Risk and CEO Turnover

Robert Bushman
Kenan-Flagler Business School
University of North Carolina at Chapel Hill

Zhonglan Dai*
School of Management
University of Texas at Dallas

Xue Wang
Goizueta Business School
Emory University

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*Corresponding author: Zhonglan Dai, School of Management, The University of Texas at Dallas, Richardson, TX 75083. E-mail: zdai@utdallas.edu.
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Extended Abstract

In this paper, we investigate direct relations between risk and CEO turnover decisions, after controlling for realized firm performance. Employing a two period model with symmetric learning about CEO talent, we derive the optimal firing rule as a function of volatility in observed performance deriving from uncertainty about a CEO’s unobservable talent level and volatility deriving from sources outside the CEO’s control. We show that these two aspects of volatility have opposite effects on the probability of CEO turnover deriving from their differential impact on the information content of realized performance with respect to learning about CEO talent. To empirically examine the predictions of the model, we conjecture that idiosyncratic return volatility reflects information arrival related to CEO talent, while systematic volatility captures return variability unrelated to CEO talent and beyond the CEO’s control. We provide strong empirical evidence that the probability of CEO turnover is increasing in idiosyncratic volatility and decreasing in systematic volatility, after controlling for firm performance. The paper complements and extends Jin (2002) by demonstrating that performance volatility impacts CEO turnover decisions very differently than it impacts pay-performance sensitivities. Where relative to CEO turnover performance volatility either enhances or obscures the ability of boards to learn about CEO talent depending on underlying source of the volatility, for incentive contracting design volatility from any sources typically represents risk for which the CEO must be compensated with a risk premium.
1. Introduction

A key aspect of corporate governance is the decision right given to a firm’s board of directors to fire or retain an incumbent CEO. Existing empirical research extensively examines the relation between CEO turnover and realized firm performance.¹ In this paper, we complement and extend the extant literature by investigating direct relations between the volatility of firm performance and CEO turnover decisions, after controlling for realized firm performance.

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. Realized firm performance is a direct - source of information about unobservable talent levels of incumbent CEOs.² However, the ability of boards to learn about CEO talent from firm performance measures depends crucially on the underlying sources of volatility in performance. If volatility is driven primarily by factors related to unobservable CEO talent, firm performance will be diagnostic about such talent, allowing boards to discover and replace low talent incumbents. On the other hand, if volatility 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 will be limited, making it difficult to cleanly distinguish an incumbent’s talent level from the assessed talent of potential replacement CEOs.

¹ Major results in the literature include that CEO turnover is inversely related to firm performance (Coughlan and Schmidt (1985), Warner, Watts and Wruck (1988), Barro and Barro (1990), Kaplan (1994a,b), Brickley and Van Horn (2002)), the sensitivity of turnover to performance increases with the fraction of outsiders on the board (Weisbach (1988)) and industry homogeneity in product market (Parrino (1997)) and product market competition (DeFond and Park (1999)), and that CEO turnover varies with the business cycle (Eisfeldt and Rampini (2007)). Kim (1996) uses a duration model to examine the extent to which firms learn about CEO ability over time. Engel, Hayes and Wang (2003) study how the properties of a firm’s accounting information affect CEO turnover probability, while Farrell and Whidbee (2003) examine how performance expectations affect CEO turnover. See Murphy (1999) for comprehensive review of the evidence. See also Brickley (2003) for a useful perspective on this literature.  
² Murphy and Zabojink (2007) argue that there has been a recent shift in the relative importance of “managerial ability” (CEO skills transferable across companies) and “firm-specific human capital” (valuable only within the organization). We do not distinguish between these two different aspects of “CEO talent” in our analysis.
Focusing on stock returns as the performance measure, our empirical design decomposes the volatility of returns into idiosyncratic and systematic components. 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 two aspects of variability will have opposite effects on CEO turnover decisions deriving from their differential implications for the information content of performance with respect to learning about CEO talent. We provide 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.

To precisely isolate the roles played by different sources of performance volatility in CEO turnover decisions, we employ a simple, two period model with symmetric learning about unknown CEO talent. We derive the optimal firing rule as a function of risk deriving from uncertainty about a CEO’s unobservable talent level, as well as risk deriving from sources outside the CEO’s control. The model produces two empirical implications. The first implication is that, all else equal, the probability of CEO turnover is increasing in the variance of the distribution of CEO talent (or “CEO talent uncertainty”). The intuition here is that when the variance of the prior distribution over CEO talent increases relative to other sources of

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3 The terms risk, variability, variance, and volatility are used interchangeably throughout this paper. In the empirical section we will be precise about our empirical proxies for risk.

4 Of course, the literature on relative performance evaluation implies that systematic aspects of performance should be filtered out and so not have an effect on CEO turnover (e.g., Holmstrom (1982), Gibbons and Murphy (1990)). However, recent research on CEO turnover documents that CEO turnover is sensitive to both firm-specific and systematic components of realized performance (Jenter and Kanaan (2006) and Kaplan and Minton (2006)). Also, it is important to note that our focus is on volatility of performance, not realized performance. Thus, all we require is that existence of significant systematic volatility makes it more difficult for the board to cleanly distinguish effects of CEO talent from luck. To avoid potential model misspecification, we follow Jenter and Kanaan (2006) and include both the firm’s idiosyncratic return, as well as the systematic portion of returns as separate performance measures in our empirical estimation of CEO turnover.
variability, firm performance becomes relatively more diagnostic about CEO talent, increasing the board’s ability to detect low talent incumbents and replace them when warranted. We empirically proxy for CEO talent uncertainty with the idiosyncratic portion of a firm’s stock return volatility that is orthogonal to market and industry returns. We document that, controlling for observed performance, the probability of CEO turnover is increasing in the standard deviation of idiosyncratic stock returns.

The second empirical implication is that, all else equal, the probability of CEO turnover is decreasing in performance volatility that is beyond the CEO’s control (or “production risk”). The intuition is that such variability represents noise from the perspective of learning about a CEO’s talent from observed performance. As such noise increases, the board learns less about talent from observing performance. This makes it difficult to distinguish between incumbents and potential rookie CEOs, increasing the board’s reluctance to incur the costs associated with firing the incumbent to hire a rookie with similar assessed talent. We proxy for production risk with the standard deviation of firms’ systematic stock returns due to industry and market returns. We empirically document that, controlling for observed performance, the probability of CEO turnover is indeed decreasing in this measure.

We further examine the notion that boards learn more from observing performance when idiosyncratic volatility is higher. We document that the sensitivity of CEO turnover to the idiosyncratic portion of stock returns and the prevalence of observed turnovers are both increasing in idiosyncratic volatility.

It is instructive to contrast our analysis to that of Jin (2002) who theoretically and empirically examines the relation between CEOs’ incentive levels and the risk characteristics of firms’ performance. Using data on executive compensation contracts, he empirically investigates
whether decomposing risk into its systematic and idiosyncratic components better explains the relation between incentives and risk. Controlling for the level of systematic risk, Jin (2002) finds that idiosyncratic risk is negatively related to incentive level, but controlling for idiosyncratic risk, he finds no significant relation between systematic risk and incentive level. In contrast, our model and empirical analysis supports the case that CEO turnover is *increasing* in idiosyncratic and *decreasing* in systematic risk.

To understand what drives this difference, note that Jin (2002) examines how different components of firm performance volatility impact the magnitude of pay-performance sensitivities. In this setting, all (unhedged) sources of 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. We, on the other hand, investigate how firm performance volatility impacts the informativeness of observed performance relative to the board’s ability to learn about CEO talent. In our setting, the impact of volatility depends on its underlying source. Volatility driven by factors related to CEO talent causes firm performance to be diagnostic about such talent, where volatility unrelated to CEO talent is just noise from the perspective of learning. Thus, our paper is not in conflict with the analysis of Jin (2002), but rather complements it by examining the impact of performance volatility in a different context. We make a fundamental contribution to the CEO turnover literature by investigating the possibility that the ability of boards to learn about CEO talent from performance depends crucially on the underlying sources of variability in performance.

It is also instructive to contrast our model with that of Hermalin and Weisbach (2008).5 Also using a two period model with symmetric learning, Hermalin and Weisbach (2008) focus

5 While there are a number of existing models on CEO turnover, the model in Hermalin and Weisbach (2008), with its emphasis on the information properties of firm performance measures, is probably the closest in spirit to ours.
on the benefits and costs of the precision of information disclosure relative to CEO turnover decisions. They view the quality of information disclosed by the firm as a choice variable and show that higher quality information is a double edged sword. On the one hand, increasing the precision of the public signal benefits the firm’s owners as the increased ability to assess CEO talent increases the value of the firing option. On the other hand, increasing precision generates costs because executives have to be compensated for the increased risk to their careers implicit in higher disclosure levels. An analogy can be made between the role of disclosure precision in Hermalin and Weisbach (2008) and our result that the probability of CEO turnover is decreasing in performance volatility that is beyond the CEO’s control. In essence, an increase in systematic performance volatility in our model is equivalent to a reduction in the precision of the performance measure in that it reduces the board’s ability to learn about CEO talent from realized performance. However, while the models share some commonalities, the objectives of the two papers differ significantly. Hermalin and Weisbach’s (2008) main objective is to examine trade-offs between the precision of performance information and corporate governance, while we take the information quality of firm performance measures as given, and examine the role played by different aspects of performance volatility in influencing CEO turnover decisions.

