Strategic Flexibility and the Optimality of Pay for Sector Performance

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While standard contract theory suggests that a Chief Executive Officer (CEO) should be paid relative to a benchmark that removes the effects of sector performance, there is evidence that CEO pay is strongly and positively related to such sector performance. In this article, we offer an explanation. We model a CEO charged with selecting the firm's strategy that determines the firm's exposure to sector performance. To incentivize the CEO to choose optimally, pay contracts will be positively and sometimes asymmetrically related to sector performance. Consistent with our predictions, the empirical analysis indicates that the observed sensitivity of pay to sector performance is almost fully confined to multisegment firms and is greater in firms that offer greater strategic flexibility to alter sector exposure, for more talented CEOs and for CEOs as compared to their subordinate executives. Our evidence is robust to alternate explanations such as CEO entrenchment. (*JEL* G30, J33)

One of the basic tenets of compensation theory is that optimal incentive-based pay should depend on variables under the manager's control, not on those over which the manager has no control. If the performance of the firm's sector is outside the manager's control, then this would imply that the optimal incentive contract should be based on the firm's performance relative to the sector performance (this is known as relative performance evaluation (RPE)).[1] This prediction has been extensively tested on Chief Executive Officer (CEO) pay

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[1] RPE is analogous to benchmarking or indexation, where some element of performance attributed to an exogenous factor is removed from the ultimate measure of an agent's performance. See Holmstrom (1982) for its origins.

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data with firm performance measured relative to that of either the firm's sector or the overall stock market. Such studies find very little evidence of RPE for the average CEO.[2] Instead, there is strong evidence of a positive relationship between CEO pay and the performance of the firm's operating sector. The lack of RPE for the average CEO has been spun under the auspice that CEOs receive compensation contracts that exhibit "pay for luck" rather than "pay for performance" (Bertrand and Mullainathan 2001). This is in fact the crux of Bebchuk and Fried's (2003) managerial power hypothesis, which argues that the pay process has been captured and unduly influenced by CEOs.[3] Our article sheds light on the lack of RPE and speaks to the popular managerial power hypothesis.

We return to the basic premise of Holmstrom (1982) and ask a simple question. Even if sector performance is outside the manager's control, can the manager influence how sector performance affects firm performance? That is, is the empirically identified portion of firm performance due to sector performance really something over which the executive has no control? We argue that the answer to this question is a resounding no. While clearly there are market forces at work that are beyond the executive's control, our basic argument is that the CEO typically has at least some discretion over the firm's exposure to such forces through the choice of the firm's strategy.

Holmstrom (2005) makes a similar point: "If John Browne's (then CEO of British Petroleum) incentive pay were insulated from oil price shocks, it would affect the way he thinks about exploration and how he reacts to price shocks once they occur." We propose a simple model to formalize optimal incentive contracts when a firm's exposure to sector movements is the CEO's choice. Our model shows that the optimal wage contract should not remove such sector forces. We derive a number of predictions about how the sensitivity of CEO pay to firm performance due to sector movements will vary cross-sectionally and find significant empirical support for them.

Our view in this article is that to understand CEO pay we should first specify what CEOs actually do. The long-standing modeling choice in the literature considers a standard agency setup, wherein expected firm performance is assumed to directly depend on the CEO's (personally) costly effort and some random factors over which she has no control. The optimal contract incentivizes the CEO to exert effort to maximize firm value. If the sector performance only affects the random portion of firm performance, then such models predict the optimality of RPE. Our contention is that the board of directors is not primarily concerned with how hard the CEO is actually working, but whether she has the vision to choose the right *strategy* for deploying the firm's assets. In doing so, the CEO's concern is with the firm's strategic direction in lieu of its surrounding market environment: Where is the sector going and how

2 Antle and Smith (1986), Janakiraman, Lambert, and Larcker (1992), Aggarwal and Samwick (1999a, b), and Garvey and Milbourn (2003) offer studies that jointly span the 1980s through early 2000s.

3 The more appropriate term for this phenomenon is "pay for firm performance due to luck," but the rather elegant "pay for luck" phrase is more common.

does the firm fit into it? What type of exposure to the sector is optimal for the firm? Such a situation forms the basis of our analysis to model the CEO's job as one of choosing the firm's strategy, which in turn affects the firm's exposure to sector movements. It is important to note that sector benchmarks are just a special case of the general theory we have in mind. The CEO could choose an exposure to anything relevant for the firm, but sector returns are something we can observe empirically.

The rapidly growing literature on leadership models CEOs as visionaries whose main role is to set the strategy for the firm (see Rotemberg and Saloner 2000; Van den Steen 2005). However, such a role has not been integrated into a formal analysis in the compensation literature. In fact, Bolton, Brunnermeier, and Veldkamp (2010) argue that "the principal-agent approach to the firm makes no room for leadership, ... more often than not shareholders are in reality looking for guidance by the manager... when a firm appoints a new CEO it [the board] may define in broad terms the CEO's compensation package, but otherwise gives *carte blanche* to the CEO in defining and implementing the firm's strategy..." Our article takes an early step at modeling such an active role for the CEO and highlights its effect on the optimal incentive contract. Such an approach yields several new predictions and also sheds light on existing puzzles.

There is significant anecdotal support for our assumption that CEOs actively influence firm strategy. McKinsey & Company surveyed 586 global corporate directors and reported that 24% of board time was spent on the development and analysis of strategy.[4] Bennedsen, Pérez-González, and Wolfenzon (2008) demonstrate the impact of CEOs on firm value using a natural experiment of CEO family deaths. Their findings suggest that the CEO is not an otherwise passive agent but adds value through decision making vis-à-vis the firm's strategic course.[5] It is in this manner that we model the CEO's role in the firm. Our model is also in the spirit of Frydman (2007) and Murphy and Zábojník (2007), who suggest that, over time, CEOs have become more highly valued for their general management skills, rather than their firm-specific knowledge. This is akin to a world where CEO ability is linked explicitly to navigating the firm within the broad market.

In our model, a CEO chooses the firm's strategy as she faces uncertainty regarding future sector movements. The CEO exerts costly effort to generate an informative signal about future sector returns. The optimal contract rewards the CEO for firm performance induced by sector movements so as to provide incentives to exert effort to forecast the sector movements and choose

4 See Chen, Osofsky, and Stephenson (2008).

5 Further buttressing our story are Coles, Daniel, and Naveen (2006), who find that compensation contracts have real effects on firm-level investments.

the firm's optimal exposure to them.[6] As our model shows, benchmarking the CEO's performance against the sector is the same as not offering pay for sector performance and will make firm investment decisions insensitive to sector movements. This practice is suboptimal if sector performance affects firm performance. Our model also helps pin down situations in which the sensitivity of pay to sector performance is more likely to be present. We find that multisegment firms, especially those in which the sector performances of the different segments are less positively correlated, will offer pay contracts that are more sensitive to sector performance as compared to single-segment firms. This is because such firms provide greater opportunities for the CEO to actively shift resources toward sectors that are likely to outperform. We also find that the sensitivity of pay to sector performance will be greater in any firm that offers greater strategic flexibility to the CEO to alter firm exposure to sector movements and for more talented CEOs. Our model also shows that the optimal contract rewards a risk-averse CEO more when sector performance is good than punishes her when sector performance is bad; that is, the optimal contract is asymmetrically sensitive to good and bad sector performance.

Oyer (2004) suggests that executive pay should be sensitive to market movements to avoid losing them to other firms since the value of their outside opportunities likely rises and falls with market levels. While probably part of the story, it does not tell us whether and how the sensitivity of CEO pay to sector forces will vary in the cross-section. Our analysis uncovers significant cross-sectional variation of this sort. Furthermore, Oyer's story does not explain the asymmetry in sector pay sensitivity, documented by Garvey and Milbourn (2006). Our model explains the asymmetric sensitivity of CEO pay to sector performance in an optimal contracting setting.

We take the theory's empirically testable predictions to CEO compensation data spanning 1992 through 2006 and find strong empirical support for the model. Using industry returns to proxy for sector performance, we confirm previous studies and document the dependence of CEO compensation on sector performance. Also, as CEOs are likely to have a greater role in setting firm strategy, we expect CEO pay to be more sensitive to sector performance as compared to the pay of other executives. Our empirical results support this conjecture. Moreover, consistent with our model, we find that CEO pay is more sensitive to sector performance for multisegment firms—those that report positive sales and assets in more than one three-digit Standard Industrial Classification (SIC) Code industry—as compared to single-segment firms. We further find that the sensitivity of CEO pay to sector performance in multisegment firms is greater when the sector performances of the different segments are less positively correlated. Our results are also robust to controlling for

[6] In our subsequent discussions, we refer to the sensitivity of CEO pay to the sector-driven component of firm performance as the sensitivity of pay to sector performance.

the quality of firm-level corporate governance using the Bebchuk, Cohen, and Ferrell (2009) entrenchment index.

To test whether the observed pay for sector performance is greater in firms that offer more strategic flexibility to the CEO, we introduce two proxies at the industry level meant to capture the extent of strategic flexibility. Our first proxy is the industry market-to-book ratio. Industries with high market-to-book ratios are likely to have greater investment and growth options and thereby offer CEOs greater strategic flexibility in timing the exercise of those options. Our second proxy relies on the level of research and development (R&D) expenditures in an industry. The idea is that firms in industries with higher levels of R&D expenditures are likely to provide their CEOs with greater strategic flexibility. In these industries, the CEO has more latitude to scale up or down such expenditures and thereby change the firm's exposure to market conditions. When we divide our sample into firms in industries with high and low market-to-book ratios, we find that pay for sector performance is in fact greater for the subsample of firms in industries with high market-to-book ratios. Similar results hold when we measure strategic flexibility using industry R&D expenditures.

If pay for sector performance provides incentives for the CEO to exploit the available strategic flexibility, then we should expect firms with greater pay for sector performance to show some evidence of CEOs exploiting their strategic flexibility to a greater extent at the firm level. To test this prediction, we classify firms with positive industry-adjusted R&D expenditures and asset growth rates as exploiting their strategic flexibility to a greater extent. Consistent with our conjecture, we find that CEO pay is more sensitive to sector performance in firms that have positive industry-adjusted R&D expenditures the following year and positive industry-adjusted asset growth rates during the sample period. This additional test offers some further support to our theory.

Apart from compensation, firms can also provide incentives to the CEO through their retention decision. Jenter and Kanaan (2008) show that a decline in the industry component of firm performance significantly increases the likelihood of a disciplinary CEO turnover. If a disciplinary turnover provides incentives for a CEO to choose the right sector exposure, then our model would predict that the likelihood of a disciplinary CEO turnover should be sensitive to sector performance, with a greater sensitivity in firms that offer greater strategic flexibility to the CEO. We follow Parrino's (1997) procedure and identify all disciplinary CEO turnovers that occur during our sample period, yielding 275 instances. Consistent with our conjecture, we find that the likelihood of a disciplinary CEO turnover is sensitive to sector performance only in firms from industries with high market-to-book ratios and R&D expenditures.

Next, we test our model's prediction of greater pay for sector performance for more talented CEOs using three proxies for CEO talent, similar to Milbourn (2003). Our first proxy is the firm's stock return under the CEO's watch. We classify CEOs with performance above the median industry-adjusted stock return during the previous year as talented. Our second proxy is based on the classification of CEOs as internal or external to the firm. We identify external CEOs as more talented than CEOs promoted from within. Hiring an external CEO indicates that the board is willing to go with a candidate with less firm-specific knowledge probably due to expectations of superior talent. Our third proxy further differentiates among external CEOs and classifies external hires from firms with better stock performance as more talented. For all three proxies, we find evidence of greater pay for sector performance for more talented CEOs.

Finally, consistent with Garvey and Milbourn (2006), we find evidence of asymmetric pay for sector performance in our sample as well. In line with our model, we find that the asymmetry in pay for sector performance is present in multisegment firms, in firms that offer greater strategic flexibility to their CEOs (as identified by our two proxies for strategic flexibility), and for more talented CEOs (as identified by our three proxies for talent).

The widespread lack of RPE and the positive sensitivity of CEO pay to sector performance and its persistence over time highlight that it may not be all about inefficient rent extraction. Our contribution in this article is to offer an optimal contracting explanation for the observed pay for sector performance. Our empirical analysis provides significant support for our model and highlights important cross-sectional patterns in the observed pay for sector performance. This evidence indicates that, at least for certain firms, the observed correlation between pay and sector movements may be designed to provide the CEO with appropriate incentives to select the firm's strategy by managing its exposure to external factors relevant to its performance. An additional contribution of our article is to highlight an alternative way to model a CEO's role as one of choosing a firm's exposure to sector movements. We believe our view of a CEO's role can be fruitfully employed to study other corporate decisions.

The remainder of the article is organized as follows. In Section 1, we present our model and derive the optimal compensation contract when CEOs choose the firm's strategy by altering its exposure to sector movements. Section 2 describes our data and empirical strategy and contains our tests of the model's predictions. Section 3 concludes. All proofs are in the Appendix.

1. The Model

We analyze a simple model and characterize the optimal incentive contract when a CEO directly determines the firm's exposure to sector performance through the choice of firm strategy. The model delivers several empirically testable predictions that we take to the data in the next section.

