1. Introduction

A key aspect of corporate governance is embodied in the decision rights granted to a firm’s board of directors to hire, compensate, and fire the chief executive officer (CEO). These decision rights are manifested in comprehensive incentive schemes that include both a formal compensation contract and an option, exercisable at the board’s discretion, to fire and replace incumbent CEOs. A vast literature examines the design of executive compensation contracts, including a number of papers focused in particular on the important role that firm performance risk plays in optimal contract design via the pay-performance-sensitivity (PPS) aspect of CEOs’ compensation contracts.¹ While there also exists a significant empirical research stream that investigates relations between CEO turnover and realized firm performance, little attention has been directed toward isolating key channels through which firm performance risk can
directly impact CEO turnover decisions. In this paper, we extend the extant literature by establishing fundamental connections between firm performance risk and CEO turnover.

The central focus of our analysis is on the role played by performance risk in impacting a board’s ability to learn about a CEO’s unknown talent. This focus on interactions between performance risk and learning processes of boards introduces a different perspective on risk from that typical in the executive compensation literature. The archetypical compensation setting is concerned with designing optimal incentives for executives to take actions that benefit shareholders. In this setting, performance risk represents noise with respect to observing an executive’s actions, and risk-averse executives must be paid a risk premium for bearing performance risk, regardless of the source of the risk. In contrast to the role of firm performance in the provision of incentives, CEO turnover decisions instead utilize firm performance to learn about a CEO’s unobservable talent. A key element in a board of director’s decision to retain or dismiss an incumbent CEO is the board’s assessment of the CEO’s talent relative to the assessed talent of potential replacement CEOs. This learning perspective shifts the focus from the impact of performance risk on the risk premium demanded by risk-averse executives to the role played by performance risk in facilitating or impeding a board’s ability to learn about CEO talent from realized performance.

The fundamental insight of our paper is that the impact of performance risk on the ability of boards to learn about CEO talent from firm performance depends crucially on the underlying sources of the risk. The idea is that if volatility in performance outcomes is driven primarily by unobservable CEO talent, firm performance is diagnostic about such talent, allowing boards to accurately assess CEO talent and to replace low talent incumbents. However, if volatility in performance outcomes is driven by factors unrelated to CEO talent (e.g., noise, economy-wide effects, etc.), then a board’s ability to infer CEO talent from performance is more limited, making it difficult to cleanly distinguish an incumbent’s talent level from the assessed talent of potential replacement CEOs.

To isolate these two fundamental economic forces, we first analyze a simple, two-period model with symmetric learning about unknown CEO talent. We derive the optimal firing rule as a function of two sources of risk: risk deriving from uncertainty about a CEO’s unobservable talent level and risk deriving from sources outside the CEO’s control. The model produces three empirical implications concerning the relation between performance risk and CEO turnover. First, the probability of CEO turnover is increasing in the variance of the distribution over CEO talent. When uncertainty over CEO talent increases relative to other sources of variability, firm performance becomes relatively more diagnostic about CEO talent, increasing the board’s ability to detect low talent incumbents and exercise their firing option when warranted. Second, the probability of CEO turnover is decreasing in volatility unrelated to talent and beyond the CEO’s control. Such volatility represents noise from the perspective of learning about a CEO’s talent from observed performance. More noise increases the difficulty of distinguishing the talent of incumbents from those of potential rookie CEOs, increasing the board’s reluctance to incur the costs of exercising their firing option. Third, the sensitivity of CEO turnover to observed performance is increasing in the variance of the distribution over CEO talent and decreasing in volatility unrelated to talent.

Turning to our empirical analysis, we use stock returns as our empirical measure of firm performance and decompose return volatility into its idiosyncratic and systematic components. We posit that idiosyncratic volatility reflects information arrival related to the impact of CEO talent on firm performance, while systematic volatility captures aspects of return variability unrelated to CEO talent and beyond the CEO’s control. We predict that these distinct aspects of volatility have opposite effects on CEO turnover given their differential implications for the process of learning about CEO talent. Consistent with this prediction, we provide robust empirical evidence that the likelihood of CEO turnover is increasing in idiosyncratic risk and decreasing in systematic risk, after controlling for firm performance.

We also predict and show that turnover-performance-sensitivity increases in idiosyncratic risk and decreases in systematic risk, consistent with the information content of performance with respect to learning about CEO’s talent increasing in idiosyncratic risk and decreasing in systematic risk. This result stands in stark contrast to the extant executive compensation literature in which higher performance risk from any source is generally expected to
decrease pay-performance-sensitivity due to risk-aversion considerations. In our turnover setting, risk impacts the learning process and can either increase or decrease turnover-performance-sensitivity depending on the underlying source of the volatility.

It is instructive to contrast our analysis of risk and CEO turnover with the Jin (2002) analysis of risk and CEO pay-performance-sensitivity. Analogous to our study, Jin (2002) decomposes the volatility of stock returns into idiosyncratic and systematic components. Using data on executive compensation contracts, he shows that idiosyncratic risk is negatively related to pay-performance-sensitivity, but he finds little relation between systematic risk and incentive level. These results are consistent with the Jin (2002) model in which all (unhedged) sources of performance volatility represent risk that the CEO must be compensated for bearing, resulting in the classic trade-off between CEO incentives and the cost of CEOs’ bearing risk. In contrast, in our setting, higher volatility driven by factors related to CEO talent (i.e., idiosyncratic risk) makes firm performance more diagnostic about talent, where volatility unrelated to CEO talent (i.e., systematic risk) is noise from a learning perspective. Thus, our paper complements Jin (2002) by exploring the impact of performance volatility in a different, but interrelated context, revealing distinct channels through which performance risk impacts contracting relations between boards and CEOs.

In Section 6, we complete our empirical analysis by exploring interrelations between the firing option and CEO compensation. First, we show that for retained CEOs, pay-performance-sensitivity is decreasing in the probability of turnover. This is consistent with our model that when the probability of turnover is high, the CEO faces high-powered implicit incentives and so requires less explicit incentives. We also show that for CEOs who are retained, subsequent pay levels are also a decreasing function of the probability of turnover, suggesting that the retained CEO could be forced to take a pay cut as turnover pressure increases. This is consistent with Gao, Harford, and Li (2008), who show that pay cuts can be a short-term substitute for dismissal.

Finally, it is important to relate our paper with Jenter and Kanaan (2008) and Kaplan and Minton (2006), who show that the systematic component of returns significantly influences the likelihood of CEO turnover, contrary to the received theory of relative performance evaluation. In contrast, we investigate how both idiosyncratic and systematic return volatility impacts CEO turnover. We do incorporate the Jenter and Kanaan (2008) and Kaplan and Minton (2006) results in our empirical analyses by including the systematic component of returns in our analyses to mitigate potential model misspecification (and replicate their results). However, we are not aware of any theory connecting systematic return volatility to violations of relative performance evaluation. It is important to stress that our analysis requires only that systematic return volatility impede ability to learn about talent from performance, and we provide evidence consistent with this story, including that the likelihood of turnover is decreasing in systematic risk, after controlling for idiosyncratic and systematic returns.

The paper is organized as follows. In Section 2, we analyze a two-period model and develop empirical implications. Section 3 describes the data underlying our empirical analyses and provides descriptive statistics. Section 4 presents our empirical analyses about the relations between CEO turnover and distinct components of risk, and Section 5 presents our results on the relation between turnover-performance-sensitivity and risk. Section 6 examines the implications of CEO turnover decisions for CEO compensation contracts, and Section 7 summarizes and concludes.

2. The model and empirical implications

2.1. Basic assumptions and model setup

CEOs are endowed with a given level of talent. The CEO and the firm have common knowledge about the distribution over CEO talent, but neither party knows the actual level of CEO talent (see also Gibbons and Murphy, 1992; Holmstrom, 1999; and Hermelin and Weisbach, 2008). CEOs are ex ante identical, with all market participants holding identical prior beliefs over talent. The firm operates for two periods, \( t=1, 2 \). A contract is signed between the firm and the CEO at the beginning of period one. The firm updates beliefs about the incumbent CEO’s talent at the end of the first period based on the observable, period one performance, and decides whether to fire or retain the CEO at that point.\(^7\)

Following Gibbons and Murphy (1992), we assume that two-period contracts are not feasible and that one-period contracts are linear in observable output. The per-period production technology is given by

\[
y_t = \theta_t + \varepsilon_t, \quad t = 1, 2,
\]

where \( y_t \) is period \( t \) output, \( \theta_t \) represents unknown CEO talent, \( \varepsilon_t \) represents CEO effort, and \( \varepsilon_t \) is a normally distributed random shock with mean zero and variance \( \sigma_e^2 \) for \( t=1,2 \). We assume that \( \theta_t \) is independent of \( \varepsilon_t \). The prior distribution over talent is normal, with mean \( \theta_0 \) and variance \( \sigma^2_0 \). Per-period CEO compensation is given as

\[
w_t = a_t + b_t y_t, \quad t = 1, 2,
\]

where \( w_t \) is the CEO’s compensation for period \( t \), and \( a_t \) and \( b_t \) are compensation parameters.

We assume that the CEO is risk-averse and the firm is risk-neutral. Further, we assume that the period utility function for the CEO is mean-variance with \( \gamma \) as a

\(^6\) In the theory of relative performance evaluation (e.g., Holmstrom, 1982; and Gibbons and Murphy, 1992), aspects of performance that are not influenced by the CEO should be filtered out in optimal compensation contract design.

\(^7\) Our model assumes that the CEO does not quit and that turnover occurs only when the board decides to fire the CEO. In reality, however, CEOs do leave voluntarily for other opportunities. To be consistent with our model assumption, we exclude such voluntary turnovers from our empirical analysis. See Subsection 3.1 for more details regarding how the final sample is determined.
risk-aversion parameter for tractability.\textsuperscript{8} Without loss of
generality, we also assume that there is no discounting for
either the CEO or the firm. Assuming no borrowing or
lending, the CEO derives his period utility from only
current period compensation. If the incumbent CEO is
fired at the end of period one, he receives severance pay, $S,$
and exits the labor market. In this case, the firm then hires
a rookie CEO with talent drawn from a normal distribu-
tion with mean $\theta_0$ and variance $\sigma^2_0.$

Fig. 1 illustrates the time line. At the beginning of
period one the firm signs a compensation contract with a
CEO. The CEO exerts effort and period one output is
realized. The firm pays the CEO, updates its belief about
talent, and decides whether or not to fire the CEO (the
decision is denoted as $F$). In period two, the firm works
either with the incumbent ($F=0$) or with a newly hired
CEO ($F=1$). The CEO exerts effort for period two, output is
realized, the CEO is paid, and the firm is dissolved.

