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.

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1 Introduction

It is well recognized that executive compensation is an important tool of corporate governance in aligning the interests of shareholders and managers. Issues related to how executive compensation should be structured have therefore been front and center in corporate governance discussions ever since Jensen and Murphy (1990) argued that what matters in CEO pay is not how much you pay, but how you pay. And on the issue of how you pay, an active debate has raged on about whether executive compensation is too short-term, with critics alleging that excessive compensation short-termism leads to self-interested and often myopic managerial behavior. For example, Bebchuk and Fried (2010) argue that observed executive compensation contracts put too much emphasis on short-term performance and should be modified. They suggest that the equity component of compensation should not be permitted to be unwound for some time after vesting, but the unwinding should not be delayed too much either. On the other side of the debate, Bolton, Scheinkman, and Xiong (2006) point out 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 leads to the overarching question: is executive compensation too short-term, presumably relative to a theoretical (first-best) benchmark, and if so, why do firms continue to use such inefficient contracts? Addressing this question is hampered by an obvious gap in our knowledge – we have no existing empirical measure of the extent to which executive compensation is short-term or long-term. The lack of such a measure renders moot the question of proceeding to the next step of assessing whether observed executive compensation contracts are inefficiently short-term in nature reflecting poor corporate governance, or could they represent the constrained-efficient (second best) outcomes of tradeoffs by the shareholders, including the stock mispricing identified by Bolton, Scheinkman, and Xiong (2006).

In this paper, as a first step in filling this gap, we develop a new measure, pay duration, to quantify 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 components of executive pay, with the weight for each component being equal to the fraction of that component in the executive's total compensation package. With this measure, and motivated by the earlier executive compensation research, we are able to address three basic questions relate to the interaction between executive compensation, corporate governance and stock prices:

1. What is the relationship between optimal pay duration and the extent of possible mispricing of the firm's stock?

2. What is the relationship between optimal pay duration and the quality of corporate governance?

3. How does pay duration affect the investment behavior of managers?

To address these questions, we begin by developing a simple theoretical model along the lines of Bolton, Scheinkman, and Xiong (2006) to understand the determinants of pay duration. Our model has two features that we believe are part of the real-world contracting environment. First, the stock market can misprice a firm's equity in the short-run. Second, the executive can divert effort to improve short-term stock price at the expense of long-term firm value. This setting allows us to clearly focus on the shareholders' tradeoff between short-term pay 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 boost short-term performance of the firm at the expense of its long-term 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 in response to the three questions raised earlier. 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.

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 believe that this is the first time in the literature that such comprehensive data on the vesting schedules of restricted stock and stock options have been brought to bear on the questions we address.

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, Ship Building & Railroad Equipment, 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 (including those below the CEO) in our sample is around 0.91 years, while CEO pay contracts have a slightly longer duration at about 1.06 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 (as measured by a lower bid-ask spread and a higher turnover) and in firms with less analyst earnings forecast dispersion.

As for our second prediction, we find that pay duration is longer for executives in firms with a higher proportion of non-executive director shareholding. Duration is also longer for executives with more shareholding in the firm. If greater director and executive shareholdings indicates greater alignment between the interests of the board and executive and those of the firm's shareholders, then these results provide support for our second prediction that pay duration is longer in firms with poorer governance. We also find CEO pay duration to be longer in firms with lower entrenchment index (Bebchuck, Cohen, and Ferrel (2009)), further supporting our second prediction.

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 as proxy for action 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 endogeneity of pay duration using a 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 covered a wide-ranging set of issues.[1] These include whether CEOs are offered sufficient stock-based incentives and how these vary cross-sectionally,[2] whether CEOs are judged using relative performance evaluation (RPE),[3] and ultimately whether executive contracts in practice are set by the firm's board of directors or the executives themselves.[4]

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 examine the pros and cons of long-term compensation contracts in a managerial career-concerns setting. Examples of other optimal contracting models that examine executive pay duration include Bizjak, Brickley, and Coles (1993), 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 directly 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 ultimately examine the effect of pay duration on corporate decisions.

[1]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).

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

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

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

Another important contribution of our work is that our duration measure is materially different from the measures used in prior literature to characterize executive pay, which include the proportion of non-cash pay in total pay (Bushman and Smith (2001)), the delta and vega of executive stock and option grants and holdings (Coles, Daniel, and Naveen (2006)), and the correlation of pay to stock returns and earnings (Bushman et al (1998)).[5] 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, of which there are often many during a particular compensation year. 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 the prior literature.

The rest of the paper proceeds as follows. Section 2 develops the model and draws out its empirical predictions. Section 3 describes the data, lays out the empirical methodology, and discusses the main results from the tests of our predictions. Section 4 conducts additional robustness tests. Section 5 concludes. All proofs are in the Appendix.

2 The Model

In this section, we develop a theoretical model of the optimal mix of short-term and long-term pay for executives. The model generates several predictions with respect to how the optimal mix is related to firm and executive characteristics, as well as how it affects executive behavior.

2.1 Agents and economic environment

Consider a firm owned by risk-neutral shareholders (who are represented by 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).[6] Both projects pay off at $t = 2$ when the firm is also liquidated. The castle project, a symbol of managerial myopia, is inefficient in the sense that any 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.,

[5]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).

[6]The term "castle-in-the-air" appears in Bolton, Scheinkman, and Xiong (2006).

increase current period earnings through accruals or an R&D cut). Reflecting this, we 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 CEO's control.

At $t = 0$, the board designs a compensation contract with three components: (i) w_0 in cash awarded to the CEO at $t = 0$ (salary), (ii) w_1 unrestricted shares of the firm that the CEO is free to sell at $t = 1$, and (iii) w_2 restricted shares that the CEO can only sell at $t = 2$. The CEO spends effort e on the real project and effort u on the castle project, at a personal cost $(e + u)^2/2$; 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 in the stock market. Specifically, when viewed at $t = 0$, $P_1 = \max(\mathbf{E}(X) + \tilde{\delta}(1 + \tau u), 0)$,[7] where τ is a positive constant that we will interpret later, and $\tilde{\delta}$ 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 ($\tilde{\delta}$).

At $t = 1$, the CEO decides whether to sell the w_1 shares of stock 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 negative exponential utility, $-\exp\{-\lambda[W - (e + u)^2/2]\}$, where W denotes her total compensation, and $\lambda > 0$ is her coefficient of absolute risk aversion. We will work with her certainty equivalent throughout:

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

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

[7] The formulation reflects the fact that P_1 cannot be negative.

2.2 Optimal compensation contract

The board's problem at $t = 0$ is to design a contract, denoted as (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:

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

$$\text{s.t. } \{e, u\} \in \text{argmax } V_E(W), \tag{2}$$

$$V_E(W) \geq \bar{V_E}. \tag{3}$$

In the above problem, the incentive-compatibility constraint in (2) stipulates that the chosen effort levels maximize the CEO's expected utility given the contract (w_0, w_1, w_2). The CEO's participation constraint is given by the weak inequality (3).

Lemma 1. *Suppose δ is large enough. Then the CEO will sell her unrestricted stock awards (w_1 shares) 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 ($P_1 = \mathbf{E}(X) + \delta(1 + \tau u) > \mathbf{E}(X)$), 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 ($P_1 = \max(\mathbf{E}(X) - \delta(1 + \tau u), 0) < \mathbf{E}(X)$). Now, whether the risk-averse CEO sells or holds on to her w_1 shares until $t = 2$ depends on the extent of undervaluation. She will sell if the undervaluation is small relative to the uncertainty in the liquidation value. But a sufficiently large undervaluation (the Appendix delineates the condition for which δ is large enough) 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 $u = 0$ on the castle project if $w_2/w_1 \geq [\delta\tau/2] - 1$, whereas if $w_2/w_1 < [\delta\tau/2] - 1$, she spends $e = 0$ on the real project and $u = w_1\delta\tau/2$ on the castle project.*

Note that unrestricted stock awards (w_1) 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), but has no effect on the liquidation value. By contrast, 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, but has no effect on the option value of unrestricted shares. Thus, in equilibrium: (i) if the CEO's pay is weighted more heavily on the liquidation value relative to the interim stock price (w_2/w_1 sufficiently large), she will not work on the castle project ($u = 0$), and her effort on the real project depends on the sum of the contract weights on the interim stock price and the liquidation value, $w_1 + w_2$; and (ii) if her pay is more heavily tied to the interim stock price relative to the liquidation value (w_2/w_1 sufficiently small), the CEO will shirk on the real project ($e = 0$), and her effort on the castle project increases with the contract weight on the interim stock price, w_1, but does not depend on the contract weight on the liquidation value, w_2. Moreover, in case (ii), 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, thereby increasing the option value of unrestricted shares.

