The Role of Board of Directors in CEO Succession: Theory and Evidence

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Job Market Paper

Abstract

In this paper, I develop a search-matching model which predicts that new CEOs who are better matches to the firms will stay longer, perform better, and require less initial compensation. Using comprehensive Execucomp dataset merged with hand collected CEO background information, I find significant benefits to firms that adopt a CEO succession plan: insider successors in such firms have 1) 30% lower hazard rate of early turnover, 2) 10% higher productivity of effort, and 3) \$1,000,000 less initial compensation. I also find that more independent boards (the percentage of outside directors > 60%) and boards with larger social networks (the average outside directorships of each director > 0.5) pick CEOs with higher match qualities. All the findings suggest that the time boards spend on screening candidates and the size of boards' social network play a role in CEO succession. My results also provide support and policy implications for a legal notice from SEC, dated October 27th 2009, which signaled increased concern about CEO succession planning among corporate boards and for the first time allows shareholders to request more disclosure from companies' CEO succession plans.

Keywords: search, matching, learning, corporate governance, succession plan, managerial characteristics, insiders, outsiders, turnover, compensation, performance, survival analysis, Sarbanes-Oxley Act
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Which types of CEO successors are "better" than others? How does a corporate board function to select the best CEO for the firm and which type of board has the highest "screening" ability? These questions are interesting to both practitioners and researchers as the costs of hiring "unsuitable" CEOs (i.e. CEOs who resign in 18 months) are substantial for both companies (10 to 20 times the executive's salary) and the U.S. economy as a whole ($14 billion per year).[1]

On October 27, 2009, the Securities and Exchange Commission (SEC)'s Division of Corporation Finance released Staff Legal Bulletin No.14 E (SLB 14 E) with "two substantive changes" which revise its historical positions on the exclusion under Rule 14a-8(i)(7) of shareholder proposals related to risk evaluation and CEO succession. The division now believes that matters pertaining to CEO succession " raised a significant policy issue regarding the governance of the corporation that transcends the day to day business matter of managing the workforce...Going forward, we will take the view that a company generally may not rely on Rule 14a-8(i)(7) to exclude a proposal that focuses on CEO succession planning". In effect, the bulletin, for the first time, allows shareholders to request more disclosure from companies' CEO succession plans.

Although the recent SEC opinion indicates a significant role for CEO succession plans, there is to date no a comprehensive study, either theoretical or empirical, of the impact of such plans. The purpose of this paper is to provide such a study. This paper shows that, besides the direct transient cost a failure of CEO succession as mentioned by the SEC ("One of the board's key functions is to provide for succession planning so that the company is not adversely affected due to a vacancy in leadership"), the indirect cost is also substantial. Adopting a CEO succession plan can significantly improve the new CEO's match quality to the firm. In particular, I find that succession plans result in new CEOs that at least have 1) $1, 000, 000 less initial compensation, 2) 10% higher productivity of effort, and 3) 30% lower hazard rate of early turnover. To explain these results, this paper builds a search-matching model that explores the role a board can play in CEO succession.

Studies that concentrate on whether and how managerial characteristics affecting corporate behavior and performance widespread.[2] My paper contributes to these studies by analyzing one specific mechanism through which managerial characteristics can affect firm's performance: the initial match

[1]According to a 2007 survey by *Directorship Magazine* and RHR international, the faulty integration of a senior executive can cost a company 10 to 20 times the executive's salary in opportunity cost. In follow-up research, Stoddard and Wyckoff(2008) show that these failures have enormous repercussions on the U.S. economy as a whole, generating a loss of productivity and social costs valued at nearly $14 billion per year.