\subsection*{2.2. The optimal firing rule}

Using backward induction, we first derive the optimal
contract for period two. At the beginning of period two,
the firm employs either a rookie or an incumbent CEO. If
the incumbent is fired in period one ($F=1$), the firm has a
simple one-period problem with no learning possibilities
with respect to the new CEO’s talent. Thus, the firm solves

\begin{equation}
\max_{e_2,y_1} E[y_2 - w_2 | y_1] \\
\text{s.t.} \quad e_2 = \arg\max \left\{ E[w_2] - \frac{1}{2} \gamma \text{Var}(w_2) - \frac{1}{2} e_2^2 \right\}
\end{equation}

\begin{equation}
E[w_2] - \frac{1}{2} \gamma \text{Var}(w_2) - \frac{1}{2} e_2^2 \geq \Pi
\end{equation}

where the period effort cost function is $c(e_2) = (1/2)e_2^2$ and
$\Pi$ is period reservation utility. Using standard solution
techniques, the optimal solution to the above program is
given by

\begin{equation}
e_2^*(F=1) = \frac{1}{1 + \gamma (\sigma_0^2 + \sigma^2)}
\end{equation}

\begin{equation}
b_2^*(F=1) = \frac{1}{1 + \gamma (\sigma_0^2 + \sigma^2)}
\end{equation}

and

\begin{equation}
a_2^*(F=1) = \frac{1}{1 + \gamma (\sigma_0^2 + \sigma^2)} \left[ \frac{1}{1 + \gamma (\sigma_0^2 + \sigma^2)} \right]^2 - \frac{\theta_0}{1 + \gamma (\sigma_0^2 + \sigma^2)}
\end{equation}

These are standard results from a single-period
principal-agent model.

However, when the incumbent CEO is retained ($F=0$),
the firm incorporates learning about CEO talent from
period one output and solves the problem

\begin{equation}
\max_{y_1} \left[ E[y_2 - w_2 | y_1] \right] \\
\text{s.t.} \quad e_2 = \arg\max \left\{ E[w_2 | y_1] - \frac{1}{2} \gamma \text{Var}(w_2 | y_1) - \frac{1}{2} e_2^2 \right\}
\end{equation}

\begin{equation}
E[w_2 | y_1] - \frac{1}{2} \gamma \text{Var}(w_2 | y_1) - \frac{1}{2} e_2^2 \geq \Pi
\end{equation}

where $\Pi$, the period two reservation utility, is assumed to
be identical for both the incumbent and the rookie CEO,
despite the fact that the incumbent’s assessed talent
would be updated based on observing $y_1.$ We want to
emphasize that this assumption is made strictly for
tractability purposes. A CEO’s outside opportunity wage
would almost surely adjust up or down on the arrival of
new information about general managerial talent that is
transferable across companies, but might not adjust to
information about firm-specific talent that is valuable
only within the organization. To create scope for firing, it
is necessary that the reservation wage not decrease so
much in response to poor performance that the principal
is always indifferent to talent because revised pay levels
could completely offset any talent differentials.\textsuperscript{9}

\begin{footnotesize}\textsuperscript{9} To clearly understand our downward rigidity assumption, contrast
it with the assumption made in Gibbons and Murphy (1992) and
Holmstrom (1999). These papers assume that the manager receives the
entire surplus while the principal earns zero profits. Consequently, the
\end{footnotesize}
of complicating the model with issues of general versus specific talent, or other potential frictions in the adjustment of outside opportunity wages, we make the simplifying assumption that reservation wage is downward rigid. While addressing this in the model is beyond the scope of this paper, we think this is an important issue that needs to be at least considered from an empirical standpoint. In Section 6, we empirically explore the possibility that the board could lower a CEO’s pay following poor performance instead of firing him.

Returning again to the analysis of the period two contract with the incumbent CEO still in place, the CEO and the firm update priors over ability after \( y_1 \) is realized (i.e., symmetric learning). The updated mean and variance from the firm’s perspective are

\[
\theta_1 = E[\theta | y_1] = \frac{\sigma_0^2 \theta_0 + \sigma_a^2 (y_1 - \hat{e}_1)}{\sigma_a^2 + \sigma_0^2},
\]

and

\[
\sigma_1^2 = \text{Var}(\theta | y_1) = \frac{\sigma_0^2 \sigma_a^2}{\sigma_a^2 + \sigma_0^2},
\]

where \( \hat{e}_1 \) is the board’s conjecture about CEO’s first period effort. Solving the principal’s period two problem for an incumbent CEO, we get

\[
e^*_2 (F = 0) = \frac{1}{1 + \gamma (\sigma_1^2 + \sigma_0^2)},
\]

\[
b^*_2 (F = 0) = \frac{1}{1 + \gamma (\sigma_1^2 + \sigma_0^2)},
\]

and

\[
a^*_2 (F = 0) = \pi + \frac{\gamma}{2} \left[ \frac{1}{1 + \gamma (\sigma_1^2 + \sigma_0^2)} \right] - \theta_1 \frac{1}{1 + \gamma (\sigma_1^2 + \sigma_0^2)}. \tag{14}
\]

Given the optimal period two contracts for an incumbent or rookie CEO, we solve for the cutoff that triggers the firing option. We first substitute the optimal solutions for the rookie from Eqs. (5)–(7) into the principal’s objective function yielding expected period two profit given a rookie CEO of

\[
\pi(F = 1) = \theta_0 + \frac{1}{2} \left[ \frac{1}{1 + \gamma (\sigma_0^2 + \sigma_0^2)} \right] - \pi - S. \tag{15}
\]

We assume that \( S \) is smaller than \( \pi \).\(^{10}\) Similarly, using Eqs. (12)–(14), the expected period two profit when the incumbent CEO is retained is given by

\[
\pi(F = 0) = \theta_1 + \frac{1}{2} \left[ \frac{1}{1 + \gamma (\sigma_1^2 + \sigma_0^2)} \right] - \pi. \tag{16}
\]

The updated talent assessment that triggers firing, \( \theta_1^* \), is then derived by equating expected period two profits across the two scenarios. Equating Eqs. (15) and (16) and solving yield the optimal cutoff point, \( \theta_1 = \theta_0 - x \), where

\[
x = S + \frac{1}{2} \left[ \frac{1}{1 + \gamma (\sigma_1^2 + \sigma_0^2)} - \frac{1}{1 + \gamma (\sigma_0^2 + \sigma_0^2)} \right] > 0. \tag{17}
\]

That is, the optimal firing rule can be stated as

\[
F = \begin{cases} 1 & \text{if } \theta_1 < \theta_1^* \\ 0 & \text{otherwise}. \end{cases} \tag{18}
\]

This leads to Proposition 1.

**Proposition 1.** There exists a unique cutoff point \( (\theta_1^*) \) for a CEO’s assessed talent at the end of period one such that if \( \theta_1 \geq \theta_1^* \), the CEO is retained. Otherwise, he is fired. \( \theta_1^* \) is defined as in Eq. (17).

**Proof.** It is straightforward to show the intersection between the two profit lines is unique.

From the expression for \( x \) in Eq. (17), we see that it is costly to fire the incumbent CEO due to severance pay, \( S \), so the cutoff decreases in \( S \). The cutoff is also affected by the posterior variance of incumbent CEO talent (\( \sigma_1^2 \)) relative to the variance of a potential rookie’s talent (\( \sigma_0^2 \)). In essence, learning lowers the posterior variance over talent for an incumbent relative to an outside rookie. This mitigates a source of risk in the performance measure, allowing the principal to increase incentive intensity in period two for the incumbent due to the reduced demands on the risk premium needed to compensate the manager for risk. Thus, the term \( x \) in Eq. (17) is the cost of firing an incumbent CEO, consisting of the severance payment and the higher risk premium that must be paid to a replacement CEO relative to the incumbent due to higher uncertainty about the replacement’s talent (i.e., \( \sigma_0^2 > \sigma_1^2 \)).\(^{11}\)

We next develop intution of the model further and derive the empirical implications of the model for the relation between CEO turnover and risk.

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\(^{10}\) We also need to assume that \( \theta_0 \) is sufficiently large that \( \pi(F = 1) \) is positive. Otherwise, the firm shuts down. Also, while we call \( S \) severance, it is important to note that there would likely be other costs associated with CEO turnover. These include the costs of finding a new CEO, costs due to disruption of business, etc. (see, e.g., Hermalin, 2005). For purposes of drawing empirical implications for the current study, it is not important to distinguish between these costs. It would matter, however, in deriving period one compensation contracts, as severance payments go directly to a fired CEO, while the other costs are born by the principal directly. The firing threshold is adjusted for direct costs of firing the CEO has been noted in previous studies. See, for example, Hirshleifer and Thakor (1998), Hermalin and Weisbach (1998, 2008), Warther (1998), Adams and Ferreira (2007), and Hermalin (2005).

\(^{11}\) To see this, suppose that updated ability, \( \theta_1 \), were equal to that of a potential rookie, \( \theta_0 \). Now, if the firm fires the CEO, it would hire a new CEO with the same expected talent, but with a variance over talent (\( \sigma_0^2 \)) larger than that for the incumbent CEO (\( \sigma_1^2 \)). This would increase the risk premium necessary to compensate the CEO for bearing risk without increasing the expected payoff to talent. This risk premium, while subtle and interesting, is likely to be a second-order effect relative to severance and the posterior volatility over the incumants talent (\( \sigma_0^2 \)), so we do not emphasize it in what follows.
2.3. Empirical implications of the model for relations between turnover and risk

We derive three empirical implications in this Subsection. The key construct underlying these implications is the ex ante probability of firing the CEO. This can be written using the optimal cutoff point derived above [Eq. (17)] as

\[
Pr(F = 1) = Pr(\theta_1 < \theta^*_1) = \Phi\left(\frac{\theta^*_1 - \theta_o}{\sigma_0}\right) = \Phi\left(-\frac{\sqrt{\sigma_0^2 + \sigma^2}}{\sigma_0}\right),
\]

where \(\sigma_0\) is the standard deviation of posterior mean talent, \(\theta_o\), and \(\Phi(\cdot)\) is the cumulative distribution function for the standard normal distribution.