The paper is organized as follows. In section 2, we formally develop a two-period model and solve for the cutoff point below which a CEO firing occurs, and develop the empirical implications of the model. Sections 3 and 4 present our empirical analysis and section 5 concludes the paper.


Note that in our setting, the possibility of being fired also imposes risk on the CEO that must be compensated in the first period contract. However, this risk premium is not germane to our analysis as the board cannot commit not to fire the CEO, and so this risk premium is not a consideration in the ex post firing decision. For completeness, in the appendix, we show the derivation of the first period compensation contract given a firing option.
2. The Model and Empirical Implications

2.1 Basic Assumptions and Model Setup

CEOs are endowed with a given level of talent. We assume that the CEO and the firm have common knowledge about the distribution over CEO talent, but neither party knows the actual level of CEO talent (i.e., it is a symmetric learning process). CEOs are ex-ante identical, with all market participants holding the same prior beliefs over talent. The firm lives for two periods, \( t = 1, 2 \). When the contract is signed between the firm and the CEO at the beginning of period one, their relationship can potentially last for two periods. The firm updates beliefs about the incumbent CEO’s talent at the end of the first period based on observable, period one performance, and decides whether to fire or retain the CEO at that point..

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

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

where \( y_t \) is period \( t \) output, \( \theta_t \) represents unknown CEO talent, \( e_t \) represents the CEO effort level, and \( \varepsilon_t \) is a random shock that is normally distributed with mean zero and variance \( \sigma^2 \) for both \( t = 1, 2 \). We assume that \( \theta_t \) is independent of \( \varepsilon_t \). The prior distribution over talent is normal, with mean \( \theta_0 \) and variance \( \sigma_0^2 \). 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.

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7 This assumption is also made in Gibbons and Murphy (1992), Holmstrom (1999) and Hermalin and Weisbach (2008), among others.

8 True CEO talent, \( \theta \), is assumed fixed in the model. However, as noted also in Hermalin and Weisbach (2008), one concern is that CEO’s ability would be quickly revealed in repeated version of the model. Holmstrom (1999) however, shows that rapid learning can be eliminated by allowing \( \theta \) to follow a random walk across periods.
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 risk-aversion parameter for tractability.\textsuperscript{9} 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 only from current period compensation.\textsuperscript{10} 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 distribution with mean $\theta_0$ and variance $\sigma_0^2$.

Figure 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 the output from period one is realized. The firm pays the CEO, updates its belief about the CEO’s talent and decides whether or not to fire the CEO (the decision is denoted as $F$). In period two, the firm has either retained the incumbent ($F=0$) or hired a new CEO ($F=1$). Again, the CEO exerts effort for period two, and output is realized. At the end of period two, the CEO is paid and the firm is dissolved.

2.2 The Optimal Firing Rule

Using backward induction, we first work out the optimal contract for period two. At the beginning of period two, the firm is working either with a rookie CEO or an incumbent CEO. When the incumbent is fired ($F=1$), the firm has a simple one-period problem as there is no learning with respect to the new CEO in the one remaining period. In this case, the firm solves:

$$\max_{a_2, b_2, e_2} E[y_2 - w_2]$$

subject to:

$$e_2 = \arg \max \{E[w_2] - \frac{1}{2} \gamma Var(w_2) - \frac{1}{2} e_2^2\}$$

\textsuperscript{9} The standard CARA utility function is problematic in this setup due to the possible discontinuity at the end of period 1.
\textsuperscript{10} This is in contrast to the LEN framework many researchers use in the dynamic setup. Under LEN, only aggregate compensation matters, while per-period compensation does not. This is equivalent to the assumption that the CEO has perfect access to the capital market for borrowing and lending.
\[ E[w_2] - \frac{1}{2} \gamma \text{Var}(w_2) - \frac{1}{2} e_2^2 \geq -u, \quad (4) \]

Where the period effort cost function is \( c(e_t) = \frac{1}{2} e_t^2 \) and \( u \) is period reservation utility. Using standard solution techniques, the optimal solution to the above program is given by:

\[ e_2^*(F = 1) = \frac{1}{1 + \gamma (\sigma_0^2 + \sigma_e^2)} \quad (5) \]

\[ b_2^*(F = 1) = \frac{1}{1 + \gamma (\sigma_0^2 + \sigma_e^2)} \quad (6) \]

\[ a_2^*(F = 1) = -u + \frac{1}{2} \left[ \gamma (\sigma_0^2 + \sigma_e^2) - 1 \right] \frac{1}{1 + \gamma (\sigma_0^2 + \sigma_e^2)} + \frac{\theta_0}{1 + \gamma (\sigma_0^2 + \sigma_e^2)}. \quad (7) \]

These are standard results from a single-period principal-agent model.\(^{11}\)

On the other hand, when the incumbent CEO is retained \((F=0)\), the firm learns about CEO talent from period 1 output, and so must solve the problem:

\[
\max_{a_2, b_2 e_2} E[y_2 - w_2 \mid y_1] \\
\text{s.t. } e_2 = \arg \max \{E[w_2 \mid y_1] - \frac{1}{2} \gamma \text{Var}(w_2 \mid y_1) - \frac{1}{2} e_2^2\} \\
E[w_2 \mid y_1] - \frac{1}{2} \gamma \text{Var}(w_2 \mid y_1) - \frac{1}{2} e_2^2 \geq -u. \quad (8) \]

Note that \( u \), the period 2 reservation utility, is not modeled as a function of the updated talent assessment based on observing \( y_1 \). This simplifying assumption is made to allow scope for a firing option to have value. Given that the updated posterior talent assessment for a retained CEO

\(^{11}\) Optimal effort equates with the optimal incentive parameter \((e_2 = b_2)\), and the base salary \((a_2)\) is set such that the participation constraint (4) holds with equality. The incentive parameter, \( b_2^*(F = 1) \), is decreasing in the output variance \( \sigma^2 \), the variance over talent \( \sigma_0^2 \), and risk aversion parameter \( \gamma \). This simply reflects the optimal trade-off between incentives and risk.
could be higher or lower than the prior, it seems natural that the reservation utility in period two would be driven up or down by competitive forces. However, if the reservation utility adjusts enough to match the talent update, the principal would be made indifferent to assessed talent, as pay levels just adjust to offset talent differentials. To create scope for firing, it is thus crucial that the reservation wage not decrease too much in response to a downward assessment in talent. To capture this, we assume that reservation wage is downward rigid.\textsuperscript{12} The assumption of no upward adjustment is not crucial, and is made solely for tractability.

Given symmetric learning, the CEO and the firm update priors over ability after \( y_1 \) is realized. The updated mean and variance from the firm’s perspective are:\textsuperscript{13}

\[
\theta_1 = E[\theta | y_1] = \frac{\sigma^2 \theta_0 + \sigma^2 (y_1 - \hat{e}_1)}{\sigma^2 + \sigma^2},
\]
(10)

\[
\sigma_1^2 = Var(\theta | y_1) = \frac{\sigma^2 \sigma^2}{\sigma^2 + \sigma^2},
\]
(11)

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

\[
e_2^*(F = 0) = \frac{1}{1 + \gamma(\sigma_1^2 + \sigma^2)}
\]
(12)

\[
b_2^*(F = 0) = \frac{1}{1 + \gamma(\sigma_1^2 + \sigma^2)}
\]
(13)

\textsuperscript{12} To clearly see the role played by our downward rigidity assumption, contrast it with the assumption made in Gibbons and Murphy (1992) and Holmstrom (1999). In these papers, it is assumed that the manager gets the entire surplus while the principal always gets zero profits. In this case, the principal is indifferent to updated talent assessments and has no incentive to fire the manager. Downward rigidity creates a wedge where under some circumstances the pay necessary to retain a manager after poor period one performance is too high relative to his assessed talent level.