[2]For example, Adams at el (2005) studies powerful CEOs; Bertrand and Mullainathan(2003) studies CEO's preference for "quite life"; Bertrand and Schoar(2003) studies the impact of manager's fixed effects on firm policies ; Chevalier and Ellison(1999) studies behaviors of mutual fund managers; Malmendier and Tate(2005) is about CEO's overconfidence; Fahlenbrach(2006) studies the impact of founder-CEOs and Bertrand(2009) surveys the recent research on CEOs

quality between CEO successors and their firms. Currently, the majority of research on CEO succession focuses on the differences between inside/outside CEO appointments.[3] However, whether insiders are a better or worse match to the firm remains an open question.[4] As a consequence, insider/outsider studies do not really tell us about the quality of CEO successors and do not help us evaluate the board's effectiveness in CEO succession. This paper shows that a subset of inside successors, the insiders in a company with a CEO succession plan (henceforth designated successors), outperform other successors in the sense that they stay longer, perform better, and require less pay, thereby providing a better proxy for match quality. This finding is also interesting to the executive compensation literature(see, e.g., Murphy 1998) because it shows that a part of the pay in CEO compensation is due to the mismatch at the beginning of CEO tenure. The extend of potential mismatches can be reduced by carrying out a meaningful CEO succession plan.

Despite the importance of this issue, there has been very little theory to explain the board's role in CEO selection. While papers on CEO turnover usually assume that the replacement of an ineffective CEOs by the board is an indicator of effective corporate governance (Parrino et al., 2004; Dehye and McConnell 2002), very few ask the question why "unsuitable" CEOs were picked in the first place. To fill this gap in the literature, I develop a board search-matching model which stresses the importance of the entire CEO succession process, as opposed to the current theoretical models in corporate governance that focus solely on how to motivate or monitor CEOs once chosen (Hermalin 2005).

I start with a simple search model (McCall, 1970; Mortensen, 1970; Reuben Gronau, 1971) in which CEOs vary in their match qualities to the firms. During their search process, the board makes hiring decisions based on their beliefs of the CEO's match quality and hence the model predicts how different board recruitment behaviors and screen ability lead to different expected value of the CEO firm match quality. After the CEO is hired, the two sides learn about the quality of a given match over time. Realization of match quality will lead bad matches to be dissolved and good matches to retain. In order to model this process, I nest a dynamic principle-agent problem into traditional matching models (Jovanovic,1979; Moscarini,2005). In equilibrium, the CEO's initial compensation package, tenure, and performance are all endogenized and dependent on the parameters of CEO-firm match quality and board monitoring ability. I then use the model to infer the unobserved distribution of match quality from the observed joint distribution of CEO's initial compensation, tenure, and

[3]see, e.g. Agrawal et al,2006; Bennedsen et al,2007; Tsoulouhas et al,2007

[4]Among large U.S. corporations, Huson et al (2004) find that post-turnover changes in firm OROA are greater when successor CEOs are firm outsiders than when they are insiders, while Allgood and Farrell (2003) find no significant differences between insider and outsider successors. For other specific type of insider, the evidence is also mixed, for example, family successors usually perform worse than average (Bennedsen et al, 2007; Perez-Gonzalez,2006); while founder-CEOs are usually better (Fahlenbrach, 2006) .

performance (henceforth I use "higher match quality" and "lower initial compensation,lower hazard rate of early turnover and better firm performance" interchangeably) . Take the search and matching model together, we are able to assess board's effectiveness in CEO succession by evaluating their CEO's match quality.

For example, boards with no succession plan usually start their search late, sometimes even after their CEO turnover. In that case, the board will set a lower standard for screening candidates because the cost for them to wait for one more period for a better candidate is much higher than the ones who planned early, say 3 years ago. On average, this will result in a lower CEO firm match quality, hence lower firm performance and higher hazard rate of CEO turnover. Based on this knowledge, managers will require higher initial pay to compensate for their additional risk of turnover. In sum, the model predicts that designated successors will have higher match quality. Using comprehensive Execucomp dataset merged with hand collected CEO background information and firm's CEO succession plan information, I find support for the model.

This paper makes several novel contributions to the literature on labor economics, corporate governance and the policy debate regarding the role that boards of directors should play. First, I augment the growing evidence indicating that the managerial labor market has become a relatively more important factor in the top U.S. executives' compensation and turnover (Himmelberg and Hubbard (2000), Oyer (2004), and Rajgopal, Shevlin, and Zamora (2006) study the lack of relative performance evaluation in pay; Gabaix and Landier (2006), Murphy and Zaojnik (2007), Kaplan and Rauh (2006) study the increase in the level of pay); Falato and Li (2009) explore the role of the labor market for CEO talent on CEO turnover). By combining the traditional matching model with principle-agent issues, I am able to study the role of CEO-firm match quality on CEO initial pay, firm performance and turnover simultaneously.Given both the broad set of new variables I examine and the large cross-section of firms I include in our hand-collected dataset, to the best of my knowledge, my investigation represents the first large-sample study of the impact of the CEO succession plan, CEO prior occupation and board's characteristics on CEO firm match quality.