To understand the intuition underpinning the model's empirical implications, recall that the posterior distribution over talent given \(y_1\) is characterized by

\[
\theta_1 = E[\theta | y_1] = \frac{\sigma^2 \theta_0 + \sigma^2 (y_1 - \hat{\epsilon}_1)}{\sigma^2_0 + \sigma^2} = \theta_0 + \left(\frac{\sigma^2_0}{\sigma^2}\right)(y_1 - \hat{\epsilon}_1),
\]

and

\[
\sigma^2_1 = Var(\theta | y_1) = \frac{\sigma^2_0^2}{\sigma^2_0 + \sigma^2}.
\]

From Eq. (20), we see that as \(\sigma_0/\sigma\), the ratio of talent risk relative to production risk (signal-to-noise ratio), gets small, the posterior assessment of talent, \(\theta_1\), becomes insensitive to performance, implying that the board learns little about the CEO’s talent from realized performance. In this case, the posterior is close to the prior, \(\theta_0\), and the firing probability is low.\(^{12}\) However, when the posterior is sensitive to the performance signal, a negative signal causes the posterior to be low, potentially triggering a firing event. In Proposition 2, we establish sufficient conditions for \((\partial \Phi(\cdot) / \partial \sigma^2_1) > 0\) and \((\partial \Phi(\cdot) / \partial \sigma^2) < 0\).

**Proposition 2.** (i) There exists a function \(K(\sigma_0^2, \sigma^2, \gamma)\) (defined in the Appendix) such that if \(S > K(\sigma_0^2, \sigma^2, \gamma)\), then \((\partial \Phi(\cdot) / \partial \sigma^2_1) > 0\). (ii) There exists a function \(G(\sigma_0^2, \sigma^2, \gamma)\) (defined in the Appendix) such that if \(S > G(\sigma_0^2, \sigma^2, \gamma)\), then \((\partial \Phi(\cdot) / \partial \sigma^2) < 0\). It is straightforward to show that \((\partial G / \partial \sigma^2) < 0\), where the \(\lim_{\sigma^2 \to 0} G = \infty\). It is also the case that \(G(\sigma_0^2, \sigma^2, \gamma) \geq K(\sigma_0^2, \sigma^2, \gamma)\) for all values of \(\sigma_0^2, \sigma^2, \gamma\); implying that if the conditions for (ii) are met and \(S > G(\sigma_0^2, \sigma^2, \gamma)\), (i) also holds.

**Proof.** See Appendix.

This leads to the following two empirical implications.

**Empirical Implication 1.** The probability of CEO turnover is increasing in the variance over CEO talent, holding firm performance and variance unrelated to CEO talent constant.

**Empirical Implication 2.** The probability of CEO turnover is decreasing in the variance unrelated to CEO talent, holding firm performance and variance over CEO talent constant.

Next, we consider how the sensitivity of turnover to observed performance is influenced by both \(\sigma_0^2\) and \(\sigma^2\). In our simple two-period model, the firing cutoff value, \(\theta^*_1\), does not depend on the realization of the signal, but only on the variance–covariance matrix. The realization of performance determines only whether the board’s posterior assessment of talent is above or below the predetermined cutoff. Thus, the derivatives \((\partial \Phi(\cdot) / \partial \gamma_1)\), \((\partial^2 \Phi(\cdot) / \partial \gamma_1 \partial \sigma_0)\), and \((\partial^2 \Phi(\cdot) / \partial \gamma_1 \partial \sigma)\) do not have any content. However, the probability of turnover is increasing in \(\sigma_0\), implying that the performance threshold for firing moves closer to the mean of performance in standard derivation terms as \(\sigma_0^2\) increases, increasing the range of outcomes over which turnover occurs. However, CEO turnover is less responsive to performance when \(\sigma^2\) is higher, moving the threshold further below the mean in standard deviations terms, decreasing the range of outcomes over which turnover occurs. Fig. 2 illustrates the intuition, leading to the third empirical implication of the model.

**Empirical Implication 3.** CEO turnover is more sensitive to observed performance as \(\sigma_0^2\) increases and less sensitive to observed performance as \(\sigma^2\) increases.

---

\(^{12}\) In the limit, if the cost of firing \(S > 0\), the firm would not pay \(S\) to buy a rookie with the same talent distribution as the incumbent, implying that the probability of firing is zero. However, if \(S = 0\), firing the manager is free, and because the talent distribution is identical for incumbent and rookie, the firm is indifferent between the two options, implying a firing probability of one-half (i.e., a coin toss).

---

**Fig. 2.** Model implications for risk and turnover-performance-sensitivity. Z is the Z-statistic calculated by standardizing the cutoff threshold for firing the chief executive officer (CEO) under a standard normal distribution. With the cutoff threshold for firing given by \(\theta^*_1\), expected CEO talent assessment by \(\theta_0\); and the standard deviation of assessed talent by \(\sigma_0\), we have \(Z = (\theta^*_1 - \theta_0) / \sigma_0\). The probability of being fired is given by \(\Phi(Z)\), where \(\Phi(\cdot)\) is the cumulative distribution function for a standard normal and \(\phi(\cdot)\) is the standard normal density. Let \(Z_1^*\) and \(Z_2^*\) be the standardized cutoff thresholds for Firm 1 and Firm 2, respectively, when Firm 2 has higher idiosyncratic risk than Firm 1, implying \(Z_1^* < Z_2^*\) (see Proposition 2). Firm 1 will fire the chief executive officer when posterior talent assessment falls below \(Z_1^*\), and Firm 2 fires for assessed talent below \(Z_2^*\). The figure shows that Firm 2 spans a larger range of potential outcomes that result in the chief executive officer being fired than Firm 1 does, implying that the sensitivity of turnover to performance is higher for Firm 2.
Our model can be intuitively interpreted from the perspective of real options. That is, the firm can view the possibility of firing the CEO as an (abandonment) option where the strike price is given by the severance package (and the period two risk premium differential discussed in the previous Subsection). The option is in the money when the underlying asset value, here the assessed talent of the incumbent CEO, is sufficiently low relative to that of a replacement. As is well known from option pricing theory, the value of this option is increasing in the volatility of the underlying assessed talent, \( \sigma^2 \). Intuitively, high volatility of assessed talent occurs when the board’s assessment of talent is very sensitive to the signal, which in turn occurs when the signal is informative about the CEO’s talent. The informativeness of the signal and thus the volatility of assessed talent are increasing in the idiosyncratic risk of talent of the incumbent CEO (\( \sigma^2 \), measured in our empirical tests by the idiosyncratic risk of the past firm performance) and decreasing in risk measured in our empirical tests by the idiosyncratic risk of talent of the incumbent CEO (\( \sigma^2 \), measured in our empirical tests by the idiosyncratic risk of the past firm performance). In essence, increasing idiosyncratic risk increases the value of firing option as captured by an increased probability of the CEO being fired. Higher systematic risk does just the opposite.

In a related model, Hermelin and Weisbach (2008) focus on benefits and costs of changing the quality of performance measures in corporate governance settings, including CEO turnover decisions.\(^{13}\) They show that, by increasing the quality of the performance measure relative to assessed CEO talent, the value of the firing option to the principal increases. Hermelin and Weisbach (2008) are concerned with understanding the determinants of optimal performance measure quality. In contrast, we take the quality of the information system as given and focus on the determinants of the probability of firing. While the models share some commonalities, the objectives of the two papers differ significantly.

We examine Empirical Implications 1 and 2 in Section 4, and Empirical Implication 3 in Section 5.

2.4. Empirical implications for relations between the firing option and CEO compensation

Finally, we consider the impact of the firing option on the first period wage contract. Proposition 3 characterizes the first period contract.

**Proposition 3.** Optimal first period effort, \( e^* \), and pay-performance-sensitivity, \( b^* \), are characterized as

\[
e^* = \frac{1}{1 + \gamma(\sigma_0^2 + \sigma^2)} \left[ \frac{\phi(\gamma(\sigma_0^2 + \sigma^2))}{[1 + \gamma(\sigma_0^2 + \sigma^2)]\sqrt{\sigma_0^2 + \sigma^2}} \right]
\times \left\{ (\overline{\mu} - S) + \frac{1}{2}\gamma(\overline{\mu} - S)^2[1 - 2\Phi(\gamma)] \right\}
\]

and

\[
b^* = \frac{1}{1 + \gamma(\sigma_0^2 + \sigma^2)} \left[ \frac{\phi(\gamma(\sigma_0^2 + \sigma^2))}{[1 + \gamma(\sigma_0^2 + \sigma^2)]\sqrt{\sigma_0^2 + \sigma^2}} \right]
\times \left\{ (\overline{\mu} - S) + \frac{1}{2}\gamma(\overline{\mu} - S)^2[1 - 2\Phi(\gamma)] \right\}
\]

**Proof.** See Appendix for a sketch of the proof.

Pay-performance-sensitivity, \( b^* \), consists of two terms, where the second term depends on the firing option through the functions \( \phi(\cdot) \) and \( \Phi(\cdot) \). As \( \Phi(\cdot) < 1/2 \), and \( S \) is assumed to be smaller than \( \overline{\mu} \), this second term is non-negative. That is, the existence of a nontrivial firing option results in a decrease in first period pay-performance-sensitivity relative to a setting without such an option. In essence, the firing option creates implicit incentives, analogous to career concerns (Gibbons and Murphy, 1992), allowing the principal to back off on explicit incentives. These implicit incentives are evident in the term for period one effort, \( e^* \), where we see that the firing option increases effort through the second term in Eq. (22). This leads to Empirical Implication 4.

**Empirical Implication 4.** The existence of a nontrivial firing option creates implicit incentives that serve to decrease period one pay-performance-sensitivity.

We investigate Empirical Implication 4 in Section 6 below.

3. CEO turnover: data and descriptive statistics

3.1. Data and construction of the forced turnover sample

Identifying whether a CEO turnover event is forced is not straightforward as involuntary turnovers are often presented as retirements. Classification thus requires hand collection of data from multiple sources, in particular, press releases. We follow the classification scheme devised by Parrino (1997) to classify turnovers into forced and routine.\(^{14}\)

CEO turnovers are identified using the Standard & Poor’s (S&P) ExecuComp database for the time period 1992–2005. We isolate a CEO turnover for each year in which the CEO identified in ExecuComp changes (2281 events). We then search the Factiva news database for details about the turnover and initially classify each CEO turnover as forced or routine based on the information in the news announcement. All turnovers for which press

\(^{13}\) Other models of turnover include Hirshleifer and Thakor (1998), Hermelin and Weisbach (1998), Warther (1998), Spear and Wang (2005), Adams and Ferreira (2007), Hermelin (2005), and Eisfeldt and Rampini (2008), among others.