1.1 Agents and economic environment

Consider a two-date ($t = 0, 1$) economy in which an all-equity firm is owned by risk-neutral investors and managed by a risk-averse CEO. The

CEO chooses a one-period project to be implemented at $t = 0$. This project is a manifestation of the firm's strategy, and henceforth we refer to this choice as such. The CEO can choose between two alternative strategies: a high-exposure strategy denoted by subscript H and a low-exposure strategy denoted by subscript L. The realized return at $t = 1$ from implementing either strategy, R_i with $i \in \{H, L\}$, is $\beta_i R_s + \varepsilon$, where β_i measures the effect of the sector return on the firm return resulting from strategy i and R_s is the realized sector return.[7] We naturally assume that $\beta_H > \beta_L \geq 0$. The loading β_i can alternatively be interpreted as a measure of firm scale, with β_H representing a larger scale. The scale interpretation of β_i is convenient when we extend our model to multisegment firms. In the recent CEO compensation literature, R_s is referred to as "luck" and $\beta_i R_s$ as the component of firm performance due to luck (Bertrand and Mullainathan 2001). The key assumption in our model is that, by the choice of strategy, the CEO directly affects the firm's exposure β_i to sector performance, so $\beta_i R_s$ is not totally driven by exogenous forces. Henceforth, we refer to $\beta_i R_s$ as sector performance to denote sector-driven firm performance. Lastly, ε represents the idiosyncratic component of firm performance. It is assumed to be common to both strategies and is independently distributed with respect to R_s on support $(-\infty, \infty)$, with $\mathbf{E}(\varepsilon) = 0$ and $\mathbf{Var}(\varepsilon) = \sigma^2$.

At this stage, it is useful to highlight the main difference between our approach and that used in the extant literature. This also serves to provide some early intuition for why the optimal contract has pay for sector performance in our setting. Typically, firm performance R_i is modeled as $R_i = \alpha(e) + \beta R_s + \varepsilon$, where e denotes CEO effort. The realized firm performance then consists of three components: CEO effort, $\alpha(e)$, sector performance, βR_s, and noise, ε. Since CEO effort does not influence sector performance in this specification, it is obvious that βR_s should be filtered out from firm performance in an optimal incentive scheme and pay for sector performance is not needed to induce CEO effort. The main innovation in our article is to recognize that, at least for some firms, the realized sector exposure depends on CEO effort. Thus, we model firm performance as $R_i = \alpha(e) + \beta(e) R_s + \varepsilon$, which makes a firm's realized exposure to the sector performance, $\beta(e)$, dependent on CEO effort. Given this specification, our model highlights the optimality of making pay sensitive to sector performance (i.e., $\beta(e) R_s$ should *not* be filtered out) and shows how it varies with firm and CEO characteristics.[8] Since

[7] We allow firm performance to depend on multiple sectors when we analyze multisegment firms in Section 1.3.

[8] Our model of a CEO is similar to that of a mutual fund manager who actively engages in market timing by increasing the fund's market exposure in anticipation of market upturns and reducing it in anticipation of downturns (see Mamaysky, Spiegel, and Zhang 2008). Similar to us, in the absence of market timing, the mutual fund manager should only be compensated for the fund's α, whereas with market timing the compensation should also include the systematic portion of fund performance due to market movement. We thank Sheridan Titman for pointing this out.

our main objective is to study the optimality of pay for sector performance and its cross-sectional variation, we suppress the term $\alpha(e)$ in specifying firm performance.

We now lay out the rest of the model. The sector performance, R_s, can be specified as $R_s = \bar{r} + \widetilde{r}_s$, where $\bar{r}$ is the expected value of R_s and $\widetilde{r}_s$ is the variable component that can take two possible values with equal probability: $r_s > 0$ (akin to a sector boom) and $-r_s < 0$ (akin to a sector bust). We assume $r_s > \bar{r}$, so the realized sector return during a sector bust is negative. To maximize firm value, naturally, it is optimal to choose the high-exposure strategy (β_H) if the expectation is for a sector upturn and the low-exposure strategy (β_L) if the expectation is for a sector downturn. At $t = 0$, the CEO can exert effort to generate a private signal, Θ, about the sector return. The signal is fully revealing and can take two values, $\Theta \in \{\theta_+, \theta_-\}$, where

$$\Pr(\Theta = \theta_+ | R_s = \bar{r} + r_s) = \Pr(\Theta = \theta_- | R_s = \bar{r} - r_s) = 1.$$

The probability that the CEO generates Θ is her effort, $e \in [0, 1]$, at a personal cost of $\delta e^2/4$. With probability $1 - e$, the CEO fails to generate Θ, in which case her information set contains only the prior belief. Note that in our model the CEO has two choice variables, namely the amount of effort to generate a signal about sector performance and the firm's strategy. While the CEO's effort lies continuously in the unit interval, [0, 1], we limit the strategy choice to two candidates, $\{\beta_H, \beta_L\}$. We believe our model can be extended, at the expense of considerable complexity, to include more strategy choices. The presence of two choice variables in our model also distinguishes it from the standard effort-choice models. In those models, CEOs typically choose effort that then directly affects firm performance. In equilibrium, investors are aware of the CEO's effort.[9] In our model, the CEO's effort affects the appropriateness of the strategy choice to the firm's sector and thus indirectly affects firm performance. Furthermore, unlike in the standard effort-choice models, even ex post investors are uninformed about one dimension of the CEO's action space, namely the choice of strategy.

At $t = 1$, both the CEO and investors observe and can verify the firm's realized return, R_i, and the realized sector performance, R_s, whereas investors do not observe the CEO's effort (e), the chosen strategy (β_i), or ε.[10] The problem confronting the investors is to appropriately design a compensation contract to incentivize the CEO to both exert effort to uncover the impending sector performance and choose the optimal strategy accordingly. Since investors only observe R_i and R_s, an incentive contract can only be contingent on these two

[9] The CEO's equilibrium effort is known to investors because they can back it out from the CEO's incentive-compatibility constraint.

[10] The CEO does not observe ε either. But since the CEO knows the strategy, she can back out ε from R_i.

variables. We initially assume a linear contract of the form $W = w_0 + wR_i$, where w_0 represents fixed pay and w is the sensitivity of pay to the firm's return. For now, we assume a contract that is, independent of R_s, but we relax this assumption subsequently in Section 1.4. In our model, firm performance is predominantly driven by sector performance, $\beta_i R_s$, and therefore any loading of pay on firm performance also loads on $\beta_i R_s$. An important question in the context of our model is whether it is optimal for investors to remove the effect of expected sector performance (i.e., $\bar{r}$, which is commonly known) in designing the incentive contract. Interestingly, in our setting it is not possible for investors to do so. To see this clearly, note that $R_i = \beta_i R_s + \varepsilon = \beta_i \bar{r} + \beta_i \widetilde{r}_s + \varepsilon$. Thus, $\bar{r}$ affects R_i through the chosen strategy, β_i. Since investors do not observe β_i even ex post, they cannot design a contract that depends on R_i and also fully removes the effect of $\bar{r}$ on compensation.

We now formally define the term "sensitivity of pay to sector performance" that we will use in our subsequent discussions.

Definition 1. CEO pay is sensitive to sector performance if it is sensitive to the sector-driven component of firm performance, $\beta_i R_s$.

Thus, in the context of our model, $w > 0$ indicates that pay is sensitive to sector performance. The CEO's utility is given by $V_{CEO}(W) - \delta e^2/4$, where $V_{CEO}(\cdot)$ is an increasing and concave function, with $V'_{CEO} > 0$ and $V''_{CEO} < 0$. The CEO's reservation utility is given by a constant, $\bar{V}_{CEO}$.

1.2 Optimal sensitivity of pay to sector performance

Suppose the CEO exerts an effort e, then with probability e she generates the signal Θ. Conditional on generating the signal, she optimally chooses the high-exposure strategy (β_H) if $\Theta = \theta_+$ and the low-exposure strategy (β_L) if $\Theta = \theta_-$. With probability $1 - e$ she fails to generate Θ, in which case she may unconditionally choose either strategy. We assume that the CEO will always choose the low-exposure strategy whenever a signal is not obtained. This can be justified as follows. Following the interpretation of β_i as a choice of firm scale—with β_H representing a larger scale than β_L—in the absence of the informative signal Θ, investing in the sector is equivalent to a zero-net-present-value investment.[11] Hence, we assume that whenever the CEO fails to obtain a signal, β_L is chosen, which minimizes the investment in the sector.[12]

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11 The implicit assumption is that $\bar{r}$, the expected return from investing in the sector without Θ, is fair compensation for the risk involved in investing in the sector. Thus, in the absence of Θ, the risk-adjusted excess return from investing in the sector is zero.

12 Similar to us, Eisfeldt and Rampini (2008) provide a model of a CEO who has private information about asset productivity and is charged with optimal capital reallocation decisions. Unlike our model, in their article, the CEO enjoys private benefits of control and her choice does not affect sector exposure.

Without loss of generality, for simplicity, we normalize $\beta_L = 0$ and denote $\beta_H \equiv \beta > 0$ subsequently. Hence, the CEO's expected utility, given any compensation contract denoted by (w_0, w), can be written as

$$V_{CEO}(w_0, w) = e\left[\frac{\mathbf{E}\big(V_{CEO}(w_0 + w[\beta\bar{r} + \beta r_s + \varepsilon]) + V_{CEO}(w_0 + w\varepsilon)\big)}{2}\right] + [1-e]\left[\frac{\mathbf{E}\big(V_{CEO}(w_0 + w\varepsilon) + V_{CEO}(w_0 + w\varepsilon)\big)}{2}\right] - \frac{\delta e^2}{4}.$$

The term in the first set of square brackets represents the CEO's payoff when the signal is generated. This equals the sum of her payoff when $\Theta = \theta_+$ (which occurs with probability 1/2) and she optimally chooses the high-exposure strategy and her payoff when $\Theta = \theta_-$ (which also occurs with probability 1/2) and she optimally chooses the low-exposure strategy. The term in the second set of square brackets represents the CEO's expected payoff when Θ is not generated and the low-exposure strategy is chosen. The last term is the CEO's personal cost of effort provision.

The investors' corresponding expected payoff, denoted as $V_I(w_0, w)$, is

$$V_I(w_0, w) = [1 - w][e]\left[\frac{\beta\bar{r} + \beta r_s}{2}\right] - w_0.$$

The investors' problem at $t = 0$ is to design a contract (w_0, w) to maximize their expected payoff, $V_I(w_0, w)$, by providing the CEO the right incentives to choose an appropriate effort level to find out the sector performance. The investor's problem can be formally stated as

$$\max_{\{w_0, w\}} \quad V_I(w_0, w), \tag{1}$$

$$\text{s.t.} \quad V_{CEO}(w_0, w) \geq \bar{V}_{CEO}, \tag{2}$$

$$\text{and} \quad e = \text{argmax}_{e\in[0,1]} V_{CEO}(w_0, w). \tag{3}$$

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

We term the CEO's ability to alter the firm's exposure to sector performance as the extent of strategic flexibility. In our model, this can be measured by the distance between the betas, that is, $\beta_H - \beta_L = \beta$. Note that, in the trivial case when $\beta = 0$, there is no flexibility for the CEO to alter firm exposure in response to sector movements. The CEO of a firm with greater strategic flexibility (larger β) has more latitude in choosing the firm's exposure to the sector performance. The CEO can alter the firm's sector exposure both through real investment decisions and also synthetically through derivative contracts. The ability to take on synthetic exposures may allow the CEO to take on extreme exposures. While not a problem in our model, this can be an issue if CEOs have option-like incentive contracts that are deep out of the money. Boards can limit such gambling if they can observe the extent of synthetic exposure and impose limits related to the firm's real exposure. For example, an oil company's board may limit short futures positions in crude oil to match expected future production. Note that implicit in our assumption of cross-sectional variation in the extent of strategic flexibility is that the CEO's ability to take synthetic exposures is related to their ability to take real exposures. If CEOs can costlessly take on any amount of synthetic exposure, then there is unlikely to be any cross-sectional variation in the extent of strategic flexibility. We take our subsequent empirical evidence showing variation in the extent of pay for sector performance with the extent of strategic flexibility as validation of this assumption.

We now provide our first result on the structure of the optimal incentive contract. To obtain a closed-form solution, we make a specific assumption about the CEO's utility function. Specifically, we assume that the CEO's utility function can be represented by a modified mean variance utility of the form $\mathbf{E}\big(V_{CEO}(w_0, w)\big) = w_0 + w[\beta_i R_s] - [\lambda/2][w^2\sigma^2] - [\lambda/2]\{w[\beta_i R_s]\}$, where $R_s \in \{\bar{r} + r_s, \bar{r} - r_s\}$ and the constant λ is the CEO's risk-aversion parameter.[13]

Proposition 1. The optimal incentive contract, denoted as (w_0^*, w^*), exhibits pay for sector performance, that is, $w^* > 0$. Moreover, w^* is strictly increasing in the extent of strategic flexibility, β, and the level of sector abnormal performance, r_s, and decreasing in the disutility of effort, δ.