\textsuperscript{13} Since the CEO knows his effort level, he uses the true \( e_1 \) to update. The firm, on the other hand, has to conjecture effort. In equilibrium, the conjectured effort will equal the true effort level. For the CEO’s perspective, just replace \( \hat{e}_1 \) with \( e_1 \).
Given the optimal period two contracts for an incumbent or rookie CEO in period two, we can solve for the performance cutoff that triggers the firing option. First, we substitute the optimal solutions for the rookie from equations (5), (6), and (7) into the principal’s objective function yielding expected period two profit given a rookie CEO of

\[ \pi(F = 1) = \theta_0 + \frac{1}{2} \left[ \frac{1}{1 + \gamma (\sigma_0^2 + \sigma^2)} \right] - \bar{u} - S \]  

We assume that \( S \) is smaller than \( \bar{u} \). Similarly, using equations (12), (13), and (14), the expected period two profit when the incumbent CEO is retained is given by:

\[ \pi(F = 0) = \theta_1 + \frac{1}{2} \left[ \frac{1}{1 + \gamma (\sigma_1^2 + \sigma^2)} \right] - \bar{u} \]  

Finally, we derive the updated talent assessment, \( \theta_1^* \), that equates expected period two profits across the two scenarios. Equating (15) and (16) and solving yields the optimal cutoff point, \( \theta_1^* = \theta_0 - x \), where

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

That is, the optimal firing rule can be stated as:

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

\[ \theta_0 \] is sufficiently large that \( \pi(F = 1) \) is positive. Otherwise, the firm will shut 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.
This result leads to our first proposition.\footnote{If the reservation wage of the incumbent in period two were allowed to vary with posterior assessed talent, the cutoff would be given by $\theta_1^r + u(\theta_1) - u(\theta_0)$, where $u(\theta_1)$ is the reservation utility given $\theta_1$. Note that without our assumption of downward rigidity, $u(\theta_1)$ could be small enough to preclude firing.}

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

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

From the expression for $x$ in equation (17), we see that it is costly to fire the incumbent CEO due to severance pay, $S$, and so the cutoff decreases in $S$.\footnote{That the ability threshold below which the current CEO is dismissed has to be adjusted for direct costs of firing the CEO has been noted in a number of previous studies. See, for example, Hirshleifer and Thakor (1998), Hermelin and Weisbach (1998, 2008), Warther (1998), Goldman et al. (2003), Adams and Ferreira (2005), and Hermelin (2005). Chan (1996) argues that inside candidates for the CEO position might be given a competitive handicap in order to provide them with appropriate incentives. Such a handicap might also lead to retention of a CEO whose ability is below the average talent of outside candidates.} 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 2 for the incumbent due to the reduced demands on the risk premium needed to compensate the manager for risk.\footnote{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.}

We next develop the empirical implications of the model for CEO turnover.

**2.3 Empirical Implications**
The key construct underlying our empirical predictions is the *ex ante* probability of firing the CEO. Using the optimal cutoff point derived above (equation (17)), the probability of firing the incumbent CEO can be written as:

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

where \( \sigma_0 \) is the standard deviation of posterior mean talent, \( \theta_0 \), and \( \Phi(\cdot) \) is the cumulative distribution function for the standard normal distribution. We now examine how changes in the different aspects of performance volatility affect the probability of turnover.

First, recall that the posterior distribution over talent given \( y_1 \) is characterized by

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

\[
= \frac{\theta_0 + \sigma_0^2 (y_1 - \hat{e}_1)}{\sigma_0^2 + \sigma^2 + 1}
\]

\[
\sigma_1^2 \equiv Var(\theta | y_1) = \frac{\sigma^2 \sigma_0^2}{\sigma_0^2 + \sigma^2}
\]

(10)

(11)

From (10), as \( \frac{\sigma_0}{\sigma} \) 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. When the posterior is insensitive to the signal, the posterior is close to the prior, \( \theta_0 \) (the opportunity talent level of a rookie), and firing probability is low.\(^{18}\) However, when the posterior is sensitive to the

\^[18] 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 0. However, if \( S = 0 \), firing the manager is free, and since the talent distribution is identical for incumbent and rookie, the firm is indifferent between retaining implying a firing probability of one half (i.e., a coin toss).
performance signal, a negative signal causes the posterior to be low, potentially triggering a firing event. In the next proposition, we establish sufficient conditions for \( \frac{\partial \Phi[\cdot]}{\partial \sigma^2_0} > 0 \).

**Proposition 2** There exists a function \( K(\sigma^2_0, \sigma^2, \gamma) \) (defined in the Appendix) such that,

if \( S > K(\sigma^2_0, \sigma^2, \gamma) \), then \( \frac{\partial \Phi[\cdot]}{\partial \sigma^2_0} > 0 \).

**Proof:** See Appendix.

Figure 2 illustrates the proposition with a series of parametric examples, leading to:

**Empirical Implication 1:** Ceteris paribus, the probability of CEO turnover is increasing in talent risk.

In proposition 3, we provide sufficient conditions for \( \frac{\partial \Phi[\cdot]}{\partial \sigma^2} < 0 \).

**Proposition 3** There exists a function \( G(\sigma^2_0, \sigma^2, \gamma) \) (defined in the appendix) such that, if

\( S > G(\sigma^2_0, \sigma^2, \gamma) \), then \( \frac{\partial \Phi[\cdot]}{\partial \sigma^2_0} < 0 \). It is the case that \( \frac{\partial G}{\partial \sigma^2} < 0 \), where the \( \lim_{\sigma^2 \to \infty} G = 0 \) and \( \lim_{\sigma^2 \to 0} G = \frac{\gamma \sigma^2_0 (1 + 7 \gamma \sigma^2_0 + 4 \gamma^2 \sigma^4_0)}{2(1 + \gamma^2 \sigma^2_0)^2} \). It is the case that \( G(\sigma^2_0, \sigma^2, \gamma) \geq K(\sigma^2_0, \sigma^2, \gamma) \) for all values of \( \sigma^2_0, \sigma^2 \) and \( \gamma \), implying that if the conditions of this proposition are met,

\( S > K(\sigma^2_0, \sigma^2, \gamma) \) and so proposition 2 also holds.

**Proof:** See Appendix.

The upshot of the proposition is that if \( S \) is large enough, ceteris paribus, the probability of firing is decreasing in general production risk (\( \sigma^2 \)). Figure 3 illustrates the proposition with a series of parametric examples. This leads to the following empirical implication.
Empirical Implication 2: *Ceteris paribus, the probability of CEO turnover is decreasing in general production risk.*

We turn now to our empirical analyses.

3. Data and Descriptive Statistics

3.1 Data and Turnover Events Classification

We identify our sample of CEO turnovers using the ExecuComp database for the 1992 to 2005 period. For each firm i and year t, we identify all cases where the executive listed as firm i CEO at the end of year t is not listed as CEO at the end of year t+1. We then resort to *Factiva* to determine if there was indeed a turnover event announced in the media and if so, to determine the reason for each turnover by reading the related articles. We then collect CEO information (such as age, tenure, founder status) from proxy statements or news announcement from *Factiva* if they are missing in the ExecuComp database. We next merge this data set with firms’ financial and stock returns data from Compustat and CRSP.

We isolate 2,281 turnover events between 1992 and 2005. Table 1 lists the reasons for the turnovers in our sample. We lose 220 turnover events due to missing information either on the CEO or the firm. We also delete 238 turnovers categorized as “death”, “interim CEO”, “merger” and “spin-off” or where we cannot locate the news announcements.\(^{19}\) We classify the remaining 1,823 turnover events into routine turnovers and forced turnovers based on the nature of turnovers. Consistent with prior studies, the most common reason provided by the press announcements for the turnovers is “retirement” (44% of the total turnover sample).

\(^{19}\) We follow prior CEO turnover literature to exclude these turnovers in our sample. Weisbach (1988) drops instances of CEO death and excludes CEO turnover arising from control changes from his analysis.
We define turnover events as forced if turnovers are classified as “demoted”, “fired”, “resign” with no explanation or poor reasons, or “retirement” with poor reasons. Poor reasons include being involved in legal lawsuits, or being a suspect of earnings management, or family reasons. We end up with a total of 500 forced turnovers, which is about 22% of the total turnover sample. The remaining 1,323 turnover events are classified as routine turnovers, which include cases such as “chairman” (when the CEO left the CEO position to become the chairman of the same firm), “retirement” with no explanation or with good reasons, and “resign” with good reasons. Good reasons include leaving to take a position in federal government, or becoming CEO of another company or a university professor, or poor health, etc. Routine turnovers are about 58% of the total turnover sample.

While our empirical tests focus on the forced turnover sample as our predictions are about CEO firings, we also conduct empirical tests using the routine turnover sample. Given the subjectivity in our classification of turnover events based on press announcements, any misclassification would lead to potential bias against our finding results.

We form the control sample by using the firm-years in the ExecuComp database where no turnovers occurred. Accordingly, we have the following 4 samples: a total turnover sample (N=1,823), a routine turnover sample (N=1,323), a forced turnover sample (N=500) and a control sample (N=15,965). Table 2 provides summary statistics for all 4 samples separately.