\(^{14}\) We have taken great care in classifying our turnover sample but acknowledge the possibility that we have incorrectly classified some turnovers. Consequently, we have verified that our results are robust to alternative classification schemes, such as using the press releases only or using a retirement age of 61 or 62 instead of 60.
Table 1

Routine and chief executive officer (CEO) turnover: descriptive statistics.

Routine turnover sample includes firm-years when a company experienced a routine turnover. Forced turnover sample includes firm-years when a company experienced a forced turnover. See Section 3 for detailed definitions of routine turnover and forced turnover. Control sample includes all firm-years when there was no turnover event. ROA (return on assets) are industry median adjusted; Ret_Idiosyncratic is calculated as the residuals from the first-stage cross-sectional regressions (annual returns) that use industry median returns to predict firm stock returns; Ret_Peer is calculated as the predicted values from the first-stage cross-sectional regressions (annual return) that use industry median returns to predict firm stock returns; Risk_Idiosyncratic is calculated as the standard deviation of residuals from regression of daily stock returns on daily industry median returns; Risk_peer is calculated as the standard deviation of the predicted values from regression of daily stock returns on daily industry median returns from year t – 1; Risk_ROA is standard deviation using 16 quarterly earnings growth rates after removing two digit standard industrial classification (SIC) median; Size is log of assets (in millions); CEO Age is age measured in years; CEO Tenure is years being on the current CEO position; Founder is founder of the current company the CEO serves and defined as one if yes and zero if no; Competition is the number of potential CEO candidates measured as number of firms in the same two-digit SIC code; Firm age is the age of the firm the CEO serves measured in years (using Center for Research in Security Price monthly return data). All the variables are measured at the year before the turnover event.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Routine turnovers (n=1,029)</th>
<th>Forced turnovers (n=794)</th>
<th>Control sample (n=15,965)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Median</td>
<td>Standard deviation</td>
</tr>
<tr>
<td>Ret_Idiosyncratic</td>
<td>–0.021</td>
<td>–0.092</td>
<td>0.472</td>
</tr>
<tr>
<td>Ret_Peer</td>
<td>0.172</td>
<td>0.163</td>
<td>0.287</td>
</tr>
<tr>
<td>Risk_Idiosyncratic</td>
<td>0.363</td>
<td>0.315</td>
<td>0.191</td>
</tr>
<tr>
<td>Risk_Peer</td>
<td>0.152</td>
<td>0.124</td>
<td>0.117</td>
</tr>
<tr>
<td>ROA</td>
<td>0.037</td>
<td>0.025</td>
<td>0.195</td>
</tr>
<tr>
<td>Risk_ROA</td>
<td>1.546</td>
<td>1.268</td>
<td>1.267</td>
</tr>
<tr>
<td>CEO Age</td>
<td>61.652</td>
<td>63.000</td>
<td>7.209</td>
</tr>
<tr>
<td>CEO Tenure</td>
<td>12.071</td>
<td>9.000</td>
<td>8.776</td>
</tr>
<tr>
<td>Founder</td>
<td>0.178</td>
<td>0.000</td>
<td>0.383</td>
</tr>
<tr>
<td>Competition</td>
<td>390.930</td>
<td>298.000</td>
<td>350.049</td>
</tr>
<tr>
<td>Firm Age</td>
<td>27.424</td>
<td>24.000</td>
<td>20.357</td>
</tr>
</tbody>
</table>

3.2. Variable definition and measurement

We estimate empirical proxies for the model constructs talent risk ($\sigma_0$) and unrelated risk ($\sigma$) by decomposing total return volatility into its idiosyncratic and systematic return volatility components. We posit that information about CEO talent is reflected in the firm-specific component of stock return performance, while the systematic component represents noise with respect to learning about CEO talent.15

Our proxy for talent risk ($\sigma_0$), denoted Risk_Idiosyncratic, is constructed as the standard deviation of the idiosyncratic portion of stock returns after removing industry returns, and our proxy for production risk ($\sigma$), denoted Risk_Peer, is the standard deviation of a firm’s stock returns due to industry effects.16 We use daily returns over the prior year to construct Risk_Peer and Risk_Idiosyncratic. Specifically, we run the following firm-specific regressions using daily stock returns:

$$r_{it} - 1 = \beta_0 + \beta_1 r_{industry,t-1} + \epsilon_{it-1}$$

where $r_{industry,t-1}$ is industry median daily returns. We run individual firm regressions using daily returns in fiscal year $t-1$, provided that there are at least one hundred of the 256 daily returns available for each firm year. The

---

15 It is difficult to empirically separate variability in idiosyncratic performance specifically due to CEO talent from other stochastic variation unrelated to industry or market shocks. As result, our measure of idiosyncratic return volatility captures a mix of the effect of talent and other aspects of firm-specific performance, some of which could be outside the CEO’s control. See also a related discussion in Jenter and Kanaan (2008).

16 While we mainly use industry returns as benchmark performance in our first-stage regressions to decompose performance (risk), we have also used the following two as peer groups: (1) both industry and market returns and (2) market returns only. We find qualitatively similar results as those presented in the paper.
standard deviation of the predicted values from this regression, \( \hat{\mu}_0 + \hat{\beta}_1 \text{industry}_{t-1} \), is our proxy for \( \text{Risk}_\text{Peer} \), and the standard deviation of the residual returns, \( \hat{\epsilon}_{t-1} \), is our proxy for \( \text{Risk}_\text{Idiosyncratic} \).

We include two aspects of a firm’s stock return performance, an idiosyncratic component conjectured to capture effects of CEO talent (\( \text{Ret}_\text{Idiosyncratic} \)) and a systematic component due to industry returns (\( \text{Ret}_\text{Peer} \)). We include the decomposed performance measures to avoid model misspecification in light of the results shown in Jenter and Kanaan (2008) and Kaplan and Minton (2006) that CEO turnover is sensitive to both aspects of performance. Specifically, we run the following first-stage cross-sectional regressions using one-year lagged annual returns: \(^{17}\)

\[
\text{r}_{t-1} = \hat{\mu}_0 + \hat{\beta}_1 \text{industry}_{t-1} + \hat{\epsilon}_{t-1},
\]

where \( \text{r}_{t-1} \) is firm-specific return and \( \text{industry}_{t-1} \) is industry-median return. The predicted value from the regression, \( \hat{\mu}_0 + \hat{\beta}_1 \text{industry}_{t-1} \), is our proxy for \( \text{Ret}_\text{Peer} \), and the residual return, \( \hat{\epsilon}_{t-1} \), is our proxy for \( \text{Ret}_\text{Idiosyncratic} \). \(^{18}\)

Finally, we construct an accounting-based risk measure denoted \( \text{Risk}_{\text{ROA}} \), measured as the standard deviation of quarterly industry median adjusted earnings growth over the past four years. We require that data from at least eight of the 16 quarters are available. \(^{19}\) Due to data limitation, we do not decompose this risk further. We also include return on assets (\( \text{ROA} \)) as an accounting performance measure. Following prior literature, we use lagged one-year median industry adjusted \( \text{ROA} \) to construct \( \text{Risk}_{\text{ROA}} \). We define industry based on two-digit standard industrial classification (SIC) codes and use Compustat and CRSP firms as our industry comparison group.

### 3.3. Summary statistics

Summary statistics for all variables used in turnover analyses are presented in Table 1 for the routine turnover sample, the forced turnover sample, and the control sample separately. Across all performance measures, the forced turnover sample has the lowest mean and median, and the control sample has the highest mean and median. The mean (median) \( \text{Ret}_\text{Idiosyncratic} \) is \(-13.5\% (-19.5\%)\) for the forced turnover sample and \( 4.1\% (-6.5\%) \) for the control sample. \( \text{ROA} \) is \( 0.6\% (1.1\%) \) for the forced turnover sample and \( 4.3\% (2.6\%) \) for the control sample. The same pattern holds for \( \text{Ret}_\text{Peer} \), but with a less pronounced difference (\( 13.5\% \) versus \( 18.9\% \)) between the forced turnover sample and the control sample.

Turning to our risk measures, we find that, on average, the forced turnover sample has the highest risk and the control sample has the lowest risk. Mean (median) \( \text{Risk}_\text{Idiosyncratic} \) is 0.46 (0.40) for the forced turnover sample and 0.38 (0.33) for the control sample. The same ordering holds for \( \text{Risk}_\text{Peer} \) but with smaller differences across samples. Finally, the forced turnover sample has the highest value of \( \text{Risk}_{\text{ROA}} \) (1.88/1.78), and the control sample has the lowest value of \( \text{Risk}_{\text{ROA}} \) (1.52/1.29).

With regard to control variables, relative to routine CEO turnovers, CEOs who are forced out tend to be younger (53.7 versus 61.7 years old), have shorter tenure (7.5 versus 12.1 years), and are less likely to be the company founder (0.099 versus 0.178). Also, firms with forced turnovers are more likely to be smaller (7.30 versus 7.58 of log assets), younger (22.92 versus 27.42 years), and face more competition (429 versus 391 firms in the same industry), compared with firms associated with routine turnovers.

### 4. Empirical relations between CEO turnover and risk

In this section, we present in Table 2 the main analysis of our predictions that CEO turnover probability is increasing in \( \text{Risk}_\text{Idiosyncratic} \) and decreasing in \( \text{Risk}_\text{Peer} \), after controlling for firm performance. In Table 3 we examine whether the impact of the two components of risk on turnover varies with two CEO characteristics: CEO tenure and company founder status. In all specifications, we include a number of key control variables and year dummies (all variables are defined in detail in Table 1). We compute robust standard errors clustered at the firm level in all regressions.

Table 2 presents the results of our probit analysis of the relation between forced CEO turnover and two risk constructs, \( \text{Risk}_\text{Idiosyncratic} \) and \( \text{Risk}_\text{Peer} \). The dependent variable is forced turnover, defined as one if there is a forced turnover in a given firm year and zero otherwise. We report results estimating the systematic component of returns using three different benchmark returns. Column 1 estimates the systematic component of returns relative to industry median returns, Column 2 uses value-weighted market returns only, and Column 3 uses both value-weighted market returns and industry median returns. For each analysis, we report both the probit coefficient estimate and an estimate of the economic significance for each variable. Economic significance is computed as the product of three terms: the coefficient estimate times mean turnover density (this product is the marginal effect of the variable) times one standard deviation of the variable (e.g., Greene, 1997).

