	(0.002)	(0.016)	(0.001)
CEO age		-0.002	-0.005**	0.038	-0.002
		(0.001)	(0.002)	(0.034)	(0.001)
CEO chair		0.016	0.035	0.019	0.013
		(0.018)	(0.023)	(0.028)	(0.016)
Board size		0.002	-0.008	-0.008	0.003
		(0.004)	(0.005)	(0.006)	(0.003)
Indpct		0.097	-0.103	-0.056	0.110**
		(0.063)	(0.085)	(0.106)	(0.053)
Indbusy		0.011	0.022	0.042	0.026
		(0.037)	(0.047)	(0.052)	(0.033)
Num fin experts		-0.001	-0.008	-0.010	-0.002
		(0.006)	(0.011)	(0.014)	(0.005)
Lagged duration	0.483***	0.459***			0.470***
	(0.015)	(0.015)			(0.008)
Year fixed effects?	Yes	Yes	Yes	Yes	No
Industry fixed effects?	Yes	Yes	No	No	No
Industry-year fixed effects?	No	No	No	No	Yes
Firm fixed effects?	No	No	Yes	No	No
CEO-firm fixed effects?	No	No	No	Yes	No
Observations	11,410	11,410	11,410	11,410	11,310
R-squared	0.529	0.539	0.610	0.691	0.577

Table 5

The effect of compensation risk on duration, cross-sectional tests

This table reports regressions examining how the relation between compensation sensitivity to risk and duration varies by stock return volatility and CEO age. The control variables are listed and defined in the Appendix. *t*-statistics, based on standard errors clustered by firm, are reported below each coefficient estimate. ***, **, * denotes significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)	(4)
Sample partition:	Low Vol	High Vol	Young CEO	Older CEO
Variable	*Duration*	*Duration*	*Duration*	*Duration*
ln(vega)	0.006	0.034***	0.041***	0.016*
	(0.012)	(0.011)	(0.011)	(0.010)
ln(delta)	-0.013	0.008	-0.009	0.008
	(0.014)	(0.013)	(0.013)	(0.012)
Option intensity	0.473***	0.490***	0.465***	0.562***
	(0.067)	(0.054)	(0.059)	(0.055)
Size	0.060	0.086**	0.008	0.023
	(0.052)	(0.037)	(0.044)	(0.041)
Market-to-book	0.040*	-0.005	0.019	-0.011
	(0.021)	(0.010)	(0.012)	(0.014)
LT assets	0.233	-0.020	0.367**	-0.054
	(0.190)	(0.142)	(0.158)	(0.161)
R&D	-0.639	0.997	0.131	2.302**
	(1.232)	(0.688)	(0.781)	(0.963)
Leverage	-0.076	0.043	0.158	-0.202
	(0.167)	(0.126)	(0.139)	(0.139)
ROA	0.148	-0.001	-0.060	0.145
	(0.276)	(0.121)	(0.142)	(0.168)
Stock return	0.004	0.017	-0.002	0.010
	(0.033)	(0.018)	(0.022)	(0.021)
Stock vol	-0.176	-0.303***	-0.409***	-0.084
	(0.126)	(0.079)	(0.091)	(0.088)
CEO tenure	0.018	-0.027	-0.076	0.007
	(0.020)	(0.038)	(0.076)	(0.017)
CEO age	-0.042	0.089*	0.167***	0.008
	(0.053)	(0.050)	(0.055)	(0.051)
CEO chair	0.096**	-0.069*	-0.033	0.054
	(0.044)	(0.042)	(0.039)	(0.044)
Board size	0.004	-0.012	-0.012	-0.001
	(0.009)	(0.008)	(0.010)	(0.008)
Indpct	0.018	-0.009	0.038	-0.149
	(0.173)	(0.151)	(0.165)	(0.151)
Indbusy	0.034	-0.111	0.058	0.021
	(0.082)	(0.076)	(0.080)	(0.073)
Num fin experts	-0.012	-0.021	-0.008	-0.005
	(0.021)	(0.021)	(0.021)	(0.019)
Lagged duration	0.098***	0.066***	0.005	0.095***
	(0.015)	(0.015)	(0.015)	(0.014)
Year fixed effects?	Yes	Yes	Yes	Yes
CEO-firm fixed effects?	Yes	Yes	No	No
Welch test of *ln(vega)*: (1) vs (2)		-0.027		
(*p*-value)		(0.041)		
Welch test of *ln(vega)*: (3) vs (4)				0.024
(*p*-value)				(0.053)
Observations	5,604	5,686	5,131	6,279
R-squared	0.727	0.744	0.734	0.714