The next result characterizes the optimal duration of executive compensation.

Proposition 1. *Assume $\delta\tau > 2$, and denote the optimal incentive contract as (w_0^*, w_1^*, w_2^*). There exists a cutoff value of δ, call it δ^*, such that:*

1. *when $\delta \leq \delta^*$, the optimal contract involves both long-term and short-term pay, with $w_2^*/w_1^* = [\delta\tau/2] - 1$; and*
2. *when $\delta > \delta^*$, the optimal contract involves only short-term pay, with $w_2^*/w_1^* = 0$.*

The tradeoff that leads to this proposition is as follows. Unrestricted (short-term) stock grants (w_1^*) enable the CEO to exploit stock mispricing, which thereby lowers the total compensation cost. However, short-term pay causes the CEO to shirk on the real project (see Lemma 2), which lowers the firm's long-term value. Restricted (long-term) pay (w_2^*) discourages the CEO's effort on the castle project and incents her to work on the real project (see Lemma 2), which increases the long-term value. 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. The other (more subtle) cost of long-term pay is that it lowers the option value of short-term pay, precisely because it discourages CEO effort on the castle project (which decreases the stock price volatility and hence the option value).

When the magnitude of possible stock mispricing is high ($\delta > \delta^*$), the marginal benefit of effort directed at the castle project in terms of a higher stock price increases and this in turn makes unrestricted stock (w_1^*), more attractive from the board's perspective. For higher values of δ, the marginal benefit of restricted stock, w_2 is also low. This is because, as shown in Lemma 2, a higher w_2 translates into higher managerial effort, e only when ($w_2^*/w_1^* \geq [\delta\tau/2] - 1$). Thus when δ is high, a marginal increase in w_2 may not translate into a higher effort on the real project. Hence the board finds it optimal to not provide any restricted stock ($w_2^* = 0$).

When the magnitude of potential stock mispricing is low ($\delta \leq \delta^*$), the marginal benefit of long-term pay relative to short-term pay (in terms of their effects on the option value of unrestricted shares) increases. As a result, the optimal contract involves both long-term and short-term pay, with the amount of long-term pay being just sufficient the deter the CEO from diverting effort to the castle project ($w_2^*/w_1^* = [\delta\tau/2] - 1$).

It is useful to highlight the necessity of long-term pay (w_2) in our model by examining whether the optimal contract can be implemented in the following alternative way: (i) at $t = 0$ the CEO is awarded w_0 in cash and w_1 unrestricted shares as before, and (ii) instead of granting her restricted shares at $t = 0$ (that must be held till $t = 2$), the board promises the CEO that she will be awarded additional shares at $t = 1$ (that can be sold at $t = 2$). Can this alternative contract with a series of short-term awards (in the absence of long-term pay) produce the same outcome as our initial contract? The answer is *no*, and the reasons is the board's commitment problem associated with the additional share issuance (at $t = 1$). To see this, note that after the CEO expends effort at $t = 0$, the board has no further incentive to grant the CEO additional shares at $t = 1$. Anticipating that, the CEO will not spend any effort on the real project at $t = 0$.

2.3 Extensions

This subsection considers two extensions of the preceding analysis. The first extension examines performance-based vesting, and the second examines accelerated vesting. Our objective is to show that the nature of the optimal contract is robust to allowing for both types of contract innovations.

2.3.1 Performance-based vesting

To examine whether the optimal contract is qualitatively affected by the inclusion of performance-based vesting, we now consider a contract specifying that the CEO will get the w_2 restricted shares at $t = 2$ only when the firm's liquidation value, X, exceeds some (exogenously specified) target value, x.

Proposition 2. *Denote the optimal incentive contract under a performance-based vesting schedule as* $(w_0^{**}, w_1^{**}, w_2^{**})$*. There exists a cutoff value of* δ*, call it* δ^{**}*, such that:*

1. *when* $\delta \leq \delta^{**}$*, the optimal contract involves both long-term and short-term pay, where* w_2^{**}/w_1^{**} *is increasing in* δ *and* τ*; and*

2. *when* $\delta > \delta^{**}$*, the optimal contract involves only short-term pay, with* $w_2^{**}/w_1^{**} = 0$*.*

Thus, the optimal contract is qualitatively unaffected when performance-based vesting provision is included as part of the feasible contracting space.

2.3.2 Accelerated vesting

Consider the following modification to the initial compensation contract: the w_1 shares granted to the CEO vest at $t = 1$ only when the stock price P_1 exceeds some (exogenously specified) target value, p; if P_1 falls below p, then the w_1 shares vest at $t = 2$. We use this setting to examine whether introducing an accelerated-vesting schedule affects the nature of the optimal contract.

Proposition 3. *Denote the optimal incentive contract under an accelerated-vesting schedule as* $(w_0^{***}, w_1^{***}, w_2^{***})$*. There exists a cutoff value of* δ*, call it* δ^{***}*, such that:*

1. *when* $\delta \leq \delta^{***}$*, the optimal contract involves both long-term and short-term pay, where* w_2^{***}/w_1^{***} *is increasing in* δ *and* τ*; and*

2. *when* $\delta > \delta^{***}$*, the optimal contract involves only short-term pay, with* $w_2^{***}/w_1^{***} = 0$*.*

That is, the basic features of the optimal contract remain the same as before: the contract involves both long-term and short-term pay when the potential magnitude of stock market mispricing is low, and only short-term pay is used when the extent of mispricing is sufficiently high.

2.4 Empirical predictions

We now gather the empirical predictions of our model. We know from Proposition 1 that the amount of long-term pay relative to short-term pay, w_2/w_1, is on average higher for lower δ. To the extent that this ratio captures the pay duration, our model predicts that pay duration is decreasing in δ, the extent of stock mispricing. Propositions 2 and 3 confirm that this also applies to performance-based vesting and accelerated vesting schedules. This leads to 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 mispricing. The first of these measures relies on stock liquidity. In the spirit of Chordia, Roll, and Subrahmanyam (2008), we posit that a less liquid stock is likely to be less informative about the firm's future performance and hence is likely to exhibit larger mispricing. Thus, measuring liquidity can help us (indirectly) measure mispricing. We use two measures of liquidity for this purpose: the bid-ask spread calculated from daily closing stock prices, *Spread*, and the average daily stock turnover, *Turnover*. Our second measure of stock mispricing relies on the manner in which short-sales constraints can lead to mispricing (Miller (1977)). Diether, Malloy, and Scherbina (2002) use Miller's framework to argue that greater dispersion in analysts' earnings forecasts indicates greater disagreement among investors about future firm performance (as formalized in Dittmar and Thakor (2007)), which can lead to greater overvaluation in the presence of short-sale constraints. Following this rationale, we use the extent of dispersion among analysts' earnings forecasts, *Analyst dispersion*, as another measure of stock mispricing.

From Proposition 1, we also know that w_2/w_1 is increasing in τ. We interpret τ as the quality of governance of the firm, with a higher value of τ indicating firms with poorer corporate governance. The idea is as follows. CEOs of firms with poorer corporate governance will find it easier to divert effort to the castle project to boost the firm's short-term performance at the expense of its long-term value. The variable τ captures this idea, with a larger τ indicating that the CEO is more easily able to manipulate the short-term stock price while sacrificing the long-term value. Thus, our second prediction is:

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

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

An important cost of short-term compensation in our model is that it induces the CEO to divert effort away from the real project towards the castle project. From Lemma 2, we know that CEO effort expended on the castle project, u, is increasing in the contract's weight on the interim stock price, w_1. This leads to:

Prediction 3. *CEOs of firms with shorter pay duration are more likely to engage in myopic investment behavior.*

We follow the prior literature and use the absolute value of discretionary accruals, *Accruals*, as our measure of myopic behavior. Prior accounting research shows that the stock market valuation depends on a firm's current period earnings, and managers may thus attempt to boost stock price by inflating current period profits through the booking of 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.