Consistent with our hypothesis that the two distinct aspects of risk have opposite effects on CEO turnover, Table 2 shows that, in all three specifications, \( \text{Risk}_\text{Idiosyncratic} \) is positively and significantly associated with the...
The probability of forced turnover and Ret_Peer is negatively and significantly associated with turnover. That is, higher levels of Risk_Idiosyncratic are consistent with performance being more diagnostic about CEO talent, and higher levels of Risk_Peer with performance being less diagnostic. Turning to economic significance, a one standard deviation increase in Risk_Idiosyncratic is associated with a greater than 1.4% increase in the probability of forced turnover across specifications, and a one standard deviation increase in Risk_Peer is associated with a greater than 0.4% decrease in forced turnover probability.

With respect to the relation between realized performance and forced turnovers, we find that, consistent with prior research, Ret_Idiosyncratic is negatively and significantly associated with turnover. In terms of economic significance, a one standard deviation increase in Ret_Idiosyncratic is associated with a greater than 2% decrease in the probability of forced turnover across specifications. While Ret_Idiosyncratic has the largest economic significance of any variable in the analysis, Risk_Idiosyncratic has the second largest effect and the effects are of comparable magnitudes.

For Ret_Peer, we replicate the basic findings of Jenter and Kanaan (2008) and Kaplan and Minton (2006). In Columns 1 and 3, Ret_Peer is negatively and significantly associated with turnover, with a one standard deviation increase in Ret_Peer associated with a greater than 0.9% decrease in the probability of forced turnover. However, in Column 2, where we estimate the systematic component of returns relative to value-weighted market returns only, Ret_Peer is not significantly related to CEO turnover. Jenter and Kanaan (2008, Tables 6 and 7) find a similar result and conjecture that corporate boards take value-weighted market indexes (such as the S&P 500) into account when assessing the performance of their CEOs, while ignoring less directly visible outside influences on firm performance. While these results on Ret_Peer represent a conundrum with respect to relative performance evaluation, it is beyond the scope of our paper to investigate this further. See Jenter and Kanaan (2008), who put forth a number of proposed explanations for these findings, although their tests do not provide convincing support for any of the proposed explanations for the industry effect on CEO turnover. From this point onward, we report only results using industry median returns to decompose
Table 3
Risk and chief executive officer (CEO) turnover: interactions with CEO tenure and founder.
The dependent variable is forced turnover, defined as one if there is a forced turnover and zero otherwise. All other variables are as defined in Table 1. Z-statistics are reported below each coefficient estimate and they are based on robust standard errors controlling for firm-level clustering. Year dummies are included in all specifications. Column 1 is when the interactions between tenure and risk are considered, and Column 2 is when the interactions between founder and risk are considered. Marginal effects are calculated as the change in the probability of a forced turnover for a one unit change in the explanatory variable, holding all other variables at the mean values. Z-statistics are calculated using the delta method (Ai and Norton, 2003). For interaction terms, both signs and Z-statistics for marginal effects could change dramatically from those for coefficient estimates (Powers, 2005). ‘*’, ‘**’, and ‘***’ denote significance at the 1%, 5%, and 10% level (two-tailed), respectively.

<table>
<thead>
<tr>
<th>(1) Tenure</th>
<th>Marginal Effect</th>
<th>(2) Founder</th>
<th>Marginal Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ret_Idiosyncratic</td>
<td>-0.339**</td>
<td>-0.029**</td>
<td>-0.339**</td>
</tr>
<tr>
<td>Ret_Peer</td>
<td>-0.341**</td>
<td>-0.029**</td>
<td>-0.342**</td>
</tr>
<tr>
<td>Risk_Idiosyncratic</td>
<td>0.898**</td>
<td>0.061**</td>
<td>0.734***</td>
</tr>
<tr>
<td>Risk_Peer</td>
<td>-0.719**</td>
<td>-0.033**</td>
<td>-0.392**</td>
</tr>
<tr>
<td>CEO Tenure</td>
<td>-0.001</td>
<td>-0.000</td>
<td>-0.195</td>
</tr>
<tr>
<td>CEO Tenure * Risk_Idio</td>
<td>-0.022</td>
<td>-0.000</td>
<td>-0.170</td>
</tr>
<tr>
<td>CEO Tenure * Risk_Peer</td>
<td>0.039</td>
<td>0.004</td>
<td>0.027</td>
</tr>
<tr>
<td>Founder</td>
<td>-0.233***</td>
<td>-0.016***</td>
<td>-0.090</td>
</tr>
<tr>
<td>Founder * Risk_Idio</td>
<td>0.066</td>
<td>0.018</td>
<td>-0.24</td>
</tr>
<tr>
<td>Founder * Risk_Peer</td>
<td>-0.090</td>
<td>0.006</td>
<td>-0.027</td>
</tr>
<tr>
<td>ROA</td>
<td>-0.176</td>
<td>-0.015</td>
<td>-0.178</td>
</tr>
<tr>
<td>Risk_ROA</td>
<td>0.072***</td>
<td>0.006***</td>
<td>0.073***</td>
</tr>
<tr>
<td>Size</td>
<td>0.019</td>
<td>0.002</td>
<td>0.019</td>
</tr>
<tr>
<td>CEO Age</td>
<td>0.001</td>
<td>0.000</td>
<td>0.001</td>
</tr>
<tr>
<td>Competition</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>Firm Age</td>
<td>-0.001</td>
<td>-0.000</td>
<td>-0.001</td>
</tr>
<tr>
<td>Pseudo-R²</td>
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<td>0.054</td>
<td>0.054</td>
</tr>
<tr>
<td>Number of observations</td>
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<td>16,759</td>
<td>16,759</td>
</tr>
<tr>
<td>n (Forced)</td>
<td>794</td>
<td>794</td>
<td>794</td>
</tr>
<tr>
<td>n (Control)</td>
<td>15,965</td>
<td>15,965</td>
<td>15,965</td>
</tr>
</tbody>
</table>

returns and return volatility into idiosyncratic and systematic components. Our results with respect to risk and turnover are robust to all three specifications.

We next investigate whether the results on Risk_Idiosyncratic and Risk_Peer presented in Table 2 vary with two characteristics of the CEO: CEO tenure and founder status. The length of a CEO’s tenure with a firm could have implications for the board’s learning process with respect to talent, as more uncertainty about the talent of newer CEOs is likely given that the board has only a short time to learn about talent. If true, this would imply that learning is relatively more important for younger CEOs and, consequently, we would expect both Risk_Idiosyncratic and Risk_Peer to have more pronounced effects on turnover as CEO tenure gets shorter. Column 1 of Table 3 reports the results of interacting CEO tenure with both Risk_Idiosyncratic and Risk_Peer.

In Table 3 we report both the probit coefficients and the marginal effects of all variables.20 Focusing on marginal effects, we find that the positive relation between forced turnover and Risk_Idiosyncratic is reduced as CEO tenure increases (interaction marginal effect is negative (−0.002) and marginally significant using a two-tailed test), while the negative relation between forced turnover and Risk_Peer is also mitigated as CEO tenure

20 Nonlinearity makes probit coefficients difficult to interpret directly. Thus, we report marginal effects (the partial derivative of the probit function with respect to the variable of interest) and the marginal effects for an interaction term (the cross-partial derivative with respect to the two interacted variables). These partial derivatives are evaluated at the mean values of all variables. To assess statistical significance, we calculate the standard errors of marginal effects using the delta method (see Ai and Norton, 2003; and Powers, 2005).
increases [interaction marginal effect is positive (0.004) and marginally significant using a two-tailed test]. These results are also consistent with longer tenure capturing CEO entrenchment. To rule out this possibility, we interact our risk variables with another CEO characteristic: founder status, under the premise that founder firms are more likely to be entrenched than non-founder firms, all else equal. However, as shown in Column 2 of Table 3, while the main effect of Founder is negative and significant (founders have a lower probability of being fired), the interaction of Founder with neither Risk_Idiosyncratic nor Risk_Peer is significantly different from zero.

In untabulated analyses, we explore the robustness of our Tables 2 and 3 results to three aspects of a firm’s governance structure: institutional investors’ holdings, board independence, and the Gompers, Ishii, and Metrick (2003) G-Index (typically posited to measure CEO entrenchment due to strong anti-takeover provisions). None of the three governance variables loads significantly by itself, while our main results with respect to Risk_Idiosyncratic and Risk_Peer remain. We also explore the impact of interacting Risk_Idiosyncratic and Risk_Peer with the three aspects of a firm’s governance structure. The only interaction term with a statistically significant marginal effect is board independence interacted with Risk_Idiosyncratic (marginal effect of 0.155, significant at the 5% level using a two-tailed test). That is, turnover becomes more sensitive to Risk_Idiosyncratic as the percentage of outside directors increases, consistent with outside directors being more reliant on the information content of realized performance to learn about CEO talent than are inside directors. These results complement Weisbach (1988), who shows that CEO turnover is more sensitive to firm performance for outsider-dominated boards than for insider-dominated boards.

To summarize, this section presents evidence consistent with our hypothesis that Risk_Idiosyncratic is positively associated with the probability of forced turn- over and Risk_Peer is negatively associated with forced turnover. These results are robust to the inclusion of a range of CEO characteristics and firm governance characteristics.

5. The empirical relation between performance risk and turnover-performance-sensitivity

In this section, we investigate the prediction (Empirical Implication 3 in Section 2) that the sensitivity of turnover to performance is increasing in idiosyncratic risk, consistent with higher levels of idiosyncratic risk implying higher information content of performance with respect to talent, and decreasing in systematic risk, consistent with higher levels of systematic risk implying lower information content. The results of our analyses are in Tables 4 and 5.

Table 4 presents the main results of this section. We estimate interactions between firm-specific returns, Ret_Idiosyncratic, and both Risk_Idiosyncratic and Risk_Peer. We report both probit coefficients and marginal effects. Consistent with our predictions, Table 4 shows that the marginal effect of the interaction between Ret_Idiosyncratic and Risk_Idiosyncratic is negative and significant (marginal effect of −0.038, significant at the 1% level two-tailed), and the marginal effect of the interaction between Ret_Idiosyncratic and Risk_Peer is positive and significant (marginal effect of 0.062, significant at the 5% level two-tailed). This result, based on our theory of learning about CEO talent, stands in stark contrast to the extant executive compensation literature where higher performance risk generally puts downward pressure on pay-performance-sensitivity due to risk-aversion considerations. In fact, we find the sensitivity of turnover to performance is increasing in idiosyncratic risk.