The intuition is as follows. The CEO's compensation is intentionally left sensitive to the sector's return R_s to ensure that she has sufficient incentives to exert effort to uncover sector performance and choose the optimal strategy accordingly. Absence of pay for sector performance (i.e., $w^* = 0$) will result in the CEO shirking and choosing the low-exposure strategy unconditionally. Thus, the firm's exposure is unlikely to be correctly matched to sector performance. To see why w^* is increasing in β, note that the marginal benefit of CEO effort to investors is increasing in β since the benefit of correctly matching the firm's exposure to sector performance increases with β. Thus, as β becomes larger, investors increase the sensitivity of pay to sector performance to induce more effort from the CEO.[14] A similar intuition applies for why w^* is increas-

[13] The CEO faces two sources of uncertainty: the first is due to the idiosyncratic shock, ε, and the second is due to the sector return, R_s. The term $-[\lambda/2][w^2\sigma^2]$ represents the CEO's risk aversion toward ε, and her risk aversion toward R_s is captured (with the minimum mathematical complexity) by the term $-[\lambda/2]\{w[\beta_i R_s]\}$. Note that, with this formulation, we need $\lambda < 2$ to ensure that the CEO's expected utility is increasing in her pay.

[14] Although for a fixed $w^* > 0$, an increase in β itself induces more effort from the CEO, that additional effort alone is typically not sufficient from the investors' perspective. This is because the CEO only enjoys a fraction of the gain from the increase in strategic flexibility and the ability to correctly match exposures to sector performance. Hence, notwithstanding the greater effort resulting from an increase in β, investors increase w^* to induce greater effort.

ing in r_s. Finally, w^* is decreasing in the effort disutility parameter δ. In our empirical analysis, we equate δ to the cross-sectional variation in CEO talent, with a more talented CEO having a lower δ.

1.3 Multisegment firm

We now extend our analysis to a setting where multiple sectors affect firm performance and examine how the sensitivity of pay to sector performance may differ between multisegment and single-segment firms. To fix ideas, consider a firm that operates in two sectors, denoted sectors 1 and 2. The $t = 1$ return for sector $k \in \{1, 2\}$, R_{sk}, can be either $\bar{r} + r_s > 0$ or $\bar{r} - r_s < 0$, which are a priori equiprobable. The two sectors' returns are correlated via the following conditional probabilities:

$$\Pr(R_{sk'} = \bar{r} + r_s | R_{sk} = \bar{r} + r_s) = \Pr(R_{sk'} = \bar{r} - r_s | R_{sk} = \bar{r} - r_s) \\ = \eta \in [0, 1], \ \forall k, k' \in \{1, 2\}.$$

Note that $\eta = 0$ corresponds to the case where the two sector returns are perfectly negatively correlated, whereas $\eta = 1$ corresponds to the case where the returns are perfectly positively correlated. At $t = 1$, the firm's return is $\beta_1 R_{s1} + \beta_2 R_{s2} + \varepsilon$, where $\beta_1, \beta_2 \in \{\beta, 0\}$. In line with our interpretation of β as a measure of the firm's sector-investment scale and in the spirit of resource constraints within a multisegment firm, we assume that at most one among β_1 and β_2 can be positive, that is, $\beta_1 + \beta_2 \leq \beta$. Thus, if the CEO allocates capital to sector 1 by choosing the high-exposure strategy for that sector ($\beta_1 = \beta$), she will have to reduce capital allocation to sector 2 by choosing the low-exposure strategy with $\beta_2 = 0$, and vice versa. The CEO's private signal Θ perfectly reveals the returns to both sectors.[15] The rest of our setup is unchanged. We denote the optimal incentive contract for the multisegment firm as (w^*_{0m}, w^*_m), where w^*_{0m} is the fixed pay and w^*_m is the sensitivity of CEO pay to firm performance and consequently to sector performance.

The following proposition compares the optimal incentive contracts between multisegment and single-segment firms.

Proposition 2. The multisegment firm, ceteris paribus, exhibits greater sensitivity of pay to sector performance than the single-segment firm, that is, $w^*_m > w^*$. Moreover, w^*_m is decreasing in the degree of sector-return correlation, η.

The key to understanding this proposition is to note that investors benefit from the CEO's effort if she can identify a sector that is, expected to outper-

15 We assume here that learning about two sectors is no more costly than learning about one sector. This allows us to directly compare pay sensitivities to sector performance between multisegment and single-segment firms in a more economically meaningful manner. Of course, a higher learning cost for two sectors will moderate the extent of pay sensitivity to sector performance for the multisegment firm. Our result in Proposition 2 sustains if the learning cost for two sectors is not too high in comparison to that for one sector. Further details are available upon request.

form and direct resources to it. Since the performances of the two sectors are not perfectly correlated, the likelihood that the CEO of a multisegment firm can identify one sector that will outperform and direct resources to it is greater than that for a single-segment firm's CEO. Note that even if a single-segment firm's CEO can also observe the returns for both sectors, she may not easily be able to direct resources to the outperforming sector if her firm does not currently operate in it, unless of course the firm diversifies into that sector. Therefore, CEO pay in multisegment firms is more sensitive to sector performance. This also explains why pay for sector performance is decreasing in the sector correlation, η, within a multisegment firm. The lower the sector correlation, the greater the likelihood that at least one sector will outperform and resources can be directed to that sector.

1.4 Asymmetric sensitivity of pay to sector performance

We now relax our original assumption on the contractual form and analyze a more general one that allows the loading on firm performance to depend on sector performance. To succinctly convey the main message in this section, we perform the analysis in a single-segment setting, but the conclusions here are robust to an extension to a multisegment setting. More specifically, we assume that investors offer the CEO a piecewise linear contract with $W = w_0 + \bar{w}R_i$ when $R_s = \bar{r} + r_s$ and $W = w_0 + \underline{w}R_i$ when $R_s = \bar{r} - r_s$, where $\bar{w}$ is the loading on firm performance when the sector performance is good and $\underline{w}$ is the loading on firm performance when the sector performance is bad. How do investors implement such an incentive contract? Since the contract we specify is piecewise linear, it can be implemented using a fixed wage (to the extent of w_0) plus stock grants. The amount of stock grants may vary with the sector performance, with the amount during sector upturns and downturns being given by $\bar{w}$ and $\underline{w}$, respectively. Analyzing this general contract helps us explore any potential asymmetry in the optimal incentive contract. Let us proceed by first defining asymmetric sensitivity of pay to sector performance in the context of our model.

Definition 2. The incentive contract exhibits asymmetric sensitivity of pay to sector performance if the sensitivity of CEO pay to sector performance during sector upturns, $\bar{w}$, is greater than the sensitivity during sector downturns, $\underline{w}$.

The following proposition delineates the result from the analysis of the general contract.

Proposition 3. The optimal compensation contract, denoted as $(w_0^*, \underline{w}^*, \bar{w}^*)$, has the following properties:

1. It loads positively on sector performance both when sector performance is good and when it is bad, that is, $\underline{w}^* > 0$ and $\bar{w}^* > 0$;

2. It exhibits asymmetric sensitivity of pay to sector performance, that is, $\bar{w}^* > \underline{w}^*$, whenever $\bar{r} \leq 0$; for a given $\bar{r} > 0$, there exists a cutoff value of CEO risk aversion such that, for all values greater than the cutoff, the contract exhibits asymmetric sensitivity to sector performance;
3. The extent of asymmetric sensitivity of pay to sector performance is increasing in the extent of strategy flexibility, that is, $\bar{w}^* - \underline{w}^*$ is increasing in β.

The intuition is as follows. Observe first that the result of a positive sensitivity of pay to sector performance obtains with the general contract as well. As stated earlier, the CEO's compensation is contingent on sector performance (i.e., $\underline{w}^* > 0$ and $\bar{w}^* > 0$) to ensure that she has sufficient incentives to exert effort to uncover the sector performance and choose the optimal strategy accordingly. The two loadings, $\underline{w}^*$ and $\bar{w}^*$, however, serve two slightly different incentive purposes. The loading when the sector performance is bad, $\underline{w}^* > 0$, ensures that the CEO does not shirk and unconditionally choose the high-exposure strategy (β_H), whereas the loading when the sector performance is good, $\bar{w}^* > 0$, ensures that the CEO does not shirk and unconditionally choose the low-exposure strategy (β_L). To see this, note that when $\underline{w}^* > 0$, the CEO suffers a loss if she undersupplies effort and chooses β_H whenever she fails to generate Θ and the low sector return, $R_s = \bar{r} - r_s$, is realized. Similarly, when $\bar{w}^* > 0$, the CEO forgoes a compensational gain if she undersupplies effort and chooses β_L whenever Θ is not generated and the sector boom, $R_s = \bar{r} + r_s$, occurs. Given risk aversion, the CEO's incentive to avoid the loss when $R_s = \bar{r} - r_s$ is ceteris paribus stronger than her incentive to avoid forgoing her compensational gain when $R_s = \bar{r} + r_s$. Hence, all other things being equal, investors rely to a lesser extent on the compensation contract to provide incentives to the CEO to not shirk and choose the high-exposure strategy unconditionally. Such reliance on the contract is further reduced if the expected sector return is nonpositive, i.e., $\bar{r} \leq 0$, in which case the CEO is ceteris paribus less likely to choose β_H whenever a signal is not obtained.[16] Thus, when $\bar{r} \leq 0$, the optimal incentive contract for a risk-averse CEO exhibits asymmetry in the sensitivity of pay to sector performance. When $\bar{r} > 0$, the CEO is ceteris paribus more likely to choose β_H unconditionally whenever a signal is not generated. This factor alone would induce investors to choose a higher $\underline{w}^*$ than $\bar{w}^*$ in the compensation contract. Note that risk aversion diminishes the CEO's preference for β_H. Thus, in order to have $\bar{w}^* > \underline{w}^*$ in this case, the CEO needs to be sufficiently risk averse, which reduces the contract's reliance on $\underline{w}^*$ to incentivize the CEO to not shirk and choose β_H unconditionally.

Importantly, as the firm's strategic flexibility increases (larger β), in order to provide incentives to the CEO to exert more effort, both loadings ($\bar{w}^*$ and

[16] To see this more clearly, note that in this case whenever the CEO fails to generate Θ, the expected return from investing in the sector is negative (since $\bar{r} \leq 0$), and hence all other things being equal (i.e., for any compensation contract without asymmetry, $\bar{w} = \underline{w}$) the CEO is strictly worse off by choosing β_H.

$\underline{w}^*$) increase. Given CEO risk aversion, each unit increase in the loading when the sector performance is bad ($\underline{w}^*$) ceteris paribus produces a stronger incentive effect than each unit increase in the loading when the sector performance is good ($\bar{w}^*$). Thus, to provide appropriate incentives, $\bar{w}^*$ increases more than $\underline{w}^*$. That is, the asymmetry in pay for sector performance, $\bar{w}^* - \underline{w}^*$, is increasing in the firm's strategic flexibility.

1.5 Empirical predictions

We now list the main empirical predictions of our model. First, from Proposition 1, we know that the optimal incentive contract rewards the CEO for firm performance resulting from sector movements. That is, the optimal incentive scheme does not remove the sector performance.

Prediction 1. Optimal incentive contracts will reward CEOs for sector performance.

Support for this prediction can be found in Bertrand and Mullainathan (2001) and Garvey and Milbourn (2006), although it was cast in a different light. One important aspect of testing Prediction 1 relative to these two articles is that our model is quite specific about the nature of what those authors call "luck." It is reasonable to argue that CEOs, through their choice of strategy, will affect the extent of the firm's exposure to its industry movements. One way to think about this is that the CEO uses capital budgeting to decide on the amount of incremental capital investment in the firm's industry. The decision is likely to depend on the CEO's view on the future prospects of the industry. Thus, according to our model, the luck that matters for CEO compensation should be industry performance. Hence, we repeat the tests of Bertrand and Mullainathan (2001) and Garvey and Milbourn (2006) for our extended sample period using industry returns.

Proposition 2 generates the second prediction of our model regarding the sensitivity of pay to sector performance in multisegment firms.

Prediction 2. The sensitivity of pay to sector performance will be greater for CEOs in multisegment firms than in single-segment firms. The sensitivity of pay to sector performance in a multisegment firm will decrease in the degree of performance correlation between the different segments.

Next, we know from Proposition 1 that the sensitivity of pay to sector performance will be greater for CEOs managing firms that offer them greater strategic flexibility. To test this prediction, we identify two proxies for the extent of ex ante strategic flexibility offered to the CEO. To be consistent with our model, we take care to ensure that the proxies are industry-level variables that a CEO cannot readily influence through her decisions. For example, industries with higher market-to-book ratios are likely to have greater investment and growth opportunities and hence offer CEOs greater strategic flexibility. The idea is that CEOs can change the sensitivity of firm performance to sector movements by timing the exercise of those growth options. Similarly, industries with higher levels of R&D expenditures may offer a greater potential for CEOs to vary the firm's sector exposure. The idea is that CEOs can alter the sensitivity of firm performance to sector movements by scaling up or down the level of R&D expenditures. Consistent with this, Bennedsen, Pérez-González, and Wolfenzon (2008) find that CEOs have a greater impact on firm performance in industries with higher levels of R&D expenditures. Summarizing, our third prediction is:

Prediction 3. The sensitivity of pay to sector performance will be greater for CEOs in firms that offer greater strategic flexibility, that is, for CEOs in firms in industries with higher market-to-book ratios and higher levels of R&D expenditures.