Table 6
Time trend in duration-vega relation

This table reports regressions examining how the relation between compensation risk and duration varies over time. Time is a linear time trend which equals the fiscal year minus 1999 (the first fiscal year in our regression sample). The control variables are listed and defined in the Appendix. *t*-statistics, based on standard errors clustered by firm, are reported below each coefficient estimate. ***, **, * denotes significance at the 1%, 5%, and 10% levels, respectively.

Variable	*Duration*
ln(vega)	-0.005
	(0.010)
ln(delta)	-0.009
	(0.006)
ln(vega)×Time	0.002**
	(0.001)
Time	0.109***
	(0.008)
Time×Time	-0.003***
	(0.000)
Option intensity	0.400***
	(0.047)
Size	0.068***
	(0.010)
Market-to-book	0.010*
	(0.006)
LT assets	-0.017
	(0.048)
R&D	-0.041
	(0.247)
Leverage	0.057
	(0.052)
ROA	0.183**
	(0.084)
Stock return	-0.032***
	(0.012)
Stock vol	-0.285***
	(0.038)
CEO tenure	-0.006***
	(0.001)
CEO age	-0.002
	(0.001)
CEO chair	0.012
	(0.018)
Board size	0.002
	(0.004)
Indpct	0.143**
	(0.062)
Indbusy	-0.137***
	(0.032)
Num fin experts	0.004
	(0.006)
Lagged duration	0.471***
	(0.015)
Year fixed effects?	No
Industry fixed effects?	Yes
Observations	11,410
R-squared	0.502

Table 7
The effect of compensation risk on duration around SOX

This table reports regressions examining the relation between compensation risk and duration surrounding the enactment of SOX. The control variables are listed and defined in the Appendix. *t*-statistics, based on standard errors clustered by firm, are reported below each coefficient estimate. ***, **, * denotes significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)
Sample partition:	Pre SOX	Post SOX
Variable	*Duration*	*Duration*
ln(vega)	-0.009	0.055***
	(0.011)	(0.013)
ln(delta)	-0.013	-0.019
	(0.011)	(0.016)
Option intensity	0.375***	0.097
	(0.057)	(0.066)
Size	0.051***	0.077***
	(0.016)	(0.018)
Market-to-book	-0.004	0.036*
	(0.008)	(0.020)
LT assets	-0.161*	-0.090
	(0.095)	(0.109)
R&D	-0.503	-0.638
	(0.438)	(0.496)
Leverage	0.043	0.100
	(0.103)	(0.116)
ROA	0.158	-0.537*
	(0.129)	(0.302)
Stock return	-0.023	0.013
	(0.023)	(0.035)
Stock vol	-0.147	-0.159
	(0.096)	(0.177)
CEO tenure	-0.004*	-0.006*
	(0.003)	(0.003)
CEO age	0.001	-0.002
	(0.003)	(0.003)
CEO chair	0.096**	-0.020
	(0.037)	(0.037)
Board size	0.002	0.006
	(0.005)	(0.007)
Indpct	-0.087	0.249**
	(0.082)	(0.125)
Indbusy	0.002	0.031
	(0.065)	(0.072)
Num fin experts	0.013	-0.000
	(0.014)	(0.012)
Lagged duration	0.499***	0.418***
	(0.017)	(0.017)
Year fixed effects?	Yes	Yes
Industry fixed effects?	Yes	Yes
Observations	2,493	2,707
R-squared	0.392	0.430