Beyond the interaction analysis of Table 4, it is also informative to consider the economic significance of the effects of Risk_Idiosyncratic and Risk_Peer on the sensitivity of turnover to performance. Given the difficulty in
assessing the economic significance of the marginal effects of the interaction terms in Table 4, we conduct an additional partition analysis. In Table 5, Panel A, we first rank all firms based on Risk_Idiosyncratic and then partition the entire sample into three equal subsamples. Column 1 is the low Risk_Idiosyncratic subsample; Column 2 the medium Risk_Idiosyncratic subsample; and Column 3 the high Risk_Idiosyncratic subsample. We report probit coefficients and economic effects. We see that the economic effect of a one standard deviation increase in Ret_Idiosyncratic changes monotonically as we move from the low Risk_Idiosyncratic sample to the high Risk_Idiosyncratic sample. Specifically, the economic effect of Ret_Idiosyncratic for the low Risk_Idiosyncratic sample is $-0.93\%$, compared with $-2.53\%$ for the medium Risk_Idiosyncratic sample and $-3.04\%$ for the high Risk_Idiosyncratic sample.

In Table 5, Panel B, we similarly partition the sample into three equal subsamples by ranking all firms based on Risk_Peer, after orthogonalizing Risk_Peer to Risk_Idiosyncratic. We do this to deal with the significant correlation between Risk_Peer and Risk_Idiosyncratic (Pearson correlation $=0.5$). We show that the economic effect of Ret_Idiosyncratic for the low Risk_Peer sample is $-3.1\%$ compared with $-1.9\%$ for the high Risk_Peer sample.

---

**Table 5**


Panel A is partitioned on idiosyncratic risk, and Panel B is partitioned on residual peer risk (residual from regression of Risk_Peer on Risk_Idiosyncratic). The dependent variable is forced turnover, defined as one if there is a forced turnover and zero otherwise. All other variables are as defined in Table 1. Z-statistics are reported below each coefficient estimate using robust standard errors clustered at the firm level. Column 1 is the low risk group, Column 2 is the medium risk group, and Column 3 is the high risk group. Control variables included, but not reported, are ROA, Risk_ROA, Size, CEO Age, CEO Tenure, Founder, Competition and Firm Age. Year dummies are included in all specifications. Economic effects (Economic) are calculated as the product of three terms: the coefficient estimate (i.e., this product is the marginal effect) times the standard deviation of the variable. $^{***}$, $^{**}$, and $^*$ denote significance at the 1%, 5%, and 10% level (two-tailed), respectively.

<table>
<thead>
<tr>
<th>Panel A: Partitioned by Risk_Idiosyncratic</th>
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<th>(2) Medium</th>
<th>(3) High</th>
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<tbody>
<tr>
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<td><strong>Economic</strong></td>
<td><strong>Coefficient</strong></td>
<td><strong>Economic</strong></td>
</tr>
<tr>
<td>Ret_Idiosyncratic</td>
<td>$-0.472^{**}$ (2.87)</td>
<td>$-0.931$</td>
<td>$-0.681^{**}$ (5.84)</td>
</tr>
<tr>
<td>Ret_Peer</td>
<td>$-0.778^{**}$ (3.60)</td>
<td>$-1.424$</td>
<td>$-0.511^{**}$ (3.36)</td>
</tr>
<tr>
<td>Risk_Idiosyncratic</td>
<td>1.670** (2.05)</td>
<td>0.790</td>
<td>0.394 (0.50)</td>
</tr>
<tr>
<td>Risk_Peer</td>
<td>0.877 (1.30)</td>
<td>0.477</td>
<td>$-0.437$ (1.04)</td>
</tr>
</tbody>
</table>

<table>
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<th>Controls included</th>
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<th>Yes</th>
<th>Yes</th>
<th>Yes</th>
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<td>355</td>
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<tr>
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<td>5,341</td>
<td>5,231</td>
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<thead>
<tr>
<th>Panel B: Partitioned by Residual Risk_Peer</th>
<th>(1) Low</th>
<th>(2) Medium</th>
<th>(3) High</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Coefficient</strong></td>
<td><strong>Economic</strong></td>
<td><strong>Coefficient</strong></td>
<td><strong>Economic</strong></td>
</tr>
<tr>
<td>Ret_Idiosyncratic</td>
<td>$-0.446^{**}$ (6.40)</td>
<td>$-3.138$</td>
<td>$-0.305^{**}$ (2.47)</td>
</tr>
<tr>
<td>Ret_Peer</td>
<td>$-0.505^{**}$ (3.41)</td>
<td>$-1.421$</td>
<td>$-0.517^{**}$ (3.21)</td>
</tr>
<tr>
<td>Risk_Idiosyncratic</td>
<td>0.408 (1.83)</td>
<td>0.927</td>
<td>0.840 (1.43)</td>
</tr>
<tr>
<td>Risk_Peer</td>
<td>1.556 (1.95)</td>
<td>1.023</td>
<td>$-0.531$ (0.30)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Controls included</th>
<th>Yes</th>
<th>Yes</th>
<th>Yes</th>
<th>Yes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pseudo $R^2$</td>
<td>0.077</td>
<td>0.053</td>
<td>0.058</td>
<td></td>
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<td>Number of observations</td>
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<td>5,591</td>
<td>5,586</td>
<td></td>
</tr>
<tr>
<td>$n$ (Forced)</td>
<td>302</td>
<td>248</td>
<td>244</td>
<td></td>
</tr>
<tr>
<td>$n$ (Control)</td>
<td>5,280</td>
<td>5,343</td>
<td>5,342</td>
<td></td>
</tr>
</tbody>
</table>
Overall, Tables 4 and 5 provide evidence that the sensitivity of CEO turnover to firm-specific performance is increasing in Risk_Idiosyncratic and decreasing in Risk_Peer. These findings are consistent with the main argument of the paper. The informativeness of firm-specific performance with respect to CEO talent is increasing in Risk_Idiosyncratic and decreasing in Risk_Peer.

6. Implications of CEO turnover on CEO compensation contracts

The model in Section 2 simultaneously solves for the optimal firing rule and the optimal CEO compensation contract. In this final empirical section, we study interrelations between the firing option and CEO compensation. First, we explore the extent to which the threat of turnover creates implicit incentives that reduce the explicit pay-performance-sensitivity in CEOs’ compensation contracts. Second, we explore how the probability of turnover impacts the future pay levels of CEOs when they are not fired in the current period.

6.1. Data, measurement, and descriptive statistics

In building our sample for these analyses, we exclude both the first and the last year of a CEO’s tenure to mitigate confounding effects from one-time payments such as a first-year signing bonus or last-year severance pay. This implies that we examine the compensation contracts only for those CEOs who are retained after their first year in the office. We employ ExecuComp database to obtain CEO compensation data, and we use Compustat and CRSP for financial data.

In our two-period model, we show that higher turnover pressure is associated with lower pay-performance-sensitivity (see Section 2.4). This prediction is similar in spirit to the idea that explicit incentives from optimal compensation contracts should be weaker when implicit career concerns are stronger in Gibbons and Murphy (1992). We use predicted turnover probability to capture implicit incentives or the threat of termination.

To proxy for pay-performance-sensitivity, we use the dollar holding measure from Core and Guay (1999) and estimate the change in the dollar value of a CEO’s stock and options holdings in year $t$ for 1% change in the stock price.\(^\text{22}\) In particular, for stockholdings, we calculate 1% of the value of the stocks and, for options, we estimate the option deltas and multiply by 1% of the stock price.\(^\text{23}\) We use the logarithmic transformation of 1+PPS (Core and Guay, 1999, and Himmelberg et al., 1999, use a similar variable construction) in the analyses.

To explore how turnover pressure affects PPS, we regress PPS (measured in year $t$) on the predicted turnover probability (estimated based on explanatory variables measured in year $t-1$). Conjecturing that the implicit incentives for the CEO are increasing in the predicted probability of turnover, we predict the coefficient on turnover probability to be negative. We include standard determinants of PPS in the regressions (e.g., Core and Guay, 1999; and Hartzell and Starks, 2003). We control for firm size (logarithm of total assets), book-to-market ratio (BTM), Firm Age, Risk_Idiosyncratic, and Risk_Peer, all of which are measured in year $t-1$. We also include firm stock returns at both year $t-1$ and year $t$ and control for CEO Age, CEO Tenure, and CEO Equity Holdings, which is the CEO’s equity ownership of the firm at year-end $t-1$ (measured as the number of stocks and options the CEO owns divided by total shares outstanding for the firm). Finally, we include industry fixed effects (defined at SIC two-digit levels) and year dummies, and we compute robust standard errors clustered at firm level.

While our model in Section 2 makes the simplifying assumption that period two reservation utility of retained incumbents does not change with updated talent assessments (in particular, downward rigidity), reductions in pay could be an alternative to firing the CEO. We explore this possibility next. In our final analysis, we investigate whether the pay level of a retained CEO decreases as the probability of him being fired increases. We examine both cash compensation (defined as salary plus bonus) and total compensation (defined as the sum of salary, bonus, other cash compensation, the value of stock options and restricted stock grants, long-term incentive plans, and all other compensation). Control variables include firm size, book-to-market ratio, Firm Age, Risk_Idiosyncratic, Risk_Peer, stock returns, and CEO age and tenure (Hartzell and Starks, 2003). All of the firm-level control variables are measured at year $t-1$, except that we include stock returns at both year $t-1$ and year $t$. Finally, we include industry fixed effects (defined at SIC two-digit levels) and year dummies, and we report robust standard errors clustered at firm level.

Table 6 presents summary statistics used in the compensation analyses. As can be seen from the table, the mean (median) predicted CEO turnover probability is 4.7% (4%). The average PPS from CEO stock and option holdings is $869$ thousand, and the average changes in cash and total compensation are $136$ thousand and $292$ thousand, respectively.

6.2. Regression results

Table 7 displays the regression results for the relation between the CEO’s probability of turnover and PPS and Table 8 presents the empirical results for regressions of changes in compensation level on the probability of turnover. In Column 1 of Table 7, we estimate the specification that includes control variables except Risk_Idiosyncratic,
Table 6
Chief Executive Officer (CEO) turnover and compensation: summary statistics.