In the empirical tests, we do not distinguish turnovers by whether the replacement CEO was hired from inside or outside the firm. While our model assumes a single pool of replacement CEOs is available, in reality the firm can choose a replacement CEO from inside or outside the

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20 In section 4.3, we show that our results are robust to other alternative schemes that have been used in the literature to classify turnovers as forced.
21 It includes one case when the outgoing CEO left from being a subsidiary CEO to become the CEO of the parent company.
firm. However, while the board learns about the talent of insiders relative to their current jobs, there is still likely to be substantial uncertainty about insiders relative to their potential talent as a CEO. Thus, we argue that the informational properties of firm performance in learning about the current CEO is an important aspect of the turnover decision regardless of whether the board is evaluating the current relative to insiders, outsiders or both. Examining the determinants of insider versus outsider hiring is beyond the scope of this paper.22

3.2 Variable Definition and Measurement

The key experimental variables in our empirical analyses are proxies for various aspects of performance measure volatility. With respect to estimating volatility characteristics of firms’ stock returns, we use daily returns to estimate the risk variables. The first risk measure, Risk_Return, is constructed as the standard deviation of daily industry-median adjusted returns over the prior year. This measure is introduced simply to connect our analyses to the prior literature.

However, as discussed earlier in the paper, our main objective is to construct empirical proxies for the model constructs talent risk ($\sigma_t$) and production risk ($\sigma$). To accomplish this, we decompose total return volatility into two components, idiosyncratic and systematic return volatility. The idea underlying this decomposition is that information about CEO talent will be reflected in the firm-specific component of stock return performance, not the systematic component. Thus, the volatility of the firm-specific component of returns should capture the impact of CEO talent (and other firm-specific elements) on firm-specific returns.23 As such, our

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22 Important papers examining the decision to hire an insider versus an outsider include Cremers and Grinstein (2008), Murphy and Zabojnik (2007), Parrino (1997) and Chan (1996), among others.
23 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 may be outside the CEO’s control. See also a related discussion in Jenter and Kanaan (2006).
proxy for talent risk ($\sigma_b$), denoted $\text{Risk}_{\text{Idiosyncratic}}$, is constructed as the standard deviation of the idiosyncratic portion of stock returns after removing the industry and market returns. On the other hand, our proxy for production risk ($\sigma$), denoted $\text{Risk}_{\text{Peer}}$, is constructed as the standard deviation of the portion of a firm’s stock returns due to industry and market returns. We use daily returns over the lagged year to construct $\text{Risk}_{\text{Peer}}$ and $\text{Risk}_{\text{Idiosyncratic}}$.

Specifically, we run the following firm-specific regressions using daily stock returns:

$$r_{t-1} = \beta_0 + \beta_1 r_{\text{industry,}t-1} + \beta_m r_{\text{market,}t-1} + \epsilon_{t-1},$$

where $r_{\text{industry,}t-1}$ is industry median daily returns, and $r_{\text{market,}t-1}$ is CRSP value-weighted daily returns. For each firm, we run individual firm regressions using daily returns in fiscal year $t-1$, provided that there are at least 100 of the 256 daily returns available for each firm-year. The standard deviation of the predicted values from this regression, $\hat{\beta}_0 + \hat{\beta}_1 r_{\text{industry,}t-1} + \hat{\beta}_m r_{\text{market,}t-1}$, is our proxy for $\text{Risk}_{\text{Peer}}$, and the standard deviation of the residual returns, $\epsilon_{t-1}$, is our proxy for $\text{Risk}_{\text{Idiosyncratic}}$.

For accounting performance, we also construct a risk measure denoted $\text{Risk}_{\text{ROA}}$. Given that we only have quarterly frequency for accounting variables, we compute the standard deviation of past 16 quarterly industry median adjusted earnings growth in the past 4 years as our proxy for $\text{Risk}_{\text{ROA}}$, provided that data from at least 8 of the 16 quarters is available.\(^{24,25}\)

To measure performance, we focus on stock returns, supplementing this with an accounting performance measure: return on assets (ROA). Again, to connect our analyses with the prior literature, we implement a median industry adjustment for both performance measures

\(^{24}\) Earnings growth rates (not earnings itself) are used to remove seasonality issue and it is also used in Berger, Chen and Li (2006) for their idiosyncratic earnings volatility measure, a similar measure to our $\text{Risk}_{\text{ROA}}$.

\(^{25}\) We also use the standard deviation of “$\text{Earn}_{t-1} - \text{Earn}_{t-4}$ / Assets$_{t-4}$” as another measure, and find qualitatively similar results.
(Return and ROA) by deducting the industry median from the raw return or ROA. We define industry based on two-digit SIC industry codes, and use Compustat / CRSP firms as our industry comparison group.

In addition, we also decompose stock returns into an idiosyncratic component that is potentially attributable to CEO talent (Ret_Idiosyncratic), and a systematic component due to the market and industry returns (Ret_Peer). Jenter and Kannan (2006) document that CEO turnover is sensitive to both measures of performance, and so we include the decomposed performance measures to avoid model misspecification (see also Kaplan and Minton (2006) for a related paper). Specifically, we run the following first-stage cross-sectional regressions using one year lagged annual returns:

\[
    r_{i,t-1} = \beta_0 + \beta_1 r_{industry,t-1} + \beta_2 r_{market,t-1} + \epsilon_{i,t-1},
\]

where \( r_{i,t-1} \) is firm specific return, \( r_{industry,t-1} \) is industry-median return, and \( r_{market,t-1} \) is CRSP value-weighted return. The predicted value from the regression, \( \hat{\beta}_0 + \hat{\beta}_1 r_{industry,t-1} + \hat{\beta}_2 r_{market,t-1} \), is our proxy for Ret_Peer, and the residual return, \( \epsilon_{i,t-1} \), is our proxy for Ret_Idiosyncratic.

### 3.3 Summary Statistics

Summary statistics for all variables are presented in Table 2. We present summary statistics for the turnover sample, the routine turnover sample, the forced turnover sample, and the control sample separately. Not surprisingly, across all performance measures, the forced turnover sample has the lowest mean/median, and the control sample has the highest mean/median. The mean (median) Return is -5.7% (-10.1%) for the forced turnover sample, and 20.6% (9.6%) for the control sample, while ROA is -0.6% (0.2%) for the forced turnover sample, and 4.3% (2.6%) for the control sample. The same pattern holds for the decomposed stock returns as well, with a more pronounced difference in Ret_Idiosyncratic (-20.8% vs. 4.1%) and a
less pronounced difference in $\text{Ret}_\text{Peer}$ (12.2% vs. 18.9%) between the forced turnover sample and the control sample.\textsuperscript{26}

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. The mean (median) $\text{Risk}_\text{Ret}$ is 0.50 (0.45) for the forced turnover sample, and 0.39 (0.34) for the control sample. The mean (median) $\text{Risk}_\text{Idiosyncratic}$ is 0.49 (0.44) for the forced turnover sample and 0.37 (0.32) for the control sample. The same ordering holds for $\text{Risk}_\text{Peer}$ but with much smaller differences across samples. Finally, we note that the forced turnover sample has the highest value of $\text{Risk}_\text{ROA}$ (2.00/1.93), and the control sample has the lowest value of $\text{Risk}_\text{ROA}$ (1.52/1.29).

With regard to control variables, we note that, relative to CEOs associated with routine turnovers, CEOs who are forced out tend to be younger (52.9 vs. 60.2 years old), have shorter tenure (6.6 vs. 11.4 years), less likely to be the founder of the company (0.088 vs. 0.165). We also note that firms associated with forced turnovers are more likely to be smaller (7.24 vs. 7.54 of log assets) and younger (21.26 vs. 26.75 years), face more competition (433 vs. 398 firms in the same industry), compared to firms associated with routine turnovers.

4. Empirical Analyses

Our model suggests that the CEO turnover probability is increasing in the variance of the distribution over CEO talent, and decreasing in performance risk that is beyond the CEO’s control. In this section, we empirically test these implications. In all the tests we include both performance measures and risk measures, in addition to the control variables. We also include

\textsuperscript{26} We note that the industry-adjusted returns and ROA are fairly high in our sample. Since we use CRSP firms as our industry comparison group, this is a likely result due to the sample selection induced by ExecuComp firms.
year dummies to control for time series variation, and compute heteroscedasticity robust standard error clustered at the firm level in all regressions.\textsuperscript{27}

4.1 CEO Turnover, Performance and Risk

Our first empirical analysis focuses on how risk affects CEO turnover probability, after controlling firm performance. Given that our model predictions are based on CEO firings, we test the model implications separately for the forced turnover sample and the routine turnover sample. Table 3 presents the empirical results from the Probit regression. In this table, we follow the prior empirical CEO turnover literature, and use the median industry-adjusted stock returns ($Return$) as the main performance measure and the standard deviation of $Return$ ($Risk\_Return$) as the main risk measure. The left two columns are for forced turnovers, and the right two columns for routine turnovers. We present two specifications for each of the turnover variables: the first specification only uses stock return performance/risk measures, while the second specification uses both stock return performance/risk and accounting performance/risk measures. Throughout our discussion, we refer to the numbers from the first specification except when we discuss $ROA$ and $Risk\_ROA$.