3 Empirical Analysis

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

3.1 Data and descriptive statistics

To test our model predictions, we need data on both the size of the different components of executive pay and the vesting schedule of the non-cash components. We obtain data on salary and bonus from ExecuComp and data on the size and vesting schedules of both restricted stock and stock options from Equilar Consultants (hereafter, Equilar). Similar to S&P (provider of 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.

In practice, the specific terms of option and stock grants are quite complex. Both the number of securities offered and the vesting schedule can depend on future firm performance. For the purpose of our analysis, we classify the grants into three categories. See Table 1 for the distribution of our sample grants across the three categories. The simplest category includes grants where the number of securities offered is fixed as of the grant date and the grant has time-based vesting. Of the total 21,466 (16,112) stock (option) grants in our sample, 12,447 (15,529) or 58% (96.38%) belong to this category. For each grant in this category, we have information on the size of the grant, the length of the vesting period (i.e., the time by when 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 on a specific date (cliff vesting).

The next class of grants are those for which the number of securities is fixed as of the grant date but the vesting is contingent on future firm performance. Of the grants in our sample, 5.34% of the stock grants and 1.97% of the option grants belong to this category. For such grants, Equilar records the size of the grant, the period over which performance is measured and the performance metrics used. For the purpose of our analysis, we assume that these grants will vest all at once at the end of the performance period. Note that in calculating our duration measure we assume that stock and option grants with a performance-linked accelerated vesting schedule only vest according to the initially specified vesting schedule. We rely on this approximation because the acceleration provisions in these grants are usually very complex and depend on multiple performance measures. Thus, it is not at all straightforward to determine if and when these grants will vest on an accelerated basis.

The next class of grants are part of long term incentive plans wherein the number of securities awarded is contingent on future performance. Most of these grants are also associated with a time-based vesting schedule – sometimes for tax purposes (see Gerakos, Ittner, and Larcker (2007)). For such grants, Equilar records the target number of securities expected to be granted, the period over which performance is measured and any time-based vesting schedule associated with the grant. Of the total stock (option) grants in our sample, 36.63% (1.61%) belong to this category. We include all these grants in our sample with the number of securities equal to the target number of securities. To calculate the vesting schedules of these grants we assume that the vesting starts after the performance measurement period.

Of the grants in our sample, we are not able to identify either the performance period or the vesting period for 17 grants. We categorize them as other grants and exclude them from our analysis. While we do not specifically differentiate between time-based and performance-based vesting grants in our analysis, see Bettis et al (2010), for a detailed discussion of grants with performance based vesting.

[Table 1 goes here]

The Equilar dataset also provides the grant date and the present value of the grant. The present value of stock grants is 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 hand-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 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.

3.2 Measure of pay duration

In this subsection, we introduce our empirical measure of executive pay duration involving both restricted stock and options.[8] 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:

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

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

[8] 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.

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 $[t_i + 1]/2$ ($[t_j + 1]/2$).[9]

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. These other measures include the proportion of stock and option grants ("non-cash pay") in total pay, the delta and vega of executive's stock and option holdings, and the extent of correlation of executive pay to stock returns and accounting earnings). 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 apparent, 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.

Our measure of pay duration does have some disadvantages. In constructing the measure, we do not include the stock and options held by the executive from grants in prior years. We also do not include severance and post-retirement benefits that may be important for providing long-term incentives. The main reason for excluding these from our duration measure is the difficulty in obtaining their vesting schedules. We have vesting schedules for only three years from Equilar. Despite these issues, we find that pay duration is significantly associated with measures of myopic behavior such as the level of discretionary accruals. This association survives controls for the total shareholding of the executive, the delta and vega of the executive's option and stock portfolio and the extent of deferred compensation. The other important limitation of our measure is that we ignore the optionality introduced by linking both the size of the grant and vesting schedule to future firm performance.

[9] 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 $\textit{Restricted stock}_{i'} \times t_{i'}$ in (4) should be replaced by $\textit{Restricted stock}_{i'} \times \left(\frac{1}{t_{i'}} + \frac{2}{t_{i'}} + \ldots + \frac{t_{i'}}{t_{i'}}\right) = \frac{\textit{Restricted stock}_{i'}}{t_{i'}} \times \frac{t_{i'}(t_{i'}+1)}{2} = \textit{Restricted stock}_{i'} \times \left(\frac{t_{i'}+1}{2}\right)$. $\textit{Option}_j \times t_j$ can be modified in the same way.

In employing our definition of duration to capture the extent of short-term and long-term pay, we implicitly assume that the executive will exercise all the stock and option grants as soon as they vest. To the extent that the executive does not exercise the grants on vesting, duration is likely to be a noisy proxy for the extent of long-term incentives provided to the executive. This noise is only likely to bias against finding significant results.

3.3 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 duration of executive pay. We do that by estimating variants of the following OLS model:

$$Duration_{ket} = \alpha + \beta_1 \mathrm{X}_{kt} + \beta_2 \mathrm{X}_{et} + \mu_{it}[\mathrm{T} \times \mathrm{I}] + \epsilon_{ket}, \tag{5}$$

where the subscript k indicates the firm, e the executive, t time in years and i the firm's three digit SIC industry. The term T refers to a set of year dummies, I to a set of three digit SIC industry 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*), leverage as measured by *Debt/Total assets*, and growth opportunities as captured by *Market-to-book*. We use *R&D/Total assets* 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*. Given the importance of firm size for pay duration, in much of our analysis, we control for firm size in a non-parametric manner by including one hundred dummy variables that denote each size percentile. Since there is likely to be significant similarity in the pay contracts for executives of firms in the same industry, in all our tests we include within industry time fixed effects. Thus our identification comes only from cross-sectional within industry-year differences in pay duration.

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 use the extent of shareholding of the non-executive directors on the board, *High director shareholding* and the executive's shareholdings in the firm (*Shareholding*). We complement these measures with the Bebchuk, Cohen, and Ferrell (2009) entrenchment index (*Entrenchment index*) and the fraction of independent directors on the firm's board (*Fraction independent*). 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 three digit SIC code industry 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:

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

where the dependent variable y_{kt} is a measure of managerial myopia. We follow the prior literature and use the absolute value of discretionary accruals, *Accruals* 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 to the pay duration of the firm's CEO. We include industry and time fixed effects and only rely on within-industry differences in the level of accruals for our identification. Although we control for all observable firm characteristics that are likely to affect *Accruals* in our model, our estimates from (6) may be biased due to omitted variables that may affect both pay duration and the independent variable. 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.

3.4 Summary statistics

In Panel A of Table 2, 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 somewhat 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 option, 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 2 goes here]

In Table 3, 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. In fact it may reflect recognition by the boards of directors of these firms that it is relatively easy for these CEOs to alter the portfolios of their firms to elevate short-term stock price, so compensation incentives must be provided to counteract this propensity.

[Table 3 goes here]

In Panels A and B of Table 4, 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 \$1.988 million, which consists of \$0.454 million of salary, \$0.278 million of bonus, \$0.652 million of stock options, and \$0.604 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 0.91 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 \$2.33 billion. On average, *Debt/Total assets* for the firms in our sample is 0.21. The average firm in our sample has an annual sales growth of 13%, and a market-to-book ratio of 1.88. Our sample firms invest about 2.2% of the book value of total assets in R&D every year, but as in other studies, more than 50% of the firm-years in our sample have *R&D/Total assets* equal to zero as seen from the median value of *R&D/Total assets*. The average *Capital expenditure* of firms in our sample is

0.055. Our sample firms are profitable as can be seen from the mean (median) value of *EBIT/Sales* of 0.15 (0.122). *Volatility*, the standard deviation of daily stock returns during the previous year, is on average 0.026 for our sample firms. Highlighting the sample tilt towards the larger firms, we find the average bid-ask spread for the firms in our sample, *Spread*, to be 0.146% and the average stock turnover to be 11.159. *Analyst dispersion*, the standard deviation of analysts' annual earnings forecasts obtained from the IBES database, is .059 for the average firm in our sample.