PPS is the change in the dollar value of the CEO's stock and options holdings for a 1% change in stock price in year \( t \); Change in Cash Comp is the change in cash compensation, and is measured as cash compensation in year \( t \) minus cash compensation in year \( t - 1 \); Change in Total Comp is the change in total compensation, and is measured as total compensation in year \( t \) minus total compensation in year \( t - 1 \); Predicted TO Probability is the predicted value from the model in Column 1 of Table 2 times one hundred; Size is the logarithm of total assets (Compustat data, in millions) measured at year \( t - 1 \); BTM is the book to market ratio, and measured as book value over market value of equity at year \( t - 1 \); CEO age is age measured in years; CEO Tenure is years being on the current CEO position; Firm Age is the age of the firm the CEO serves measured in years (using Center For Research in Security Prices monthly return data); Risk_Idio is the standard deviation of residuals from regression of daily stock returns on daily industry median returns at year \( t - 1 \); Risk_peer is the standard deviation of the predicted values from regression of daily stock returns on daily industry median returns at year \( t - 1 \); Ret is stock returns at year \( t \); Ret \(_{-1}\) is stock returns at year \( t - 1 \); and CEO Equity Holding \(_{t-1}\) is the percentage of shares and options owned by the CEO at year \( t - 1 \).

<table>
<thead>
<tr>
<th>Variable</th>
<th>N</th>
<th>Mean</th>
<th>Median</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>PPS sample</td>
<td>9,974</td>
<td>868.824</td>
<td>226.816</td>
<td>4184.72</td>
</tr>
<tr>
<td>Predicted TO Probability</td>
<td>9,974</td>
<td>4.674</td>
<td>4.045</td>
<td>3.064</td>
</tr>
<tr>
<td>Size (_{t-1})</td>
<td>7,185</td>
<td>7.172</td>
<td>7.556</td>
<td>1.778</td>
</tr>
<tr>
<td>BTM (_{t-1})</td>
<td>7,185</td>
<td>0.496</td>
<td>0.433</td>
<td>0.386</td>
</tr>
<tr>
<td>CEO Age</td>
<td>7,185</td>
<td>55.462</td>
<td>56.000</td>
<td>6.686</td>
</tr>
<tr>
<td>CEO Tenure</td>
<td>7,185</td>
<td>8.873</td>
<td>7.000</td>
<td>6.251</td>
</tr>
<tr>
<td>Firm Age</td>
<td>7,185</td>
<td>27.921</td>
<td>24.000</td>
<td>19.867</td>
</tr>
<tr>
<td>Risk_Idio (_{t-1})</td>
<td>7,185</td>
<td>0.355</td>
<td>0.305</td>
<td>0.189</td>
</tr>
<tr>
<td>Risk_Peer (_{t-1})</td>
<td>7,185</td>
<td>0.164</td>
<td>0.133</td>
<td>0.125</td>
</tr>
<tr>
<td>Ret (_{t})</td>
<td>7,185</td>
<td>0.141</td>
<td>0.104</td>
<td>0.433</td>
</tr>
<tr>
<td>Ret (_{t-1})</td>
<td>7,185</td>
<td>0.153</td>
<td>0.113</td>
<td>0.456</td>
</tr>
<tr>
<td>CEO Equity Holding (_{t-1})</td>
<td>7,185</td>
<td>0.025</td>
<td>0.011</td>
<td>0.045</td>
</tr>
<tr>
<td>Compensation sample</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Change in Cash Comp.</td>
<td>13,346</td>
<td>136.018</td>
<td>69.715</td>
<td>1,350.75</td>
</tr>
<tr>
<td>Change in Total Comp.</td>
<td>13,196</td>
<td>292.058</td>
<td>124.702</td>
<td>10,992.81</td>
</tr>
<tr>
<td>Predicted TO Probability</td>
<td>13,346</td>
<td>4.750</td>
<td>4.093</td>
<td>3.036</td>
</tr>
<tr>
<td>Size (_{t-1})</td>
<td>13,346</td>
<td>7.446</td>
<td>7.262</td>
<td>1.749</td>
</tr>
<tr>
<td>BTM (_{t-1})</td>
<td>13,346</td>
<td>0.515</td>
<td>0.440</td>
<td>0.409</td>
</tr>
<tr>
<td>CEO Age</td>
<td>13,346</td>
<td>55.570</td>
<td>56.000</td>
<td>7.346</td>
</tr>
<tr>
<td>CEO Tenure</td>
<td>13,346</td>
<td>9.633</td>
<td>7.000</td>
<td>7.460</td>
</tr>
<tr>
<td>Firm Age</td>
<td>13,346</td>
<td>25.744</td>
<td>22.000</td>
<td>18.729</td>
</tr>
<tr>
<td>Risk_Idio (_{t-1})</td>
<td>13,346</td>
<td>0.374</td>
<td>0.324</td>
<td>0.199</td>
</tr>
<tr>
<td>Risk_Peer (_{t-1})</td>
<td>13,346</td>
<td>0.160</td>
<td>0.130</td>
<td>0.122</td>
</tr>
<tr>
<td>Ret (_{t})</td>
<td>13,346</td>
<td>0.182</td>
<td>0.111</td>
<td>0.554</td>
</tr>
<tr>
<td>Ret (_{t-1})</td>
<td>13,346</td>
<td>0.219</td>
<td>0.129</td>
<td>0.669</td>
</tr>
</tbody>
</table>

Risk_Peer, and stock returns at year \( t - 1 \). The coefficient on the predicted turnover probability is negative and statistically significant, supporting the model prediction that turnover pressure provides implicit incentives and is negatively associated with pay-performance-sensitivity. We then include Risk_Idiosyncratic and Risk_Peer in Column 2 and add stock returns at year \( t - 1 \) in Column 3. While the inclusion of stock returns at year \( t - 1 \) lowers the statistical significance on the coefficient of the predicted turnover probability in Column 3, it remains negative and statistically significant in both columns. The results also suggest that PPS is significantly greater for larger (Size) and more established (BTM) firms.

Table 7
Relation between turnover probability and pay-performance-sensitivity.

The dependent variable is the logarithm of (1+PPS), with PPS (pay-performance-sensitivity) as the change in the dollar value of the chief executive officer’s (CEO) stock and options holdings for a 1% change in stock price in year \( t \) defined in Table 6. Predicted turnover probability is estimated using the specification in Table 2, Column 1. All the other variables are as defined in Table 6. Industry (defined at two-digit Standard Industrial Classification levels) fixed effects and year dummies are included. \( T \)-statistics is below each coefficient and estimated using robust standard error clustered at firm level. *, **, and *** denote significance at the 1%, 5%, and 10% level (two-tailed), respectively.

<table>
<thead>
<tr>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Predicted TO Probability</td>
<td>-0.046***</td>
<td>-0.055***</td>
</tr>
<tr>
<td></td>
<td>(-6.23)</td>
<td>(-5.49)</td>
</tr>
<tr>
<td>Size (_{t-1})</td>
<td>0.577***</td>
<td>0.580***</td>
</tr>
<tr>
<td></td>
<td>(29.81)</td>
<td>(30.35)</td>
</tr>
<tr>
<td>BTM (_{t-1})</td>
<td>-1.104***</td>
<td>-1.087***</td>
</tr>
<tr>
<td></td>
<td>(-8.95)</td>
<td>(-8.82)</td>
</tr>
<tr>
<td>CEO Age</td>
<td>-0.004</td>
<td>-0.003</td>
</tr>
<tr>
<td></td>
<td>(-1.20)</td>
<td>(-0.93)</td>
</tr>
<tr>
<td>CEO Tenure</td>
<td>0.039***</td>
<td>0.038***</td>
</tr>
<tr>
<td></td>
<td>(6.93)</td>
<td>(6.86)</td>
</tr>
<tr>
<td>Firm Age</td>
<td>-0.007***</td>
<td>-0.006***</td>
</tr>
<tr>
<td></td>
<td>(-5.77)</td>
<td>(-5.44)</td>
</tr>
<tr>
<td>Ret (_{t})</td>
<td>0.864***</td>
<td>0.871***</td>
</tr>
<tr>
<td></td>
<td>(24.33)</td>
<td>(24.23)</td>
</tr>
<tr>
<td>Ret (_{t-1})</td>
<td>1.087***</td>
<td>1.095***</td>
</tr>
<tr>
<td></td>
<td>(5.96)</td>
<td>(5.93)</td>
</tr>
<tr>
<td>Constant</td>
<td>0.014</td>
<td>-0.019</td>
</tr>
<tr>
<td></td>
<td>(0.60)</td>
<td>(-0.09)</td>
</tr>
<tr>
<td>Risk_Idio</td>
<td>0.491***</td>
<td>0.345***</td>
</tr>
<tr>
<td></td>
<td>(2.59)</td>
<td>(2.83)</td>
</tr>
<tr>
<td>Risk_Peer</td>
<td>0.077***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(1.84)</td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>0.874***</td>
<td>0.760***</td>
</tr>
<tr>
<td></td>
<td>(2.14)</td>
<td>(1.93)</td>
</tr>
</tbody>
</table>

Number of observations 7,185 7,185 7,185
Adjusted \( R^2 \) 0.73 0.73 0.73
downward (and upward) rigidity is strong, all we need is the existence of some friction in the downward adjustment of reservation utility to allow scope for firing. The empirical evidence is consistent with the existence of some friction in the downward (and upward) rigidity is strong, all we need is the change in total compensation, measured as total compensation in year $t$ minus total compensation in year $t-1$, and predicted turnover probability is estimated using the specification in Table 2, Column 1. Industry (defined at two-digit Standard Industrial Classification levels) fixed effects and year dummies are included. T-statistics are in parentheses below each coefficient and are estimated using robust standard error clustered at firm level. All other variables are as defined Table 6. **, *, and denote significance at the 1%, 5%, and 10% level (two-tailed), respectively.

