The Optimal Duration of Executive Compensation: Theory and Evidence*

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Abstract

While much is made of the ills of "short-termism" in executive compensation, in reality very little is known empirically about the extent of short-termism in CEO compensation. This paper develops a new measure of CEO pay duration that reflects the vesting periods of different components of compensation, thereby quantifying the extent to which compensation is short-term and the extent to which it is long-term. It also develops a theoretical model that generates three predictions for which we find strong empirical support using our measure of pay duration. First, optimal pay duration is decreasing in the extent of mispricing of the firm's stock. Second, optimal pay duration is longer in firms with poorer corporate governance. Third, CEOs with shorter pay durations are more likely to engage in myopic investment behavior, and this relationship is stronger when the extent of stock mispricing is larger.

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The recent financial crisis has renewed the interest in understanding what, if anything, may be wrong with current executive pay practices. This question has been front and center in corporate governance discussions ever since Jensen and Murphy (1990) famously argued that what matters in CEO pay is not *how much* you pay, but *how* you pay. Recently, the debate on executive pay has focused on how much of the compensation should be short-term and how much of it should be long-term. For example, Bebchuk and Fried (2010) suggest that the equity component of executive compensation should *not* be permitted to be unwound for some time after vesting (but the unwinding should not have to wait until the executive retires either). By contrast, Bolton, Scheinkman, and Xiong (2006) argue that, in a speculative market where stock prices may deviate from fundamentals, an emphasis on short-term stock performance may be the outcome of an optimal contracting problem rather than rent extraction by managers. This debate is hampered by a lack of systematic evidence on the mix of short-term and long-term pay for corporate executives. Specifically, we know very little about the vesting schedules of the two most important components of CEO pay – restricted stock and stock options, and that prevents one from answering the following simple yet important questions: How long does it take for a typical pay contract to vest, and how does this vary in the cross-section? Does the mix of short-term and long-term pay affect executive behavior?

We address these questions by developing a new measure, *pay duration*, to characterize the mix of short-term and long-term executive pay. This measure is a close cousin of the duration measure developed for bonds. We compute it as the weighted average of the vesting periods of the different pay components, with the weight for each component being equal to the fraction of that component in the executive's total compensation. We use this measure with systematic data on the vesting schedules of restricted stock and stock options for our empirical analysis; we believe this is the first time in the literature that such comprehensive data have been brought to bear on the questions we address.[1]

To guide our empirical analysis, we develop a simple model along the lines of Bolton, Scheinkman, and Xiong (2006) to understand the determinants of pay duration. Our model has two features that

[1] Cadman, Rusticus, and Sunder (2010) examine the vesting schedules of stock options (leaving out restricted stock) in their study of financial reporting issues.

we believe are part of real-world contracting environments. First, the stock market can misprice a firm's equity in the short-run. Second, the executive can engage in inefficient extraction of private benefits which can be partly moderated through a long-term incentive contract. This setting allows us to focus on the shareholders' tradeoff between short-term and long-term pay for the CEO. Given the potential for short-term mispricing of the firm's stock, giving the CEO short-term stock compensation allows her to benefit from the option of selling overvalued stock, which effectively lowers the initial shareholders' cost of compensating the CEO. However, exclusive reliance on such short-term compensation also encourages the CEO to behave myopically, diverting effort to the extraction of inefficient private benefits at the expense of long-term firm value. Thus, providing the CEO with long-term compensation is optimal because it helps to attenuate this moral hazard.

This model generates three main predictions. First, optimal pay duration is decreasing in the extent/magnitude of stock mispricing. Second, optimal pay duration is longer in firms with poorer corporate governance. Third, CEOs with shorter pay durations are more likely to engage in myopic investment behavior, and this relation between pay duration and investment myopia is stronger when potential stock mispricing is larger.

With the model's predictions in hand, we proceed with our empirical analysis and uncover strong support for the model's predictions. Our data on the levels and vesting schedules of restricted stock and stock options come from Equilar Consultants (Equilar). Similar to Standard and Poor's (S&P) ExecuComp, Equilar collects their compensation data from the firms' proxy statements. We obtain details of all stock and option grants to all named executives of firms in the S&P 1500 index for the period 2006-08. We obtain data on other components of executive pay, such as salary and bonus from ExecuComp, and we ensure comparability of Equilar and ExecuComp by making sure that the total number of options granted during the year for each executive in our sample is the same across Equilar and ExecuComp.

We find that the vesting periods for both restricted stock and stock options cluster around the three to five-year period with a large proportion of the grants vesting in a fractional (graded) manner during the vesting period (see Table 1). There is, however, significant cross-sectional variation in the vesting schedules. Industries with longer-duration projects, such as Defense, Utilities, and Coal, offer longer vesting schedules to their executives, suggesting executive pay duration may be matched with project and asset duration. We also find that firms in the financial services industry have some of the longest vesting schedules in their executive pay contracts. This is somewhat surprising, given the recent criticism that short-termism in executive compensation at banks may have contributed to the 2007-09 financial crisis.

The average pay duration for all executives in our sample is around 1.18 years, while CEO pay contracts have a slightly longer duration at about 1.39 years. Executives with longer-duration contracts receive higher compensation, but a lower bonus, on average. As for the cross-sectional variation of pay duration, we find that larger firms and growth firms offer their executives longer-duration pay contracts than other firms. Pay duration is also longer for firms with more research and development expenditures (R&D), which again is consistent with firms trying to match executive pay duration to project duration.

To test our first prediction, we use stock liquidity and the extent of dispersion among analysts' earnings forecast to identify stock mispricing, with lower liquidity and greater dispersion indicating a greater magnitude of mispricing. Consistent with our model's prediction, we find that pay duration is decreasing in the extent of stock mispricing – it is longer for executives in firms with more liquid stocks (lower bid-ask spread and higher turnover) and in firms with less analyst earnings forecast dispersion.

As for our second prediction, we also find that pay duration is longer for CEOs in firms with a higher entrenchment index (Bebchuck, Cohen, and Ferrel (2009)) and is longer for all executives in firms with smaller boards, with less non-executive director shareholding and for executives with lower shareholdings. If a higher entrenchment index and a smaller board are indicative of poor corporate governance, and if lower director and executive shareholdings indicate lower alignment between the interests of the board and executive with respect to the firm's shareholders, then these results provide support for our second prediction that pay duration is longer in firms with poorer governance.

Finally, turning to our third prediction, we find evidence that executives with short-duration pay contracts act myopically. We use the level of discretionary accruals and the likelihood of R&D expenditure cut as proxies for actions spurred by managerial myopia. We find that firms that offer their CEOs shorter-duration pay contracts have higher levels of discretionary accruals. The positive association between CEO pay duration and discretionary accruals is only present for earnings-enhancing, positive accruals and is robust to controlling for the sensitivity of CEO stock and option portfolio to the stock price (see Bergstresser and Philippon (2006)) and for the endogenity of pay duration using a switching-regression model. We further find that firms that offer their CEOs shorter-duration pay contracts are more likely to cut R&D expenditure. This effect is stronger in the subsample of firms with less liquid stock where we anticipate the magnitude of mispricing to be greater. The positive association between CEO pay duration and the likelihood of cutting R&D expenditure is again robust to controlling for the sensitivity of CEO pay to stock price movements, for the vega of the CEO's stock option portfolio, as well as for the endogeneity of pay duration using the switching regression model. Thus, our third prediction is empirically supported as well.

Our paper is related to the vast literature on executive compensation. The broader literature has centered on various issues over time.[2] These include whether CEOs are offered sufficient stock-based incentives and how these vary cross-sectionally,[3] whether CEOs are judged using relative performance evaluation (RPE),[4] and ultimately whether executive contracts in practice are set by the firm's board of directors or the executives themselves.[5]

With respect to the duration of executive pay, there have been numerous theoretical contributions, even going back as far as Holmstrom and Ricart i Costa (1986) who examined the pros and cons of long-term compensation contracts in a career-concerns setting. Examples of other optimal contracting models that examine executive pay duration include Bolton, Scheinkman, and Xiong (2006), and Dutta and Reichelstein (2003). Empirically, numerous papers have documented various features of CEO compensation. Walker (2010) describes the evolution of stock and option compensation and the aggregate shift away from options and toward restricted stocks. Core, Holthausen, and Larcker (1999), among others, have examined the determinants of the cross-sectional variation in CEO compensation. Our marginal contribution to this literature is that we develop a novel measure of pay duration that captures the mix of short-term and long-term pay, and then use this measure to explain how pay duration varies in the cross-section based on CEO and firm characteristics in a dataset that is much more detailed than ExecuComp, and examine the effects of pay duration on corporate decisions.

Another important contribution of our work is that our duration measure also differs from the measures used in prior literature to characterize executive pay, such as the proportion of non-cash pay in total pay (Bushman and Smith (2001)), the delta and vega of executive stock and option

[2] We do not attempt to provide a thorough review here; the reader is referred to review papers like Frydman and Jenter (2010) and Murphy (1999).

[3] See Aggarwal and Samwick (1999a), Garen (1994), Hall and Liebman (1998), Haubrich (1994), and Milbourn (2003).

[4] See Aggarwal and Samwick (1999b), Garvey and Milbourn (2003), Janakiraman, Lambert, and Larcker (1992), and Oyer(2004).

[5] See Bebchuk and Fried (2003), Bertrand and Mullainathan (2001), Garvey and Milbourn (2006), and Gopalan, Milbourn, and Song (2010).

grants and holdings (Coles, Daniel, and Naveen (2006)), and the correlation of pay to stock returns and earnings (Bushman et al (1998)),[6] The key difference is that our pay duration measure explicitly takes into account the length of the vesting schedule for each component of the executive's pay. This is important because, for example, a larger stock grant by itself is unlikely to contribute to short-term incentives especially if it has a long vesting schedule. Our empirical analysis confirms that duration does a better job of predicting executive behavior than the coarser measures used in prior literature.

The rest of the paper proceeds as follows. Section 1 develops the model and draws out its empirical predictions. Section 2 describes the data, lays out the empirical methodology, and discusses the main results from the tests of our predictions. Section 3 conducts additional robustness tests. Section 4 concludes. All proofs are in the Appendix.

1 The Model

In this section, we develop a simple model of the optimal mix of short-term and long-term pay for executives. The model generates several predictions regarding how the optimal mix is related to firm and executive characteristics, as well as how it affects executive behavior. The model is parsimonious and has two key ingredients of real world contracting environments: short-term stock mispricing (as in Bolton, Scheinkman, and Xiong (2006)) and inefficient extraction of private benefits by the manager.

1.1 Agents and economic environment

Consider a firm owned by risk-neutral shareholders (who are represented by a board of directors) and run by a risk-averse CEO. There are three dates, $t = 0, 1, 2$, and discount rates between dates are normalized to zero. At $t = 0$, the CEO can spend effort on two projects, a (productive) real project and an (inferior) "castle-in-the-air" project (henceforth, castle project).[7] Both projects pay off at $t = 2$ when the firm is also liquidated. The castle project, a symbol of CEO myopia, is inefficient in the sense that any CEO effort spent on it does not contribute to firm value. For example, the CEO may take actions to boost short-term performance at the expense of long-term value (e.g., increase current period earnings through accruals or an R&D cut). Reflecting this, we

[6] Much of this work has appeared in the accounting literature where researchers are also interested as to how incentive-based pay loads on both corporate earnings measures and the firm's stock price. See also Banker and Datar (1989), Lambert and Larcker (1987), and Sloan (1993).

[7] The term "castle-in-the-air" is introduced by Bolton, Scheinkman, and Xiong (2006).

model the firm's liquidation value as $X = e + \tilde{\varepsilon}$, where e is CEO effort spent on the real project (we will model effort on the castle project shortly), and $\tilde{\varepsilon} \sim N(0, \sigma^2)$ represents some exogenous noise outside the firm's control.