Proposition 1 also implies that the sensitivity of pay to sector performance will be greater for more talented CEOs, as captured by the decreasing disutility of effort of more talented executives. We construct three proxies for CEO talent to test this. Our first proxy, drawn from Milbourn (2003), is the industry-adjusted stock return during the previous year. The idea is that firms managed by more talented CEOs will exhibit higher industry-adjusted performance. Our second proxy is whether the CEO is an internal or external hire. We identify CEOs appointed from outside the firm as being more talented than inside CEOs, since these executives overcome their relative lack of firm-specific knowledge to get hired anyway. Our third proxy further differentiates among externally-hired CEOs by sorting on the stock performance of their prior firms.

Prediction 4. The sensitivity of pay to sector performance will be greater for more talented CEOs, that is, for CEOs in firms with above median industry-adjusted stock returns, for externally-hired CEOs, and for external CEOs hired from firms with better stock performance.

From Proposition 3, we know that in the optimal contract we have $\bar{w}^* > \underline{w}^*$. This implies that the optimal contract rewards the CEO more for firm performance resulting from good sector returns ($R_s = \bar{r} + r_s$) than punishes her for declines owing to bad sector outcomes ($R_s = \bar{r} - r_s$). Alternatively put, the optimal incentive contract is asymmetric in the pay sensitivity to sector performance and our prediction is thus in line with the results of Garvey and Milbourn (2006). Interestingly, apart from the asymmetry built into the optimal contract, the CEO's ability to change firm exposure to sector performance implies that empirical tests that ignore this fact may be biased toward finding asymmetry in the sensitivity of pay to sector performance. The reason for this is as follows. In estimating the sector component of firm performance, these tests typically estimate one average β for every firm, say $\bar{\beta}$. However, if a CEO actively changes her firm's exposure to sector performance by increasing the exposure of the firm's projects during sector upturns and reducing the exposure during downturns, then such tests are likely to underestimate the actual β during upturns and overestimate the actual β during downturns. This is likely to bias the estimates toward finding asymmetry in the sensitivity of pay to sector performance. Note that, in the context of our model, in equilibrium (whenever the CEO generates a signal) $\beta_H \times [\bar{r} + r_s]$ and $\beta_L \times [\bar{r} - r_s]$ represent the sector-driven component of firm performance during sector upturns and downturns, respectively, and $\bar{w}^*$ and $\underline{w}^*$ are the loadings on these two components. However, the empirically estimated, sector-driven component of firm performance during upturns and downturns will be, respectively, $\bar{\beta} \times [\bar{r} + r_s]$ and $\bar{\beta} \times [\bar{r} - r_s]$. Let w^+ and w^- represent the empirically estimated loadings on these two components. It is easy to show that we will have $w^+ = \bar{w}^* \beta_H / \bar{\beta}$ and $w^- = \underline{w}^* \beta_L / \bar{\beta}$. Thus, even if $\bar{w}^* = \underline{w}^*$, we are likely to have $w^+ > w^-$ because $\beta_H > \bar{\beta} > \beta_L$. Thus, empirically, we will observe asymmetry in the compensation contracts if we ignore the fact that CEOs can change the firm's sector exposure.

Moreover, similar to Predictions 2–4, our model also predicts that we should observe asymmetry between pay for good and bad sector outcomes in incentive contracts for CEOs in multisegment firms, in firms that offer greater strategic flexibility, and for more talented CEOs. Note that strictly speaking, Proposition 3 predicts greater asymmetry in the sensitivity of pay to sector performance for firms that offer more strategic flexibility. Our ability to test this prediction is compromised by a couple of issues. The first one is the above noted bias in estimating the extent of asymmetry. Second, when we estimate pay for good and bad sector outcomes for the subsample of firms (i.e., firms with more vs. less strategic flexibility), the pay for either good or bad sector realizations is insignificant in a number of cases. This makes comparison of the difference in coefficients across the two subsamples difficult. Given these issues, we confine our tests to establishing the presence of asymmetric sensitivity of pay to sector performance as predicted by our model.

Prediction 5. CEO pay will be more sensitive to sector performance when it is good than when it is bad. This asymmetric sensitivity will be present for CEOs in multisegment firms, in firms that offer greater strategic flexibility (that is, for firms in industries with higher market-to-book ratios, and higher levels of R&D expenditures), and for more talented CEOs (that is, for CEOs in firms with better industry-adjusted stock performance, for externally-hired CEOs, and for external CEOs hired from firms with better stock performance).

With these predictions in hand, we turn now to our empirical analysis.

2. Empirical Analysis

In this section, we describe the data, lay out the empirical methodology, and provide the main results stemming from the tests of the model's predictions.

2.1 Data and descriptive statistics

The data for testing our predictions are drawn from two standard sources. Stock returns come from the Center for Research in Security Prices (CRSP), and compensation data are from Standard and Poor's ExecuComp. Our sample period covers the years 1992–2006. The compensation data are for each firm's executive identified by ExecuComp as the CEO. To obtain a sample suitable for testing, we modify this overall sample in the following ways. First, we drop firms with fiscal years ending in any month other than December. We do this to ensure that the period we use to measure firm performance coincides with the period used to measure industry performance, which we use as the benchmark. Second, to ensure that we have a full year's compensation data, we drop firm years in which the CEO changed. In Section 2.3, we compare the overall ExecuComp sample to our sample to ensure that the selection does not bias our conclusions. For robustness, we repeat all our tests with the full sample and obtain results similar to the ones reported.

2.2 Empirical specification and key variables

In testing our predictions, we are broadly interested in examining how CEO compensation is related to the component of firm performance due to sector movements. To do this, we follow the approach used in Bertrand and Mullainathan (2001) and Garvey and Milbourn (2006) and break the test into two stages. In the first stage, we calculate the sector and firm-specific components of the firm's dollar return. We achieve this using the following specification:

$$y_{it} = \beta \mathrm{X}_s + \mu_t \mathrm{T} + \epsilon_{it}, \tag{4}$$

where i indicates the firm; s indicates the sector; t refers to time in years; and the term T refers to a set of time dummies. The dependent variable y is the annual stock return, and X represents the return on a set of sector indices. We convert the firm's stock return and sector return into dollar returns by multiplying them with the firm's market capitalization at the beginning of the year. In the baseline specification, the sector indices include the equal- and value-weighted industry returns, where industry is identified at the level of the two-digit SIC Code. We remove the firm's return while calculating the industry returns. As discussed earlier, industry returns are most relevant for testing our model implications. For robustness, we repeat our tests using equal- and value-weighted portfolio returns of all NYSE/AMEX/NASDAQ stocks, the return on the S&P 500 index, and the return on the firm's size-decile portfolio. Many of these indices are highly correlated with industry returns, so not surprisingly we obtain similar results with these as well. Lastly, since all of these are imperfect measures of the sector return that is likely to be relevant for choosing a firm's strategy, we may misclassify some sector and firm-specific portions of performance.

Because our tests are based on how CEO pay is related to the sector component of firm performance in the cross-section, measurement error is unlikely to bias our conclusions. Note also that even our tests are likely to be biased toward finding asymmetry in pay for sector performance because we only estimate one average loading (β) for a firm. Due to the noise in short-term return measures and the lack of sufficient observations, we are unable to estimate time-varying loadings for a firm. With this potential bias in mind, we confine our tests to establishing the presence of asymmetric pay for sector performance consistent with our predictions. We calculate the sector component of firm performance as

$$Sector_{it} = \widehat{\beta}\mathrm{X}_s + \widehat{\mu}_t\mathrm{T}, \tag{5}$$

where $\widehat{\beta}$ and $\widehat{\mu}_t$ represent the coefficient estimates from Equation (4). The difference between firm stock return and its sector component is referred to as the firm-specific component.

Having estimated the sector and firm-specific components of firm performance, next we estimate how CEO compensation varies with these two. We follow Aggarwal and Samwick (1999a) and Garvey and Milbourn (2006) for the pay for performance relationship and estimate

$$z_{it} = \alpha_1 \times Sector_{it} + \alpha_2 \times Firm\ specific_{\ it} + \gamma\mathrm{X}_{it} + \mu_e\mathrm{E} + \mu_t\mathrm{T}, \tag{6}$$

where the dependent variable z is the level of compensation. We begin with three alternative measures of CEO pay. Our first is the executive's total direct compensation, *Total compensation*, which sums the CEO's yearly salary, bonus, other annual compensation, long-term incentive payouts, other cash payouts, the value of restricted stock, and the Black-Scholes value of stock option awards in the year. The other two measures of compensation are the CEO's yearly *Bonus* and the Black-Scholes value of yearly *Option grants*.

Following Garvey and Milbourn (2006), we do not fix the sensitivity of pay to either *Sector* or *Firm specific* to be the same for all firms. Instead, we let the loadings vary with the riskiness of the two components of firm performance by including interaction terms between *Sector* and *Firm specific* and the cumulative distribution function (CDF) of their own respective variances. We also include the level of the CDF as an additional control. Thus, our set of controls X_{it} include interaction terms between *Sector* and *Firm specific* and the CDF of their variances (i.e., *Sector* × *CDF of var of sector* and *Firm specific* × *CDF of var of firm specific*), the level of the CDF of the two variances, and the tenure of the CEO. We calculate CEO tenure in any year as the difference in years between the fiscal year-end of that year and the date when the executive became CEO. Jensen and Murphy (1990) find that firm size matters for pay for performance sensitivity. To control for this, we include a dummy variable *Large* that identifies firms with above sample median firm size as measured by the natural logarithm of the book value of total assets.[17] We also control for executive fixed effects (E) and for time fixed effects (T). Our predictions are about how α_1 varies in the cross-section of CEOs. In the tests designed to measure asymmetry in pay for sector performance, we augment the above model by replacing *Sector* with two interaction terms. These are *Sector*×(+*ve Sector*) and *Sector*×(−*ve Sector*), where +*ve Sector* (−*ve Sector*) is a dummy variable that takes the value 1 when *Sector* is positive (negative) and 0 otherwise.

2.3 Summary statistics

In Panels A and B of Table 1, we compare the summary statistics for compensation and firm-specific variables for executives identified as the CEO (given by the CEOANN field) for the full ExecuComp sample (Panel A) to our subsample that excludes firms with fiscal years ending in any month other than December and firm years in which the CEO changed (Panel B). These summary statistics show that our subsample is comparable to the full sample in terms of average market value and CEO pay. Focusing on Panel B, the average salary and bonus for a CEO in our sample are approximately $653,207 and $723,793, respectively, while option grants in the year average about $2.0 million. The standard deviations of stock returns are the volatilities provided in the ExecuComp database that are used to calculate the Black-Scholes value of options. The more important feature of both samples is the significant right skewness. For instance, the maximum value of option grants is about $290 million in our subsample, and the median value is approximately one-fourth of the mean. To reduce the effects of such outliers, our variables of empirical interest are all winsorized at the 1% level, and we estimate robust standard errors throughout our analyses.

Critical to our ability to test the hypothesis that CEOs change firm exposures to sector returns is the fact that the benchmark can take both positive and negative values. Table 2 summarizes the percentage of the observations for each benchmark that are positive.

2.4 Empirical results

With the data and empirical strategy in hand, we now proceed to test our model's predictions.

17 We do not include an interaction term between *Sector* and firm size as measured by either *Large* or the natural logarithm of the book value of total assets because the correlation between this interaction term and *Sector* is more than 90%. Our results are robust to controlling for the book value of total assets instead of the dummy *Large*.

Table 1
Summary statistics

Variable	*N*	Mean	Min	Median	Max	Std. Dev.
Panel A: Summary statistics for full ExecuComp sample						
Salary ($ thousand)	22,966	620.021	0	561	5,806.651	346.664
Bonus ($ thousand)	22,966	696.959	0	324.909	102,015.2	1,625.406
Option grants ($ thousand)	21,809	2,174.368	0	526.351	600,347	8,804
Total compensation ($ thousand)	22,754	4,573.603	0	2,081.918	2,256,186	18,494
Tenure (years)	17,377	7.460	0	5.170	46.027	7.051
Age (years)	21,424	55.602	28	56	91	7.601
Stock return (%)	21,984	18.936	−97.842	11.101	2,619.417	63.690
Volatility	19,966	0.424	0.102	0.363	4.211	0.245
Market value ($ million)	22,685	6,292.372	0.190	1,338.287	507,216.7	20,819.3
Log(assets)	22,946	7.437	0.644	7.276	14.449	1.779
Panel B: Summary statistics for our subsample						
Salary ($ thousand)	14,507	653.207	0	600	5,806.651	360.342
Bonus ($ thousand)	14,507	723.793	0	346	102,015.2	1,713.297
Option grants ($ thousand)	13,363	2,000.138	0	534.573	290,594.8	6,675.643
Total compensation ($ thousand)	14,436	4,607.190	0	2,194.180	2,256,186	20,497.180
Tenure (years)	13,272	7.997	1	5.986	46.027	6.800
Age (years)	13,496	56.007	29	56	91	7.325
Stock return (%)	13,736	19.050	−97.842	11.843	1,494.336	59.777
Volatility	13,968	0.407	0.102	0.341	4.211	0.260
Market value ($ million)	13,872	6,270	5.102	1,460	506,000	19,900
Log(assets)	14,468	7.695	1.233	7.582	14.449	1.837

Descriptive statistics of CEOs and firms. The data are collected for every CEO in ExecuComp for the period 1992–2006. Panel A summarizes the full ExecuComp sample, and Panel B summarizes the subsample that only includes firms with fiscal year ending in December and excludes the firm years with CEO transition. Details on the definitions of the variables are in Appendix B. Compensation data are in thousands, and market values are in millions of yearly dollars.