<table>
<thead>
<tr>
<th></th>
<th>(1) Change in cash comp.</th>
<th>(2) Change in total comp.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Predicted TO</strong></td>
<td>4.811</td>
<td>-288.905***</td>
</tr>
<tr>
<td><strong>Probability</strong></td>
<td>(0.84)</td>
<td>(-3.10)</td>
</tr>
<tr>
<td><strong>Size $t_{-1}$</strong></td>
<td>48.184***</td>
<td>149.512</td>
</tr>
<tr>
<td></td>
<td>(5.56)</td>
<td>(1.49)</td>
</tr>
<tr>
<td><strong>BTM $t_{-1}$</strong></td>
<td>-26.789***</td>
<td>67.871</td>
</tr>
<tr>
<td></td>
<td>(-0.88)</td>
<td>(0.29)</td>
</tr>
<tr>
<td><strong>CEO Age</strong></td>
<td>0.757</td>
<td>2.460</td>
</tr>
<tr>
<td></td>
<td>(0.82)</td>
<td>(0.26)</td>
</tr>
<tr>
<td><strong>CEO Tenure</strong></td>
<td>-1.792</td>
<td>-4.967</td>
</tr>
<tr>
<td></td>
<td>(-1.40)</td>
<td>(-0.64)</td>
</tr>
<tr>
<td><strong>Firm Age</strong></td>
<td>0.489</td>
<td>0.654</td>
</tr>
<tr>
<td></td>
<td>(1.17)</td>
<td>(0.21)</td>
</tr>
<tr>
<td><strong>Risk Idio</strong></td>
<td>58.917</td>
<td>1,900.173</td>
</tr>
<tr>
<td></td>
<td>(0.67)</td>
<td>(1.28)</td>
</tr>
<tr>
<td><strong>Risk Peer</strong></td>
<td>-135.154***</td>
<td>-2,271.832***</td>
</tr>
<tr>
<td></td>
<td>(-1.19)</td>
<td>(-1.73)</td>
</tr>
<tr>
<td><strong>Ret $t$</strong></td>
<td>239.509***</td>
<td>1,560.775***</td>
</tr>
<tr>
<td></td>
<td>(7.95)</td>
<td>(4.39)</td>
</tr>
<tr>
<td><strong>Ret $t_{-1}$</strong></td>
<td>33.976**</td>
<td>-75.561</td>
</tr>
<tr>
<td></td>
<td>(2.05)</td>
<td>(-0.16)</td>
</tr>
<tr>
<td><strong>Constant</strong></td>
<td>-316.683***</td>
<td>-1,466.910***</td>
</tr>
<tr>
<td></td>
<td>(-3.96)</td>
<td>(-1.71)</td>
</tr>
<tr>
<td>Number of observations</td>
<td>13,346</td>
<td>13,196</td>
</tr>
<tr>
<td>Adjusted $R^2$</td>
<td>0.02</td>
<td>0.01</td>
</tr>
</tbody>
</table>

7. Summary and conclusions

In this paper, we investigate the role played by performance risk in impacting a board’s ability to learn about a CEO’s未知才能。A key element in a board of director’s decision to retain or dismiss an incumbent CEO is the board’s assessment of the CEO’s才能。The fundamental insight of our paper is that the impact of performance risk on the ability of boards to learn about CEO talent from firm performance depends crucially on the underlying sources of the risk. If volatility in performance is driven primarily by unobservable CEO talent, firm performance is diagnostic about such talent. However, if volatility in performance is driven by factors unrelated to CEO talent (e.g., noise, economy-wide effects, etc.), then a board’s ability to infer CEO talent from performance is more limited, making it difficult to cleanly distinguish an incumbent’s talent level from the assessed talent of potential replacement CEOs.

We conjecture that idiosyncratic volatility reflects information arrival related to the impact of CEO talent on aspects of performance under the CEO’s control, while systematic volatility captures aspects of return variability unrelated to CEO talent and beyond the CEO’s control. We predict that these distinct aspects of volatility have opposite effects on CEO turnover given their differential implications for the process of learning about CEO talent. We provide robust empirical evidence that the probability of CEO turnover is increasing in idiosyncratic, firm-specific risk and decreasing in systematic risk, after controlling for firm performance.

We also predict and show that turnover-performance-sensitivity increases in idiosyncratic risk and decreases in systematic risk, consistent with the information content of performance with respect to learning about CEO’s talent increasing in idiosyncratic risk and decreasing in systematic risk. We make a fundamental contribution to the CEO turnover literature by focusing on the learning process of boards and showing that the ability of boards to learn about CEO talent from performance depends crucially on the underlying sources of variability in performance. The learning perspective in our paper complements the executive compensation literature by shifting the focus from the impact of performance risk on risk premium demanded by risk-averse executives to the role played by performance risk in facilitating or impeding a board’s ability to learn about CEO talent from realized performance. In our turnover setting, risk impacts the learning process and can either increase or decrease turnover-performance-sensitivity depending on the underlying source of the volatility.

Finally, we extend the executive compensation literature by empirically exploring interrelations between a board of director’s option to fire the CEO and CEO compensation. We demonstrate in our model and empirically show that, for retained CEOs, pay-performance-sensitivity is decreasing in the probability of turnover, consistent with the firing option creating implicit incentives that reduce the need for explicit pay-performance-sensitivity in CEOs’ compensation contracts. We also show that, for CEOs who are retained, subsequent pay levels are a decreasing function of the probability of turnover, consistent with Gao et al., (2008), who show that pay cuts can be a short-term substitute for dismissal.

Appendix

A1. Proof of Proposition 2

(i) In equilibrium, the probability of firing is given by $Pr(F = 1) = \Phi(\frac{-x}{\sqrt{\sigma^2_0 + \sigma^2 / \sigma_0^2}})$. So, $(\partial F(\cdot) / \partial \sigma_0) > 0$ is equivalent to $(\partial x / \sqrt{\sigma^2_0 + \sigma^2 / \sigma_0^2}) / \partial \sigma_0 < 0$. Taking this derivative and tedious algebra yields the condition that the derivative is negative when $S > K$, where $K$ is
given by

\[
K = -\frac{\gamma \sigma_0^2 (-2\gamma^2 \sigma^6 - \sigma_0^6 + \gamma \sigma_0^2 (4 + 3 \gamma \sigma_0^4) + \sigma_0^2 (2 - 6 \gamma^2 + \gamma \sigma_0^2) + \sigma_0^2 (3 - 2 \gamma^2 + 2 \gamma^2 \sigma_0^4))}{2 (2 \sigma^2 + \sigma_0^2 (\gamma^2 + \sigma_0^2 + \gamma \sigma_0^4) + \gamma \sigma_0^2 (2 + 3 \gamma \sigma_0^2) + \sigma_0^2 (1 + 4 \gamma \sigma_0^2 + 2 \gamma^2 \sigma_0^4))^2}
\]  

(26)

(ii) In equilibrium, the probability of firing is given by

\[
\Pr(F = 1) = \Phi(-x \sqrt{\sigma_0^2 + \sigma^2 / \sigma_0^2}).
\]

So, \((\partial \Phi(\cdot) / \partial \sigma^2) < 0\) is equivalent to \((\partial (x \sqrt{\sigma_0^2 + \sigma^2 / \sigma_0^2}) / \partial \sigma) > 0\). Taking this derivative and manipulating the algebra yields the condition that the derivative is positive when \(S > G\), where \(G\) is given by

\[
G = \frac{\gamma \sigma_0^2 (5 \gamma^2 \sigma^6 + \sigma_0^6 + 7 \gamma \sigma_0^2 + 4 \gamma^2 \sigma_0^4 + 3 \gamma^4 (2 + 5 \gamma \sigma_0^2) + \sigma_0^2 (1 + 12 \gamma \sigma_0^2 + 14 \gamma^2 \sigma_0^4))}{2 (\gamma^2 \sigma^6 + \sigma_0^6 + \gamma \sigma_0^2 + \gamma \sigma_0^4 (2 + 3 \gamma \sigma_0^2) + \sigma_0^2 (1 + 4 \gamma \sigma_0^2 + 2 \gamma^2 \sigma_0^4))^2}
\]  

(27)

It is straightforward to show that \((\partial G / \partial \sigma) < 0\). Substituting \(\sigma = 0\) into Eq. (26) yields the result that \(\lim G = (\gamma \sigma_0^2 (1 + 7 \gamma \sigma_0^2 + 4 \gamma^2 \sigma_0^4) / 2 (1 + \gamma^2 \sigma_0^4))\). To see that \(\lim G = 0\) as \(\sigma \rightarrow \infty\), expand the numerator and denominator in Eq. (26) and note that the highest power of \(\sigma\) in the numerator is 6, while in the denominator it is 12.

Finally, taking the expression for \(K\) in Eq. (26), it is straightforward to show that \(G - K > 0\).

A2. Proof sketch of Proposition 3: period one contract given a firing option

We solve the maximization problem faced by the firm at the beginning of period one, written as

\[
\max_{a_1, b_1, \epsilon_1} : E_1((y_1 - w_1) + Pr(F = 0)E_2(y_2 - w_2 | y_1, F = 0) + Pr(F = 1)E_2(y_2 - w_2 - S))
\]

s.t.

\[
e_1 = \arg \max E_1 \left\{ \left[ E_1(w_1) - \frac{1}{2} \gamma V_1(w_1) - \frac{1}{2} e_1^2 \right] + [Pr(F = 0)E_2(w_2 | y_1) - \frac{1}{2} \gamma V_2(w_2 | y_1) + Pr(F = 1)S - \frac{1}{2} \gamma Pr(F = 1)Pr(F = 0) | T - S |^2 \right\}
\]  

RHS ≥ Π.  

(28)

(29)

RHS refers to the right-hand side of incentive comparability constraint. The last term in the incentive comparability constraint represents the risk premium associated with firing.24 \(T\) represents the outcome when the CEO is retained and equals to

\[
E_2[w_2 | y_1] - \frac{1}{2} \gamma V_2(w_2 | y_1) - \frac{1}{2} e_2^2.
\]

the mean–variance utility the CEO expects to receive if he is retained. Now, if we substitute the optimal solutions from period two into the above expression, we have \(T = \Pi\), which is his reservation utility.

Taking the derivative with respect to \(e_1\) and imposing the equilibrium condition that \(\epsilon_1 = e_1\), the solution to the above optimization problem is

\[
e_1^* = \frac{1}{1 + \gamma (\sigma_0^2 + \sigma^2)} \frac{\phi(\cdot) \gamma (\sigma_0^2 + \sigma^2)}{[1 + \gamma (\sigma_0^2 + \sigma^2)] \sqrt{\sigma_0^2 + \sigma^2}} \times \left\{ (\Pi - S) + \frac{1}{2} \gamma (\Pi - T) \right\}^2
\]  

(30)

and

\[
b_1^* = \frac{1}{1 + \gamma (\sigma_0^2 + \sigma^2)} \frac{\phi(\cdot)}{[1 + \gamma (\sigma_0^2 + \sigma^2)] \sqrt{\sigma_0^2 + \sigma^2}} \times \left\{ (\Pi - S) + \frac{1}{2} \gamma (\Pi - T) \right\}^2
\]  

(31)

where

\[
\phi(\cdot) = \phi \left[ -\frac{x \sqrt{\sigma_0^2 + \sigma^2}}{\sigma_0^2} \right]
\]  

(32)

and

\[
\Phi(\cdot) = \Phi \left[ -\frac{x \sqrt{\sigma_0^2 + \sigma^2}}{\sigma_0^2} \right] < \frac{1}{2}.
\]  

(33)

References