At $t = 0$, the board designs a compensation contract, $W = w_0 + w_1 P_1 + w_2 X$, where w_0 represents salary, P_1 is the firm's stock price at $t = 1$, and w_1 and w_2 are contract weights on the interim stock price and the liquidation value, respectively. The CEO spends effort e on the real project at a personal cost $e^2/2$, and effort u on the castle project at a personal cost $u^2/2$; we assume e and u are observable but not contractible. Stock price P_1 is formed at $t = 1$, depending on the shareholders' expectation of X and some noise factor in the stock market. Specifically, when viewed at $t = 0$, $P_1 = \mathbf{E}(X) + u\tilde{\delta}$, where $\tilde{\delta}$ is a zero-mean noise term that can take two possible values, $\delta > 0$ and $-\delta < 0$, with equal probability. Note that CEO effort on the castle project (u) does not contribute to the firm's liquidation value (X), but merely amplifies the noise in the stock price ($\tilde{\delta}$).

The board implements the CEO compensation contract as follows. At $t = 0$, the CEO is awarded w_0 in cash, w_1 shares of the firm that she is free to sell at $t = 1$, and w_2 shares that she can only sell at $t = 2$. At $t = 1$, the CEO decides whether to sell the w_1 shares of stocks immediately or hold them until $t = 2$. If the CEO sells at $t = 1$, some other risk-neutral investors in the market (not the existing shareholders) will purchase the shares at the prevailing price P_1 and then hold them until $t = 2$, claiming w_1 shares of the firm's liquidation value at that time. At $t = 2$, the firm is liquidated, and X is realized and observed by all, with the CEO receiving a fraction w_2 of X if she sold her w_1 shares at $t = 1$ and a fraction $w_1 + w_2$ if she held on to her w_1 shares.

The CEO has a negative exponential utility, $-\exp\{-\lambda(W - e^2/2 - u^2/2)\}$, where $\lambda > 0$ is her coefficient of absolute risk aversion. We will work with her certainty equivalent throughout:

$$V_E(W) = \mathbf{E}(W) - (\lambda/2)\mathbf{Var}(W) - (e^2/2 + u^2/2).$$

We assume that the CEO's reservation utility in terms of the certainty equivalent is a constant $\bar{V}_E$.

1.2 Optimal compensation contract

The board's problem at $t = 0$ is to design a contract, (w_0, w_1, w_2), to maximize the expected payoff to the existing shareholders:

$$V_B(W) = (1 - w_1 - w_2)e - w_0,$$

by providing the CEO with the right incentive to choose appropriate effort levels. The board's problem can be formulated as:

$$\max_{\{w_0,w_1,w_2\}} V_B(W), \tag{1}$$

$$\text{s.t.} \max_{\{e,u\}} V_E(W) \geq \bar{V}_E. \tag{2}$$

In the above problem, the participation constraint captured by the inequality (2) stipulates that given the contract (w_0, w_1, w_2), the chosen effort levels maximize the CEO's expected utility (incentive-compatibility constraint), which must be no smaller than her reservation utility.

Lemma 1. *Suppose δ is large enough. The CEO will sell her stock awards at $t = 1$ if $\tilde{\delta} = \delta$ is realized, and hold them until $t = 2$ if $\tilde{\delta} = -\delta$ is realized.*

When $\tilde{\delta} = \delta$ is realized, the stock is overvalued ($P_1 = \mathbf{E}(X) + u\delta > \mathbf{E}(X)$), so it is privately optimal for the CEO to sell her w_1 shares to lock in the overpricing gains and also avoid the uncertainty in the liquidation value (i.e., $\tilde{\varepsilon}$). When $\tilde{\delta} = -\delta$ is realized, the stock is undervalued ($P_1 = \mathbf{E}(X) - u\delta < \mathbf{E}(X)$). Now, whether the risk-averse CEO sells or holds on to her w_1 shares until $t = 2$ depends on the extent of undervaluation. The CEO will sell if the undervaluation is small in comparison to the uncertainty in the liquidation value. But a sufficiently large undervaluation (δ large enough – see the Appendix) will cause the CEO to hold on to her shares until $t = 2$.

The following lemma describes the effect of the pay contract on the CEO's effort choices.

Lemma 2. *Given any contract (w_0, w_1, w_2), the CEO spends $e = w_1 + w_2$ on the real project and $u = w_1\delta/2$ on the castle project.*

The CEO's effort on the real project, e, affects the expected final liquidation value and the expected interim stock price to the same extent. Thus, in equilibrium, e only depends on the sum of the contract weights on the stock price and the liquidation value, $w_1 + w_2$, but not on individual weights. To understand the CEO's effort on the castle project, note that interim stock awards essentially grant the CEO an *option* at $t = 1$: she can sell the stock if it is overvalued ($\tilde{\delta} = \delta$) and hold the stock if it is undervalued ($\tilde{\delta} = -\delta$). The CEO's effort on the castle project, u, affects the value of the option by affecting the volatility of the stock price, with a higher u making the option more valuable. By contrast, u has no effect on the final liquidation value. Thus, in equilibrium, u is increasing in the contract weight on the stock price, w_1, but does not depend on the contract weight on the liquidation value, w_2. Moreover, a higher δ increases the CEO's incentive to amplify the effect of the stock market mispricing by diverting more effort to the castle project (higher u), thereby increasing the option value of short-term pay.

Proposition 1. *The optimal incentive contract, denoted as* (w_0^*, w_1^*, w_2^*), *provides the CEO with only short-term compensation, i.e.,* $w_1^* > 0$ *and* $w_2^* = 0$. *Moreover, both* w_1^* *and the CEO's equilibrium effort on the castle project,* u^*, *are increasing in the extent of stock mispricing,* δ.

We know from Lemma 2 that the CEO's effort on the real project depends only on the total pay-performance sensitivity, $w_1 + w_2$, but not on the individual contract weights. Thus, given the option effect of short-term compensation discussed above, it is cheaper for the board to pay the CEO only in terms of interim stock awards (i.e., $w_1^* > 0$ and $w_2^* = 0$). When the magnitude of possible stock mispricing increases (larger δ), the option becomes more valuable and consequently the board relies more on short-term pay (higher w_1^*) to lower the total compensation cost. However, this also provides the CEO more incentive to increase effort on the castle project (higher u^*) to further increase the value of the option.

1.3 Long-term compensation

In practice, pay contracts include a mix of both short-term and long-term pay. But our analysis above shows that when the stock can be mispriced in the short-run, the optimal incentive contract involves only short-term pay. This is because we have not modeled some important costs of short-term pay, as well as any benefits of long-term pay. For example, an important assumption in our analysis is that the CEO's effort choices on the two projects are independent. In reality, if the CEO has limited effort capacity, then greater effort allocated toward the castle project means less effort devoted to the real project. This would be a cost of short-term pay. Alternatively, there can also be some benefits of long-term pay. In our model, if the stock is overpriced at $t = 1$, the CEO will sell all her stock grants when they vest at $t = 1$, and the CEO will then be left with no stake in the firm. If the CEO remains in control of the firm's assets after $t = 1$, then lack of sufficient exposure to the firm's final payoff may lead to inefficient private-benefits consumption by the CEO that can destroy firm value. This is especially the case if the firm's corporate governance mechanisms are not effective in preventing such rent extraction. To capture this, we now include the second ingredient of the model: the possibility of inefficient consumption of private benefits by the CEO.

Specifically, we assume that between $t = 1$ and $t = 2$ the CEO can take some hidden action (such as perquisites consumption) that yields her some private benefits, θB, at the expense of reducing the firm's liquidation value by B, where $\theta \in (0, 1)$ is a constant; this action is inefficient since $\theta < 1$. Clearly, the CEO will refrain from taking the value-reducing action only if her stake in the firm's final payoff, X, is sufficiently large at $t = 1$. The CEO's stake in X at $t = 1$ includes her interim stock grants if she holds them untill $t = 2$, along with any long-term share grants, w_2.

The following proposition delineates the characteristics of the optimal incentive contract with this extension:

Proposition 2. *There exists a cutoff value of* B*,* $\widehat{B}$*, such that*

1. *when* $B \geq \widehat{B}$*, the optimal contract, denoted as* (w_0^*, w_1^*, w_2^*)*, involves both long-term and short-term pay, i.e.,* $w_1^* > 0$ *and* $w_2^* > 0$*, where* w_2^*/w_1^* *is increasing in* θ*, and decreasing in* δ*; and*

2. *when* $B < \widehat{B}$*, the optimal contract involves only short-term pay, i.e.,* $w_1^* > 0$ *and* $w_2^* = 0$*, where* w_1^* *is increasing in* δ*.*

Moreover, in both cases the CEO's equilibrium effort on the castle project, u^**, is increasing in* δ*.*

The tradeoff that leads to this proposition is as follows. On the one hand, interim stock grants ($w_1^* > 0$) enable the CEO to exploit stock mispricing which lowers the total compensation cost. On the other hand, long-term pay ($w_2^* > 0$) gives the CEO a long-term stake in the firm and thus discourages extraction of private benefits. The cost of long-term pay, however, is that it exposes the risk-averse CEO to greater pay uncertainty (due to the randomness of the liquidation value) for which she has to be compensated in equilibrium. If the value reduction from the CEO's benefits consumption is sufficiently large ($B \geq \widehat{B}$), say due to poor corporate governance, then the benefit of long-term pay outweighs its cost and we have $w_2^* > 0$ in the optimal contract. The ratio w_2^*/w_1^* is increasing in θ, because the CEO is more likely to undertake the value-reducing action when θ is larger. The ratio w_2^*/w_1^* is decreasing in δ, because the benefit of short-term pay increases with the extent of stock mispricing. When the problem of the CEO's private benefits consumption is not too severe ($B < \widehat{B}$), the cost of long-term pay outweighs its benefit and we are back to the case considered in Proposition 1 with only short-term pay.

1.4 Pay duration

Focusing on the case when $B \geq \widehat{B}$ (so $w_2^* > 0$), we now introduce our measure of pay duration:

$$Duration^* = \frac{w_0^* \times 0 + [w_1^* e^* + 0.5 w_1^* \mu^* \delta] \times 1 + [w_2^* e^*] \times 2}{w_0^* + [w_1^* e^* + 0.5 w_1^* \mu^* \delta] + w_2^* e^*}. \tag{3}$$

To understand this measure, note that there are three components in the pay: salary w_0^*, short-term shareholding with an expected value of $w_1^* e^* + 0.5 w_1^* \mu^* \delta$, and long-term shareholding with an expected value of $w_2^* e^*$.[8] The vesting periods for the three components are $0, 1$, and 2, respectively. Our duration measure is calculated as the weighted average of the vesting periods of the three pay components, where the weight for each component is the fraction of that component in the total pay, $w_0^* + [w_1^* e^* + 0.5 w_1^* \mu^* \delta] + w_2^* e^*$.

Proposition 3. *$Duration^*$ is increasing in w_2^*/w_1^*, and hence is increasing in θ and decreasing in δ.*

1.5 Empirical predictions

We now list our model's predictions. We know from Proposition 3 that $Duration^*$ is decreasing in δ, the extent of stock mispricing. This forms our first prediction:

Prediction 1. *The optimal pay duration is decreasing in the extent of stock mispricing.*

To test this prediction, we first employ two measures of stock liquidity under the assumption that a less liquid stock is less likely to be informative of the firm's future performance and hence is likely to exhibit large mispricing. This is consistent with Chordia, Roll, and Subrahmanyam (2008). We use the bid-ask spread calculated from daily closing stock prices, *Spread*, and the average daily stock turnover, *Turnover*, as measures of stock liquidity. Next, Diether, Malloy, and Scherbina (2002) argue that dispersion among analysts' earnings forecasts can also lead to stock

[8] To see this, note that when viewed at $t = 0$ when the pay package is granted, with probability $1/2$ the stock is overvalued at $t = 1$ and the CEO will sell the interim stock awards and get $w_1^*[e^* + \mu^* \delta]$, and with probability $1/2$ the stock is undervalued at $t = 1$ and the CEO will hold the awards till $t = 2$ when she will claim $w_1^* e^*$. Thus, the $t = 0$ expected value of the interim stock grants is $[1/2]\{w_1^*[e^* + \mu^* \delta]\} + [1/2][w_1^* e^*] = w_1^* e^* + 0.5 w_1^* \mu^* \delta$.

mispricing. The rationale is that greater dispersion in analysts' earnings forecasts indicates greater disagreement among investors about future firm performance (Dittmar and Thakor (2007)), which can lead to overvaluation in the presence of short-sale constraints (Miller (1977)). Following this rationale, we use the extent of dispersion among analysts' earnings forecasts, *Analyst dispersion*, as another measure of stock mispricing.