Our next set of variables measure the corporate governance characteristics of the firm. The average shareholding of non-executive directors in our sample is 2.4%, while in the median firm less than 1% of its shares are held by non-executive directors. Note that ExecuComp records director shareholding less than 1% as zero. 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, of which about 74.6% are independent as indicated by the average value of *Fraction independent*. The average level of *Accruals* in our sample is 0.043. The average executive in our sample holds about 0.52% of the firm's shares and 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 ($4.26 million in comparison to $1.988 million). This higher compensation is found across all four pay components (salary, bonus, option grants, and restricted stock grants). The pay duration is also longer for the CEO than for the average executive (1.06 years as compared to 0.91 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 (1.957% in comparison to 0.524%). 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 4 goes here]

In Panel A of Table 5, 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 about $219,000 less bonus on average. The difference in pay durations across the subsamples is about 1.71 years. Larger firms award pay contracts with longer duration, and such firms have higher leverage as measured by debt over total assets (0.224 in comparison to 0.195). 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 (13.8% in comparison to 12.1%) and a higher market-to-book ratio (1.95 in comparison to 1.82). 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 lower bid-ask spreads, higher stock turnover and higher levels of analyst dispersion. These are consistent with *Prediction 1*. Focusing on the corporate governance characteristics, we find that firms that offer contracts with longer duration have non-executive directors with lower shareholdings and a higher entrenchment index. If higher shareholdings of non-executive directors and a lower entrenchment index indicate firms with better governance, then these results are consistent with *Prediction 2*. We also find that firms that offer a longer duration pay contract are associated with larger boards and a higher proportion of independent directors. Firms that offer longer duration pay contracts have lower discretionary accruals, consistent with *Prediction 3*. 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, on average, lower shareholdings and are younger.

[Table 5 goes here]

3.5 Empirical results

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

3.5.1 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 6 where the independent variable is *Duration*. To understand the extent to which pay duration is similar for firms within the same industry, we begin our empirical analysis in Column (1) by estimating equation (5) with only the within-industry time fixed effects. In this specification we obtain an R^2 of 31.3%. Thus, within-industry clustering is able to explain about one-third of the variation in pay duration in our sample. In Column (2) we include a number of firm characteristics along with the fixed effects and find that the R^2 increases to 36.4%. Thus firm characteristics are also important determinants of pay duration across firms.[10] The positive and significant 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. While leverage and the market to book ratio are not significantly related to pay duration, we do find longer pay duration for firms that have a higher R&D expenditure 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, this 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 being more expensive for riskier firms. The negative association between volatility and pay duration may also reflect the greater risk taken by executives with short-duration pay. To partly control for this latter effect, we use lagged volatility in our analysis. We also find that firms with higher stock return in the recent past offer longer-duration pay contracts. Our coefficient estimates are also economically significant. The coefficient on *Log(Total assets)* in Column (2) indicates that pay duration for an executive in a firm with *Log(Total assets)* equal to 8.96 (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 6.68 (25^{th} percentile in our sample). We also find that on average CEOs have pay contracts with about 0.2 years longer duration than other executives.

In Column (3), 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

[10] Note that within industry clustering in pay duration may also result from forces we model. Since we are unable to isolate the different effects that drive the within industry clustering in duration, in testing our model predictions, we control for within industry clustering. To this extent our estimates represent lower bounds on the true effect.

stock mispricing. Consistent with *Prediction 1*, we find that pay duration is longer for firms with lower bid-ask spreads. Since larger firms have more liquid stock prices, one concern with our analysis is that the coefficient on *Spread* simply captures the fact that larger firms offer pay contracts with longer durations. Although we control for *Log(Total Assets)* in our regression, to ensure that our results are robust to alternate ways of controlling for firm size, in Column (4) we control for firm size in a non-parametric manner. In this specification we replace *Log(Total assets)* with one hundred dummy variables that denote firms in each size percentile. We find that our results are robust to this control for firm size. In fact, our estimates on *Spread* are higher in Column (4) as compared to in Column (3). In Column (5), we use the average daily turnover of the stock as a measure of stock liquidity and find that consistent with the results in Column (3): firms with more liquid stock – those with higher turnover – offer their executives longer-duration pay contracts. In Column (6), 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 (5) indicates that pay duration for a firm with *Turnover* equal to 20.98 (90^{th} percentile in our sample) is 0.19 years longer than the pay duration for a firm with *Turnover* equal to 4.16 (10^{th} percentile in our sample).

In unreported tests, we find our results to be robust 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 6, we find pay duration to be longer for larger firms and 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.

Given the significant clustering in pay duration across firms in the same industry, in unreported tests, we collapse the dataset to one observation per industry-year and replace the variables by their industry median values. We then repeat our tests in this smaller data set and find that pay duration is longer in industries with more long-lived assets (i.e., industries with larger firms, lower proportion of current assets to total assets, and more tangible assets) and in industries where the individual firm's stock is more mispriced (i.e., industries with higher median spread, analyst dispersion and lower stock turnover).

3.5.2 Pay duration and governance characteristics: test of Prediction 2

In Panel B of Table 6, we test *Prediction 2* by examining how the firm's governance characteristics affect executive pay duration. In all the regressions, unless specified, we control for firm size in a non-parametric manner using dummy variables. In Column (1), we test how the shareholdings of the non-executive directors of the firm is related to pay duration. We do this by including a dummy variable, *High director shareholding*, which identifies firms with more than 1% shareholdings by non-executive directors. Our results indicate that pay duration is longer in firms with lower shareholdings 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*.

In Column (2), we repeat our tests after confining the sample to CEOs and find that consistent with *Prediction 2*, CEOs of firms with high director shareholdings have long-duration pay contracts. In Column (3), we estimate the effect of the executive's share ownership on pay duration. We find that the extent of executive shareholdings, *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 indicates 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 Column (4), we repeat our tests confining the sample to CEOs and again find pay duration to be longer for CEOs with greater shareholdings. In Column (5), we employ the Bebchuk, Cohen, and Ferrell (2009) entrenchment index as a measure of firm governance and find that while the coefficient is positive, indicating longer pay duration for firms with higher entrenchment index, it is not statistically significant. In Column (6), we repeat our estimates after confining the sample to CEOs and find that consistent with *Prediction 2*, pay duration is longer for CEOs of firms with a higher *E-Index*. In Column (7), we test whether pay duration is related to the fraction of independent directors on the board, and find that pay duration is actually longer for firms with a larger fraction of independent directors. If having a larger proportion of independent directors improves firm governance, then this result is inconsistent with *Prediction 2*. In unreported tests, we find that the number of directors on the firm's board is not significantly related to pay duration.

Also 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 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 spend less effort on the "castle" project 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 for 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 more 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 competing 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 6 goes here]

3.5.3 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* as a proxy 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. 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 Table 7, 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 we include industry and time fixed effects. Here again we control for firm size in a non-parametric manner using dummy variables for size percentiles. 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 firms with higher market-to-book ratios and those managed by younger CEOs 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. Inclusion of *Fraction non-cash pay* actually increases the coefficient on *Duration* four-fold. This shows that the negative coefficient on *Duration* is not just an artifact of the fraction of stock and stock options but is a result of our duration measure capturing the vesting schedules of the components of non-cash pay. Bergstresser and Philippon (2006) show that the sensitivity of CEO pay to stock price movements affects the incentives for executives to manage earnings. As a first step in controlling for the nature of the executive's portfolio, in Column (3) we repeat our estimates after controlling for the fraction of the executives' shareholdings and find our results to be robust. Apart from a long vesting schedule, executives can also be given long-term incentives through deferred compensation. Furthermore some executives do not exercise the option grants as soon as they are exercisable. Such unexercised options can also lengthen the executive's horizon. To see if *Duration* is robust to controlling for the extent of long-term incentives provided by such components of compensation, in Column (4) we include a dummy variable *High deferred pay* to indicate executives with above median value of deferred compensation and unexercised stock options as a fraction of total compensation. We again find our results are robust. In Column (5), we explicitly control for the delta of the executive's portfolio. We do this by repeating our estimation after including the logarithm of the delta of the CEO's stock and option portfolio, *Log(Delta)*. We measure *Log(Delta)* following the procedure in Coles, Daniel, and Naveen (2009). 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 (6) and (7), we split *Accruals* into positive and negative accruals and repeat our estimation. Specifically, our dependent variable in Column (6) is $\textit{Accruals} \times \textit{Positive accruals}$ (where *Positive accruals* is a dummy variable that identifies firms with positive accruals), while the dependent variable in Column (7) is $\textit{Accruals} \times [1 - \textit{Positive accruals}]$. 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. Our results are also economically significant. The results in Column (6) indicates that a one year increase in pay duration is associated with a 10% decrease in positive accruals.