Second, This paper offers the first model that explains the role of board of directors in CEO succession and developing a unique empirical method to measure the board's strength in CEO selection and monitoring. The role of the corporate board in my model is two fold: (1) to select a new CEO with good match quality (screening ability) and (2) to monitor the CEO and fire him if his is unsuitable for the firm (monitoring ability). An empirical challenge for this paper is how to isolate board's screening ability from their monitoring ability. For example, if we observe that boards of certain type are more likely to fire CEOs, is that because they are bad screeners, or stricter monitors, or both? I address this by studying the hazard rate of CEO turnover over his tenure. The fact that the hazard rate of CEO turnover exhibiting a inverted U shape over CEOs' tenure has been well documented in Allgood and Farrell (2003) and Gregory-Smith et al (2009), but none of them have explained its underline determinants.

According to my model, there are two offset forces that drive the hazard rate. The first is the increasing possibility of the board observing the CEOs' true type (learning) and this effect drives unsuitable CEOs' hazard up. On the other hand, as unsuitable CEOs are fired over time, the average level of match quality of retained CEOs goes up, which implies less CEO turnover, hence driving the hazard rate down. At the beginning of CEO tenure, the first effect dominates the second, therefore we will observe a rise in the hazard of CEO turnover. After the learning process, the second effect dominates and we will observe hazard rate decreases. Based on this argument, I can measure the board's strength in screening and monitoring separately. Namely, the strength of screening ability is measured by the percentage of CEOs retained when learning is over, because boards with stronger screening abilities pick more qualified CEOs on average (by definition) and they should retain more CEOs. And monitoring strength is measured by the slope of hazard rate in CEO early term, which represents the speed of board learning, and by definition boards with strong monitoring abilities learn faster than others. Many empirical research studies in corporate governance include board characteristics into regressions without a clear theoretical model telling us for what they are really control. To my knowledge, this is the first model that helps distinguish these two different roles of boards.

The rest of the paper is organized as follows. Section 1 develops the theoretical Model. Section 2 provides empirical support for the model. Section 3 answers the question: which type of board can pick the best CEO? Section 4 provides concluding remarks. Proofs, definitions of some control variables and some technical details are put in the appendices to reduce the length of formal text.

1 Board Search-Matching Model

Consider an infinite horizon world where time is discrete and denoted by $t = 0, 1, 2, ...$ There are two types of players in the labor market: the boards who are looking for a CEO and managers who want to become CEO.[5] They both are ex ante expected discounted utility maximizers and discount the future by the common discount factor $\beta \in (0, 1)$. The boards are risk neutral and the managers are risk averse. CEOs' efforts are unobservable, therefore there is moral hazard. For simplification, I assume

[5]Here I talk about both internal and external markets.

that there is no quits of CEOs and all new CEOs come from non CEO positions or CEOs who were fired. As a result, CEO turnover in my model is due to either initial mismatch or retirement.[6]

The first departure of my model from the standard matching model consists in the introduction of heterogeneity in the market, a crucial ingredient to make recruitment and screening activities play a meaningful role. I start with the assumptions about the heterogeneity in CEO's productivity and board's type, then show the search model of board's screening process and matching model of board's monitoring process respectively.

1.0.1 CEO's Productivity

I start with an assumption that manager i's productivity can be divided into two components:

$$productivity_i = A_i + \mu$$

where A_i is their talent (or ability, skills) and it is fully observable to the public, including age, education, former employer, former firm performance and etc. The other one, $\mu \sim N(\bar{\mu}, \sigma^2)$,[7] is the CEO-firm match quality. The match quality between a new CEO and a firm is unknown to both the CEO and the board until production takes place and output can be observed. In other words, CEOs are ex-ante identical in their match quality, but they are ex post different when their match quality is realized.