2.4.1 Pay for sector performance. We begin our empirical analysis by testing Prediction 1 to see if there is evidence of pay for sector performance in our sample. These tests are similar to those in Bertrand and Mullainathan (2001) except that our sample period is longer. We repeat the tests to ensure that the results hold in our sample as well. The results are reported in Table 3. In Column 1, the dependent variable is *Total compensation*. The statistically significant positive coefficient on *Sector* confirms pay for sector performance. In Columns 2 and 3, we repeat the estimation with *Bonus* and *Option grants* as measures of compensation, respectively, and find evidence of reward for sector

Table 2
Market indices

Variable	Percent positive	Percent negative	Min	Median	Max	Std. Dev.
Equal-weighted industry return	74.9%	25.1%	−50%	13.9%	126%	31.3%
Value-weighted industry return	73%	27%	−51.8%	12.9%	83.4%	24.3%

This table reports the summary statistics of the two market indices that we use in our baseline specification to estimate the sector and firm-specific components of firm performance: equal-weighted industry return and value-weighted industry return. We define the firm's industry at the level of the two-digit SIC Code. The data are collected for every firm in which a CEO in ExecuComp is identified as defined by the CEOANN field for each year 1992–2006. The percent positive (negative) represents the proportion of the sample for which the relative benchmark return is positive (negative).

Table 3
Pay for sector performance

	Total compensation	*Bonus*	*Option grants*	*Total compensation*	*Bonus*	*Option grants*
	(1)	(2)	(3)	(4)	(5)	(6)
Sector	1.195	0.268	0.210	0.790	0.203	0.014
	(0.311)***	(0.055)***	(0.222)	(0.319)**	(0.060)***	(0.223)
Firm specific	0.684	0.353	−0.085	0.767	0.289	0.031
	(0.197)***	(0.036)***	(0.130)	(0.205)***	(0.037)***	(0.132)
$Sector \times CEO$				0.522	0.077	0.230
				(0.121)***	(0.028)***	(0.078)***
$Firm\ specific \times CEO$				−0.160	0.025	−0.153
				(0.115)	(0.021)	(0.076)**
CEO ($\times 10^8$)				4.450	1.310	4.200
				(0.877)***	(0.148)***	(0.551)***
Large ($\times 10^8$)	11.508	0.992	7.156	8.349	0.897	5.442
	(1.990)***	(0.314)***	(1.359)***	(1.822)***	(0.265)***	(1.207)***
$Sector \times CDF$	−1.156	−0.253	−0.239	−1.244	−0.252	−0.267
of var of sector	(0.350)***	(0.062)***	(0.254)	(0.336)***	(0.060)***	(0.237)
$Firm\ specific \times CDF$	−0.526	−0.312	0.098	−0.422	−0.264	0.153
of var of firm specific	(0.240)**	(0.044)***	(0.161)	(0.223)*	(0.041)***	(0.146)
Obs.	12,654	12,723	11,692	14,947	15,179	13,991
R^2	0.727	0.724	0.615	0.697	0.692	0.580

This table reports the results of the regression relating CEO compensation to the sector and firm-specific components of firm performance. Specifically, we estimate the panel corrected ordinary least squares (OLS) regression: $z_{it} = \alpha_1 \times Sector_{it} + \alpha_2 \times Firm\ specific_{it} + \gamma \mathrm{X}_{it} + \mu_e \mathrm{E} + \mu_t \mathrm{T}$, where z is *Total compensation* in Columns 1 and 4, *Bonus* in Columns 2 and 5, and *Option grants* in Columns 3 and 6. The compensation data are from ExecuComp, and stock returns are from CRSP. Details on the definitions of the variables are in Appendix B. The sample includes all CEO firm year data from ExecuComp after excluding CEO transition years and firms with fiscal year ending other than December for the years 1992–2006. Robust standard errors are reported in parentheses, and the coefficients on the intercept, the CDF of the dollar variance return, and the year and executive fixed effects are suppressed for convenience. The standard errors are clustered at individual executive level. Asterisks denote statistical significance at the 1%(***), 5%(**), and 10%(*) levels.

performance for bonus payments, whereas for option grants it is positive but not statistically significant. Our point estimates are consistent with earlier articles. The point estimates imply that for a CEO of a firm with median risk, an additional $1,000 increase in firm value arising from sector movements (i.e., luck in Bertrand and Mullainathan 2001) increases the CEO's total compensation by approximately $1.20, bonus payouts by 27 cents, and new option grants by 21 cents.

It is reasonable to expect that within a firm the CEO has greater control in setting the firm's strategy and hence its sector exposure as compared to other executives. If, according to our model, pay for sector performance is aimed at providing incentives for the executive to find out the sector movements and choose the right sector exposure, then we should expect greater pay for sector performance for the CEO as compared to other executives within a firm. We test this prediction in Columns 4–6 of Table 3 by including both CEOs and non-CEO executives from ExecuComp. We include all executives who appear for more than three years in the database. We re-estimate model (6) after including three additional terms: a dummy variable *CEO* to identify CEOs and two interaction terms *Sector* × *CEO* and *Firm specific* × *CEO*. Note that in Columns

4–6 the coefficient estimates on *Sector* × *CEO* are all positive and statistically significant, regardless of how we measure compensation. This shows that pay for sector performance is indeed greater for CEOs than non-CEO executives, which is consistent with our conjecture. Interestingly, we do not find a similar pattern in pay for firm-specific performance (insignificant coefficient on *Firm specific* × *CEO*). This additional test offers some further support for our theory.

Since pay for sector performance is statistically insignificant for *Option grants* (see Columns 3 and 6 of Table 3), in the subsequent analysis, we drop *Option grants* as a measure of compensation. Furthermore, since the optimal contract in our model involves a fixed wage and stock grants, we also drop *Bonus* as a measure of compensation subsequently.

2.4.2 Pay for sector performance in multisegment firms. One main advantage of our theory is that it identifies specific situations in which pay for sector performance should be more prevalent. From Prediction 2, we expect greater pay for sector performance for multisegment firms as compared to single-segment firms. To test this, we classify firms in our sample as multisegment or single-segment firms and repeat our analysis. We identify a firm as a multisegment firm if it reports positive sales and assets in more than one three-digit SIC Code. In measuring *Sector* for multisegment firms, we use the sector performance of the firm's largest segment. In unreported robustness tests, we repeat our estimation using the weighted average sector performance of all the segments in the firm to measure *Sector* and obtain consistent results.

The results in Columns 1 and 2 of Table 4 show that there is pay for sector performance only for multisegment firms.[18] We also find that the coefficient estimates on *Sector* across the two subsamples are significantly different from each other. These results offer strong support for our theory. Since ex ante, it is not apparent that CEOs of multisegment firms are more talented than single-segment CEOs, these results also help distinguish our model from that of Oyer (2004), who predicts greater pay for sector performance for more talented CEOs with higher reservation utility.

Prior research shows that firms may endogenously choose to have multiple segments (Campa and Kedia 2002), and hence it may not be appropriate to compare the valuations of multisegment and single-segment firms. While a similar critique may be leveled against our tests as well, there are two mitigating arguments. First, it is not obvious why the differences across multisegment and single-segment firms should result in greater pay for sector performance in multisegment firms. One possible reason could be that multisegment firms may have worse governance structures as compared to single-segment firms and pay for sector performance may be a manifestation of CEO power. To

[18] We run separate tests in the subsamples of single-segment and multisegment firms to allow for different coefficients on the control variables across the two subsamples.

partly control for this, in unreported tests, we repeat our analysis after controlling for the Bebchuk, Cohen, and Ferrell (2009) entrenchment index and find that our results are robust. Second, in all our specifications, we employ executive fixed effects. To the extent that CEOs remain with the same firm, these fixed effects are likely to control for time-invariant differences across multisegment and single-segment firms. In additional robustness checks, we repeat our analysis with firm fixed effects instead of executive fixed effects and after controlling for the number of segments in the multisegment firm and obtain consistent results.

In Column 3 of Table 4, we test the second part of Prediction 2, which states that the sensitivity of pay to sector performance within a multisegment firm should be decreasing in the degree of correlation between the performance of the segments. We measure the correlation between segment performance using the correlation between the industry profitability of a multisegment firm's main segment (by total assets) and the weighted average industry profitability of all other (nonmain) segments. We use the industry profitability as opposed

Table 4
Pay for sector performance in multisegment firms

	Total compensation		
	Multisegment	Single segment	Multisegment
	(1)	(2)	(3)
Sector	1.937	0.457	1.908
	(0.470)***	(0.603)	(0.481)***
$Sector \times Low\ corr$			0.241
			(0.118)**
Low corr ($\times 10^8$)			9.018
			(13.354)
Large ($\times 10^8$)	7.134	16.033	4.788
	(2.913)**	(3.424)***	(2.908)*
Firm specific	1.163	0.587	1.162
	(0.289)***	(0.384)	(0.301)***
$Sector \times CDF\ of\ var\ of\ sector$	−1.974	−0.344	−2.047
	(0.518)***	(0.690)	(0.536)***
$Firm\ specific \times CDF\ of\ var\ of\ firm\ specific$	−1.016	−0.403	−1.010
	(0.343)***	(0.465)	(0.356)***
Obs.	4,263	4,193	3,820
R^2	0.772	0.706	0.775
$\Delta Coeff$	1.478		
	(0.770)*		

This table reports the results of the regression relating CEO compensation to the sector and firm-specific components of firm performance for the subsamples of multisegment firms (which are firms that report positive assets and sales in more than one three-digit SIC Code industry) and single-segment firms. Specifically, we estimate the panel corrected OLS regression: $Total\ compensation_{it} = \alpha_1 \times Sector_{it} + \alpha_2 \times Firm\ specific_{it} + \gamma X_{it} + \mu_e E + \mu_t T$ for each subsample. $\Delta Coeff$ is the difference between the coefficient estimates on *Sector* for the multisegment firms and the single-segment firms. The compensation data are from ExecuComp, and stock returns are from CRSP. Details on the definitions of the variables are in Appendix B. The sample includes all CEO firm year data from ExecuComp after excluding CEO transition years and firms with fiscal year ending other than December for the years 1992–2006. Robust standard errors are reported in parentheses, and the coefficients on the intercept, the CDF of the dollar variance return, and the year and executive fixed effects are suppressed for convenience. The standard errors are clustered at individual executive level. Asterisks denote statistical significance at the 1% (***), 5% (**), and 10% (*) levels.

to the actual segment profitability to avoid spurious correlations. We use the book value of total assets of the non-main segments as the weights to calculate the weighted industry performance. We then construct a dummy variable, *Low corr*, which takes the value 1 if the correlation is less than the sample median and 0 otherwise. Then, we re-estimate Equation (6), including both *Low corr* and an interaction term between *Low corr* and *Sector*. These tests are confined to firms that we identify as multisegment firms.[19] The results in Column 3 show that there is evidence of greater pay for sector performance in multisegment firms where the correlation between the industry performance of the main segment and all other segments is low. This result offers support for our theory and shows that, at least for some firms, pay for sector performance may be optimal and aimed at providing incentives for the CEO to choose the appropriate strategy.

2.4.3 Strategic flexibility and pay for sector performance. We now test Prediction 3, which predicts greater pay for sector performance in firms that offer greater strategic flexibility to the CEO. We use two alternate proxies to identify such firms. First, we use the market-to-book ratio of a firm's industry as a proxy for strategic flexibility. We define a firm's industry at the level of two-digit SIC Code and measure the industry market-to-book ratio as the median market-to-book ratio of all firms in that industry. We classify industries with market-to-book ratios above the 60th percentile as offering greater strategic flexibility to the CEO.[20] We then repeat our estimates of pay for sector performance in subsamples of firms with high and low industry market-to-book ratios. The evidence in Columns 1 and 2 of Table 5 shows that there is evidence of greater pay for sector performance for firms in industries with high market-to-book ratios. We also find that the coefficient estimates on *Sector* for the two subsamples are significantly different from each other.[21]

Next, we use industry R&D expenditures to identify flexible industries. Again, we define a firm's industry at the two-digit SIC Code level and measure the industry R&D expenditures as the median ratio of R&D expenditures to total assets of all firms in the industry. We classify industries with R&D expenditures above the 70th percentile as offering greater strategic flexibility

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19 We do not estimate our model separately for multisegment firms with low and high segment correlations because of the limited sample size.

20 The cutoff to identify high and low market-to-book industries is chosen to make the two subsamples approximately equal in size. The same split criterion is used for our second proxy of industry R&D. Our results are robust to defining high/low market-to-book and high/low R&D industries with alternate cutoffs of 50th, 60th, or 70th percentiles.

21 In our model, the CEO's private information about future sector performance may also be interpreted as information about potential misvaluation of the sector. It is reasonable to expect in such a setting that firms in currently undervalued sectors may design incentive contracts with higher pay for sector performance so as to induce the CEO to increase the exposure to the undervalued sector. To the extent that low market-to-book industries are more likely to be undervalued, such an interpretation would predict greater pay for sector performance for firms in low market-to-book industries as compared to those in high market-to-book industries. Our result of greater pay for sector performance in high market-to-book industries is not consistent with this interpretation.