From Proposition 3, we also know that $Duration^*$ is increasing in θ. We can interpret θ as the extent of private benefits extracted by the CEO or the ease with which the CEO can extract private benefits. Since CEOs of firms with poor corporate governance are more likely to be able to extract private benefits and extract more such benefits, either interpretation of θ shows that it can be used as a measure of the firm-level governance quality, with a higher value of θ indicating firms with poorer corporate governance. Thus, our second prediction is:

Prediction 2. *The optimal pay duration is longer in firms with poor corporate governance.*

In our empirical analysis, we employ a number of measures of the firm-level governance quality. These include the entrenchment index of Bebchuk, Cohen, and Ferrell (2009), the size of the firm's board, the fraction of independent directors on the board, the extent of shareholding of the non-executive directors on the board, and the extent of shareholding of the executive.

An important cost of short-term compensation in our model is that it inefficiently diverts CEO effort towards the castle project which does not contribute to firm value. Given that in equilibrium the CEO has to be compensated for the cost of effort incurred in the castle project, such effort destroys firm value from the board's perspective. From Lemma 2, we know that CEO effort spent on the castle project, u, is increasing in the contract's weight on the interim stock price, w_1, and such positive association is stronger when the potential magnitude of stock mispricing is greater. This leads to:

Prediction 3. *CEOs of firms with shorter pay duration are more likely to engage in myopic investment behaviors, and such an association between pay duration and managerial myopia is stronger when the extent of stock mispricing is greater.*

We follow the prior literature and use the absolute value of discretionary accruals, *Accruals*, as our first measure of myopic behavior. Prior accounting research shows that the stock market valuation depends on a firm's current period earnings and managers may cater to the stock market by inflating current period profits by booking abnormal accruals (e.g., Collins and Hribar (2000), Jiang, Petroni, and Wang (2010), and Sloan (1996)). Thus, we expect myopic executives to engage in accruals to a greater extent. Apart from using accruals, the CEO can also boost short-term performance by cutting R&D expenditure. Prior research shows that firms do sometimes engage in opportunistic R&D cuts in order to meet analyst earnings forecasts (e.g., Dechow and Sloan (1991), and Jacobs (1991)). Thus, our second proxy for managerial myopia is a dummy variable that identifies firms that cut R&D expenditures relative to the previous year, *R&D cut*. *Prediction 3* would then indicate that firms that offer their CEOs shorter-duration pay contracts have higher levels of discretionary accruals and are more likely to cut R&D expenditures, and this effect is stronger when the amplitude of potential stock mispricing is larger.

2 Empirical Analysis

In this section, we describe our data and the empirical methodology, and discuss the main results from the tests of our predictions.

2.1 Data and descriptive statistics

To test our model predictions, we need data on both the level of the different components of executive pay and the vesting schedule of the non-cash components. We obtain data on levels and vesting schedules of restricted stock and stock options from Equilar Consultants (Equilar). Similar to S&P's ExecuComp, Equilar collects their compensation data from the firms' proxy statements. We obtain details of all stock and option grants to all named executives of firms in the S&P 1500 index for the three-year period 2006-08. For each grant, we have both the size of the grant, the length of the vesting period (i.e., the time it takes before the grant is completely vested) and the nature of the vesting, i.e., whether the grant vests equally over the vesting period (graded vesting) or entirely at a specific time (cliff vesting).[9] The Equilar dataset also provides us the grant date and the value of the grant. The value of stock grants is estimated as the product of stock price on the grant date and the number of stocks granted, while the value for option grants is estimated by Equilar using the Black-Scholes option pricing formula. We obtain data on other components of executive pay such as salary and bonus from ExecuComp. We carefully match Equilar and ExecuComp using firm ticker symbols and executive names. Since prior studies on executive compensation predominantly use ExecuComp, we ensure comparability of Equilar and

[9]Some grants in our sample have vesting schedules that are contingent on firm performance. Of the 28,582 option and stock grants in our sample, about 1,499 have such performance-based vesting provisions. We repeat all our tests after excluding executives who obtain grants with performance-based vesting and obtain results similar to the ones reported. For detailed analysis of such performance-based vesting provisions, see Bettis et al (2009).

ExecuComp by making sure the total number of options granted during the year for each executive in our sample is the same across Equilar and ExecuComp. We complement the compensation data with stock returns from the Center for Research in Security Prices (CRSP) and firm financial data from Compustat.

2.2 Measure of pay duration

We are interested in measuring the duration of executive pay and in understanding how it varies in the cross-section. To do that, we introduce a novel empirical measure of executive pay duration involving both restricted stock and options.[10] We follow the fixed income literature and calculate pay duration as the weighted average duration of the four components of executive pay (i.e., salary, bonus, restricted stock, and stock options). In situations where the stock and option awards have a cliff vesting schedule, we estimate pay duration as:

$$Duration = \frac{(Salary + Bonus) \times 0 + \sum_{i=1}^{n_1} Restricted\ stock_i \times t_i + \sum_{j=1}^{n_2} Option_j \times t_j}{Salary + Bonus + \sum_{i=1}^{n_1} Restricted\ stock_i + \sum_{j=1}^{n_2} Option_j}, \tag{4}$$

where the subscript i denotes a restricted stock grant and the subscript j denotes an option grant. *Salary* and *Bonus* are, respectively, the dollar values of annual salary and bonus. We calculate pay duration relative to the end of the year, and hence *Salary* and *Bonus* have a vesting period of zero. $Restricted\ stock_i$ is the dollar value of restricted stock grant i with corresponding vesting period t_i in years. The firm may have other restricted stock grants with different vesting periods (different t_i), and n_1 is the total number of such stock grants during the year. $Option_j$ is the Black-Scholes value of stock option grant j with the corresponding vesting period t_j in years; n_2 has a similar interpretation as n_1. In cases where the restricted stock grant (option grant) has a graded vesting schedule, we modify the above formula by replacing t_i (t_j) with $(t_i + 1)/2$ ($(t_j + 1)/2$).[11]

Our measure of pay duration has a number of advantages over the measures used in the prior literature to characterize executive pay. One of the main objectives of all the measures is to understand the mix of short-term and long-term pay, and hence the extent to which overall pay provides short-term incentives to the executives. Some of the measures used in the prior literature

[10] Cadman, Rusticus, and Sunder (2010) also introduce a similar measure of pay duration, but use only the vesting schedule of stock options. Since we include both stock options and restricted stock, ours is a more comprehensive measure of pay duration.

[11] To see this, consider a stock grant i' that vests equally over $t_{i'}$ years. Since a fraction $1/t_{i'}$ of the grant is vested each year, the term $Restricted\ stock_{i'} \times t_{i'}$ in (4) should be replaced by $Restricted\ stock_{i'} \times \left(\frac{1}{t_{i'}} + \frac{2}{t_{i'}} + \ldots + \frac{t_{i'}}{t_{i'}}\right) = \frac{Restricted\ stock_{i'}}{t_{i'}} \times \frac{t_{i'}(t_{i'}+1)}{2} = Restricted\ stock_{i'} \times \left(\frac{t_{i'}+1}{2}\right)$. $Option_j \times t_j$ can be modified in the same way.

include the proportion of stock and option grants ("non-cash pay") in total pay (Bushman and Smith (2001)), the delta and vega of executive's stock and option grants and holdings (Coles, Daniel, and Naveen (2006)), and the extent of correlation of executive pay to stock returns and accounting earnings (Sloan (1993)). The important difference between pay duration and these measures is that duration explicitly takes into account the length of the vesting schedules of the restricted stock and option grants. As is obvious, a larger stock grant by itself is unlikely to contribute to short-term incentives, especially if it has a long vesting schedule. While the delta and vega of an executive's compensation portfolio capture its sensitivities to movements in stock price and its volatility, respectively, they do not capture the mix of short-term and long-term incentives in the pay contract. Finally, unlike the correlation measure, we directly measure the mix of short-term and long-term pay. Furthermore, our empirical analysis later confirms that our duration measure does a better job of predicting executive behavior than the measures used in the prior literature.

2.3 Empirical specification and key variables

We conduct two sets of tests in our empirical analysis. We first examine how firm and executive characteristics affect the cross-sectional distribution of executive pay duration. Since pay duration is bounded below at zero and takes the value zero for about 24.4% of our sample executives, we employ the following Tobit model with a lower bound of zero for these tests:

$$Duration_{ket} = F(\alpha + \beta_1 \mathrm{X}_{kt} + \beta_2 \mathrm{X}_{et} + \mu_t \mathrm{T} + \epsilon_{ket}), \quad (5)$$

where the subscript k indicates the firm, e the executive, and t time in years. The term T refers to a set of time dummies, X_{kt} is a set of firm characteristics, and X_{et} refers to executive characteristics. Detailed definitions of all the variables used in our analysis are provided in Appendix B. The main firm characteristics we include are firm size measured using *Log(Total assets)*, growth opportunities as captured by *Market-to-book*, asset structure as captured by *R&D/Total assets*, which we use to measure the "duration" of the firm's assets with higher R&D expenditures indicating longer-duration assets. To control for stock performance, we also include the firm's stock return over the previous year, *Stock return*, and the volatility of daily stock returns during the previous year, *Volatility*.

To test *Prediction 1*, we employ three measures of the extent of stock mispricing: the bid-ask spread (*Spread*), the average daily turnover in the firm's stock (*Turnover*), and the standard deviation of analysts' earnings forecasts (*Analyst dispersion*). To test *Prediction 2*, we include the Bebchuck, Cohen, and Ferrell (2009) entrenchment index (*Entrenchment index*), the number of directors on the firm's board (*Number of directors*), the fraction of independent directors on the firm's board (*Fraction independent*), the extent of shareholding of the non-executive directors on the board, *High director shareholding*, and the executive's shareholdings in the firm (*Shareholding*). The sample for these tests include all executives in S&P 1500 firms for whom we are able to calculate the pay duration measure. In all the tests, the standard errors are robust to heteroscedasticity and clustered at the firm level.

In our second set of tests, we test *Prediction 3* by estimating the effect of CEO pay duration on managerial myopia. To do this, we employ the following OLS specification:

$$y_{kt} = \alpha + \beta_1 \times Duration_{ket} + \beta_2 \mathrm{X}_{kt} + \mu_t \mathrm{T} + \mu_l \mathrm{L} + \epsilon_{kt}, \tag{6}$$

where the dependent variable y_{kt} is a measure of managerial myopia. As mentioned, we follow the prior literature and use the absolute value of discretionary accruals, *Accruals*, and the likelihood of the firm cutting its R&D expenditure, *R&D cut*, to identify myopic behavior. We calculate *Accruals* following the procedure outlined in Jones (1991), modified by including controls for earnings performance as proposed in Kothari, Leone, and Wasley (2005).