Table 8

The effect of compensation risk on duration around the issuance of FAS 123R

This table reports regressions examining the effect of FAS 123R on duration. *Treated* equals one for firms not expensing stock options prior to FAS 123R, and zero for firms expensing stock options before 2003. *FAS123R* equals one for years 2005–2007, and zero for years 2002-2004. The other variables are defined in the Appendix. Columns (1) and (2) have duration as the dependent variable and columns (3) and (4) have vega as the dependent variable. *t*-statistics, based on standard errors clustered by firm, are reported below each coefficient estimate. ***, **, * denotes significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)	(4)
Sample partition:	Pre FAS 123R	Post FAS 123R	Pre FAS 123R	Post FAS 123R
Variable	*Duration*	*Duration*	*ln(vega)*	*ln(vega)*
Affected firm	-0.029	-0.141***	-0.036	-0.220***
	(0.039)	(0.041)	(0.041)	(0.060)
ln(vega)	0.033**	0.049***	0.685***	0.685***
	(0.013)	(0.015)	(0.032)	(0.030)
ln(delta)	-0.021	-0.022	-0.142***	-0.137***
	(0.013)	(0.019)	(0.033)	(0.036)
Option intensity	0.101	0.579***	1.436***	1.520***
	(0.078)	(0.096)	(0.126)	(0.139)
Size	0.063***	0.073***	0.185***	0.176***
	(0.019)	(0.021)	(0.027)	(0.034)
Market-to-book	0.019	0.020	0.011	0.002
	(0.019)	(0.028)	(0.026)	(0.041)
LT assets	-0.050	-0.203	0.329**	0.106
	(0.101)	(0.129)	(0.138)	(0.197)
R&D	-0.406	-1.210**	1.276**	1.761*
	(0.431)	(0.588)	(0.618)	(0.955)
Leverage	0.146	0.065	-0.040	0.255
	(0.104)	(0.144)	(0.163)	(0.201)
ROA	-0.091	-0.289	0.701**	2.464***
	(0.178)	(0.388)	(0.306)	(0.592)
Stock return	-0.022	0.132**	0.451***	0.081
	(0.027)	(0.058)	(0.046)	(0.094)
Stock vol	-0.149	-0.262	-1.772***	-1.698***
	(0.131)	(0.243)	(0.239)	(0.442)
CEO tenure	-0.005*	-0.009**	0.006	0.018***
	(0.003)	(0.004)	(0.005)	(0.006)
CEO age	-0.000	-0.003	-0.001	-0.001
	(0.003)	(0.003)	(0.003)	(0.005)
CEO chair	0.045	-0.004	0.056	0.032
	(0.040)	(0.044)	(0.048)	(0.065)
Board size	-0.000	0.010	-0.003	0.017
	(0.007)	(0.008)	(0.009)	(0.012)
Indpct	0.009	0.361**	-0.008	0.453
	(0.107)	(0.180)	(0.150)	(0.277)
Indbusy	-0.007	0.058	0.066	0.014
	(0.069)	(0.103)	(0.089)	(0.131)
Num fin experts	0.014	-0.024*	-0.018	-0.012
	(0.015)	(0.014)	(0.017)	(0.019)
Lagged duration	0.449***	0.341***	0.005	0.043
	(0.030)	(0.030)	(0.024)	(0.033)
Year fixed effects?	Yes	Yes	Yes	Yes
Industry fixed effects?	Yes	Yes	Yes	Yes
Welch test of *Affected firm*: (1) vs (2)		0.112		
(*p*-value)		(0.024)		
Welch test of *Affected firm*: (3) vs (4)				0.184
(*p*-value)				(0.006)
Observations	2,144	2,028	2,146	2,031
R-squared	0.363	0.407	0.728	0.610