In order to study how boards treat these two components of CEO's productivity, I specify two stages in CEO selection, corresponding to the two types of recruitment activities. The first one is extensive recruitment, concerning all the actions taken by the board to improve the probability of meeting a candidate (or to increase the number of applications received). These activities include hiring an executive search company, the board looking for candidates through their social network etc. This is a search process based on observed talent. Directly importing the settings of the model of Gabaix and Landier (2008),[8] I assume a continuum of firms with different size and a continuum of

[6]More precisely, "no quit" here means that when the CEOs get an outside offer, the boards always provide a counteroffer to keep them. This simplification is based on two observations. First, CEOs rarely quit, especially in EXECUCOMP, which contains mainly the largest firms in the U.S. Using EXECUCOMP, I find that only 5% of CEOs leave their firm for an new job; Cremers and Grinstein(2009) find that 88% CEOs (63% insiders, 68% of outsiders) were promoted from non CEO positions. Second, incorporating quit into my model doesn't change its main predictions. It just inflates the threshold of turnover. By "threshold", I mean that the board will fire the CEO if his match quality is below some level. Now CEOs may quit because they find a better match than current firm.

[7]From now on, I will use $\bar{\cdot}$ denotes the mean of a random variable , e.g. $\bar{\mu}$ is the mean of μ; $\bar{\mu}_t$ is the mean of random variable μ_t

[8]Since the firm size is fixed in my model, it can not explain merge and acquisition. Therefore I delete all the turnover due to merge and acquisition in my empirical work, which is only 5 % of all the CEO turnovers. Baranchuk et al (2009) developed a Gabaix and Landier (2008) type model where homogenous firms choose its size and its CEO in the same

CEOs with different talent, and the search for CEO's talent is frictionless. Even though all boards would rather hire the most able individual for the firm, it is the companies where ability is at its most productive that will pay the most for it and therefore attract the best individuals. In the equilibrium, the best CEOs manage the largest firms, as this maximizes their impact and economic efficiency. And the reservation wage $\bar{w}_i$ of CEOs of same talent level T_i are the same, which depends on firm size and firm rank in its industry. [9]

Since the major goal for this paper is to study the role of board on CEO selection, I will skip the external recruitment here, by assuming that the boards' short list of CEO candidates are of the same ability level and the board's task is to select their CEOs from this pool of candidates. As a result, only the unobserved part of μ_i matters for boards' decisions. Therefore I normalize μ_i to be independent of A_i. A consequence of this assumption is that when the board gets some bad signals from incumbent CEO and fire him, it does not affect the outside employer's belief of the CEO's talent level. Therefore, different from Fama(1980)'s reputation story, the career concern of CEOs do not come from concerns of reputation, but from the fact that they need wait for a long time to find a new CEO position. [10]

The second stage is called intensive recruitment, which has to do with all the actions taken by the board to improve their knowledge about the manager's match quality. These actions include building a CEO succession plan, interviewing with the CEO candidates and etc. In order to model the fact that it takes time and other resources for a board to find a suitable CEO to the firm, I use a search model to study this process.

1.0.2 Board's Type

Boards can be characterized by (S, M), where S represents their screening ability and M monitoring ability. They are formally defined as follows: when the board makes hiring and firing decisions, they are based on the information they collect by observing the CEOs. Their screening ability and monitoring ability determine how precise the signals they can get.

For example, regarding intensive recruitment, I assume that the board gets a signal of the CEO

time. In equilibrium, firms are heterogenous in their size and more capable CEOs manage larger firms.

[9] For example, Gabaix and Landier (2008) find

$$\bar{w}(n, n^*) = D(n_*)S(n_*)^{\frac{\beta}{\alpha}}S(n)^{\gamma-\frac{\beta}{\alpha}} = f(firm\,rank, firm\,size)$$

where $S(n)$ is the size of firm n(the $n-th$ most talented CEO is matched with the $n-th$ largest firm), n_* is the index of a reference firm (e.g., the 250th largest firm in the economy), $S(n_*)$ is the size of that reference firm, $D(n_*)$ is a constant independent of firm size.