Column (1) shows that both stock returns and risk significantly affect the probability of CEO forced turnover. With regard to stock returns, when $Return$ decreases by one standard deviation, the turnover probability increases by about 2.2%. With regard to stock return volatility, one standard deviation increase in $Risk\_Return$ is associated with 1.3% increase in the probability of CEO turnover. These results show that risk is an important factor in explaining CEO turnover. When we include accounting variables (Column (2)), we find that $ROA$ has no

\textsuperscript{27} While we use industry adjusted performance measures in the regressions, we also run a regression specification that includes industry fixed effects with industry defined at the two-digit SIC level. We find qualitative similar results as those reported in the paper.
impact on CEO turnover but Risk_roa has a positive impact. One standard deviation increase in Risk_roa is associated with 0.74% increase in the CEO turnover probability.

With regard to control variables, the CEO age variable has no impact on the probability of forced turnovers. However, we note that both the CEO tenure and Founder variables affect forced CEO turnover negatively, which is consistent with a CEO entrenchment hypothesis. The results also show that the Firm age variable is negatively associated with the likelihood of forced turnovers.

Turning to routine turnovers we find, in contrast to forced turnovers, that while the effects of performance and risk on CEO turnover probability have the same direction as those of forced turnovers, the economic magnitudes decline dramatically. The marginal effect of Return declines from 2.2% to only 0.89%, while the marginal effect of Risk_Return decreases from 1.3% to 0.78%. On the other hand, the CEO age variable is the most important factor in explaining routine turnovers, with one standard deviation increase in CEO age associated with 5.4% increase in CEO turnover probability. The effect of the CEO age variable appears to dominate those of other explanatory variables including both stock return performance and stock return volatility (See Brickley, 2003). This is not very surprising given that retirement comprises 76% of the routine turnover sample, and that a CEO usually chooses to retire when he is at the retirement age.

Taken together, we find that risk is as important a determinant as performance in forced CEO turnover decisions. We also find that the determinants for the forced CEO turnovers are different from those for the routine CEO turnovers. It appears that both poorer performance and higher risk are associated with a higher likelihood of forced turnovers, while the CEO age variable plays a dominant role in determining routine turnovers.
4.2 Decomposition of Risk

We predict that the impact of risk on the probability of CEO turnover differs depending crucially on the underlying sources of variability in performance. If variability in performance is primarily driven by factors related to CEO talent, performance will be very diagnostic about talent, and variability should have a positive effect on the probability of CEO turnover. Alternatively, if variability in performance is driven primarily by factors unrelated to CEO talent, variability should have a negative effect on the probability of CEO turnover.

To test these predictions, we use the systematic (market/industry) and idiosyncratic sources of return variability to proxy for the constructs in the model (Risk_Peer and Risk_Idiosyncratic). Table 4 presents the empirical results. As in Table 3, we present results on both forced turnovers and routine turnovers, and within each, we have two model specifications. 28

Focusing first on forced turnovers in Columns (1) and (2), we document that Risk_Idiosyncratic has a strong positive effect on the probability of forced turnovers, with one standard deviation increase in Risk_Idiosyncratic associated with 1.44% increase in the forced turnover probability. On the other hand, Risk_Peer has a negative effect on the probability of forced turnovers, with one standard deviation increase in Risk_Peer associated with 0.36% reduction in the probability of forced turnovers. These results are consistent with the empirical implications of our model. To the degree that Risk_Peer proxies the variability in performance deriving from sources outside the CEO’s control, the board’s assessment of CEO talent will not be very sensitive to poor performance. On the other hand, if Risk_Idiosyncratic reflects the variability in performance deriving from sources related to CEO talent or forces under the CEO’s

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28 An alternative hypothesis for why the probability of turnover would be positively related to Risk_Idiosyncratic is that that stockholders prefer less volatility in stock prices and accounting returns to more volatility and hold CEOs accountable to the extent that they can control this volatility. While this is possible, it is not obvious why diversified investors would care about idiosyncratic volatility. Also, this theory cannot explain why there would be a negative relation between systematic volatility and the probability of turnover.
control, the board would use it in its retention decision. Higher Risk_ Idiosyncratic makes performance more diagnostic about CEO talent, and allows boards to better assess and replace low talent incumbents.

Regarding the performance measures, we find that both Ret_ Peer and Ret_ Idiosyncratic have a negative effect on forced turnovers, which is consistent with Jenter and Kanaan (2006). This implies that the board does not filter out market or industry effects in the CEO retention decisions even though Ret_ Idiosyncratic has a larger impact than that of Ret_ Peer (2.3% vs. 1.1% increase in the forced turnover probability for one standard deviation reduction in the performance measures). Finally, the results on other control variables are very similar to those presented in Table 3.

Next, we turn to the results on routine turnovers in Columns (3) and (4). In contrast to the results from forced turnovers, we find that while Ret_ Idiosyncratic affects routine turnovers negatively, Ret_ Peer has no effect. Similarly, the decomposition of risk measure shows that only Risk_ Idiosyncratic has a moderate effect on routine turnovers, while Risk_ Peer has no effect. With regard to other control variables, we again find that the CEO age variable is the most prominent factor in explaining routine turnovers.

To complete the analysis, we further examine the notion that boards learn more from observing performance when idiosyncratic volatility is higher. If boards learn more about an incumbent’s talent when Risk_ Idiosyncratic is higher, we expect that the prevalence of observed turnovers is increasing in Risk_ Idiosyncratic, and that the sensitivity of CEO turnover to performance is increasing in Risk_ Idiosyncratic. The intuition follows from the observation that the probability of CEO turnover is increasing in Risk_ Idiosyncratic. Thus, all else equal, CEO
turnover is more responsive to performance when \textit{Risk\_Idiosyncratic} increases as the performance threshold for firing moves closer to the mean in standard deviation terms. To this end, we partition the sample into three equal sub-samples by ranking all firms based on \textit{Risk\_Idiosyncratic}. We focus on forced turnovers in this test. Table 5 presents the results. Column (1) is the low \textit{Risk\_Idiosyncratic} sub-sample, Column (2) is the medium \textit{Risk\_Idiosyncratic} sub-sample, and Column (3) is the high \textit{Risk\_Idiosyncratic} sub-sample.

First, we document that the prevalence of observed turnovers is increasing in idiosyncratic volatility. Specifically, the mean turnover probability is 0.038 for the low \textit{Risk\_Idiosyncratic} sub-sample, 0.058 for the medium \textit{Risk\_Idiosyncratic} sub-sample, and 0.091 for the high \textit{Risk\_Idiosyncratic} sub-sample. We also document a monotone increase in the sensitivity of turnover to performance sensitivity across \textit{Risk\_Idiosyncratic} partitions. We focus on \textit{Ret\_Idiosyncratic} because it reflects the performance related to CEO talent. Specifically, we find that the marginal effect of \textit{Ret\_Idiosyncratic} for the low \textit{Risk\_Idiosyncratic} sub-sample is 0.94%, compared to 2.04% for the medium \textit{Risk\_Idiosyncratic} sub-sample and 4.12% for the high \textit{Risk\_Idiosyncratic} sub-sample.29

Overall, we find that \textit{Risk\_Idiosyncratic} and \textit{Risk\_Peer} have opposite effects on CEO turnover decisions. Also, consistent with our learning through \textit{Risk\_Idiosyncratic} conjecture, we document that the prevalence of observed turnovers and the sensitivity of CEO turnover to the idiosyncratic portion of stock returns are both increasing in idiosyncratic volatility.

4.3 Robustness Checks

We conduct a variety of sensitivity analyses, which we omit from the tables for brevity. First, we test whether our empirical results are sensitive to different definitions of forced

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29 Note that while we use \textit{Risk\_Idiosyncratic} both in our partition of the sample and in the regressions. As a robustness check, we also drop \textit{Risk\_Idiosyncratic} in the regressions and find the similar results as those reported in Table 5.
turnovers. While we treat the majority of retirements (“retirement” with no explanations or with good reasons) as routine turnovers, prior studies (Warner, Watts and Wruck (1988) and Defond and Park (1999)) suggest that involuntary turnovers are often presented as retirements in press releases. Therefore, we address this potential misclassification issue of involuntary turnovers by considering the retiring CEO’s age at “retirement”. Following prior literature, we define retirement age to be 60 years (Parrino (1997)). As such, in addition to those forced turnovers defined in Section 3.1, we classify “retirement” as a forced turnover if the retiring CEO retired at age less than 60. We conduct the empirical analyses by using the revised forced turnover definition, and find very similar results as those presented in the tables. We also repeat the analyses by defining retirement age to be 62 (64) years, and again find qualitatively similar results.

Second, we address the concern that the data frequency used in decomposing performance is different from the data frequency used in decomposing risk. Recall that the estimation of the variability of performance within one particular year requires multiple observations, thus we use daily returns to construct Risk_Idiosyncratic and Risk_Peer. On the other hand, we use annual returns to construct the performance measures Ret_Idiosyncratic and Ret_Peer in the cross-sectional regression. To address this issue, we use daily returns to estimate firm-specific market/industry betas for every firm year, and then construct annualized Risk_Idiosyncratic and Risk_Peer. We then employ these performance measures in Table 4 and Table 5. We find very similar results as those presented in the current tables.