Summarizing, our results in this table show that firms that offer their CEOs pay contracts with longer duration are associated with lower levels of absolute and positive accruals, a finding that is consistent with *Prediction 3*.

As mentioned before, our measure of pay duration does not capture the incentives provided by prior-year stock and option grants and by deferred compensation. While our results in Panel A show that the effect of *Duration* on the level of *Accruals* is robust to controlling for the level of the executive's shareholdings, the delta of the executives' stock and option portfolio and the extent of deferred compensation, one interesting question is to know if *Duration* has a greater effect on the level of accruals when the annual compensation is more important for executive incentives. To test this, in unreported tests, we separately estimate the effect of *Duration* on *Accruals* for firms with high- and low- executive shareholdings. Our results indicate that the effect of duration on accruals is confined to firms in which the CEO does not have high shareholdings. We also repeat our tests and separately estimate the effect of *Duration* on *Accruals* for firms with high- and low-levels of deferred pay. Our results indicate that duration only affects accruals for firms with high deferred compensation. These results provide mixed evidence that duration is more important when annual compensation provides a greater share of executive incentives. These results are available upon request. In unreported tests, we also repeat our estimates after including a dummy variable *Performance sensitive* to identify executives that get performance based grants (see Bettis et al (2010)). We obtain results similar to the ones reported.

[Table 7 goes here]

4 Switching Regression Model

We now perform tests that explicitly control for the endogeneity of pay duration. In Panels A and B of Table 8, we relate *Accruals* to CEO pay duration after controlling for endogeneity. 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.[11] We augment the two OLS models with the Inverse Mills ratio and the Mills ratio, respectively, estimated from the first-stage regression.[12]

[11] 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.

[12] 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

In Column (1) of Panel A, we present the results of the first-stage probit model. To identify an exogenous instrument for pay duration, we follow Hochberg and Lindsey (2010) and use the median pay duration of all CEOs in the same state as the firm as an exogenous instrument. To ensure that we adequately control for firm fundamentals, we include within industry time fixed effects in our regressions. The identifying assumption in our analysis is that after controlling for firm characteristics and within-industry time fixed effects, the median duration of all firms in the same state should not affect the level of accruals. Apart from the exogenous instrument, we also include all observable firm and executive characteristics that may affect duration and also the level of accruals. 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 market to book ratio, sales volatility, and bid-ask spread, lower stock return and older CEOs. We also find that the median pay duration of CEOs in the same state is significantly negatively related to *Low duration*.

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 level of accruals for firms with below-median pay duration is significantly higher than the counterfactual level of accruals.

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*. Consistent with our theoretical model, we find that lower pay duration for CEOs leads to higher accruals.

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.

[Table 8 goes here]

5 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 decisions 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 *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 research.

Appendix A: Proofs

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

Proof of Lemma 2. Given any contract, (w_0, w_1, w_2), the CEO's expected utility at $t = 0$ is:

$$\begin{aligned} V_E(W) = &\frac{1}{2}\left[w_0 + w_1[e + \delta(1 + \tau u)] + w_2 e - \frac{\lambda w_2^2\sigma^2}{2}\right] + \frac{1}{2}\left[w_0 + (w_1 + w_2)e - \frac{\lambda(w_1 + w_2)^2\sigma^2}{2}\right] \\ &- \frac{(e + u)^2}{2}. \end{aligned} \tag{A1}$$

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 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 $V_E(W)$. Note:

$$\frac{\partial V_E(W)}{\partial e} = w_1 + w_2 - (e + u), \tag{A2}$$

$$\frac{\partial V_E(W)}{\partial u} = \frac{w_1\delta\tau}{2} - (e + u). \tag{A3}$$

It is clear that: (i) when $w_2/w_1 \geq [\delta\tau/2] - 1$, we have $\partial V_E(W)/\partial e \geq \partial V_E(W)/\partial u$, in which case the CEO chooses $u = 0$ and e is determined by solving $\partial V_E(W)/\partial e = 0$, which yields $e = w_1 + w_2$,[13] and (ii) when $w_2/w_1 < [\delta\tau/2] - 1$, we have $\partial V_E(W)/\partial e < \partial V_E(W)/\partial u$, in which case the CEO chooses $e = 0$ and u is determined by solving $\partial V_E(W)/\partial u = 0$, which yields $u = w_1\delta\tau/2$. □

Proof of Proposition 1. We have two cases to analyze:

Case 1: Suppose $w_2/w_1 \geq [\delta\tau/2] - 1$, so the CEO chooses $e = w_1 + w_2$ and $u = 0$ (see Lemma 2). The CEO's participation constraint (3), which must be binding in equilibrium, can be rewritten as:

$$\begin{aligned} V_E(W) &= w_0 + \frac{1}{2}\left[w_1(e + \delta) + w_2 e - \frac{\lambda w_2^2\sigma^2}{2}\right] + \frac{1}{2}\left[(w_1 + w_2)e - \frac{\lambda(w_1 + w_2)^2\sigma^2}{2}\right] - \frac{e^2}{2} \\ &= w_0 + \frac{(w_1 + w_2)^2}{2} + \frac{w_1\delta}{2} - \frac{\lambda w_2^2\sigma^2}{4} - \frac{\lambda(w_1 + w_2)^2\sigma^2}{4} \\ &= \bar{V}_E. \end{aligned} \tag{A4}$$

[13] We assume that in the case of indifference, i.e., $w_2/w_1 = [\delta\tau/2] - 1$ and hence $\partial V_E(W)/\partial e = \partial V_E(W)/\partial u$, the CEO chooses $e = w_1 + w_2$ and $u = 0$.

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

$$\max_{\{w_1,w_2\}} (w_1+w_2) - \frac{(w_1+w_2)^2}{2} + \frac{w_1\delta}{2} - \frac{\lambda w_2^2\sigma^2}{4} - \frac{\lambda(w_1+w_2)^2\sigma^2}{4} - \bar{V}_E. \tag{A5}$$

It is clear from (A5) that for any fixed w_1+w_2, we should let w_2 to be as small as possible. Thus, we must have $w_2/w_1 = [\delta\tau/2] - 1 \equiv y$ under an optimal contract. Substituting this into (A5), we can further rewrite the board's problem as:

$$\max_{\{w_1\}} \ (1+y)w_1 + \frac{w_1\delta}{2} - \frac{(1+y)^2 w_1^2}{2} - \frac{\lambda y^2 w_1^2\sigma^2}{4} - \frac{\lambda(1+y)^2 w_1^2\sigma^2}{4} - \bar{V}_E, \tag{A6}$$

which yields $w_1^* = \frac{2\delta(1+\tau)}{\delta^2\tau^2+\lambda\sigma^2(\delta^2\tau^2-2\delta\tau+2)}$, and hence $w_2^* = \frac{\delta(1+\tau)(\delta\tau-2)}{\delta^2\tau^2+\lambda\sigma^2(\delta^2\tau^2-2\delta\tau+2)}$. Substituting these into (A6) yields the expected payoff to the existing shareholders, denoted as $V_B(W)_1$, as:

$$V_B(W)_1 = \frac{\delta^2(1+\tau)^2}{2[\delta^2\tau^2+\lambda\sigma^2(\delta^2\tau^2-2\delta\tau+2)]} - \bar{V}_E. \tag{A7}$$