Table 5
Strategic flexibility and pay for sector performance

	Total compensation			
	High MTB	Low MTB	High R&D	Low R&D
	(1)	(2)	(3)	(4)
Sector	1.714	0.533	1.498	0.991
	(0.471)***	(0.453)	(0.519)***	(0.406)**
Large	13.008	8.264	13.910	10.559
	(2.705)***	(2.921)***	(3.175)***	(2.606)***
Firm specific	0.559	0.915	0.318	0.959
	(0.258)**	(0.314)***	(0.273)	(0.292)***
$Sector \times CDF\ of\ var\ of\ sector$	−1.655	−0.536	−1.398	−0.988
	(0.519)***	(0.510)	(0.575)**	(0.460)**
$Firm\ specific \times CDF\ of\ var$	−0.402	−0.776	−0.103	−0.827
$of\ firm\ specific$	(0.311)	(0.393)**	(0.325)	(0.365)**
Obs.	6,953	5,701	5,957	6,697
R^2	0.736	0.766	0.719	0.759
$\Delta Coeff$	1.184		0.509	
	(0.650)*		(0.660)	

This table reports the results of the regression relating CEO compensation to the sector and firm-specific components of firm performance. The specification is the same as that in Table 3. In Column 1 (Column 2), we report the results for the subsample of firms in industries with market-to-book ratio above (below) the 60th percentile, and in Column 3 (Column 4), we report the results for the subsample of firms in industries with R&D expenditures above (below) the 70th percentile. The cutoffs to identify the subsamples are determined so as to obtain approximately equal-sized subsamples. $\Delta Coeff$ is the difference between the coefficient estimates on *Sector* for the subsamples. The compensation data are from ExecuComp, and stock returns are from CRSP. Details on the definitions of the variables are in Appendix B. The sample includes all CEO firm year data from ExecuComp after excluding CEO transition years and firms with fiscal year ending other than December for the years 1992–2006. Robust standard errors are reported in parentheses, and the coefficients on the intercept, the CDF of the dollar variance return, and the year and executive fixed effects are suppressed for convenience. The standard errors are clustered at individual executive level. Asterisks denote statistical significance at the 1% (***), 5% (**), and 10% (*) levels.

to the CEO. The idea is that, by scaling up or down R&D expenditures, CEOs can alter the speed of new product introduction and hence the sensitivity of firm performance to sector movements. As in Columns 3 and 4 of Table 5, pay for sector performance is greater for firms in industries with higher levels of R&D expenditures. These results offer further support for our theory.

2.4.4 Pay for sector performance, R&D expenditures, and asset growth.

Our results so far indicate that pay for sector performance is greater in firms in industries that offer the CEO greater strategic flexibility. If, according to our model, pay for sector performance provides incentives for the CEO to exploit the available strategic flexibility, then it can be argued that we should expect firms with greater pay for sector performance to show some evidence of the CEOs exploiting such flexibility to a greater extent at the firm level. To test this, we use actual firm R&D expenditures and asset growth rates to identify firms that show evidence of CEOs exploiting their strategic flexibility. Results are reported in Table 6. For each year in the sample, we classify firms with positive industry-adjusted R&D expenditures as firms in which the CEO exploits her strategic flexibility. We then form two subsamples of firms with

Table 6
Pay for sector performance, firm R&D expenditures, and asset growth

	High R&D	Low R&D	High growth	Low growth
	(1)	(2)	(3)	(4)
Sector	2.249	1.023	1.457	1.114
	(1.079)**	(0.345)***	(0.539)***	(0.362)***
Firm specific	0.253	0.621	0.610	0.667
	(0.497)	(0.235)***	(0.306)**	(0.251)***
Large ($\times 10^8$)	23.543	9.302	11.739	10.933
	(6.739)***	(2.133)***	(3.144)***	(2.141)***
$Sector \times CDF\ of\ var\ of\ sector$	−2.221	−1.014	−1.351	−1.163
	(1.165)*	(0.390)***	(0.610)**	(0.405)***
$Firm\ specific \times CDF\ of\ var$ $of\ firm\ specific$	−0.156	−0.439	−0.429	−0.527
	(0.550)	(0.285)	(0.369)	(0.307)*
Obs.	2,052	9,639	5,571	7,083
R^2	0.710	0.739	0.727	0.732
$\Delta Coeff$	1.226		0.343	
	(1.130)		(0.649)	

This table reports the results of the regression relating CEO compensation to the sector and firm-specific components of firm performance. The specification is the same as that in Table 3. In Columns 1 and 2, we report results for subsamples of firms with positive and negative industry-adjusted R&D expenditures in the following year, respectively, and in Columns 3 and 4 we report results for firms with positive and negative industry adjusted asset growth rates during the sample period, respectively. Δ*Coeff* is the difference between the coefficient estimates on *Sector* for the subsamples. The compensation data are from ExecuComp, and stock returns are from CRSP. Details on the definitions of the variables are in Appendix B. The sample includes all CEO firm year data from ExecuComp after excluding CEO transition years and firms with fiscal year ending other than December for the years 1992–2006. Robust standard errors are reported in parentheses, and the coefficients on the intercept, the CDF of the dollar variance return, and the year and executive fixed effects are suppressed for convenience. The standard errors are clustered at individual executive level. Asterisks denote statistical significance at the 1% (***), 5% (**), and 10% (*) levels.

positive (Column 1) and negative (Column 2) industry-adjusted R&D expenditures in year $t + 1$. We then re-estimate Equation (6) in the two subsamples. A larger coefficient estimate on *Sector* in the subsample of firms with positive industry-adjusted R&D expenditures as compared to firms with negative R&D expenditures in the following year would indicate greater pay for sector performance in firms that show evidence of ultimately exploiting their strategic flexibility the next year. The evidence in Columns 1 and 2 shows that pay for sector performance is indeed greater in firms that end up with higher industry-adjusted R&D expenditures. Although the coefficient on *Sector* in Column 1 is about twice the one in Column 2, we find that the coefficient estimates are not significantly different from each other. Next, we classify firms into subsamples based on whether they have positive or negative industry-adjusted asset growth rates during the sample period and re-estimate Equation (6) in the two subsamples.[22] Consistent with our conjecture, the results in Columns 3 and 4 indicate that pay for sector performance is greater in firms that have positive industry-adjusted asset growth rates, further supporting our theory.

22 Since we wish to identify firms that exploit the available strategic flexibility, we study firms with abnormally high asset growth rates and not abnormal market-to-book ratios.

2.4.5 Strategic flexibility and CEO turnover. Apart from compensation, firms can also provide incentives to the CEO through their retention decision. If CEOs suffer when they are fired, then the threat of a performance-induced dismissal likely provides additional incentives to the CEO to choose appropriate sector exposures. Jenter and Kanaan (2008) show that a decline in the industry component of firm performance significantly increases the likelihood of a disciplinary CEO turnover. Several explanations are proposed in their article, but none of them is fully supported by the data. Our theory offers a new angle to understand their finding. If disciplinary turnovers provide incentives to the CEO to choose the right sector exposure, then our model would predict that the likelihood of a disciplinary CEO turnover should be sensitive to sector performance. Furthermore, we should also observe greater sensitivity of disciplinary CEO turnover to sector performance in firms that offer greater strategic flexibility to the CEO, since in these firms sector performance is ceteris paribus more informative about the CEO's effort and talent in choosing the right sector exposure.[23]

We identify all disciplinary CEO turnovers that occur during our sample period. A turnover event is recognized for a firm in a given year if the CEO identification in the ExecuComp database changes. We then hand-collect media reports that announce CEO turnover and classify a CEO turnover as disciplinary following the procedure in Parrino (1997). Specifically, a CEO turnover is classified as disciplinary if it is reported that the CEO is fired, forced to step down, or departs due to unspecified policy differences. For announced retirements of CEOs under 65 years of age, when the announcement is not made at least six months before the effective date or does not report the reason for the departure as related to death, poor health, or the acceptance of another position, the CEO turnover is classified as a disciplinary turnover. We identify 275 instances of disciplinary CEO turnover in our sample. We then create a dummy variable *Fired* that takes the value 1 if a firm experiences a disciplinary CEO turnover and 0 otherwise. We then estimate Equation (6) with *Fired* as the dependent variable and present the results in Table 7.[24]

In Columns 1 and 2 of Table 7, we present the results in subsamples of firms with high and low industry market-to-book ratios, respectively. The evidence shows that, consistent with our conjecture, the likelihood of a disciplinary CEO turnover is more sensitive to *Sector* for firms in industries with high market-to-book ratios. Although the coefficient estimate for firms in high market-to-book industries is thrice the coefficient for firms in low market-to-book industries (−0.049 in comparison to −0.016), due to the noise in our estimation, we find that the estimates are not statistically different from each other. We repeat our estimation in Columns 3 and 4 with industry R&D expenditures as a measure

[23] It is also reasonable to expect the sensitivity to be greater for multisegment as compared to single-segment firms. We have very few instances of disciplinary CEO turnovers for multisegment firms and thus we do not test this.

[24] We do not employ the logit or the probit models due to the incidental parameters problem that is likely in nonlinear models with a large number of variables (Woolridge 2001).

Table 7
Strategic flexibility and CEO turnover

	Fired			
	High MTB	Low MTB	High R&D	Low R&D
	(1)	(2)	(3)	(4)
Sector ($ billion)	−0.049	−0.016	−0.063	−0.022
	(0.018)***	(.017)	(0.023)***	(0.014)
Firm specific ($ billion)	−0.038	0.0009	−0.046	0.006
	(0.012)***	(0.011)	(0.014)***	(0.009)
Large	0.007	−0.001	−.008	0.002
	(0.007)	(0.010)	(0.008)	(0.009)
$Sector \times CDF\ of\ var\ of\ sector$ ($ billion)	0.053	0.013	0.070	0.019
	(0.019)***	(0.019)	(0.025)***	(0.015)
$Firm\ specific \times CDF$	0.041	−0.007	0.050	−0.011
of var of firm specific ($ billion)	(0.014)***	(0.013)	(0.017)***	(0.011)
Obs.	6,994	5,729	5,992	6,731
R^2	0.432	0.464	0.380	0.442
$\Delta Coeff$	−0.033		−0.041	
	(0.024)		(0.027)	

This table reports the results of the regression relating the probability of a CEO getting fired to the sector and firm-specific components of firm performance. Specifically, we estimate the panel corrected OLS regression: $Fired_{it} = \alpha_1 \times Sector_{it} + \alpha_2 \times Firm\ specific_{it} + \gamma \mathrm{X}_{it} + \mu_e \mathrm{E} + \mu_t \mathrm{T}$. In Columns 1 and 2, we report the results for the subsample of firms in industries with market-to-book ratio above and below the 60th percentile, respectively, and in Columns 3 and 4, we report the results for the subsample of firms in industries with R&D expenditures above and below the 70th percentile, respectively. The cutoffs to identify the subsamples are determined so as to obtain approximately equal-sized subsamples. $\Delta Coeff$ is the difference between the coefficient estimates on *Sector* for the subsamples. The CEO turnover data are from ExecuComp, and stock returns are from CRSP. Details on the definitions of the variables are in Appendix B. The sample includes all CEO firm year data from ExecuComp after excluding CEO transition years and firms with fiscal year ending other than December for the years 1992–2006. Robust standard errors are reported in parentheses, and the coefficients on the intercept, the CDF of the dollar variance return, and the year and executive fixed effects are suppressed for convenience. The standard errors are clustered at individual executive level. Asterisks denote statistical significance at the 1% (***), 5% (**), and 10% (*) levels.

of strategic flexibility. Our results again show that the likelihood of a disciplinary CEO turnover is more sensitive to *Sector* in firms in industries with high R&D expenditures, consistent with our theory and Jenter and Kanaan's (2008) finding.

2.4.6 CEO talent and pay for sector performance. In Table 8, we test Prediction 4, which indicates greater pay for sector performance for more talented CEOs. We use three proxies for CEO talent. Our first proxy for talent is the industry-adjusted stock performance of the firm during the previous year. Our second proxy is a classification of the CEO as internal or external. Our third proxy measures the talent of external CEOs and is based on the stock performance of the firm from which the external CEO is hired.

We use the industry-adjusted stock performance during the previous year as our first proxy for CEO talent.[25] The idea is that firms managed by more

25 Since we measure performance over a one-year period, we do not use a performance measure such as the Carhart (1997) four-factor alpha whose accurate estimation may require more data.