Our sample for these regressions includes one observation per firm-year. In these tests, we relate the level of discretionary accruals and the likelihood of a firm cutting R&D to the pay duration of the firm's CEO. Apart from time fixed effects, T, we also include industry fixed effects, L, at the level of the Fama-French forty-eight industry groups. Although we control for all observable firm characteristics that are likely to affect *Accruals* and *R&D cut* in our model, our estimates from (6) may be biased due to omitted variables that may affect both pay duration and the independent variables. To control for possible bias, we later estimate a switching regression model that explicitly controls for unobserved variables. We explain this in greater detail in Section 3.

2.4 Summary statistics

In Panel A of Table 1, we provide the distributions of the vesting periods for restricted stock and option grants for all the executives in our sample. We find the distributions to be quite similar for stocks and options, although a chi-squared test rejects the null that the two distributions are identical. The vesting periods cluster around the three to five-year period and a large fraction of the vesting schedules are graded. In Panel B, we provide the distributions of the vesting periods just for CEOs (identified by the CEOANN field in ExecuComp). The distributions are similar to those in Panel A for all executives. For both restricted stock and stock options, we find that the vesting-period distributions of CEOs first-order stochastic dominate (FOSD) those for all executives. This is consistent with a longer pay duration for CEOs, which is confirmed later by our univariate evidence.

[Table 1 goes here]

In Table 2, we provide the industry distribution of pay duration for CEOs and all executives. We use the Fama-French forty-eight industry classification and report the average pay duration of all executives and CEOs in separate columns within each industry. We include all industries with pay duration information for at least five executives. For ease of reference, we sort the data in terms of decreasing CEO pay duration. We find that industries wherein we would suspect that the assets have longer duration, such as Defense, Utilities, and Coal, have higher pay duration (for CEOs as well as for all executives). It is also interesting to note that firms in the financial services industry provide some of the longest-duration pay contracts. This latter evidence is partly inconsistent with the notion of excessive short-termism in executive compensation in financial services.

[Table 2 goes here]

In Panels A and B of Table 3, we provide, respectively, the summary statistics for the key variables used in our analysis for all executives and for CEOs in our sample. Focusing on Panel A, we find that the average total compensation for an executive in our sample is $2.16 million, which consists of $0.45 million of salary, $0.21 million of bonus, $0.72 million of stock options, and $0.79 million of restricted stock grants. These numbers are comparable to those in previous studies. We find that the average duration of executive pay in our sample is 1.18 years. Thus, executive pay vests on average about one year after it is granted.

Our sample tilts towards larger firms in Compustat, as shown by the median total assets value of $2.39 billion. On average, firms finance 21.7% of the book value of their assets using debt. The average firm in our sample has an annual sales growth of 12.3%, and a market-to-book ratio of 1.84. Our sample firms invest about 2.1% of the book value of total assets in R&D every year, but as in other studies, the median value of *R&D/Total assets* in our sample is zero. Firms also invest about 4.9% of the value of total assets every year in capital expenditure. Our sample firms are profitable as can be seen from the mean (median) value of *EBIT/Sales* of 15.1% (12.5%). *Volatility*, the standard deviation of daily stock returns during the previous year, is on average 15% for our sample firms. The average level of *Accruals* in our sample is .043. Highlighting the sample tilt towards the larger firms, we find the average bid-ask spread for the firms in our sample, *Spread*, to be 0.03% and the average stock turnover to be 11.5. *Analyst dispersion*, the standard deviation of analysts' annual earnings forecasts obtained from the IBES database, is .062 for the average firm in our sample.

Our next set of variables measure the corporate governance characteristics of the firm. The average entrenchment index of the firms in our sample is about 3 (out of 6), and the median number of directors on our sample firms' board is 9, among which about 75.1% are independent as indicated by the average value of *Fraction independent*. The average shareholding of non-executive directors in our sample is 2.4%, while median executive in our sample has no significant shareholding in the firm. The average executive in our sample is 52 years old.

In Panel B, we present the summary statistics for the CEOs in our sample. Comparing with Panel A, we find that as expected, the CEOs in our sample have a higher total compensation than the average executive ($4.7 million in comparison to $2.16 million). This higher compensation is found in all four pay components (salary, bonus, option grants, and restricted stock). The pay duration is also longer for the CEO than for the average executive (1.39 years as compared to 1.18 years for the average executive). Although the median CEO has no significant shareholding in the firm, the average shareholding of CEOs in our sample is greater than the average shareholding of all executives (2.21% in comparison to 0.6%). We also find that the average CEO is 55 years old. To reduce the effects of outliers, our variables of empirical interest are all winsorized at the 1% level.

[Table 3 goes here]

In Panel A of Table 4, we split our sample into executives with above and below sample median pay duration, and compare the characteristics across these two subsamples. Executives with above-median pay duration have a higher total compensation. The higher compensation is reflected in three components of pay, but most starkly in the values of option and restricted stock grants. Interestingly, executives with longer-duration pay contracts receive less bonus on average. The difference in pay durations across the subsamples is about 1.5 years. Larger firms award pay contracts with longer duration, and such firms have higher leverage as measured by debt over total assets (22.6% in comparison to 20.8%). Consistent with growth firms awarding pay contracts with longer duration, we find that executives with above-median pay duration are from firms that have higher sales growth (13.4% in comparison to 11.2%), higher market-to-book ratios (1.92 in comparison to 1.77), and greater investments in R&D (2.5% in comparison to 1.8%). Note that all these variables are significantly different across the two subsamples. Executives with longer pay duration are from more profitable firms and firms with a slightly lower stock return volatility. Firms that offer pay contracts with longer duration have slightly lower level of *Accruals*, have lower bid-ask spreads and higher stock turnover. Focusing on the corporate governance characteristics, we find that firms that offer contracts with longer duration have larger boards, and higher proportions of independent directors. The non-executive directors in those firms have lower shareholding in the firm. We find that executives with longer pay duration have slightly less shareholding in the firm and are younger.

In Panel B, we confine our comparisons to the CEOs. We only examine pay and executive characteristics as the firm-characteristic comparisons are similar to those in Panel A. We find that CEOs with longer pay duration have significantly higher total compensation as well as higher pay along three subcategories of pay (salary, restricted stock, and options). CEOs with longer-duration pay contracts have significantly lower bonus payments on average. We also find that CEOs with longer pay duration have lower shareholding and are younger.

[Table 4 goes here]

2.5 Empirical results

In this section, we discuss the results from our multivariate analysis that test the three main predictions discussed earlier.

2.5.1 Pay duration and the extent of stock mispricing: test of prediction 1

We begin our empirical analysis by relating executive pay duration to firm characteristics. The results are provided in Panel A of Table 5. The positive coefficient on *Log*(*Total assets*) in Column (1) indicates that pay duration is longer for larger firms. Since the projects of larger firms are likely to be more complex and on average have longer duration, this evidence is consistent with firms trying to match executive pay duration to the duration of the firm's assets. Consistent with our univariate evidence, we find that pay duration is longer for growth firms as can be seen from the positive coefficient on *Market-to-book*. We also find longer pay duration for firms with higher R&D expenditures as a proportion of total assets (positive coefficient on *R&D/Total assets*). Since R&D-intensive projects are on average likely to have longer duration as compared to capital-expenditure intensive projects, the latter evidence is again consistent with firms trying to match executive pay duration to project duration. We also find that pay duration is longer for CEOs as compared to other executives, as can be seen from the significantly positive coefficient estimate on *CEO*, a dummy variable that identifies CEOs. Firms with more volatile stock prices have shorter-duration pay contracts. This is consistent with long-term pay imposing greater risk on executives, especially in firms with more volatile stock prices. We also find that firms with higher stock returns in the recent past have longer-duration pay contracts. Our coefficient estimates are also economically significant. The coefficient on *Log*(*Total assets*) indicates that pay duration for an executive in a firm with *Log*(*Total assets*) equal to 8.97 (75^{th} percentile in our sample) is 0.28 years longer than the pay duration for an executive in a firm with *Log*(*Total assets*) equal to 6.70 (25^{th} percentile in our sample). We also find that on average CEOs have pay contracts with more than one quarter longer duration than other executives.

In Column (2), we test the effect of stock mispricing on pay duration as per *Prediction 1* by using *Spread* as a measure of the extent of stock mispricing. Since *Spread* is a measure of stock illiquidity, we expect firms with higher values of *Spread* to have an illiquid stock and hence more stock mispricing. Consistent with *Prediction 1*, we find that pay duration is longer for firms with lower bid-ask spreads. In Column (3), we use the average daily turnover of the stock as a measure of stock liquidity and find that firms with more liquid stock – those with higher turnover – offer their executives longer-duration pay contracts, consistent with the results in Column (2). In Column (4), we use the extent of dispersion among analysts' earnings forecasts as a measure of the extent of stock mispricing. Consistent with our earlier results, we find that pay duration is shorter for firms with greater *Analyst dispersion*. Our results are also economically significant. For example, the coefficient on *Turnover* in Column (3) indicates that pay duration for a firm with *Turnover* equal to 21.18 (90^{th} percentile in our sample) is 0.20 years longer than the pay duration for a firm with *Turnover* equal to 4.34 (10^{th} percentile in our sample).

In unreported tests, we find our results to be robust to the inclusion of industry fixed effects, to confining the sample to CEOs, and to explicitly controlling for the proportion of non-cash pay. Summarizing our results in Panel A of Table 5, we find pay duration to be longer for larger firms and growth firms. We also find pay duration to be longer for firms with assets of longer maturity.

Finally, consistent with *Prediction 1*, we find pay duration is shorter for firms whose stock is likely to have a greater degree of mispricing.

2.5.2 Pay duration and governance characteristics: test of prediction 2

In Panel B of Table 5, we test *Prediction 2* by examining how the firm's governance characteristics affect executive pay duration. In Column (1), we test how the Bebchuk, Cohen, and Ferrell (2009) entrenchment index is related to pay duration. Our results in Column (1) show that while the coefficient on *Entrenchment index* is positive, indicating longer-duration pay contracts for executives in firms with higher values of the entrenchment index, the coefficient is not significant at conventional levels. In Column (2), we repeat our tests confining the sample to CEOs and find that the coefficient on *Entrenchment index* is positive and significant. Since firms with higher values of *Entrenchment index* are likely to have worse governance, this result is consistent with *Prediction 2*. In Column (3), we relate pay duration to board size and find that pay duration is longer for firms with smaller boards. If we expect larger boards to be more diverse and have greater expertise to offer better governance, then this result is consistent with *Prediction 2*. In Column (4), we test whether pay duration is related to the fraction of independent directors on the board, and find no evidence of a statistically significant relationship. In Column (5), we relate pay duration to the shareholding of the non-executive directors of the firm. We do this by including a dummy variable, *High director shareholding*, which identifies firms with more than 1% shareholding by non-executive directors. Our results indicate that pay duration is longer in firms with lower shareholding by non-executive directors. If higher director shareholding improves the incentives of the directors to monitor the executive and prevent perquisite consumption (e.g., Ryan and Wiggins (2004)), then this result is consistent with *Prediction 2*.[12] Finally, in Column (6) we estimate the effect of the executive's share ownership on pay duration. We find that the extent of executive shareholding, *Shareholding*, is negatively related to pay duration. That is, pay duration is shorter for executives with more shareholdings in the firm. Since a larger shareholding may indicate greater alignment between the executive and the firm's shareholders, value-dissipating private-benefits consumption by the executive may be lower in firms with larger *Shareholding*. Thus, this result is again consistent with *Prediction 2*.