Case 2: Suppose $w_2/w_1 < [\delta\tau/2] - 1$, so the CEO chooses $e = 0$ and $u = w_1\delta\tau/2$ (see Lemma 2). In this case, P_1 is never smaller than $\mathbf{E}(X) = 0$, so the CEO always sells the w_1 shares at $t = 1$. The CEO's participation constraint (3), which must be binding in equilibrium, can be rewritten as:

$$\begin{aligned} V_E(W) &= w_0 + \frac{1}{2}\left[w_1\delta(1+\tau u) - \frac{\lambda w_2^2\sigma^2}{2}\right] + \frac{1}{2}\left[-\frac{\lambda w_2^2\sigma^2}{2}\right] - \frac{u^2}{2} \\ &= w_0 + \frac{w_1\delta}{2} + \frac{w_1^2\delta^2\tau^2}{8} - \frac{\lambda w_2^2\sigma^2}{2} \\ &= \bar{V}_E. \end{aligned} \tag{A8}$$

Substituting (A8) into the board's objective function (1), we can rewrite the board's problem as:

$$\max_{\{w_1,w_2\}} \frac{w_1\delta}{2} + \frac{w_1^2\delta^2\tau^2}{8} - \frac{\lambda w_2^2\sigma^2}{2} - \bar{V}_E. \tag{A9}$$

It is clear from (A9) that $w_1^* = 1$ and $w_2^* = 0$. The expected payoff to the existing shareholders, denoted as $V_B(W)_2$, is:

$$V_B(W)_2 = \frac{\delta^2\tau^2 + 4\delta}{8} - \bar{V}_E. \tag{A10}$$

We now compare the two cases, assuming $\delta\tau > 2$ (otherwise $[\delta\tau/2]-1 < 0$ and *Case 1* degenerates). Note: (i) both $V_B(W)_1$ and $V_B(W)_2$ are increasing in δ, (ii) when $\delta \uparrow \infty$, $V_B(W)_1 \uparrow \frac{(1+\tau)^2}{2\tau^2(1+\lambda\sigma^2)}$ and $V_B(W)_2 \uparrow \infty$, and (iii) when $\delta\tau$ is close to 2, $V_B(W)_1 > V_B(W)_2$ for sufficiently small $\lambda\sigma^2$. Thus, there exists a cutoff, δ^*, such that: (i) $V_B(W)_1 > V_B(W)_2$ when $\delta < \delta^*$, and the optimal contract is described in *Case 1*, and (ii) $V_B(W)_1 < V_B(W)_2$ when $\delta > \delta^*$, and the optimal contract is described in *Case 2*. □

Proof of Proposition 2. Viewed at $t = 0$, conditional on CEO effort e on the real project, the probability that the CEO will get the w_2 shares of the firm is $\Pr(X \geq x) = \Pr(\tilde{\varepsilon} \geq x - e) = N(e - x)$, where $N(\cdot)$ is the cumulative probability distribution function for a variable that is normally distributed with a mean of zero and a standard deviation of σ. The CEO's expected utility at $t = 0$ is:

$$V_E(W) = \frac{1}{2}\left[w_0 + N(e-x)\left[(w_1+w_2)e - \frac{\lambda(w_1+w_2)^2\sigma^2}{2}\right] + N(x-e)\left[w_1 e - \frac{\lambda w_1^2\sigma^2}{2}\right]\right] + \frac{1}{2}\left[w_0 + w_1[e+\delta(1+\tau u)] + N(e-x)\left[w_2 e - \frac{\lambda w_2^2\sigma^2}{2}\right]\right] - \frac{(e+u)^2}{2}. \quad \text{(A11)}$$

The term in the first set of squared brackets represents the CEO's payoff when the stock is undervalued and she holds the w_1 shares to $t = 2$. In this case: (i) with probability $N(e - x)$ the CEO gets the w_2 shares, so she claims $w_1 + w_2$ shares of the liquidation value; and (ii) with probability $1 - N(e - x) = N(x - e)$, X falls below x and the CEO only claims w_1 shares of the liquidation value. The term in the second set of squared brackets represents the CEO's payoff when the stock is overvalued and she sells the w_1 shares at $t = 1$. In this case, the CEO gets the w_2 shares with probability $N(e - x)$. The CEO chooses e and u to maximize $V_E(W)$. Note:

$$\frac{\partial V_E(W)}{\partial e} = w_1 + N(e-x)w_2 + N'(e-x)\left[w_2 e - \frac{w_2(w_1+w_2)\lambda\sigma^2}{2}\right] - (e+u), \quad \text{(A12)}$$

$$\frac{\partial V_E(W)}{\partial u} = \frac{w_1\delta\tau}{2} - (e+u). \quad \text{(A13)}$$

The CEO's effort choices depend on the comparison between $\partial V_E(W)/\partial e$ and $\partial V_E(W)/\partial u$. Similar as the Proof of Lemma 2, we can easily show that there exists a cutoff value for w_2/w_1 such that: (i) the CEO chooses $e = 0$ if w_2/w_1 is below that cutoff, and u is determined by setting $\partial V_E(W)/\partial u = 0$, which yields $u = w_1\delta\tau/2$, and (ii) the CEO chooses $u = 0$ if w_2/w_1 is above that cutoff, and e is determined by setting $\partial V_E(W)/\partial e = 0$. Note that $\partial V_E(W)/\partial u$ is increasing in δ and τ, whereas $\partial V_E(W)/\partial e$ is not a function of δ or τ. Thus, that cutoff value for w_2/w_1 is also increasing in δ and τ. The rest follows from the similar idea in the Proof of Proposition 1. □

Proof of Proposition 3. The CEO's expected utility at $t = 0$ is:

$$V_E(W) = \frac{1}{2} \times 1_{\{e+\delta(1+\tau u)\geq p\}}\left[w_0 + w_1[e+\delta(1+\tau u)] + w_2 e - \frac{\lambda w_2^2\sigma^2}{2}\right] + \frac{1}{2} \times 1_{\{e+\delta(1+\tau u)<p\}}\left[w_0 + (w_1+w_2)e - \frac{\lambda(w_1+w_2)^2\sigma^2}{2}\right] + \frac{1}{2}\left[w_0 + (w_1+w_2)e - \frac{\lambda(w_1+w_2)^2\sigma^2}{2}\right] - \frac{(e+u)^2}{2}, \quad \text{(A14)}$$

where $1_{\{\omega\}}$ is an indicator function that takes the value one if the event ω is true and zero otherwise. The term in the first set of squared brackets represents the CEO's payoff when the stock is overvalued *and* the stock price is above the target value. In this case, the w_1 shares vest immediately at $t = 1$ and the CEO sells them right away. The term in the second set of squared brackets represents the CEO's payoff when the stock is overvalued but the stock price is below the target value. In this case, the w_1 shares vest at $t = 2$ when the CEO claims $w_1 + w_2$ shares of the liquidation value. The term in the third set of squared brackets represents the CEO's payoff when the stock is undervalued and she holds the w_1 shares to $t = 2$, regardless of the vesting schedule of the w_1 shares. The CEO chooses e and u to maximize $V_E(W)$. Note:

$$\begin{aligned}\frac{\partial V_E(W)}{\partial e} &= w_1 + w_2 - (e+u) \\ &\quad + \left[\frac{\Delta(e+\delta(1+\tau u)-p)}{2}\right]\left[w_1\delta(1+\tau u) - \frac{\lambda w_2^2\sigma^2}{2} + \frac{\lambda(w_1+w_2)^2\sigma^2}{2}\right], \qquad \text{(A15)}\\ \frac{\partial V_E(W)}{\partial u} &= \frac{w_1\delta\tau}{2} \times 1_{\{e+\delta(1+\tau u)\geq p\}} - (e+u) \\ &\quad + \delta\tau\left[\frac{\Delta(e+\delta(1+\tau u)-p)}{2}\right]\left[w_1\delta(1+\tau u) - \frac{\lambda w_2^2\sigma^2}{2} + \frac{\lambda(w_1+w_2)^2\sigma^2}{2}\right], \qquad \text{(A16)}\end{aligned}$$

where $\Delta(\cdot)$ is a delta function, which is the derivative of a step function, i.e., $\Delta(z) \equiv d1_{\{z\geq 0\}}/dz$. It is clear from (A15) and (A16) that $\partial V_E(W)/\partial e - \partial V_E(W)/\partial u$ is increasing in w_2/w_1 and decreasing in δ and τ. Thus, for sufficiently high w_2/w_1, the CEO will choose $u = 0$ and e is determined by solving $\partial V_E(W)/\partial e = 0$ in (A15); and for sufficiently low w_2/w_1, the CEO will choose $e = 0$ and u is determined by solving $\partial V_E(W)/\partial u = 0$ in (A16). The rest follows from the similar idea in the Proof of Proposition 1. □

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.
- *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.