Table 8
CEO talent and pay for sector performance

	Total compensation					
	High return	Low return	External	Internal	External	
					Prev +ve alpha	Prev −ve alpha
	(1)	(2)	(3)	(4)	(5)	(6)
Sector	1.436	0.952	1.786	0.997	3.773	1.053
	(0.484)***	(0.534)*	(0.705)**	(0.337)***	(1.514)**	(1.264)
Firm specific	0.385	1.116	1.344	0.455	0.077	1.315
	(0.291)	(0.318)***	(0.468)***	(0.208)**	(0.707)	(0.886)
Large ($\times 10^8$)	14.150	9.022	16.372	9.607	19.254	19.136
	(3.017)***	(2.722)***	(4.724)***	(1.905)***	(6.555)**	(9.775)**
$Sector \times CDF\ of\ var\ of\ sector$	−1.495	−0.811	−1.791	−0.954	−3.998	−0.766
	(0.546)***	(0.609)	(0.791)**	(0.382)**	(1.861)**	(1.393)
$Firm\ specific \times CDF\ of\ var\ of\ firm\ specific$	−0.155	−0.949	−1.303	−0.253	0.614	−1.444
	(0.351)	(0.389)**	(0.590)**	(0.251)	(0.946)	(1.088)
Obs.	6,191	6,308	3,176	9,478	1,362	858
R^2	0.775	0.791	0.678	0.747	0.605	0.629
$\Delta Coeff$	0.484		0.789		2.72	
	(0.721)		(0.781)		(1.970)	

This table reports the results of the regression relating CEO compensation to the sector and firm-specific components of firm performance. The specification is the same as that in Table 3. In Columns 1 and 2, we report results for the subsamples of CEOs of firms with above and below industry-adjusted performance during the previous year; in Columns 3 and 4, we report results for the subsamples of internal and external CEOs; and in Columns 5 and 6, we report results for the subsamples of external CEOs who have positive and negative Carhart (1997) four-factor alphas in their previous firms. Δ*Coeff* is the difference between the coefficient estimates on *Sector* for the subsamples. The compensation data are from ExecuComp, and stock returns are from CRSP. Details on the definitions of the variables are in Appendix B. The sample includes all CEO firm year data from ExecuComp after excluding CEO transition years and firms with fiscal year ending other than December for the years 1992–2006. Robust standard errors are reported in parentheses, and the coefficients on the intercept, the CDF of the dollar variance return, and the year and executive fixed effects are suppressed for convenience. The standard errors are clustered at individual executive level. Asterisks denote statistical significance at the 1% (***), 5% (**), and 10% (*) levels.

talented CEOs will exhibit better industry-adjusted stock performance. We measure the annual industry-adjusted performance as the average of $\frac{R_i - R_{ind}}{\sigma_i}$, where R_i is the monthly return on the firm i's stock, R_{ind} is the monthly equal-weighted industry return, and σ_i is the standard deviation of the monthly return of all firms in the same industry as firm i. To test for greater pay for sector performance for more talented CEOs, we divide our sample into two: CEOs of firms with above and below median industry-adjusted performance during the previous year. We then repeat the estimation in both subsamples. The results reported in Columns 1 and 2 of Table 8 show that there is strong evidence of pay for sector performance for more talented CEOs. Specifically, *Total compensation* loads significantly more on *Sector* for CEOs with above median industry-adjusted performance.

Next, we classify CEOs as internal or external depending on whether the CEO was recruited from inside or outside the firm. We classify a CEO as external if the individual becomes the CEO within two years of joining the firm. Following Milbourn (2003), we associate external CEOs as being more talented than internal CEOs and repeat our tests in the two subsamples. The results reported in Columns 3 and 4 show that there is evidence of greater pay for sector performance for external CEOs as compared to internal CEOs.

Last, we look at the subsample of external CEOs to try to further differentiate between talented and untalented ones. To achieve that, we identify the previous firm from which an external CEO was hired and measure the stock performance of that firm during the tenure of the executive. We use the Carhart (1997) four-factor alpha during the executive's tenure as a measure of firm performance.[26] We then identify external CEOs hired from firms with positive four-factor alphas as more talented than those hired from firms with negative alphas. We then re-estimate Equation (6) in the two subsamples of external CEOs. Our results in Columns 5 and 6 provide evidence of greater pay for sector performance for external CEOs hired from firms with positive four-factor alphas.

2.4.7 Asymmetric pay for sector performance. In this section, we test Prediction 5, which predicts asymmetry in the optimal pay for sector performance relationship. In Panel A of Table 9, we test whether there is evidence of asymmetry in the overall pay for sector performance relationship. The tests in this subsection are similar to those in Garvey and Milbourn (2006) except that our sample period is longer. To test for asymmetry, we repeat the estimation of Equation (6) after replacing *Sector* with two interaction terms, namely *Sector* $\times$ (+*ve Sector*) and *Sector* $\times$ (−*ve Sector*). Recall that +*ve Sector* (−*ve Sector*) is a dummy variable that takes the value 1 when *Sector* is positive

[26] Since we estimate performance during the full tenure of the executive, we have sufficient data to estimate the four-factor alphas.

Table 9
Asymmetric pay for sector performance

Panel A: Asymmetric pay for sector performance

	Total compensation
Sector × (+*ve Sector*)	2.080
	(0.333)***
Sector × (−*ve Sector*)	0.036
	(0.339)
Firm specific	0.812
	(0.200)***
Sector × *CDF of var of sector*	−1.740
	(0.359)***
Firm specific × *CDF of var of firm specific*	−0.648
	(0.243)***
Obs.	12,654
R^2	0.729
Sector × (+*ve Sector*) − *Sector* × (−*ve Sector*)	2.044
	(0.261)***

Panel B: Conglomeration, strategic flexibility, and asymmetric pay for sector performance

	Total compensation					
	Multisegment	Single segment	High MTB	Low MTB	High R&D	Low R&D
	(1)	(2)	(3)	(4)	(5)	(6)
Sector × (+*ve Sector*)	2.650	1.342	2.479	1.385	2.340	1.696
	(0.491)***	(0.635)**	(0.494)***	(0.494)***	(0.565)***	(0.431)***
Sector × (−*ve Sector*)	0.884	−0.773	0.181	−0.225	0.629	−0.202
	(0.527)*	(0.633)	(0.536)	(0.496)	(0.557)	(0.453)
Firm specific	1.270	0.729	0.712	1.001	0.445	1.037
	(0.293)***	(0.393)*	(0.263)***	(0.315)***	(0.278)	(0.294)***
Sector × *CDF of var of sector*	−2.408	−0.905	−2.112	−1.137	−2.038	−1.372
	(0.520)***	(0.699)	(0.526)***	(0.531)**	(0.603)***	(0.467)***
Firm specific × *CDF of var of firm specific*	−1.114	−0.536	−0.547	−0.869	−0.233	−0.892
	(0.348)***	(0.476)	(0.316)*	(0.394)**	(0.330)	(0.367)**
Obs.	4,263	4,193	6,953	5,701	5,957	6,697
R^2	0.774	0.706	0.737	0.768	0.719	0.761
Sector × (+*ve Sector*) − *Sector* × (−*ve Sector*)	1.765	2.117	2.298	1.611	1.711	1.898
	(0.416)***	(0.416)***	(0.405)***	(0.379)***	(0.397)***	(0.353)***

Table 9
(Continued)

Panel C: CEO talent and asymmetric pay for sector performance

	Total compensation					
	High return	Low return	External	Internal	External (prev +ve alpha)	External (prev −ve alpha)
	(1)	(2)	(3)	(4)	(5)	(6)
Sector × (+*ve Sector*)	2.089	1.820	3.023	1.761	5.752	1.488
	(0.527)***	(0.550)***	(0.769)***	(0.356)***	(1.631)***	(1.238)
Sector × (−*ve Sector*)	0.574	−0.517	0.404	−0.120	2.154	−0.348
	(0.529)	(0.571)	(0.766)	(0.376)	(1.696)	(1.368)
Firm specific	0.449	1.234	1.529	0.565	0.155	1.764
	(0.295)	(0.322)***	(0.487)***	(0.209)***	(0.762)	(0.736)**
Sector × *CDF of var of sector*	−1.925	−1.322	−2.641	−1.436	−5.439	−0.876
	(0.567)***	(0.609)**	(0.825)***	(0.388)***	(1.964)***	(1.262)
Firm specific × *CDF of var of firm specific*	−0.218	−1.061	−1.486	−0.355	0.583	−1.911
	(0.355)	(0.394)***	(0.610)**	(0.252)	(0.982)	(0.954)**
Obs.	6,191	6,308	3,176	9,478	1,365	855
R^2	0.774	0.795	0.679	0.749	0.602	0.642
Sector × (+*ve Sector*) − *Sector* × (−*ve Sector*)	1.515	2.337	2.619	1.881	3.411	2.805
	(0.418)***	(0.377)***	(0.573)***	(0.289)***	(0.842)***	(1.543)*

Panel A of this table reports the results of the regression relating CEO compensation to sector and firm-specific components of firm performance. Specifically, we estimate the panel corrected OLS regression: $\textit{Total compensation}_{it} = \alpha_1 \times \textit{Sector} \times (+\textit{ve Sector})_{it} + \alpha_2 \times \textit{Sector} \times (-\textit{ve Sector})_{it} + \alpha_3 \times \textit{Firm specific}_{it} + \gamma X_{it} + \mu_e E + \mu_t T$. *Sector* × (+*ve Sector*) − *Sector* × (−*ve Sector*) is the difference between the coefficient estimates on *Sector* × (+*ve Sector*) and *Sector* × (−*ve Sector*). Panel B repeats the estimations separately for multisegment and single-segment firms (Columns 1–2) and for firms that offer different degrees of strategic flexibility (Columns 3–6). We identify multisegment firms as those which report positive assets and sales in more than one three-digit SIC Code industry. We measure the extent of strategic flexibility using industry market-to-book ratio (Columns 3–4) and industry R&D expenditures (Columns 5–6). Panel C repeats the estimations for talented and less talented CEOs, where talent is measured by industry-adjusted firm performance during previous year (Columns 1–2), whether the CEO is hired from inside or outside (Columns 3–4), and the performance of the externally hired CEO's previous employer as measured by Carhart (1997) four-factor alpha (Columns 5–6). The compensation data are from ExecuComp, and stock returns are from CRSP. Details on the definitions of the variables are in Appendix B. The sample includes all CEO firm year data from ExecuComp after excluding CEO transition years and firms with fiscal year ending other than December for the years 1992–2006. Robust standard errors are reported in parentheses; the coefficients on the intercept, the CDF of the dollar variance return, and the year and executive fixed effects are suppressed for convenience. The standard errors are clustered at individual executive level. Asterisks denote statistical significance at the 1% (***), 5% (**), and 10% (*) levels.

(negative) and 0 otherwise. The results in Panel A show that there is significantly greater reward for good sector performance than for bad sector performance. These results are consistent with Garvey and Milbourn (2006) and our model.

In Panel B of Table 9, we repeat our estimation to see if pay for sector performance asymmetry is present in multisegment firms and firms that offer more strategic flexibility. Although our objective is only to establish pay for sector performance asymmetry in these firms, to provide a complete picture, we repeat the estimation in both subsamples of multisegment and single-segment firms. Consistent with our prediction, we do find asymmetry in the pay for sector performance relationship in multisegment firms (see Column 1). Next, we repeat our estimation to see if the asymmetry in pay for sector performance is present for firms that offer greater strategic flexibility to the CEO. In Columns 3 and 4, we measure strategic flexibility using industry market-to-book ratio. As stated, industries with higher market-to-book ratios are likely to offer greater strategic flexibility to the CEO. Consistent with our prediction, we do find asymmetry in the pay for sector performance relationship in the subsample with high market-to-book ratios. We next use industry R&D expenditure as a measure of strategic flexibility in Columns 5 and 6. Here again, consistent with our model, we find pay for sector performance asymmetry in firms in high R&D industries.

In Panel C of Table 9, we test to see if pay for sector performance asymmetry is present for more talented CEOs. We rely on our same three proxies for CEO talent. In Columns 1 and 2, we use the industry-adjusted stock performance during the previous year as a measure of CEO talent and find that pay for sector performance asymmetry is present for CEOs in firms with higher industry-adjusted stock performance during the previous year. In Columns 3 and 4, we classify CEOs as internal or external and find that pay for sector performance asymmetry is present for externally hired CEOs, who are likely to be more talented. Finally, in Columns 5 and 6, we classify external CEOs based on the stock performance of their previous employers and find that pay for sector performance asymmetry is present for those hired from firms with positive Carhart four-factor alphas. Overall, these results offer strong support for our theory.

3. Conclusion

Optimal contracting prescribes that any portion of a firm's performance that is truly outside of the CEO's control should be filtered out of her pay, but empirically, neither sector nor market movements are filtered out in CEO pay packages. Many interpret this as a failure of corporate governance, arguing that CEOs have taken control over their own corporate boards and set pay in their own interests. Our article suggests that the observed relationship between CEO pay and sector performance is consistent with optimal contracting if one takes an alternative perspective on the genesis of the portion of the firm's performance popularly referred to as luck. In this article, we provide a simple model of firms employing CEOs to select and implement the firm's strategy and that this strategy choice manifests itself in realized exposures to sector returns. Ultimately, we attribute at least a portion of the firm's returns that correlate with sector returns to the CEO's decision to have just such an exposure. Optimal compensation necessarily adapts to such a setting and predicts the positive relationship uncovered empirically between CEO pay and sector performance. In fact, our analysis suggests that filtering out the portion of a firm's performance that is attributable to sector forces would actually distort CEO incentives. Our analysis also suggests that the positive reward for sector performance should be more prominent in multisegment firms and in firms for which the CEO has greater flexibility to change the firm's strategy by altering its exposures. Using a novel set of proxies for strategic flexibility, we uncover strong empirical support for this prediction. In future work, we hope to move beyond our current empirical focus on industry returns and explore the implications of modeling a CEO's action space more broadly as an active agent leading the firm and allocating its resources accordingly.