In unreported tests, we estimate how pay duration is related to executive age and tenure, and find that pay duration is shorter for older executives and executives with longer tenure. While our

[12] In unreported tests, we find no significant relationship between pay duration and CEO-Chairman duality.

model does not have any direct prediction on this relationship, there are two possible interpretations of this finding. In the optimal contracting framework of our model, one can argue that older executives and those with longer tenure in the firm may obtain less benefits given the shorter time span they have remaining in the firm. Furthermore, such executives are also likely to have more reputational capital at stake and legacies to lose if caught consuming perquisites. As a consequence, there is less need of long-duration pay contracts to prevent such executives from extracting private benefits. Alternatively, in an inefficient contracting framework à la Bebchuk and Fried (2003), one can argue that older executives and those with longer tenure are more likely to be entrenched and award themselves short-term pay to both match their tenure in the firm as well as to avoid the risk of long-term pay. We will not be able to differentiate between these alternate explanations. But our results do indicate that pay contracts do not compensate for the possible shorter horizon of older executives and those with longer tenure.

[Table 5 goes here]

2.5.3 Pay duration and managerial myopia: test of prediction 3

In this section, we test *Prediction 3*, which predicts that myopic behavior is more likely among executives with short-duration pay contracts. We use *Accruals* and *R&D cut* as proxies for managerial myopia to test this prediction. Since executive pay duration is itself endogenous, it is important to correct for the endogeneity to accurately estimate its effect on the level of accruals and the likelihood of cutting R&D. We first present OLS estimates, where we do not control for endogeneity, and then present the switching regression model in Section 3, where we explicitly control for the endogeneity of pay duration.

In Panel A of Table 6, we relate CEO pay duration to the level of absolute value of discretionary accruals, *Accruals*. Our specification in these tests is similar to that in Bergstresser and Philippon (2006). The sample for this regression includes one observation per firm-year, and apart from year fixed effects, we also include industry fixed effects at the level of Fama-French forty-eight industry categories. The results in Column (1) show that firms that offer a longer-duration pay contract to their CEOs are associated with lower absolute levels of discretionary accruals. The coefficients on the control variables indicate that smaller firms, firms with more volatile sales growth rates and firms with higher market-to-book ratios are associated with higher levels of accruals. In Column (2), we repeat our estimation after including the fraction of non-cash pay as an additional control and find that our results are robust to its inclusion. Bergstresser and Philippon (2006) show that the sensitivity of CEO pay to stock price movements affects the incentives for executives to manage earnings. To control for this, in Column (3) we repeat our estimation after including the logarithm of the delta of the CEO's stock and option portfolio, *Log(Delta)*. Our results indicate that pay duration remains a strong predictor of the level of accruals. Consistent with Bergstresser and Philippon (2006), we also find that *Log(Delta)* is positively associated with the level of accruals. Finally, in Columns (4)and (5), we split *Accruals* into positive and negative accruals and repeat our estimation. Specifically, our dependent variable in Column (4) is *Accruals* × *Positive accruals* (where *Positive accruals* is a dummy variable that identifies firms with positive accruals), while the dependent variable in Column (5) is *Accruals* × [1 − *Positive accruals*]. Our results indicate that pay duration is negatively related to positive accruals. This clearly indicates that a longer-duration pay contract reduces the CEO's incentive to engage in earnings-enhancing accruals. Summarizing, our results in Panel A of this table show that firms that offer their CEOs pay contracts with longer duration are associated with a lower level of absolute and positive accruals, which is consistent with *Prediction 3*.

In Panel B, we examine the relationship of the likelihood of a firm cutting R&D expenditure with CEO pay duration. The dependent variable, *R&D cut*, is a dummy variable that takes the value one if the firm reduces R&D expenditure as compared to the previous year and zero otherwise. The results in Column (1) show that firms that offer their CEOs longer-duration pay contracts are less likely to cut R&D expenditure. From the coefficients on the control variables, we find that firms with less liquid stock, those with lower stock returns in the recent past and those with lower *EBIT/Sales* are more likely to cut R&D expenditure. Coles, Daniel, and Naveen (2006) show that the vega of the CEO's option portfolio affects her risk choices and that firms whose CEOs have a higher vega portfolio are associated with higher R&D expenditure. Taking this into account, in Column (2) we repeat our estimation after controlling for the vega of the CEO's compensation portfolio. While the coefficient on *Log(Vega)* is positive and significant, its inclusion does not affect the coefficient on *Duration*. In Column (3), we repeat our estimation after controlling for the fraction of non-cash pay and find that our results are robust. In Column (4), instead of industry fixed effects, we identify instances where firms cut industry-adjusted R&D expenditure. That is, the dependent variable in this regression takes the value one in the years in which industry-adjusted *R&D/Total assets* is less than that of the previous year. We obtain consistent results with this measure as well.

Prediction 3 also indicates that short-duration pay contracts are more likely to exacerbate managerial myopia when the extent of stock mispricing is greater. To test this, in Column (5) we replace *Duration* with a dummy variable, *Short duration*, which takes the value one for firms with below-median pay duration contracts. We also include an interaction term, *Short duration*×*Spread*. If short-duration pay contracts are especially detrimental for firms with greater stock mispricing, then we expect the coefficient on the interaction term to be positive. Our results in Column (5) are consistent with this conjecture. This offers further support for a causal effect of pay duration on reductions in R&D expenditure.

[Table 6 goes here]

3 Switching Regression Model

We now perform tests that explicitly control for the endogeneity of pay duration. In Panels A and B of Table 7, we relate *Accruals* to CEO pay duration after controlling for endogenity. To do this, we first convert our main independent variable, *Duration*, into a dummy variable, *Short duration*, which takes the value one for CEOs with below-median pay duration. To control for endogeneity, we estimate a switching regression model (see Fang (2005), and Li and Prabhala (2007)). The model consists of estimating three regressions: a probit selection model with *Short duration* as the dependent variable, and two separate OLS models with *Accruals* as the dependent variable that are estimated for firms with below-median and above-median CEO pay duration.[13] We augment the two OLS models with the Inverse Mills ratio and the Mills ratio, respectively, estimated from the first-stage regression.[14]

In Column (1) of Panel A, we present the results of the first-stage probit model. Since we lack an exogenous instrument for pay duration, we model pay duration using all observable firm and executive characteristics. The coefficients in Column (1) are consistent with those in Table 5 and indicate that firms with shorter-duration pay contracts are likely to be smaller, have higher bid-ask spreads, and older CEOs are more likely to have shorter-duration pay contracts.

[13] The switching regression model, while similar to a Heckman selection model, is more general because it estimates two second-stage equations and thus allows for different coefficients on the covariates for the "selected" and the "not selected" samples. Similar to the Heckman model, the identification comes from the non-linearity of the model, which arises from the assumption of joint normality for the error terms.

[14] The Mills ratio and the Inverse Mills ratio are given by the formulas $\frac{\phi(\hat{\gamma}Z')}{\Phi(\hat{\gamma}Z')}$ and $\frac{-1\times\phi(\hat{\gamma}Z')}{1-\Phi(\hat{\gamma}Z')}$, where ϕ and Φ denote respectively the probability density function and the cumulative distribution function of the standard normal distribution, Z is the vector of regressors used in the selection model, and $\hat{\gamma}$ denotes the vector of coefficient estimates from the selection model.

In Columns (2) and (3), we present the results of the OLS regressions with *Accruals* as the dependent variable for firms with below-median CEO pay duration (Column (2)) and those with above-median CEO pay duration (Column (3)). The empirical specification in these columns is similar to that in Column (1) of Panel A of Table 6, except that we include the *Inverse Mills ratio* and *Mills ratio* as additional regressors in Columns (2) and (3), respectively, to control for unobserved characteristics (i.e., private information) that may affect both pay duration and *Accruals*. A test of whether *Accruals* is higher for firms with below-median CEO pay duration is to compare the actual level of *Accruals* for such firms with the counterfactual level of *Accruals* if the same firms had below-median pay duration. We estimate the counterfactual by combining the coefficient estimates in Column (3) with the firm and executive characteristics for firms with below-median pay duration. In Panel B, we report the result of a t-test for the statistical significance of the difference between the actual accruals and the counterfactual. Our results indicate that the accruals for firms with below-median pay duration is significantly higher than the counterfactual.

In Panels C and D, we perform the switching regression model with *R&D cut* as the dependent variable. The methodology is similar to that in Panels A and B, except that in these Panels we relate CEO pay duration to the likelihood of cutting R&D. Our results in Panel D again show that firms that offer shorter-duration pay contracts for their CEOs are more likely to cut R&D expenditure.

Overall, the switching regression model allows us to explicitly control for the endogenous selection of pay duration based on unobserved characteristics and to estimate the effect of pay duration on *Accruals* and *R&D cut*. Consistent with our model, we find that lower pay duration for CEOs leads to greater accruals, and to a greater likelihood of R&D expenditures being cut.

[Table 7 goes here]

4 Conclusion

There has been a long-standing intuition in the executive compensation literature that the extent to which a CEO's compensation is long-term or short-term will affect the investment and effort allocation decision of the CEO. However, lacking an empirical measure that quantified the extent to which compensation is short-term or long-term, it has not been possible to give legs to this intuition. Filling such a gap in the literature has been the motivation for this paper.

We develop a theoretical model that generates predictions about the relationship between the short-term versus long-term balance in executive compensation on the one hand, and a host of variables on the other hand. These variables include the extent of mispricing in the firm's stock, the quality of corporate governance, and the myopia in the firm's investment decisions. To take these predictions to the data, we develop a new measure of the extent to which executive compensation is short-term versus long-term. This measure is called *pay duration* and is conceptually similar to the duration for fixed-income securities. Our empirical analysis uses this measure and relies on data on the vesting schedules of restricted stock and stock options, the use of which is novel. The empirical analysis provides strong support for the predictions of the model.

We believe that potential applications of our pay duration measure in future empirical research should go far beyond what we have done in this paper. For example, it would be interesting to examine the intertemporal properties of pay duration and the factors that impinge on these dynamics. We leave this to future projects.

Appendix A: Proofs of Propositions

Proof of Lemma 1. Suppose $\tilde{\delta} = \delta$. If the CEO sells the w_1 shares of stock awards, her expected utility is $V_E^{sell} = w_1(e + u\delta) + w_2 e - \lambda w_2^2\sigma^2/2$, whereas if she holds, her expected utility is $V_E^{hold} = (w_1 + w_2)e - \lambda(w_1 + w_2)^2\sigma^2/2$. It is clear that $V_E^{sell} > V_E^{hold}$ and hence the CEO sells. Suppose $\tilde{\delta} = -\delta$. If the CEO sells, her expected utility is $V_E^{sell} = w_1(e - u\delta) + w_2 e - \lambda w_2^2\sigma^2/2$, whereas if she holds, her expected utility is $V_E^{hold} = (w_1 + w_2)e - \lambda(w_1 + w_2)^2\sigma^2/2$. Note that $V_E^{hold} - V_E^{sell} = w_1 u\delta - \lambda w_1\sigma^2(w_2 + w_1/2) > 0$ if δ is sufficiently large (a sufficient condition is $u\delta \geq \lambda\sigma^2$), in which case the CEO holds. □

Proof of Lemma 2. Given any contract, (w_0, w_1, w_2), the CEO's expected utility is:

$$V_E(W) = \frac{1}{2}\left[w_0 + w_1(e + u\delta) + w_2 e - \frac{\lambda w_2^2\sigma^2}{2}\right] + \frac{1}{2}\left[w_0 + (w_1 + w_2)e - \frac{\lambda(w_1 + w_2)^2\sigma^2}{2}\right] - \frac{e^2 + u^2}{2}. \quad \text{(A1)}$$

The term in the first set of squared brackets represents the CEO's payoff when the stock is overvalued and she sells the w_1 shares of interim stock awards at $t = 1$, and the term in the second set of squared brackets represents the CEO's payoff when the stock is undervalued and she holds the w_1 shares to $t = 2$. The CEO chooses e and u to maximize $V_E(W)$, i.e., $e = w_1 + w_2$ and $u = w_1\delta/2$. □