- *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 stock and option grants

Year	2006	2007	2008	Total
Stock grants				
Total number	6,682	7,850	6,934	21,466
Grants with time vesting	3,879	4,461	4,107	12,447
	(58.05%)	(56.83%)	(59.23%)	(57.98%)
Grants with performance vesting	276	453	417	1,146
	(4.13%)	(5.77%)	(6.01%)	(5.34%)
Performance contingent grants with time vesting	2,522	2,931	2,409	7,862
	(37.74%)	(37.34%)	(34.74%)	(36.63%)
Other grants	6	5	1	12
Option grants				
Total number	5,400	5,855	4,857	16,112
Grants with time vesting	5,211	5,656	4,662	15,529
	(96.50%)	(96.60%)	(95.99%)	(96.38%)
Grants with performance vesting	88	98	132	318
	(1.63%)	(1.67%)	(2.72%)	(1.97%)
Performance contingent grants with time vesting	101	96	63	260
	(1.87%)	(1.64%)	(1.30%)	(1.61%)
Other grants	0	5	0	5

This table provides the distribution of the option and stock grants in our sample. The fraction of a particular category is provided within brackets.

Table 2: Distribution of vesting schedules

Panel A: All executives

	Restricted stock			Options		
Vesting period (years)	Frequency	Percent	Fraction graded	Frequency	Percent	Fraction graded
0	6,266	29.19	0.00	631	3.92	0.00
1	567	2.64	0.17	932	5.78	0.05
2	1,488	6.93	0.56	424	2.63	0.76
3	6,481	30.19	0.54	5,856	36.35	0.87
4	3,875	18.05	0.81	5,990	37.18	0.98
5	2,429	11.32	0.77	2,073	12.87	0.95
6	92	0.43	0.72	68	0.42	0.81
7	93	0.43	0.66	54	0.34	0.87
8	39	0.18	0.69	40	0.25	0.28
9	17	0.08	0.88	10	0.06	0.90
10	117	0.55	0.68	34	0.21	0.85
13	1	0.00	1.00			
14	1	0.00	1.00			
Total	21466			16112		

Panel B: CEOs

	Restricted stock			Options		
Vesting period (years)	Frequency	Percent	Fraction graded	Frequency	Percent	Fraction graded
0	1,169	30.58	0	142	4.93	0
1	129	3.37	0.18	171	5.94	0.04
2	279	7.30	0.57	75	2.60	0.73
3	1,105	28.90	0.57	1,062	36.86	0.87
4	654	17.11	0.78	1,028	35.68	0.97
5	427	11.17	0.74	360	12.50	0.94
6	16	0.42	0.63	13	0.45	0.69
7	19	0.50	0.58	8	0.28	0.88
8	4	0.10	0.75	14	0.49	0.07
9	1	0.03	1.00	2	0.07	1.00
10	19	0.50	0.58	6	0.21	0.83
13	1	0.03	1.00			
Total	3,823			2,881		

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 3: Industry distribution of pay duration

Industry	CEOs		All executives	
	N	Duration	N	Duration
Beer & Liquor	19	2.019	109	1.547
Finance - Trading	9	1.829	60	1.450
Defense	15	1.685	85	1.216
Personal Services	91	1.380	542	1.232
Utilities	213	1.378	1215	1.176
Petroleum and Natural Gas	18	1.357	102	1.272
Rubber and Plastic Products	32	1.319	181	1.037
Pharmaceutical Products	169	1.238	983	1.090
Candy & Soda	8	1.224	50	1.021
Transportation	23	1.211	126	1.012
Textiles	14	1.209	87	0.978
Communication	303	1.208	1800	0.937
Shipping Containers	74	1.177	424	0.981
Construction Materials	88	1.176	515	0.939
Ship building and Railroad Equipment	39	1.172	211	1.088
Other	311	1.171	1640	1.002
Coal	24	1.148	136	0.955
Healthcare	111	1.146	595	1.038
Machinery	181	1.142	1050	0.925
Banking	109	1.117	632	0.886
Wholesale	138	1.099	768	1.000
Consumer Goods	40	1.077	237	0.868
Chemicals	113	1.063	633	0.917
Real Estate	235	1.060	1362	0.916
Measuring and Control Equipment	309	1.048	1775	0.858
Steel Works etc.	73	1.037	425	0.820
Medical Equipment	122	1.027	668	0.937
Electrical Equipment	48	1.021	260	0.834
Aircraft	52	0.999	308	0.865
Business Supplies	111	0.976	607	0.891
Computers	466	0.965	2678	0.872
Construction	77	0.960	413	0.815
Recreation	26	0.956	163	0.840
Insurance	330	0.948	1883	0.826
Electronic Equipment	156	0.926	880	0.872
Food and Food Products	105	0.898	578	0.815
Retail	163	0.898	943	0.800
Printing and Publishing	32	0.897	182	0.830
Business Services	49	0.879	300	0.705
Restaurants, Hotels and Motels	286	0.863	1652	0.776
Automobiles and Trucks	48	0.722	260	0.551
Apparel	85	0.722	473	0.701
Entertainment	28	0.645	159	0.910
Agriculture	11	0.615	54	0.485
Precious Metals	21	0.576	127	0.473

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 4: Summary statistics

Panel A: Summary statistics for the full sample

Variable	N	Mean	Median	Std. Dev.
Pay characteristics				
Total compensation	28848	1.988	0.853	4.603
Salary	28848	0.454	0.375	0.319
Bonus	28848	0.278	0	1.287
Options	28848	0.652	0	2.648
Restricted stock	28848	0.604	0	2.145
Duration (years)	28848	0.911	0.772	0.969
Firm characteristics				
Total assets	28790	18900	2334.2	108000
Debt/Total assets	28705	0.21	0.191	0.172
Sales growth	28775	0.13	0.099	0.197
Market to book	28770	1.882	1.522	1.083
R\&D/Total assets	28790	0.022	0	0.042
Capital expenditure	28713	0.055	0.035	0.067
EBIT/Sales	28790	0.15	0.122	0.127
Volatility	28689	0.026	0.022	0.013
Spread	28689	0.146	0.123	0.101
Turnover	28689	11.159	9.109	7.43
Analyst dispersion	26172	0.059	0.03	0.107
Director shareholding (%)	24249	2.415	0	8.029
Entrenchment index	19841	3.227	3	1.346
No. of directors	24249	8.909	9	2.558
Fraction independent	24249	0.746	0.769	0.141
Accruals	23390	0.043	0.031	0.042
Executive characteristics				
Shareholding (%)	28848	0.524	0	2.872
Age (years)	20821	52.403	52	7.724

Panel B: Summary statistics for the subsample of CEOs

Variable	N	Mean	Median	Std. Dev.
Pay characteristics				
Total compensation	5065	4.26	1.98	7.723
Salary	5065	0.763	0.712	0.407
Bonus	5065	0.578	0	2.363
Options	5065	1.545	0	4.617
Restricted stock	5065	1.375	0	3.766
Duration (years)	5065	1.059	1.092	1.06
Executive characteristics				
Shareholding (%)	5065	1.957	0	5.512
Age (years)	4911	55.445	55	7.342