Appendix A: Proofs of Propositions

Proof of Proposition 1. Note that under the specific assumption for the CEO's utility function, we have $\mathbf{E}\Big(V_{CEO}(w_0 + w[\beta_i \bar{r} \pm \beta_i r_s + \varepsilon])\Big) = w_0 + w[\beta_i \bar{r} \pm \beta_i r_s] - [\lambda/2][w^2\sigma^2] - [\lambda/2]\{w[\beta_i \bar{r} \pm \beta_i r_s]\}$, $i \in \{H, L\}$, where $\lambda \in (0, 2)$. The CEO's incentive-compatibility constraint, Equation (3), can be written as

$$e = \frac{[w\beta][\bar{r} + r_s][2 - \lambda]}{2\delta}, \tag{A1}$$

and the participation constraint, Equation (2), can then be written as

$$\begin{aligned} 2\bar{V}_{CEO} &= \mathbf{E}\Big(V_{CEO}(w_0 + w\varepsilon) + V_{CEO}(w_0 + w\varepsilon)\Big) + \frac{\delta e^2}{2} \\ &= 2w_0 - \lambda w^2\sigma^2 + \frac{[w^2\beta^2][\bar{r} + r_s]^2[2 - \lambda]^2}{8\delta}. \end{aligned} \tag{A2}$$

Substituting both Equations A1 and A2 into the investors' objective function (1), we can rewrite the investors' optimization problem as

$$\max_{\{w\}} \frac{w[1 - w][\beta^2][\bar{r} + r_s]^2[2 - \lambda]}{4\delta} + \frac{[w^2\beta^2][\bar{r} + r_s]^2[2 - \lambda]^2}{16\delta} - \frac{\lambda w^2\sigma^2}{2} - \bar{V}_{CEO}. \tag{A3}$$

Denote the solution as w^*, we have

$$w^* = \frac{4 - 2\lambda}{4 - \lambda^2 + \frac{8\lambda\delta\sigma^2}{\beta^2[\bar{r} + r_s]^2}}. \tag{A4}$$

It is clear from Equation A4 that w^* is increasing in β and r_s and decreasing in δ.

Proof of Proposition 2. Note that w^* is given by Equation A4. We now analyze the multisegment firm. Given the contract (w_{0m}, w_m), the CEO's expected utility is

$$V_{CEO}(w_{0m}, w_m) = [e\eta]\left[\frac{\mathbf{E}\Big(V_{CEO}(w_{0m} + w_m[\beta\bar{r} + \beta r_s + \varepsilon]) + V_{CEO}(w_{0m} + w_m\varepsilon)\Big)}{2}\right] + [e][1-\eta]\mathbf{E}\Big(V_{CEO}(w_{0m} + w_m[\beta\bar{r} + \beta r_s + \varepsilon])\Big) + [1-e]\mathbf{E}\Big(V_{CEO}(w_{0m} + w_m\varepsilon)\Big) - \frac{\delta e^2}{4}. \quad (A5)$$

To understand Equation A5, first suppose the CEO generates the signal. With probability η, the two sectors realize the same return, in which case: (i) with probability $1/2$, both sectors realize $\bar{r} + r_s > 0$ but the CEO can only choose the high-exposure strategy for one sector, resulting in the firm return being $[\beta][\bar{r} + r_s] + [0][\bar{r} + r_s] + \varepsilon = \beta\bar{r} + \beta r_s$; and (ii) with probability $1/2$, both sectors realize $\bar{r} - r_s < 0$ and the CEO chooses the low-exposure strategy for both, resulting in the firm return being ε. This corresponds to the first term in Equation A5. With probability $1-\eta$, the two sectors realize different returns. The CEO chooses the high-exposure strategy for the outperforming sector (with return of $\bar{r} + r_s$) and the low-exposure strategy for the underperforming sector (with return of $\bar{r} - r_s$), resulting in the firm return being $[\beta][\bar{r} + r_s] + [0][\bar{r} - r_s] + \varepsilon = \beta\bar{r} + \beta r_s$, regardless of which sector outperforms. This corresponds to the second term in Equation A5. Finally, if the CEO fails to generate the signal, she chooses $\beta_L = 0$ for the two sectors, resulting in the firm return being $[0][R_{s1} + R_{s2}] + \varepsilon = \varepsilon$, regardless of the realized values of R_{s1} and R_{s2}.

The CEO's incentive-compatibility constraint can be written as

$$e = \frac{[w_m\beta][\bar{r} + r_s][2-\lambda][2-\eta]}{2\delta}. \quad (A6)$$

The investors' expected payoff is

$$V_I(w_{0m}, w_m) = [1 - w_m][e]\left\{[\eta]\left[\frac{\beta\bar{r} + \beta r_s}{2}\right] + [1-\eta][\beta\bar{r} + \beta r_s]\right\} - w_{01}. \quad (A7)$$

The investors' contracting problem can be solved in the same way as that in the proof of Proposition 1 for the single-segment firm, which yields

$$w_m^* = \frac{4 - 2\lambda}{4 - \lambda^2 + \frac{8\lambda\delta\sigma^2}{\beta^2[\bar{r}+r_s]^2[2-\eta]^2}}, \quad (A8)$$

which is larger than w^*. It is also clear that $\partial w_m^*/\partial\eta < 0$, and $w_m^* \downarrow w^*$ when $\eta \uparrow 1$.

Proof of Proposition 3. If the CEO always chooses the high-exposure strategy ($\beta_H = \beta$) when the private signal Θ is not generated, then the CEO's incentive-compatibility constraint, Equation (3), can be written as

$$\mathbf{E}\Big(V_{CEO}(w_0 + \underline{w}\varepsilon) - V_{CEO}(w_0 + \underline{w}[\beta\bar{r} - \beta r_s + \varepsilon])\Big) = \delta e. \quad (A9)$$

On the other hand, if the CEO always chooses the low-exposure strategy ($\beta_L = 0$) when Θ is not generated, then we have

$$\mathbf{E}\Big(V_{CEO}(w_0 + \bar{w}[\beta\bar{r} + \beta r_s + \varepsilon]) - V_{CEO}(w_0 + \bar{w}\varepsilon)\Big) = \delta e. \quad (A10)$$

Thus, in equilibrium under the optimal contract, we have

$$\delta e = \mathbf{E}\Big(V_{CEO}(w_0^* + \underline{w}^*\varepsilon) - V_{CEO}(w_0^* + \underline{w}^*[\beta\bar{r} - \beta r_s + \varepsilon])\Big) = \mathbf{E}\Big(V_{CEO}(w_0^* + \bar{w}^*[\beta\bar{r} + \beta r_s + \varepsilon]) - V_{CEO}(w_0^* + \bar{w}^*\varepsilon)\Big) > 0. \quad (A11)$$

First, note that we must have $\bar{w}^* > 0$ and $\underline{w}^* > 0$ in order for Equation A11 to hold. The reason is as follows. If $\bar{w}^* = 0$, then $\mathbf{E}\Big(V_{CEO}(w_0^* + \bar{w}^*[\beta\bar{r} + \beta r_s + \varepsilon]) - V_{CEO}(w_0^* + \bar{w}^*\varepsilon)\Big) = 0$; similarly, if $\underline{w}^* = 0$, then $\mathbf{E}\Big(V_{CEO}(w_0^* + \underline{w}^*\varepsilon) - V_{CEO}(w_0^* + \underline{w}^*[\beta\bar{r} - \beta r_s + \varepsilon])\Big) = 0$. Second, note that, for any realized value of ε, $\{w_0^* + \bar{w}^*[\beta\bar{r} + \beta r_s + \varepsilon]\} > \{w_0^* + \bar{w}^*\varepsilon\} > \{w_0^* + \underline{w}^*[\beta\bar{r} - \beta r_s + \varepsilon]\}$. Thus, we must have $\{w_0^* + \bar{w}^*[\beta\bar{r} + \beta r_s + \varepsilon]\} - \{w_0^* + \bar{w}^*\varepsilon\} > \{w_0^* + \underline{w}^*\varepsilon\} - \{w_0^* + \underline{w}^*[\beta\bar{r} - \beta r_s + \varepsilon]\}$, that is,

$$\bar{w}^*[\bar{r} + r_s] > \underline{w}^*[r_s - \bar{r}], \tag{A12}$$

in order for Equation A11 to hold because $V_{CEO}(\cdot)$ is concave. If $\bar{r} \leq 0$, Equation A12 clearly implies that $\bar{w}^* > \underline{w}^*$. If $\bar{r} > 0$, in order to have $\bar{w}^* > \underline{w}^*$, $\bar{w}^*[\bar{r} + r_s]$ must be sufficiently larger than $\underline{w}^*[r_s - \bar{r}]$, that is, $V_{CEO}(\cdot)$ must be sufficiently concave and the CEO be sufficiently risk averse.

To show $\bar{w}^* - \underline{w}^*$ is increasing in β, note that $\{w_0^* + \bar{w}^*[\beta\bar{r} + \beta r_s + \varepsilon]\} - \{w_0^* + \bar{w}^*\varepsilon\} = \bar{w}^*\beta[\bar{r} + r_s]$, and $\{w_0^* + \underline{w}^*\varepsilon\} - \{w_0^* + \underline{w}^*[\beta\bar{r} - \beta r_s + \varepsilon]\} = \underline{w}^*\beta[\bar{r} - r_s]$. As β increases, say by $\Delta\beta$, there are four possibilities for the changes of $\bar{w}^*$ and $\underline{w}^*$ under the new optimal contract. First, both $\bar{w}^*$ and $\underline{w}^*$ increase. Suppose $\bar{w}^*$ increases by $\Delta\bar{w}^*$ and $\underline{w}^*$ increases by $\Delta\underline{w}^*$ under the new optimal contract. If the CEO is sufficiently risk averse (i.e., $V_{CEO}(\cdot)$ is sufficiently concave), $\Delta\bar{w}^*\Delta\beta[\bar{r} + r_s]$ must be much larger than $\Delta\underline{w}^*\Delta\beta[\bar{r} - r_s]$ in order for the incentive-compatibility constraint Equation A11 to hold under the new optimal contract; this is because $V_{CEO}(\cdot)$ is concave. That is, $\Delta\bar{w}^* > \Delta\underline{w}^*$, and $\bar{w}^* - \underline{w}^*$ is increasing in β. Second, $\bar{w}^*$ increases, whereas $\underline{w}^*$ decreases. In this case, it is trivially true that $\bar{w}^* - \underline{w}^*$ increases. Third, both $\bar{w}^*$ and $\underline{w}^*$ decrease. Suppose $\bar{w}^*$ decreases by $\Delta\bar{w}^*$ and $\underline{w}^*$ decreases by $\Delta\underline{w}^*$ under the new optimal contract. We must have $\Delta\bar{w}^*\Delta\beta[\bar{r} + r_s] < \Delta\underline{w}^*\Delta\beta[\bar{r} - r_s]$, and hence $\Delta\bar{w}^* < \Delta\underline{w}^*$, in order for the incentive-compatibility constraint Equation A11 to hold under the new optimal contract; this is again because $V_{CEO}(\cdot)$ is concave. That is, $\bar{w}^* - \underline{w}^*$ is again increasing in β in this case. Finally, $\bar{w}^*$ decreases, whereas $\underline{w}^*$ increases. This is, however, not possible, since the incentive-compatibility constraint Equation A11 will not hold under the new contract in this case.

Appendix B: Empirical Variable Definitions

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

- *Salary* is the CEO's yearly salary value.
- *Bonus* is the CEO's yearly bonus value.
- *Option grants* represents the Black-Scholes value of the options granted to the CEO in the 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.
- *Tenure* for any year is calculated as the difference between the fiscal year-end of that year and the date at which the CEO became CEO as given by the BecameCEO field in ExecuComp.
- *Age* is the CEO's age in the data year.
- *Stock return* is the one-year percentage return for the firm over its fiscal year.
- *Volatility* is the stock return volatility provided in ExecuComp that is used to calculate the Black-Scholes value of the stock options.
- *Market value* is the firm's equity market capitalization at the end of the firm's fiscal year.
- *Log*(*assets*) is the natural logarithm of the book value of total assets.
- *Sector* is the sector component of firm performance estimated using the equal- and value-weighted industry returns, where industry is defined at the two-digit SIC Code level.

- *+ve Sector* (*−ve Sector*) is a dummy variable that takes the value 1 when the sector performance is positive (negative) and 0 otherwise.
- *Firm specific* is the residual firm performance and is estimated as the difference between firm return and *Sector*.
- *CDF of var of sector* (*Firm specific*) is the CDF of the variance of *Sector* (*Firm specific*).
- *CEO* is a dummy variable that takes the value 1 if the executive is a CEO and 0 otherwise.
- *Large* is a dummy variable that equals 1 if the firm size, as measured by the natural logarithm of the book value of total assets, is above the sample median.
- *Low corr* is a dummy variable that takes the value 1 for multisegment firms in which the correlation between the industry performance of the main segment and the weighted-average industry performance of the other (nonmain) segments is less than the sample median.
- *Fired* is a dummy variable that takes the value 1 for a disciplinary CEO turnover. We classify a CEO turnover as disciplinary following the procedure in Parrino (1997). Specifically, a CEO turnover is classified as disciplinary if it is reported that the CEO is fired, is forced to step down, or departs due to unspecified policy differences. For other cases, if the departing CEO is under the age of 65 and the news announcement reports that the CEO is retiring but does not announce the retirement at least six months before the effective date or if the announcement does not report the reason for the departure as related to death, poor health, or the acceptance of another position, then the turnover is classified as disciplinary.

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