Proof of Proposition 1. To prove that $w_2 = 0$ and $w_1 > 0$ in an optimal contract, it is sufficient to show that any contract $W \equiv (w_0, w_1, w_2)$, where $w_2 > 0$, is dominated by another contract $\widehat{W} \equiv (w_0, \hat{w}_1, 0)$, where $\hat{w}_1 = w_1 + w_2$. Note that under W, the CEO's expected utility, $V_E(W)$, is given by (A1). The CEO's expected utility under $\widehat{W}$ is:

$$V_E(\widehat{W}) = \frac{1}{2}[w_0 + (w_1 + w_2)(\hat{e} + \hat{u}\delta)] + \frac{1}{2}\left[w_0 + (w_1 + w_2)\hat{e} - \frac{\lambda(w_1 + w_2)^2\sigma^2}{2}\right] - \frac{\hat{e}^2 + \hat{u}^2}{2}. \quad \text{(A2)}$$

We know from (A1) that the CEO chooses $e = w_1 + w_2$ and $u = w_1\delta/2$ under the contract W, and from (A2) we know that she chooses $\hat{e} = w_1 + w_2$ and $\hat{u} = (w_1 + w_2)\delta/2$ under the contract $\widehat{W}$. Note that $\hat{e} = e$ and $\hat{u} > u$. Thus, to show that $\widehat{W}$ dominates W, i.e., $V_B(\widehat{W}) > V_B(W)$, it is sufficient to show that $V_E(\widehat{W}) > V_E(W)$, so the fixed pay w_0 can be lowered under $\widehat{W}$. To show this, we further examine (A2). Suppose the CEO chooses $\hat{u}' = u = w_1\delta/2$, instead of the higher utility-maximizing effort level $(w_1 + w_2)\delta/2$, and we denote the corresponding expected utility to the CEO as $V_E'(\widehat{W})$. Comparing with (A1), it is clear that $V_E'(\widehat{W}) > V_E(W)$. Thus, we must have $V_E(\widehat{W}) \geq V_E'(\widehat{W}) > V_E(W)$, and this proves the first part of the proposition.

To show w_1^* and u^* are increasing in δ, consider a contract $(w_0, w_1, 0)$. The CEO's expected utility is:

$$V_E(W) = \frac{1}{2}[w_0 + w_1(e + u\delta)] + \frac{1}{2}\left[w_0 + w_1 e - \frac{\lambda w_1^2\sigma^2}{2}\right] - \frac{e^2 + u^2}{2}. \quad \text{(A3)}$$

From the CEO's incentive-compatibility constraint (2), we have $e^* = w_1$ and $u^* = w_1\delta/2$. The CEO's participation constraint (2), which must be binding in equilibrium, can be rewritten as:

$$w_0 + \frac{w_1^2}{2} + \frac{w_1^2\delta^2}{8} - \frac{\lambda w_1^2\sigma^2}{4} = \bar{V}_E. \tag{A4}$$

Substituting (A4) into the board's objective function (1), we can rewrite the board's problem as:

$$\max_{\{w_1\}} w_1 - \frac{w_1^2}{2} + \frac{w_1^2\delta^2}{8} - \frac{\lambda w_1^2\sigma^2}{4} - \bar{V}_E, \tag{A5}$$

from which we have:

$$w_1^* = \frac{4}{4 + 2\lambda\sigma^2 - \delta^2}, \tag{A6}$$

which is increasing in δ. It is clear that $u^* = w_1^*\delta/2$ is also increasing in δ. □

Proof of Proposition 2. Suppose after the CEO makes her stock selling/holding decision at $t = 1$, her remaining exposure to the firm is w, where $w = w_2$ if the CEO sells her w_1 shares of interim stock awards, and $w = w_1 + w_2$ if she withholds. The incentive-compatibility constraint for the CEO to not undertake the value-reduction action is $we - \lambda w^2\sigma^2/2 \geq w(e - B) + \theta B - \lambda w^2\sigma^2/2$, i.e., $w \geq \theta$. We have three cases.

First, consider case 1 where $w_1 + w_2 \geq w_2 \geq \theta$, so the CEO never undertakes the value-reduction action. The CEO's expected utility is:

$$V_E(W) = w_0 + \frac{1}{2}\left[w_1(e + u\delta) + w_2 e - \frac{\lambda w_2^2\sigma^2}{2}\right] + \frac{1}{2}\left[(w_1 + w_2)e - \frac{\lambda(w_1 + w_2)^2\sigma^2}{2}\right] - \frac{e^2 + u^2}{2}, \tag{A7}$$

from which we have $e^* = w_1 + w_2$ and $u^* = w_1\delta/2$. Analyzing the contract in the same way as that in the proof of Proposition 2, we can rewrite the board's optimization problem as:

$$\max_{\{w_1, w_2\}} (w_1 + w_2) - \frac{(w_1 + w_2)^2}{2} + \frac{w_1^2\delta^2}{8} - \frac{\lambda w_2^2\sigma^2}{4} - \frac{\lambda(w_1 + w_2)^2\sigma^2}{4} - \bar{V}_E. \tag{A8}$$

It is clear from (A8) that for any fixed $w_1 + w_2$, we should let $w_2 = 0$. However, w_2 has a lower bound θ. Thus, we must have $w_2^* = \theta$. Substituting this into (A8), we can further rewrite the board's problem as:

$$\max_{\{w_1\}} (w_1 + \theta) - \frac{(w_1 + \theta)^2}{2} + \frac{w_1^2\delta^2}{8} - \frac{\lambda\theta^2\sigma^2}{4} - \frac{\lambda(w_1 + \theta)^2\sigma^2}{4} - \bar{V}_E, \tag{A9}$$

which yields $w_1^* = \frac{4 - 4\theta - 2\lambda\theta\sigma^2}{4 + 2\lambda\sigma^2 - \delta^2}$. The expected payoff to the existing shareholders, denoted as $V_B(W)_1$, is:

$$V_B(W)_1 = y - \frac{y^2}{2} + \frac{(y - \theta)^2\delta^2}{8} - \frac{\lambda\theta^2\sigma^2}{4} - \frac{\lambda y^2\sigma^2}{4} - \bar{V}_E, \tag{A10}$$

where $y \equiv \frac{4 - \theta\delta^2}{4 + 2\lambda\sigma^2 - \delta^2}$.

Next, consider case 2 where $w_1 + w_2 \geq \theta > w_2$, so the CEO only undertakes the value-reduction action if she sells the stocks (when $\tilde{\delta} = \delta$). The CEO's expected utility is:

$$\begin{aligned} V_E(W) &= w_0 + \frac{1}{2}\left[w_1(e - B + u\delta) + w_2(e - B) + \theta B - \frac{\lambda w_2^2 \sigma^2}{2}\right] \\ &\quad + \frac{1}{2}\left[(w_1 + w_2)e - \frac{\lambda (w_1 + w_2)^2 \sigma^2}{2}\right] - \frac{e^2 + u^2}{2}, \end{aligned} \tag{A11}$$

from which we have $e^* = w_1 + w_2$ and $u^* = w_1\delta/2$. We can rewrite the board's optimization problem as:

$$\max_{\{w_1, w_2\}} (w_1 + w_2) - \frac{(w_1 + w_2)^2}{2} + \frac{w_1^2 \delta^2}{8} - \frac{\lambda w_2^2 \sigma^2}{4} - \frac{\lambda (w_1 + w_2)^2 \sigma^2}{4} - \frac{(1 - \theta)B}{2} - \bar{V}_E. \tag{A12}$$

It is clear from (A12) that $w_2^* = 0$. Substituting this into (A12), we have $w_1^* = \frac{4}{4 + 2\lambda\sigma^2 - \delta^2}$. The corresponding expected payoff to the existing shareholders, denoted as $V_B(W)_2$, is:

$$V_B(W)_2 = z - \frac{z^2}{2} + \frac{z^2 \delta^2}{8} - \frac{\lambda z^2 \sigma^2}{4} - \frac{(1 - \theta)B}{2} - \bar{V}_E, \tag{A13}$$

where $z \equiv \frac{4}{4 + 2\lambda\sigma^2 - \delta^2}$.

Finally, consider case 3 where $\theta > w_1 + w_2 \geq w_2$, so the CEO always undertakes the value-reduction action. The CEO's expected utility is:

$$\begin{aligned} V_E(W) &= w_0 + \theta B + \frac{1}{2}\left[w_1(e - B + u\delta) + w_2(e - B) - \frac{\lambda w_2^2 \sigma^2}{2}\right] \\ &\quad + \frac{1}{2}\left[(w_1 + w_2)(e - B) - \frac{\lambda (w_1 + w_2)^2 \sigma^2}{2}\right] - \frac{e^2 + u^2}{2}, \end{aligned} \tag{A14}$$

from which we again have $e^* = w_1 + w_2$ and $u^* = w_1\delta/2$. We can rewrite the board's optimization problem as:

$$\max_{\{w_1, w_2\}} (w_1 + w_2) - \frac{(w_1 + w_2)^2}{2} + \frac{w_1^2 \delta^2}{8} - \frac{\lambda w_2^2 \sigma^2}{4} - \frac{\lambda (w_1 + w_2)^2 \sigma^2}{4} - (1 - \theta)B - \bar{V}_E. \tag{A15}$$

Again, it is clear from (A15) that $w_2^* = 0$. Substituting this into (A15), we have $w_1^* = \frac{4}{4 + 2\lambda\sigma^2 - \delta^2}$. The corresponding expected payoff to the existing shareholders, denoted as $V_B(W)_3$, is:

$$V_B(W)_3 = z - \frac{z^2}{2} + \frac{z^2 \delta^2}{8} - \frac{\lambda z^2 \sigma^2}{4} - (1 - \theta)B - \bar{V}_E. \tag{A16}$$

Comparing (A13) and (A16), we have $V_B(W)_2 > V_B(W)_3$, so case 2 always dominates case 3. Thus, we only need to compare cases 1 and 2. Note that $V_B(W)_2$ is decreasing in B, whereas $V_B(W)_1$ is independent of B. Thus, it is clear that there exists a cutoff value $\widehat{B}$, such that $V_B(W)_1 \geq V_B(W)_2$ when $B \geq \widehat{B}$, and $V_B(W)_1 < V_B(W)_2$ when $B < \widehat{B}$. The rest of the proposition follows directly. □

Proof of Proposition 3. Substituting $e^* = w_1^* + w_2^*$ and $u^* = w_1^*\delta/2$ into (3), we can rewrite it as:

$$Duration^* = \frac{(w_1^* + w_2^*)^2 + w_2^*(w_1^* + w_2^*) + 0.25(w_1^*\delta)^2}{w_0^* + (w_1^* + w_2^*)^2 + 0.25(w_1^*\delta)^2}. \tag{A17}$$

From the analysis of the contract in the proof of Proposition 2 (case 1), we can derive:

$$w_0^* = \bar{V}_E - \frac{(w_1^* + w_2^*)^2}{2} - \frac{(w_1^*\delta)^2}{8} + \frac{\lambda\sigma^2[w_2^{*2} + (w_1^* + w_2^*)^2]}{4}. \tag{A18}$$

Substituting (A18) into (A17) (and normalizing $\bar{V}_E$ to zero), we have:

$$Duration^* = \frac{(1+x)^2 + x(1+x) + 0.25\delta^2}{0.5(1+x)^2 + 0.25\lambda\sigma^2[x^2 + (1+x)^2] + 0.125\delta^2}, \tag{A19}$$

where $x \equiv w_2^*/w_1^*$. It can be shown by straightforward algebra that:

$$\frac{\partial Duration^*}{\partial x} \propto 4(1+x)^2 + \delta^2(1+2x) - 4\lambda\sigma^2(1+x^2) - \lambda\sigma^2\delta^2(1+2x), \tag{A20}$$

which is positive if $\lambda\sigma^2$ is not too large (i.e., the CEO is not too risk averse and/or the uncertainty of the liquidation value is not too high).[15] □

[15]The intuition is as follows. If $\lambda\sigma^2$ is too large, then the pay uncertainty induced by a higher w_2^*/w_1^* is so large that in equilibrium the increase in w_0^* (to compensate the CEO's exposure to the pay uncertainty) is sufficiently high to cause the denominator in (A17) to increase faster than the numerator, resulting in a decrease of $Duration^*$.