Table 9

The effect of compensation risk on duration: alternative measures

This table reports regressions examining the relation between compensation risk and alternative measures of duration. The variables are defined in the Appendix. *t*-statistics, based on standard errors clustered by firm, are reported below each coefficient estimate. ***, **, * denotes significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)
Variable	*Duration* (stock + options)	*Duration* (including pensions)
ln(vega)	0.018***	0.016**
	(0.006)	(0.007)
ln(delta)	-0.011*	-0.011
	(0.007)	(0.007)
Option intensity	0.401***	0.351***
	(0.046)	(0.047)
Size	0.053***	0.051***
	(0.010)	(0.011)
Market-to-book	0.004	0.005
	(0.006)	(0.006)
LT assets	-0.008	-0.080
	(0.049)	(0.057)
R&D	-0.057	-1.101***
	(0.241)	(0.265)
Leverage	0.025	0.061
	(0.053)	(0.062)
ROA	0.062	0.066
	(0.085)	(0.096)
Stock return	-0.013	0.004
	(0.013)	(0.016)
Stock vol	-0.385***	-0.330***
	(0.051)	(0.060)
CEO tenure	-0.005***	-0.005***
	(0.001)	(0.002)
CEO age	-0.002	-0.011***
	(0.001)	(0.002)
CEO chair	0.012	0.075***
	(0.018)	(0.022)
Board size	0.002	0.005
	(0.004)	(0.004)
Indpct	0.104	0.123*
	(0.064)	(0.070)
Indbusy	0.012	0.011
	(0.037)	(0.042)
Num fin experts	-0.002	0.003
	(0.007)	(0.008)
Lagged duration	0.463***	0.562***
	(0.016)	(0.015)
Year fixed effects?	Yes	Yes
Industry fixed effects?	Yes	Yes
Observations	11,435	11,404
R-squared	0.528	0.624

Table 10

The effect of compensation risk on duration: by grant type

This table reports regressions examining the relation between compensation risk and duration. Each regression uses a different measure of duration based on the type of grant (option, stock, time-based award, performance-based award). For brevity, year and industry fixed effects are included as noted but not tabulated. *t*-statistics, based on standard errors clustered by firm, are reported below each coefficient estimate. ***, **, * denotes significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)
Variable	*Duration* (stock only)	*Duration* (time)	*Duration* (p-v)
ln(vega)	0.033***	0.014***	0.015***
	(0.006)	(0.005)	(0.005)
ln(delta)	-0.019***	-0.009	-0.013***
	(0.006)	(0.006)	(0.005)
Option intensity	-0.391***	0.747***	-0.269***
	(0.042)	(0.044)	(0.033)
Size	0.066***	0.029***	0.058***
	(0.010)	(0.009)	(0.008)
Market-to-book	0.014***	-0.008	0.011**
	(0.005)	(0.006)	(0.005)
LT assets	0.083	-0.052	0.051
	(0.051)	(0.048)	(0.042)
R&D	-0.259	0.013	-0.180
	(0.240)	(0.230)	(0.187)
Leverage	-0.063	0.039	-0.059
	(0.054)	(0.050)	(0.044)
ROA	-0.076	0.077	-0.010
	(0.084)	(0.077)	(0.068)
Stock return	-0.005	-0.005	0.014
	(0.013)	(0.013)	(0.011)
Stock vol	-0.166***	-0.333***	-0.101**
	(0.048)	(0.046)	(0.042)
CEO tenure	-0.005***	-0.003*	-0.004***
	(0.002)	(0.001)	(0.001)
CEO age	-0.002	-0.003**	-0.000
	(0.001)	(0.001)	(0.001)
CEO chair	0.004	-0.009	0.019
	(0.019)	(0.017)	(0.016)
Board size	0.000	-0.001	0.001
	(0.003)	(0.003)	(0.003)
Indpct	0.226***	0.046	0.162***
	(0.060)	(0.057)	(0.044)
Indbusy	-0.017	-0.010	0.038
	(0.039)	(0.039)	(0.030)
Num fin experts	0.001	-0.004	0.002
	(0.007)	(0.007)	(0.006)
Lagged duration	0.458***	0.513***	0.578***
	(0.016)	(0.014)	(0.016)
Year fixed effects?	Yes	Yes	Yes
Industry fixed effects?	Yes	Yes	Yes
Observations	11,428	11,435	11,430
R-squared	0.528	0.493	0.574