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 5: Univariate comparison

Panel A: Univariate comparison for the full sample

Variable	Short duration	Long duration	Difference
	Pay characteristics		
Total compensation	0.864	3.112	-2.248***
Salary	0.421	0.486	-0.065***
Bonus	0.388	0.169	0.219***
Options	0.027	1.277	-1.25***
Restricted stock	0.029	1.18	-1.151***
Duration (years)	0.057	1.766	-1.709***
	Firm characteristics		
Total assets	15500	22300	-6800***
Debt/Total assets	0.195	0.224	-0.029***
Sales growth	0.138	0.121	0.017***
Market to book	1.946	1.819	0.127***
R\&D/Total assets	0.022	0.023	-0.001
Capital expenditure	0.053	0.058	-0.005***
EBIT/Sales	0.148	0.153	-0.005***
Volatility	0.025	0.026	-0.001***
Spread	0.154	0.138	0.016***
Turnover	10.571	11.747	-1.176***
Analyst dispersion	0.054	0.064	-0.01***
Director shareholding (%)	2.716	2.134	0.582***
Entrenchment index	3.168	3.26	-0.092***
No. of directors	8.579	9.216	-0.637***
Fraction independent	0.724	0.766	-0.042***
Accruals	0.045	0.042	0.003***
	Executive characteristics		
Shareholding (%)	0.574	0.474	0.1***
Age (years)	52.992	51.921	1.071***

Panel B: Univariate comparison for CEOs

Variable	Short duration	Long duration	Difference
	Pay characteristics		
Total Compensation	1.928	6.592	-4.664***
Salary	0.713	0.812	-0.099***
Bonus	0.878	0.278	0.6***
Options	0.181	2.909	-2.728***
Restricted Stock	0.157	2.593	-2.436***
Duration (years)	0.107	2.011	-1.904***
	Executive characteristics		
Shareholding (%)	2.268	1.647	0.621***
Age (years)	56.237	54.671	1.566***

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 6: Stock mispricing, firm governance, and pay duration

Panel A: Firm characteristics and pay duration

	(1)	(2)	(3)	(4)	(5)	(6)
Log(Total assets)		.119 (.018)***	.104 (.019)***			
Debt/Total assets		.105 (.094)	.105 (.093)	.161 (.088)*	.123 (.087)	.069 (.083)
Market to book		.007 (.011)	-.005 (.012)	-.007 (.012)	-.002 (.012)	-.005 (.011)
R&D/Total assets		1.322 (.409)***	1.260 (.404)***	1.196 (.391)***	1.055 (.320)***	1.278 (.377)***
CEO		.197 (.014)***	.197 (.014)***	.196 (.014)***	.197 (.014)***	.201 (.015)***
Volatility		-11.815 (2.075)***	-9.879 (2.042)***	-10.330 (1.842)***	-15.792 (1.860)***	-11.671 (1.968)***
Stock return		.163 (.032)***	.144 (.032)***	.139 (.034)***	.124 (.033)***	.164 (.036)***
Spread			-.589 (.169)***	-.666 (.197)***		
Turnover					.011 (.002)***	
Analyst dispersion						-.012 (.002)***
Const.	.913 (1.82e-15)***	.153 (.180)	.332 (.196)*	.973 (.112)***	.826 (.112)***	.854 (.137)***
Obs.	28790	28176	28176	28176	28176	25591
R^2	.313	.364	.366	.376	.377	.385

Panel B: Governance characteristics and pay duration

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Debt/Total assets	.172 (.097)*	.317 (.114)***	.164 (.088)*	.244 (.099)**	.189 (.113)*	.338 (.138)**	.150 (.096)
Volatility	-10.101 (2.031)***	-12.287 (2.850)***	-10.298 (1.830)***	-12.601 (2.532)***	-11.502 (2.086)***	-13.634 (3.034)***	-10.111 (2.027)***
R&D/Total assets	1.238 (.458)***	1.248 (.676)*	1.185 (.391)***	1.226 (.624)**	1.458 (.506)***	1.505 (.715)**	1.247 (.433)***
Stock return	.165 (.038)***	.187 (.049)***	.138 (.034)***	.171 (.043)***	.225 (.044)***	.274 (.060)***	.164 (.039)***
Spread	-.819 (.170)***	-.978 (.260)***	-.628 (.182)***	-.656 (.288)**	-.857 (.250)***	-.995 (.393)**	-.817 (.169)***
High director shareholding	-.090 (.025)***	-.111 (.041)***					
Shareholding (%)			-.014 (.004)***	-.021 (.005)***			
CEO	.202 (.015)***		.221 (.013)***		.254 (.020)***		.202 (.015)***
Entrenchment index					.010 (.012)	.031 (.020)	
Fraction independent							.285 (.103)***
Const.	.951 (.144)***	1.148 (.225)***	.948 (.117)***	1.166 (.180)***	1.084 (.179)***	1.276 (.286)***	.726 (.131)***
Obs.	23916	4210	28176	4957	19550	3396	23916
R^2	.403	.501	.378	.469	.256	.346	.403

This table reports the results of the regression relating executive pay duration to firm, governance, and executive characteristics. Specifically, we estimate the tobit regression: $Duration_{ket} = F(\alpha + \beta_1 \mathrm{X}_{kt} + \beta_2 \mathrm{X}_{et} + \mu_t \mathrm{T} + \epsilon_{ket})$. 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 7: Absolute accruals and pay duration (OLS)

	Absolute accruals					Positive accruals	Negative accruals
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Duration	-.002 (.0007)**	-.004 (.001)***	-.001 (.0007)**	-.002 (.0007)**	-.002 (.0008)*	-.002 (.0006)***	.0007 (.0006)
Sales volatility ($\times 10^6$)	-.550 (.462)	-.574 (.464)	-.546 (.459)	-.556 (.462)	-.390 (.465)	-.016 (.267)	-.374 (.356)
Market to book	.002 (.001)**	.002 (.001)**	.002 (.001)**	.003 (.001)**	.002 (.001)**	.002 (.0008)***	.0003 (.0009)
Age	-.0002 (.0001)	-.0002 (.0001)	-.0002 (.0001)*	-.0002 (.0001)	-.0002 (.0001)*	-.00005 (.0001)	-.0002 (.00009)**
Fraction non-cash pay		.008 (.005)*					
Shareholding (%)			.0002 (.0002)				
High deferred pay				-.002 (.002)			
Log(Delta)					.002 (.0007)**	.0002 (.0006)	.001 (.0006)**
Const.	.065 (.016)***	.065 (.016)***	.066 (.016)***	.064 (.016)***	.064 (.017)***	.033 (.011)***	.031 (.010)***
Obs.	3920	3920	3920	3920	3378	3378	3378
R^2	.191	.192	.192	.192	.203	.15	.205

This table reports the results of the regression relating the level of absolute accruals 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*. 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 8: 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		.007 (.008)	
Mills			-.0007 (.014)
Industry duration	-.815 (.127)***		
Log(Total assets)	-.177 (.057)***	-.003 (.002)	-.003 (.002)
Market to book	.094 (.036)***	.0008 (.002)	.0002 (.002)
Sales volatility	.00002 (1.00e-05)*	4.56e-07 (4.34e-07)	-2.35e-07 (4.56e-07)
R&D/Total assets	-2.307 (1.758)	.038 (.063)	-.007 (.060)
Stock return	-.211 (.105)**	.007 (.004)*	.009 (.004)**
Spread	2.195 (.546)***	-.002 (.026)	.034 (.031)
Age	.028 (.006)***	.0004 (.0002)*	-.0007 (.0003)***
Log(Delta)	.002 (.032)	.002 (.001)*	.0007 (.001)
Const.	6.372 (.626)***	.029 (.025)	.095 (.019)***
Obs.	2925	1041	1362
R^2 or Pseudo R^2	.237	.395	.32

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

	Actual	Predicted	Difference
Accruals for firms with low duration	.046	.044	.002 (.001)**

This table reports the results of the regression relating the level of absolute accruals 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 Panel A), and two outcome equations that examine *Accruals* separately for firms with below and above-median pay duration in Columns (2) and (3) in Panel A. The *Inverse Mills* Ratio and the *Mills* Ratio are used as additional controls in Columns (2) and (3), respectively. Panel B presents the results of a *t*-test for the difference between the actual *Accruals* for firms with below-median pay duration and the counterfactual *Accruals* (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.