Appendix B: Empirical variable definitions

The variables used in the empirical analysis are defined as follows:

- *Accruals* is the absolute value of abnormal accruals. We calculate this measure following the procedure outlined in Jones (1991), modified by including controls for earnings performance as proposed in Kothari, Leone, and Wasley (2005).
- *Age* is the executive's age in the data year.
- *Analyst dispersion* is the standard deviation of analysts annual earnings forecast. We obtain this measure from the IBES database.
- *Bonus* is the executive's yearly bonus value.
- *Capital expenditure* is the ratio of capital expenditure to lagged value of total assets.
- *CEO* is a dummy variable that takes the value one if the executive is a CEO and zero otherwise.
- *Debt/Total assets* is the ratio of sum of long-term and short-term debt (Compustat items: dltt and dlc) to total assets.
- *Delta* and *Vega* are the sensitivity of the executive's stock and options portfolio to changes in the level and volatility of stock price, respectively.
- *Director shareholding* is the non-executive directors' share ownership.
- *Duration* is the duration of executive compensation calculated in (4).
- *EBIT/Sales* is the ratio of earnings before interest and taxes over sales.
- *Entrenchment index* is the Bebchuk, Cohen, and Ferrell (2009) entrenchment index.
- *Fraction independent* is the fraction of independent directors on the firm's board.
- *Fraction non-cash pay* is the fraction of non-cash component of executive pay (sum of restricted stock and stock options) over the total compensation.
- *High director shareholding* is a dummy variable that takes the value one if *Director shareholding* is greater than 1%, and zero otherwise.
- *Industry-adjusted R&D cut* is a dummy variable that takes the value one if the firm reduces its industry-adjusted R&D (the difference between the firm's R&D/Total assets and the median R&D/Total assets for all the firms in the same Fama-French forty-eight industry group) from the previous year, and zero otherwise.
- *Log(Total assets)* is the natural logarithm of the book value of total assets.
- *Market-to-book* is the ratio of market value of total assets to book value of total assets.

- *Number of directors* is the number of directors on the firm's board.
- *Options* represents the Black-Scholes value of the options granted to the executive during the year.
- *R&D/Total assets* is the ratio of research and development expenditure (Compustat item: xrd) over book value of total assets. We code missing values of research and development expenditure as zero.
- *R&D cut* is a dummy variable that takes the value one if the firm reduces its R&D/Total assets from the previous year, and zero otherwise.
- *Restricted stock* represents the value of the restricted stock granted to the executive during the year.
- *Salary* is the executive's yearly salary value.
- *Sales growth* is the firm's annual sales growth rate.
- *Sales volatility* is the standard deviation of the firm's annual sales growth during the period 1980-2008.
- *Shareholding* is the executive's share ownership in the firm.
- *Spread* is the average stock bid-ask spread during the previous year.
- *Stock return* is the one-year percentage return for the firm's stock over the previous fiscal year.
- *Total compensation* is the sum of salary, bonus, other annual compensation, long-term incentive payouts, other cash payouts, and the value of restricted stock and stock option awards.
- *Turnover* equals 1,000 times the annual average of the ratio of the daily trading volume over shares outstanding.
- *Volatility* is the stock return volatility calculated as the volatility of daily stock returns during the previous year.

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Table 1: Distribution of vesting schedules

Panel A: All executives

	Restricted stock			Options		
Vesting period (years)	Frequency	Percent	Fraction graded	Frequency	Percent	Fraction graded
1	359	2.43	0.09	932	5.74	0.03
2	802	5.43	0.65	403	2.48	0.74
3	6650	45.06	0.52	6283	38.72	0.87
4	4038	27.36	0.79	6250	38.52	0.98
5	2513	17.03	0.78	2151	13.26	0.95
6	110	0.75	0.76	63	0.39	0.76
7	92	0.62	0.62	57	0.35	0.86
8	37	0.25	0.73	45	0.28	0.27
9	10	0.07	0.80	8	0.05	1.00
10	144	0.98	0.75	34	0.21	0.85
13	1	0.01	1.00			
14	1	0.01	1.00			
Total	14757	100		16226	100	

Panel B: CEOs

	Restricted stock			Options		
Vesting period (years)	Frequency	Percent	Fraction graded	Frequency	Percent	Fraction graded
1	92	3.52	0.11	174	5.9	0.02
2	154	5.9	0.69	76	2.58	0.75
3	1147	43.91	0.56	1144	38.81	0.88
4	689	26.38	0.78	1108	37.58	0.97
5	466	17.84	0.75	398	13.5	0.95
6	16	0.61	0.63	13	0.44	0.54
7	21	0.8	0.57	8	0.27	0.88
8	4	0.15	0.75	19	0.64	0.11
9	1	0.04	1.00	2	0.07	1.00
10	21	0.8	0.62	6	0.2	0.83
13	1	0.04	1.00			
Total	2612			2948		

Distribution of vesting schedules for restricted stock and option grants in our sample. Panel A includes data for all executives, and Panel B only includes the subsample of CEOs. Details on the definition of the variables reported in this table are provided in Appendix B. For all the grants with a given vesting period, the percentage of grants that vest in a fractional (graded) manner is given in the column *Fraction graded*.

Table 2: Industry distribution of pay duration

Industry	CEOs		All executives	
	N	Duration	N	Duration
Beer & Liquor	17	2.254	81	1.443
Finance-Trading	9	2.157	60	1.784
Defense	11	2.025	63	1.537
Banking	74	1.858	428	1.319
Medical Equipment	88	1.825	502	1.534
Business Services	32	1.668	194	1.220
Utilities	178	1.666	1008	1.410
Wholesale	119	1.663	638	1.417
Coal	18	1.583	113	1.213
Chemicals	85	1.576	485	1.316
Pharmaceutical Products	134	1.573	782	1.388
Other	273	1.564	1422	1.400
Personal Services	74	1.509	434	1.314
Ship building and Railroad Equipment	25	1.485	136	1.369
Machinery	126	1.479	751	1.154
Real Estate	200	1.472	1171	1.249
Petroleum and Natural Gas	15	1.464	86	1.306
Measuring and Control Equipment	228	1.439	1261	1.240
Healthcare	90	1.429	483	1.268
Aircraft	38	1.400	221	0.992
Electrical Equipment	32	1.384	169	1.224
Business Supplies	90	1.374	493	1.207
Construction	56	1.363	306	1.168
Construction Materials	72	1.351	426	1.045
Computers	381	1.331	2188	1.180
Communication	266	1.314	1568	0.957
Shipping Containers	58	1.303	350	1.065
Electronic Equipment	115	1.252	647	1.232
Restaurants, Hotels and Motels	224	1.239	1200	1.133
Retail	114	1.225	660	1.003
Consumer Goods	30	1.215	168	1.070
Recreation	24	1.194	138	0.985
Steel Works etc.	59	1.180	348	0.940
Candy & Soda	8	1.161	42	0.831
Insurance	275	1.159	1609	0.988
Transportation	17	1.111	93	0.992
Printing and Publishing	20	1.105	118	0.979
Food and Food Products	78	1.044	419	0.960
Rubber and Plastic Products	29	1.036	163	0.780
Textiles	12	0.971	78	0.754
Apparel	64	0.957	346	0.812
Entertainment	26	0.947	132	1.322
Agriculture	9	0.890	45	0.899
Automobiles and Trucks	40	0.632	201	0.644
Precious Metals	20	0.618	115	0.581

Distribution of executive pay duration (in years) in our sample across industries based on the Fama-French forty-eight industry classification. Definition of duration is provided in Appendix B.

Table 3: Summary statistics

Panel A: Summary statistics for the full sample

Variable	*N*	Mean	Median	Std. Dev.
Pay characteristics				
Total compensation	22674	2.161	0.974	4.923
Salary	22674	0.451	0.375	0.318
Bonus	22674	0.205	0	1.275
Options	22674	0.718	0.034	2.537
Restricted stock	22674	0.786	0.049	2.879
Duration (years)	22674	1.177	1.239	0.935
Firm characteristics				
Total assets	22652	18961.05	2387.6	110375.6
Debt/Total assets (%)	22585	21.7	19.8	17.6
Sales growth (%)	22637	12.3	9.4	19.8
Market-to-book	22632	1.84	1.468	1.09
R&D/Total assets (%)	22652	2.1	0	4.2
Capital expenditure (%)	22597	4.9	3.1	5.6
EBIT/Sales (%)	22652	15.1	12.5	13.0
Volatility	22549	0.15	0.126	0.105
Turnover	22549	11.506	9.429	7.545
Spread (%)	22549	0.027	0.023	0.014
Accruals	18066	0.043	0.031	0.042
Analyst dispersion	21396	0.062	0.03	0.11
Entrenchment index	18249	3.242	3	1.349
Number of directors	19240	8.949	9	2.576
Fraction independent	19240	0.751	0.778	0.139
Director shareholding	19240	2.357	0	7.649
Executive characteristics				
Shareholding (%)	22674	0.603	0	3.018
Age (years)	17514	52.234	52	7.78

Panel B: Summary statistics for the subsample of CEOs

Variable	*N*	Mean	Median	Std. Dev.
Pay characteristics				
Total compensation	4014	4.7	2.497	8.278
Salary	4014	0.762	0.712	0.419
Bonus	4014	0.444	0	2.477
Options	4014	1.693	0.202	4.321
Restricted stock	4014	1.801	0.184	5.242
Duration (years)	4014	1.391	1.531	1.017
Executive characteristics				
Shareholding (%)	4014	2.212	0	5.645
Age (years)	3915	55.362	55	7.492

Descriptive statistics of executives and firms. The data are collected for all executives in S&P 1500 firms that we are able to match across ExecuComp and Equilar for the period 2006-08. Panel A summarizes our full sample for all executives, and Panel B summarizes the subsample of CEOs. Details on the definition of the variables reported in this table are provided in Appendix B. Compensation data are in millions and total assets are in billions of yearly dollars.

Table 4: Univariate comparison

Panel A: Univariate comparison for the full sample

Variable	Short duration	Long duration	Difference
	Pay characteristics		
Total compensation	0.923	3.398	-2.475
Salary	0.405	0.498	-0.093
Bonus	0.244	0.167	0.077
Options	0.151	1.285	-1.134
Restricted stock	0.123	1.448	-1.325
Duration (years)	0.425	1.929	-1.504
	Firm characteristics		
Total assets	13973.12	23941.93	-9968.81
Debt/Total assets (%)	20.8	22.6	-1.8
Sales growth (%)	11.2	13.4	-2.2
Market-to-book	1.765	1.915	-0.15
R&D/Total assets (%)	1.8	2.5	-0.7
Capital expenditure (%)	4.7	5	-0.3
EBIT/Sales (%)	14.1	16.1	-2
Volatility	0.027	0.026	0.001
Accruals	0.044	0.042	0.002
Spread (%)	0.167	0.134	0.033
Turnover	10.895	12.119	-1.224
Analyst dispersion	0.061	0.063	-0.002
Entrenchment index	3.253	3.232	0.021
Number of directors	8.813	9.078	-0.265
Fraction independent	0.742	0.76	-0.018
Director shareholding (%)	2.731	1.999	0.732
	Executive characteristics		
Shareholding (%)	0.671	0.534	0.137
Age (years)	52.83	51.682	1.148

Panel B: Univariate comparison for CEOs

Variable	Short duration	Long duration	Difference
	Pay characteristics		
Total compensation	2.451	6.949	-4.498
Salary	0.728	0.796	-0.068
Bonus	0.636	0.253	0.383
Options	0.57	2.815	-2.245
Restricted stock	0.517	3.084	-2.567
Duration (years)	0.606	2.175	-1.569
	Executive characteristics		
Shareholding (%)	2.695	1.73	0.965
Age (years)	56.374	54.37	2.004

This table compares the mean values of the key variables across subsamples of executives with pay duration below (*Short duration*) and above (*Long duration*) the sample median. Panel A includes data for all executives, and Panel B only includes CEOs. Details on the definition of the variables reported in this table are provided in Appendix B. Compensation data are in millions and total assets is in billions of yearly dollars. All variables are significantly different across the two subsamples at less than 1% level.