Next, we check whether our empirical results are sensitive to the definition of peer groups. Recall that we use both market returns and industry returns as benchmark performance in our first stage regressions to decompose performance (risk) into the systematic component and
the idiosyncratic component. We replace the benchmark performance by (1) using only market returns; (2) using only industry returns; in the first stage regressions. We again find qualitatively similar results.

Finally, we consider alternative measures of systematic (market/industry) risk and idiosyncratic (talent) risk by using earnings growth variables. Specifically, we regress earnings growth on industry median earnings growth and market earnings growth, and use the standard deviation of the predicted earnings growth to proxy for Risk_Peer, and the standard deviation of the residual earnings growth to proxy for Risk_Idiosyncratic. Consistent with our model predictions, we again find that Risk_Idiosyncratic and Risk_Peer constructed using earnings growth variables have opposite effects on the probability of CEO turnovers.

5. Summary and Conclusions

In this paper, we investigate direct relations between risk and CEO turnover decisions, after controlling for realized firm performance. If the volatility of performance is driven primarily by factors related to CEO talent, performance will be very diagnostic about talent, allowing boards to discover and replace low talent incumbents. On the other hand, if volatility 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 will be limited, making it difficult to cleanly distinguish an incumbent’s talent level from the assessed talent of potential replacement CEOs.

To precisely isolate the roles played by different sources of performance volatility in CEO turnover decisions, we employ a simple, two period model with symmetric learning about unknown CEO talent. We derive the optimal firing rule as a function of risk deriving from uncertainty about a CEO’s unobservable talent level, as well as risk deriving from sources
outside the CEO’s control. The model produces two empirical implications. The first implication is that, all else equal, the probability of CEO turnover is increasing in the variance of the distribution of CEO talent (or “CEO talent uncertainty”). The second empirical implication is that, all else equal, the probability of CEO turnover is decreasing in performance volatility that is beyond the CEO’s control (or “production risk”).

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 provide 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 make a fundamental contribution to the CEO turnover literature by documenting that the ability of boards to learn about CEO talent from performance depends crucially on the underlying sources of variability in performance. In this respect, the paper complements and extends Jin (2002) by demonstrating that performance volatility impacts CEO turnover decisions very differently than it impacts pay-performance sensitivities. Where relative to CEO turnover performance volatility either enhances or obscures the ability of boards to learn about CEO talent depending on underlying source of the volatility, for incentive contracting design volatility from any sources typically represents risk for which the CEO must be compensated with a risk premium.
References


Appendix

Proof of Proposition 2

In equilibrium, the probability of firing is given by \( \Pr(F = 1) = \Phi[-\frac{x\sqrt{\sigma_0^2 + \sigma^2}}{\sigma_0^2}] \). So, \( \frac{\partial \Phi[\cdot]}{\partial \sigma_0} > 0 \)

\[
\frac{\partial}{\partial \sigma_0} \left( \frac{x\sqrt{\sigma_0^2 + \sigma^2}}{\sigma_0^2} \right)
\]

is equivalent to \( \frac{\partial}{\partial \sigma_0} \left( \frac{x\sqrt{\sigma_0^2 + \sigma^2}}{\sigma_0^2} \right) < 0 \). Taking this derivative and tedious algebra yields the condition that the derivative is negative when \( S > K \), where \( K \) is given by

\[
K = -\frac{y\sigma_0^4(-2y^2\sigma_0^4 - \sigma_0^4 + y\sigma_0^6 - \sigma_0^4(4 + 3y\sigma_0^4) + \sigma_0^4(-2 - 6y\sigma_0^4 + \gamma^2\sigma_0^4) + \sigma_0^4(-3 - 2y\sigma_0^4 + 2\gamma^2\sigma_0^4))}{2(2\sigma_0^4 + \sigma_0^4)(\gamma^2\sigma_0^4 + \sigma_0^4 + \gamma\sigma_0^4 + \gamma\sigma_0^4(2 + 3y\sigma_0^4) + \sigma_0^4(1 + 4y\sigma_0^4 + 2\gamma^2\sigma_0^4))^2} \quad (A1)
\]

\( \blacksquare \)

Proof of Proposition 3

In equilibrium, the probability of firing is given by \( \Pr(F = 1) = \Phi[-\frac{x\sqrt{\sigma_0^2 + \sigma^2}}{\sigma_0^2}] \). So, \( \frac{\partial \Phi[\cdot]}{\partial \sigma_0} < 0 \)

\[
\frac{\partial}{\partial \sigma} \left( \frac{x\sqrt{\sigma_0^2 + \sigma^2}}{\sigma_0^2} \right)
\]

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

\[
G = \frac{y\sigma_0^4(5\gamma^2\sigma_0^4 + \sigma_0^4 + 7\gamma\sigma_0^4 + 4\gamma^2\sigma_0^4 + 3\gamma\sigma_0^4(2 + 5\gamma\sigma_0^4) + \sigma_0^4(1 + 12\gamma\sigma_0^4 + 14\gamma^2\sigma_0^4))}{2(\gamma^2\sigma_0^4 + \sigma_0^4 + \gamma\sigma_0^4 + \gamma\sigma_0^4(2 + 3\gamma\sigma_0^4) + \sigma_0^4(1 + 4\gamma\sigma_0^4 + 2\gamma^2\sigma_0^4))^2} \quad (A2)
\]

It is straightforward to show that \( \frac{\partial G}{\partial \sigma} < 0 \). Substituting \( \sigma = 0 \) into (A1) yields the result that

\[
\lim_{\sigma \to 0} G = \frac{y\sigma_0^4(1 + 7\gamma\sigma_0^4 + 4\gamma^2\sigma_0^4)}{2(1 + \gamma^2\sigma_0^4)^2} \quad \text{to see that } \lim_{\sigma \to \infty} G = 0 \quad \text{ expand the numerator and denominator in (A1) and note that the highest power of } \sigma \text{ in the numerator is } 6, \text{ while in the denominator it is } 12.
\]

Finally, taking the expression for \( K \) in equation (A1), it is straightforward to show that \( G-K>0 \).\( \blacksquare \)
Derivation of the Period 1 Contract Given a Firing Option

We solve the maximization problem faced by the firm at the beginning of period 1, written as

$$\max_{a_i, h_i, e_i} E_i \{ (y_1 - w_1) + \Pr(F = 0)E_2 (y_2 - w_2 \mid y_1, F = 0) + \Pr(F = 1)E_2 (y_2 - w_2 - S) \}$$

s.t.

$$e_1 = \arg \max E_i \{ [E_1(w_1) - \frac{1}{2} \gamma V'_1(w_1) - \frac{1}{2} e_1^2] + [\Pr(F = 0)(E_2(w_2 \mid y_1) - \frac{1}{2} \gamma V'_2(w_2 \mid y_1) + \Pr(F = 1)S] - \frac{1}{2} \gamma \Pr(F = 1)\Pr(F = 0)[T - S]^2 \}$$

$$\text{RHS} \geq \bar{u}$$  \hspace{1cm} (18)

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.\(^{30}\) \(T\) represents the outcome when the CEO is retained and equals to

$$E_2[w_2 \mid y_1] - \frac{1}{2} \gamma V'_2(w_2 \mid y_1) - \frac{1}{2} e_2^2$$

the mean-variance utility the CEO expects to receive if he is retained. Now, if we substitute the optimal solutions from period 2 into the above expression, we have \(T = \bar{u}_1\), which is his reservation utility.

Taking the derivative with respect to \(e_1\) and imposing the equilibrium condition that \(\hat{e}_1 = e_1\), the solution to the above optimization problem is

$$e_1^* = \frac{1}{1 + \gamma(\sigma_0^2 + \sigma^2)} + \frac{\phi(.) \gamma(\sigma_0^2 + \sigma^2)}{[1 + \gamma(\sigma_0^2 + \sigma^2)]^{\frac{1}{2}} \sigma_0^2 + \sigma^2} \{(u_1 - S) + \frac{1}{2} \gamma(u_1 - S)^2[1 - 2\Phi(.)]\}$$  \hspace{1cm} (20)

$$b_1^* = \frac{1}{1 + \gamma(\sigma_0^2 + \sigma^2)} - \frac{\phi(.)}{[1 + \gamma(\sigma_0^2 + \sigma^2)]^{\frac{1}{2}} \sigma_0^2 + \sigma^2} \{(u_1 - S) + \frac{1}{2} \gamma(u_1 - S)^2[1 - 2\Phi(.)]\},$$  \hspace{1cm} (21)

where

\(^{30}\) Since to fire or not to fire is a binary choice, it is straightforward to show that the variance equals the product of the probabilities associated with each outcome and the squared difference between the two outcomes.
\[ \phi(.) = \phi\left( -\frac{x \sqrt{\sigma_0^2 + \sigma^2}}{\sigma_0^2} \right) \]

\[ \Phi(.) = \Phi\left( -\frac{x \sqrt{\sigma_0^2 + \sigma^2}}{\sigma_0^2} \right) < \frac{1}{2} . \]
Figure 1. Time line for the two-period model
Figure 2. The x-axis is talent risk $\sigma_0$ and the y-axis is the probability of firing $\Phi[\cdot]$. The parameters are set such that $\sigma = 2$, $\gamma = 3$. 
Figure 3. The x-axis is general production risk $\sigma$ and the y-axis is the probability of firing $\Phi[.]$. The parameters are set such that $\sigma_0 = 2$, $\gamma = 3$. 
### Table 1 Classification of CEO Turnover Events

<table>
<thead>
<tr>
<th>Reason</th>
<th>Number</th>
<th>Percent</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Routine Turnovers</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chairman</td>
<td>256</td>
<td>11.19</td>
<td>The outgoing CEO becomes company’s chairman after leaving the CEO post.</td>
</tr>
<tr>
<td>RT</td>
<td>1,006</td>
<td>43.96</td>
<td>The outgoing CEO retires from the post without any explanation, or taking a government, university job.</td>
</tr>
<tr>
<td>RS with good cause</td>
<td>61</td>
<td>2.67</td>
<td>The outgoing CEO resigns with reasons, like being named as CEO in another company.</td>
</tr>
<tr>
<td>Subtotal</td>
<td>1,323</td>
<td>58.00</td>
<td></td>
</tr>
<tr>
<td><strong>Forced Turnovers</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Demoted</td>
<td>19</td>
<td>0.83</td>
<td>The outgoing CEO takes a lower ranked job within the company, like COO.</td>
</tr>
<tr>
<td>Fired</td>
<td>37</td>
<td>1.62</td>
<td>The outgoing CEO is frankly fired by the company with or without reason provided.</td>
</tr>
<tr>
<td>RS with no explanation</td>
<td>398</td>
<td>17.45</td>
<td>The outgoing CEO resigns from the CEO post with no explicit explanation.</td>
</tr>
<tr>
<td>RS with bad cause</td>
<td>36</td>
<td>1.57</td>
<td>The outgoing CEO resigns from the CEO post with reasons, like earnings management or legal issue.</td>
</tr>
<tr>
<td>RT with bad cause</td>
<td>10</td>
<td>0.44</td>
<td>The outgoing CEO retires from the CEO post with excuses, like family reason or legal issue.</td>
</tr>
<tr>
<td>Subtotal</td>
<td>500</td>
<td>21.92</td>
<td></td>
</tr>
<tr>
<td><strong>Cases not used</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Cases deleted</td>
<td>238</td>
<td>10.43</td>
<td>Cases such as interim CEOs, deceased, merger, spinoff, and missing news announcement.</td>
</tr>
<tr>
<td>Cases with missing data</td>
<td>220</td>
<td>9.64</td>
<td>Cases when there is either missing information on the CEO or on the firm.</td>
</tr>
<tr>
<td>Subtotal</td>
<td>458</td>
<td>20.08</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>2,281</td>
<td>100.00</td>
<td></td>
</tr>
</tbody>
</table>

Note: The source data set is Executive Compensation from 1992 to 2005. Note that in the ExecuComp data, some time, a firm may have co-CEOs in the same year. When this is the case, we keep only one CEO information in the sample and treat it as no turnover firm-year.
Table 2 Summary Statistics

<table>
<thead>
<tr>
<th></th>
<th>Turnover sample (N=1,823)</th>
<th>Routine turnovers (N=1,323)</th>
<th>Forced turnovers (N=500)</th>
<th>Control sample (N=15,965)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Median</td>
<td>Std Dev</td>
<td>Mean</td>
</tr>
<tr>
<td>Return</td>
<td>0.086</td>
<td>0.021</td>
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<td>0.140</td>
</tr>
<tr>
<td>Ret_ Idiosyncratic</td>
<td>-0.071</td>
<td>-0.137</td>
<td>0.495</td>
<td>-0.019</td>
</tr>
<tr>
<td>Ret_ Peer</td>
<td>0.156</td>
<td>0.137</td>
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<td>0.168</td>
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<tr>
<td>Risk_Ret</td>
<td>0.393</td>
<td>0.339</td>
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<td>Risk_ Idiosyncratic</td>
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<td>0.366</td>
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<tr>
<td>Risk_ Peer</td>
<td>0.181</td>
<td>0.148</td>
<td>0.123</td>
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<tr>
<td>ROA</td>
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<td>Risk_ROA</td>
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<td>1.572</td>
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<tr>
<td>Size</td>
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<td>7.304</td>
<td>1.769</td>
<td>7.541</td>
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<td>CEO age</td>
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<td>59.000</td>
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<td>60.191</td>
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<tr>
<td>CEO tenure</td>
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<td>8.000</td>
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</tr>
<tr>
<td>Founder</td>
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<td>0.000</td>
<td>0.351</td>
<td>0.165</td>
</tr>
<tr>
<td>Competition</td>
<td>407.690</td>
<td>330.000</td>
<td>362.099</td>
<td>398.143</td>
</tr>
</tbody>
</table>

Note: Turnover sample includes only firm-years when a company has experienced a turnover (routine turnovers and forced turnovers). See table 1 for detailed definition. Routine turnover sample includes firm-years when a company has experienced a routine turnover. Forced sample includes firm-years when a company has experienced a forced turnover. Control sample includes all firm-years when there was no turnover event. Both Return and ROA (return on assets) are industry median adjusted annual returns; Ret_ Idiosyncratic is calculated as the residuals from the first stage cross sectional regressions (annual returns) that use both market return and industry return to predict firm stock returns; Ret_ Peer is calculated as the predicted values from the first stage cross sectional regressions (annual return) that use both market return and industry return to predict firm stock returns; Risk_Ret is calculated as standard deviation of industry median-adjusted daily returns (a measure corresponding to Return); Risk_ Idiosyncratic is calculated as the standard deviation of residuals from regression of daily stock returns on daily market returns and industry returns; Risk_ Peer is calculated as the standard deviation of the predicted values from regression of daily stock returns on daily market returns and industry returns from year t-1; Risk_ ROA: standard deviation using 16 quarterly earnings growth rates after removing 2 digit SIC industry median; Size: log of assets (in millions); CEO age: age measured in years; Tenure: years being on the current CEO position; Founder: founder of the current company the CEO serves and defined as one if yes, zero if no; Competition: the number of potential CEO candidates measured as number of firms in the same 2-digit SIC code; Firm age: the age of the firm the CEO serves measured in years (using CRSP monthly return data). All the variables are measured at the year before the turnover event.
Table 3 Performance and Risk

<table>
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<tr>
<th></th>
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<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
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</thead>
<tbody>
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<td></td>
<td>estimate</td>
<td>marginal</td>
<td>estimate</td>
<td>marginal</td>
</tr>
<tr>
<td>Return</td>
<td>-0.543***</td>
<td>-2.237</td>
<td>-0.535***</td>
<td>-2.191</td>
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<tr>
<td></td>
<td>(-9.08)</td>
<td>(-9.03)</td>
<td>(-3.34)</td>
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</tr>
<tr>
<td>Risk_Return</td>
<td>0.986***</td>
<td>1.332</td>
<td>0.784***</td>
<td>1.053</td>
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<tr>
<td></td>
<td>(9.29)</td>
<td>(6.81)</td>
<td>(3.25)</td>
<td>(2.06)</td>
</tr>
<tr>
<td>Size</td>
<td>0.040***</td>
<td>0.452</td>
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<td>CEO age</td>
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<td>(0.44)</td>
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<td>(-0.33)</td>
<td>(-0.33)</td>
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<tr>
<td>CEO tenure</td>
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<td>(19.49)</td>
</tr>
<tr>
<td>Founder</td>
<td>-0.247***</td>
<td>-0.544</td>
<td>-0.248***</td>
<td>-0.542</td>
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<tr>
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<td>(-3.24)</td>
<td>(-3.22)</td>
<td>(-0.11)</td>
<td>(0.15)</td>
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<tr>
<td>Competition</td>
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<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
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<td>(0.86)</td>
<td>(0.95)</td>
<td>(3.69)</td>
<td>(3.97)</td>
</tr>
<tr>
<td>Firm age</td>
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<td>-0.237</td>
<td>-0.003**</td>
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<td>-0.099</td>
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<tr>
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<td>(1.60)</td>
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<tr>
<td>Risk_ROA</td>
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<td>-5.249***</td>
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<td></td>
<td>(-11.77)</td>
<td>(-11.15)</td>
<td>(-26.78)</td>
<td>(-26.33)</td>
</tr>
</tbody>
</table>