Table 5: Stock mispricing, firm governance, and pay duration

Panel A: Firm characteristics and pay duration

	(1)	(2)	(3)	(4)
Log(Total assets)	.124 (.016)***	.097 (.017)***	.119 (.016)***	.117 (.015)***
Market-to-book	.091 (.025)***	.067 (.026)***	.080 (.026)***	.083 (.025)***
R&D/Total assets	1.953 (.495)***	1.756 (.491)***	1.741 (.492)***	1.846 (.491)***
CEO	.300 (.022)***	.300 (.022)***	.300 (.022)***	.300 (.022)***
Volatility	-3.519 (2.088)*	-.137 (2.281)	-8.310 (2.332)***	-2.782 (2.064)
Stock return	.063 (.044)	.018 (.045)	.029 (.044)	.066 (.043)
Spread		-1.223 (.307)***		
Turnover			.012 (.003)***	
Analyst dispersion				-.056 (.006)***
Const.	-.734 (.175)***	-.362 (.193)*	-.677 (.174)***	-.636 (.174)***
Obs.	22278	22278	22278	21059
Pseudo R^2	.022	.025	.024	.021

Panel B: Governance characteristics and pay duration

	(1)	(2)	(3)	(4)	(5)	(6)
Log(Total assets)	.097 (.016)***	.076 (.022)***	.113 (.020)***	.093 (.017)***	.089 (.017)***	.095 (.017)***
Volatility	-1.378 (2.241)	-3.229 (3.025)	-.103 (2.335)	.467 (2.334)	.374 (2.330)	-.136 (2.283)
Market-to-book	.089 (.023)***	.035 (.035)	.081 (.027)***	.082 (.026)***	.081 (.026)***	.071 (.025)***
R&D/Total assets	1.834 (.462)***	1.325 (.641)**	1.771 (.492)***	1.780 (.491)***	1.654 (.488)***	1.705 (.490)***
Stock return	.051 (.046)	.068 (.062)	.030 (.046)	.031 (.045)	.030 (.045)	.019 (.045)
CEO	.308 (.020)***		.308 (.022)***	.309 (.022)***	.309 (.022)***	.343 (.024)***
Spread	-1.152 (.298)***	-1.436 (.384)***	-1.145 (.328)***	-1.159 (.328)***	-1.140 (.322)***	-1.184 (.306)***
Entrenchment index	.004 (.016)	.039 (.021)*				
Number of directors			-.020 (.010)*			
Fraction independent				.201 (.150)		
High director shareholding					-.173 (.061)***	
Shareholding						-.023 (.009)**
Const.	.085 (.186)	.516 (.260)**	-.321 (.202)	-.479 (.217)**	-.260 (.206)	-.363 (.191)*
Obs.	18059	3186	19039	19039	19039	22278
Pseudo R^2	.022	.015	.026	.026	.027	.026

This table reports the results of the regression relating executive pay duration to firm, governance, and executive characteristics. Specifically, we estimate the tobit regression: $Duration_{ket} = F(\alpha + \beta_1 X_{kt} + \beta_2 X_{et} + \mu_t T + \epsilon_{ket})$. The regression in Column (2) of Panel B confines to the subsample of CEOs, whereas the regressions in the rest columns are for all executives. The compensation data are from Equilar and ExecuComp, firm financial data are from Compustat, and stock returns are from CRSP. Details on the definition of the variables in this table are provided in Appendix B. The sample includes all executive-firm year data that we are able to obtain by matching Equilar and ExecuComp. Standard errors reported in parentheses are robust to heteroskedasticity and are clustered at individual firm level. Asterisks denote statistical significance at the 1% ($***$), 5% ($**$) and 10% ($*$) levels.

Table 6: Managerial myopia and pay duration (OLS)

Panel A: CEO pay duration and absolute accruals

	Absolute accruals			Positive accruals	Negative accruals
	(1)	(2)	(3)	(4)	(5)
Duration	-.002 (.0007)**	-.003 (.001)**	-.001 (.0007)*	-.001 (.0006)**	.00006 (.0006)
Log(Total assets)	-.004 (.0009)***	-.004 (.0009)***	-.003 (.001)**	-.001 (.0005)***	-.001 (.001)
Sales volatility	.040 (.010)***	.040 (.010)***	.043 (.011)***	.033 (.010)***	.010 (.004)**
Market-to-book	.003 (.001)**	.003 (.001)**	.002 (.001)*	.002 (.001)	.0007 (.001)
Age	-.0002 (.0001)*	-.0002 (.0001)*	-.0003 (.0001)**	-.00006 (.0001)	-.0002 (.0001)**
Fraction non-cash pay		.005 (.005)			
Log(Delta)			.002 (.0008)**	.0006 (.0006)	.001 (.0007)
Const.	.072 (.010)***	.071 (.010)***	.066 (.013)***	.029 (.008)***	.037 (.009)***
Obs.	3074	3074	2571	2571	2571
R^2	.108	.109	.12	.073	.084

Panel B: CEO pay duration and likelihood of cutting R&D

	R&D cut			Industry-adjusted R&D cut	
	(1)	(2)	(3)	(4)	(5)
Duration	-.012 (.006)**	-.012 (.007)*	-.013 (.007)**	-.030 (.016)*	
Short duration					.034 (.017)**
Spread	.161 (.087)*	.260 (.121)**	.162 (.087)*	.084 (.108)	-.149 (.112)
Spread × Short duration					.344 (.128)***
Log(Vega)		.0002 (.0003)			
Fraction non-cash pay			.004 (.024)	.074 (.053)	.032 (.039)
Log(Total assets)	.002 (.004)	.004 (.005)	.002 (.005)	-.045 (.008)***	-.045 (.008)***
Age	.0001 (.0006)	.0005 (.0008)	.0001 (.0006)	.0007 (.0006)	.0007 (.0006)
Spread	.161 (.087)*	.260 (.121)**	.162 (.087)*	.084 (.108)	-.149 (.112)
Volatility	-.582 (.567)	-.185 (.957)	-.585 (.563)	-2.147 (1.484)	-1.926 (1.490)
Market-to-book	-.013 (.007)*	-.016 (.009)*	-.013 (.007)*	-.004 (.009)	-.005 (.009)
Stock return	-.082 (.016)***	-.099 (.020)***	-.083 (.016)***	-.066 (.026)**	-.065 (.027)**
Const.	.128 (.045)***	.086 (.064)	.128 (.045)***	.462 (.110)***	.461 (.108)***
Obs.	3840	2770	3840	3840	3840
R^2	.15	.166	.15	.056	.057

This table reports the results of the regression relating the level of absolute accruals and R&D expenditure cut to the CEO pay duration. Specifically, we estimate the OLS regression: $y_{kt} = \alpha + \beta_1 Duration_{ket} + \beta_2 \mathrm{X}_{kt} + \mu_t \mathrm{T} + \mu_l \mathrm{L}\epsilon_{kt}$, where y is *Accruals* in Panel A, *R&D cut* Columns (1) to (3) in Panel B, and *Industry-adjusted R&D cut* in Columns (4) and (5) in Panel B. The compensation data are from Equilar and ExecuComp, firm financial data are from Compustat, and stock returns are from CRSP. Details on the definition of the variables in this table are provided in Appendix B. The sample includes one observation per firm-year and includes all firm year data that we are able to obtain by matching Equilar and ExecuComp. Standard errors reported in parentheses are robust to heteroskedasticity and are clustered at individual firm level. Asterisks denote statistical significance at the 1% ($***$), 5% ($**$) and 10% ($*$) levels.

Table 7: Managerial myopia and pay duration (switching regression model)

Panel A: CEO pay duration and absolute accruals

	Short duration	Accruals	
		Short-duration firms	Long-duration firms
	(1)	(2)	(3)
Inverse Mills		.001 (.060)	
Mills			.020 (.075)
Log(Total assets)	-.125 (.040)***	-.003 (.005)	-.004 (.005)
Market-to-book	-.005 (.023)	.003 (.002)	.001 (.001)
Sales volatility	-.276 (.251)	.049 (.022)**	.033 (.020)
R&D/Total assets	-1.355 (1.377)	-.0009 (.081)	-.068 (.057)
Stock return	-.006 (.079)	.012 (.003)***	.008 (.003)**
Spread	1.267 (.455)***	.018 (.040)	.021 (.061)
Age	.021 (.005)***	-.0002 (.0007)	-.00009 (.001)
Log(Delta)	.014 (.031)	.002 (.0009)**	.002 (.001)
Const.	-.493 (.456)	.056 (.054)	.075 (.036)**
Obs.	3194	1213	1339
R^2 or Pseudo R^2	.076	.179	.101

Panel B: Test of significance of difference between actual and counterfactual *Accruals*

	Actual	Predicted	Difference
Accruals for firms with low duration	.044	.042	.002 (.001)*

Panel C: CEO pay duration and R&D/Total assets

	Short duration	R&D/Total Assets	
		Short-duration firms	Long-duration firms
	(1)	(2)	(3)
Inverse Mills		.193	
		(.276)	
Mills			.181
			(.372)
Log(Total assets)	-.135	-.019	-.009
	(.031)***	(.023)	(.030)
Volatility	2.238	-.463	-.319
	(4.496)	(1.078)	(.997)
Market-to-book	-.014	-.016	-.014
	(.031)	(.009)*	(.007)*
Duration			
Spread	1.128	.291	.201
	(.451)**	(.193)	(.275)
Stock return	-.012	-.099	-.069
	(.083)	(.027)***	(.019)***
Age	.021	.003	.002
	(.004)***	(.003)	(.005)
Const.	-.117	-.035	.201
	(.396)	(.280)	(.197)
Obs.	3833	1912	1921
R^2 or Pseudo R^2	.077	.185	.134

Panel D: Test of significance of difference between actual and counterfactual *R&D/Total assets*

	Actual	Predicted	Difference
R&D cut for firms with short duration	.108	.072	.036
			(.007)***

This table reports the results of the regression relating the level of absolute accruals and the likelihood of cutting R&D to the CEO pay duration after controlling for endogeneity using the switching regression model. The model consists of a selection equation (Probit) to estimate the probability that a firm has a low-duration pay contract (Column (1) in Panels A and C), and two outcome equations that examine *Accruals* (*R&D cut*) separately for firms with below and above-median pay duration in Columns (2) and (3) in Panel A (C). The *Inverse Mills* Ratio and the *Mills* Ratio are used as additional controls in Columns (2) and (3), respectively. Panel B (D) presents the results of a t-test for the difference between the actual *Accruals* (*R&D cut*) for firms with below-median pay duration and the counterfactual *Accruals* (*R&D cut*) (estimated using the coefficient estimates from Column (3)) if the same firm had a low-duration pay contract. The compensation data are from Equilar and ExecuComp, firm financial data are from Compustat, and stock returns are from CRSP. Details on the definition of the variables in this table are provided in Appendix B. The sample includes one observation per firm-year and includes all firm year data that we are able to obtain by matching Equilar and ExecuComp. Standard errors reported in parentheses are robust to heteroskedasticity and are clustered at individual firm level. Asterisks denote statistical significance at the 1% ($***$), 5% ($**$) and 10% ($*$) levels.