Note: Dependent variable is turnover (routine or forced) which is defined as one if there is turnover (routine or forced), zero otherwise. Z-value is below each estimated coefficient. All other variables are as defined in Table 2. Column (1) is when accounting variables are not included while column (2) is when two accounting variables are included (ROA and Risk_ROA). Z-stats are calculated using robust standard errors controlling for firm level clustering. Year dummies are included in all specifications. Marginal effect is calculated as product of three terms: variable estimate, its one standard deviation and the mean turnover density except for Founder variable for which the marginal effect is simply product of the parameter estimate and density mean (See Greene, 1997).
### Table 4: Decomposition of Performance and Decomposition of Risk

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<th>marginal</th>
<th>(2) estimate</th>
<th>marginal</th>
<th>(1) estimate</th>
<th>marginal</th>
<th>(2) estimate</th>
<th>marginal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ret_Idiosyncratic</td>
<td>-0.566***</td>
<td>-2.324</td>
<td>-0.554***</td>
<td>-2.260</td>
<td>-0.105***</td>
<td>-0.885</td>
<td>-0.098***</td>
<td>-0.825</td>
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<td>(-8.64)</td>
<td>(-3.30)</td>
<td>(-3.06)</td>
<td>(-3.30)</td>
<td>(-3.06)</td>
<td>(-3.06)</td>
<td>(-3.06)</td>
</tr>
<tr>
<td>Ret_Peer</td>
<td>-0.576***</td>
<td>-1.086</td>
<td>-0.579***</td>
<td>-1.085</td>
<td>-0.106</td>
<td>-0.412</td>
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<td>Risk_Idiosyncratic</td>
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<td>(2.26)</td>
<td>(1.44)</td>
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<td>(1.44)</td>
<td>(1.44)</td>
<td>(1.44)</td>
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<tr>
<td>Risk_Peer</td>
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<td>-0.363</td>
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<tr>
<td>Size</td>
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<tr>
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<td>-0.002</td>
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<td>(19.48)</td>
<td>(19.48)</td>
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<tr>
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<td>-0.010**</td>
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<td>(-0.42)</td>
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</tr>
<tr>
<td>Founder</td>
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<td>-0.537</td>
<td>-0.245***</td>
<td>-0.532</td>
<td>0.003</td>
<td>0.014</td>
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<td>0.000</td>
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<td>0.000</td>
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<td>(-1.47)</td>
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<td>0.097***</td>
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<td>(-25.8)</td>
</tr>
</tbody>
</table>

**Note:** Dependent variable is turnover (routine or forced) which is defined as one if there is turnover (routine or forced), zero otherwise. Z-value is below each estimated coefficient. All other variables are as defined in Table 2. Column (1) is when accounting variables are not included while column (2) is when two accounting variables are included (ROA and Risk_ROA). Z-stats are calculated using robust standard errors controlling for firm level clustering. Year dummies are included in all specifications. Marginal effect is calculated as product of three terms: variable estimate, its one standard deviation and the mean turnover density except for Founder variable for which the marginal effect is simply product of the parameter estimate and density mean (see Greene, 1997).
### Table 5: Performance with Varying Idiosyncratic Risk

<table>
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<tr>
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<th>(1) Estimate</th>
<th>(1) Marginal</th>
<th>(2) Estimate</th>
<th>(2) Marginal</th>
<th>(3) Estimate</th>
<th>(3) Marginal</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ret_Idiosyncratic</strong></td>
<td>-0.912***</td>
<td>-0.943</td>
<td>-0.850***</td>
<td>-2.042</td>
<td>-0.456***</td>
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</tr>
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<td>(-6.88)</td>
<td>(8.28)</td>
<td>(-6.88)</td>
<td>(8.28)</td>
</tr>
<tr>
<td><strong>Ret_Peer</strong></td>
<td>-1.279***</td>
<td>-1.239</td>
<td>-0.751***</td>
<td>-1.274</td>
<td>-0.404***</td>
<td>-1.213</td>
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<td>(8.28)</td>
<td>(-6.88)</td>
<td>(8.28)</td>
</tr>
<tr>
<td><strong>Risk_Idiosyncratic</strong></td>
<td>3.390**</td>
<td>0.827</td>
<td>1.416</td>
<td>0.688</td>
<td>0.574***</td>
<td>1.093</td>
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<td>(1.49)</td>
<td>(3.24)</td>
<td>(6.42)</td>
<td>(3.24)</td>
<td>(6.42)</td>
</tr>
<tr>
<td><strong>Risk_Peer</strong></td>
<td>0.618</td>
<td>0.169</td>
<td>-0.917*</td>
<td>-0.482</td>
<td>-0.617**</td>
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<td>(0.64)</td>
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<td>(-2.21)</td>
<td>(4.10)</td>
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<td>(4.10)</td>
</tr>
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<td><strong>ROA</strong></td>
<td>0.141</td>
<td>0.040</td>
<td>-0.665</td>
<td>-0.347</td>
<td>-0.226*</td>
<td>-0.482</td>
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<td>(0.18)</td>
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<td>(-1.82)</td>
<td>(3.64)</td>
<td>(-1.82)</td>
<td>(3.64)</td>
</tr>
<tr>
<td><strong>Risk_ROA</strong></td>
<td>0.088**</td>
<td>0.413</td>
<td>0.110***</td>
<td>0.794</td>
<td>0.024</td>
<td>0.250</td>
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<td></td>
<td>(2.39)</td>
<td>(3.80)</td>
<td>(2.50)</td>
<td>(6.42)</td>
<td>(2.50)</td>
<td>(6.42)</td>
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<tr>
<td><strong>Size</strong></td>
<td>0.057*</td>
<td>0.342</td>
<td>0.038</td>
<td>0.327</td>
<td>0.067**</td>
<td>0.839</td>
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<td></td>
<td>(1.71)</td>
<td>(1.35)</td>
<td>(2.50)</td>
<td>(6.42)</td>
<td>(2.50)</td>
<td>(6.42)</td>
</tr>
<tr>
<td><strong>CEO age</strong></td>
<td>-0.011</td>
<td>-0.262</td>
<td>-0.002</td>
<td>-0.086</td>
<td>0.001</td>
<td>0.072</td>
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<td>(-1.24)</td>
<td>(-3.73)</td>
<td>(-2.21)</td>
<td>(3.64)</td>
<td>(2.21)</td>
<td>(3.64)</td>
</tr>
<tr>
<td><strong>CEO tenure</strong></td>
<td>0.008</td>
<td>0.209</td>
<td>-0.010</td>
<td>-0.466</td>
<td>-0.026***</td>
<td>-1.708</td>
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<td>(1.03)</td>
<td>(1.42)</td>
<td>(-3.85)</td>
<td>(7.58)</td>
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<td>(7.58)</td>
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<tr>
<td><strong>Founder</strong></td>
<td>-0.137</td>
<td>-0.519</td>
<td>-0.227</td>
<td>-1.311</td>
<td>-0.180*</td>
<td>-1.639</td>
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<td>(-1.45)</td>
<td>(-1.96)</td>
<td>(3.64)</td>
<td>(-1.96)</td>
<td>(3.64)</td>
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<tr>
<td><strong>Competition</strong></td>
<td>-0.000</td>
<td>0.000</td>
<td>0.000**</td>
<td>0.000</td>
<td>0.000</td>
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<td>(-0.02)</td>
<td>(2.11)</td>
<td>(1.49)</td>
<td>(6.42)</td>
<td>(1.49)</td>
<td>(6.42)</td>
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<tr>
<td><strong>Firm age</strong></td>
<td>-0.006**</td>
<td>-0.451</td>
<td>-0.002</td>
<td>-0.201</td>
<td>0.002</td>
<td>0.223</td>
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<td>(-2.55)</td>
<td>(-0.83)</td>
<td>(1.03)</td>
<td>(3.64)</td>
<td>(1.03)</td>
<td>(3.64)</td>
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<tr>
<td><strong>Constant</strong></td>
<td>-2.922***</td>
<td>-2.548***</td>
<td>-3.012***</td>
<td>-3.012***</td>
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<td>(-4.45)</td>
<td>(-5.22)</td>
<td>(-8.28)</td>
<td>(10.56)</td>
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<td><strong>Sample size</strong></td>
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<td>5493</td>
<td>5488</td>
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<tr>
<td><strong>Mean turnover density</strong></td>
<td>0.03789</td>
<td>0.05774</td>
<td>0.09109</td>
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</table>

**Note:** Dependent variable is forced turnover which is defined as one if there is a forced turnover, zero otherwise. Z-value is below each estimated coefficient. All other variables are as defined in Table 2. Columns (1) to (3) correspond to low, medium and high idiosyncratic risk groups. Z-stats are calculated using robust standard errors controlling for firm level clustering. Year dummies are included in all specifications. Marginal effect is calculated as product of three terms: variable estimate, its one standard deviation and the mean turnover density except for Founder variable for which the marginal effect is simply product of the parameter estimate and density mean (see Greene, 1997).