[10] A more general assumption is that μ includes the unobserved part of manager's talent and match quality and board is in charge of identifying of this μ. Since this will not alter the analysis of my paper, I use the above assumption for simplification.

candidate's match quality:

$$s = \bar{\mu} + \epsilon, \epsilon \sim N(0, \sigma^2_{\epsilon^S})$$

This signal could be a one time observation from a job interview, or a sum of multiple observations of an insider candidates. ϵ_1 represents the mistake that the board will make when doing such observations. It could be because that they set an improper future strategy for the firm and looking for a candidate in the wrong direction; or they overestimate the candidate's match quality to the firm. By the definition of board's screening ability, we know that $S \propto \frac{1}{\sigma^2_{\epsilon^S}}$.

Similarly, we say that $M \propto \frac{1}{\sigma^2_{\epsilon^M}}$, where ϵ^M is the error term in board's signal after the CEO starts to produce: $s_t = \nu + E_t(y_{t+1}|\mu_t) + \epsilon^M$, ν is the private information the board will get and $\epsilon \sim N(0, \sigma_\epsilon)$.

The managers' knowledge regarding boards' type are defined as follows: with probability $\xi (0 \leq \xi \leq 1)$, managers knows the board's type, otherwise, they know nothing about the board.

1.1 Board Search Model

I model this stage using a simple search model (McCall 1970; Mortensen 1970; Reuben Gronau 1971), in which the board screens CEO candidates until they find some one whose match quality is above his reservation "match quality", the threshold μ^*. This threshold comes from the board solving the following equation:

$$V = max\{V_h, \beta V_{new} - C_{wait}\}$$

where V_h is firm's present value if it hires CEO for this period, V_{new} is to wait for another period and find a new candidate and C_{wait} is the cost to the firm if the board waits for another period to find a permanent CEO. μ^* is the match quality satisfying $V_h(\mu^*) = \beta V_{new}$.

During the screening process, the board gets a signal regarding CEOs' match quality: $s = \bar{\mu} + \epsilon$. Therefore the probability that the board correctly picks a "suitable" CEO for the firm (i.e. $\mu > \mu^*$) is:

$$P \equiv Prob(\underbrace{\bar{\mu} > \mu^*}_{CEO\,is\,suitable} \quad | \quad \underbrace{s > \mu^*}_{board\,thinks\,CEO\,is\,suitable}) = Prob(\bar{\mu} > \mu^* | \bar{\mu} + \epsilon^S > \mu^*)$$

$$\propto \frac{Prob(\epsilon^S > 0)}{Prob(\epsilon^S > \mu^* - \bar{\mu})} = \frac{1/2}{1 - \Phi(\frac{\mu^* - \bar{\mu}}{\sigma^2_{\epsilon^S}})} \propto \Phi(S(\mu^* - \bar{\mu}))$$

And the expected initial match quality is

$$\bar{\mu}_0 = P\bar{\mu}I(\bar{\mu} > \mu^*) + (1 - P)\bar{\mu}I(\bar{\mu} < \mu^*)$$

where $I(\cdot)$ is indicator function. Easy to see, $\bar{\mu}_0$ is increasing in P.

1.1.1 Search Model Predictions

Proposition 1

$$\frac{d\bar{\mu}_0}{dC} < 0$$

Proof 1 *See Appendix B*

Interpretation: Less patient board will pick CEOs with lower initial match quality. Board could be less patient because they start their search late and the cost of waiting is high. Therefore an natural conclusion from this proposition is designated successors have better match quality.

Proposition 2

$$\frac{d\bar{\mu}_0}{d\sigma^2_{\epsilon^S}} < 0$$

Proof 2 *See Appendix B*

Interpretation: The less volatile the signal is, the higher expected initial match quality will be. The precise of the signal depends on 1) the boards' screen ability: with high screening abilities S will pick up a CEO with higher initial match quality $\bar{\mu}_0$, because that boards with higher screening abilities are less likely to make mistakes in CEO selection.[11] 2) Information on CEO's background : CEOs candidates whose prior occupation are similar to their current job will give a more precise signal to the board(smaller σ^2_ϵ). Therefore their match quality should be higher, ceteris paribus.

1.2 Board Matching Model

The matching model in this paper draws on the analysis by Jovanovic (1979), Moscarini (2005) and papers analyzing the impact of board of directors on CEO turnover by Hermalin (2005). The second departure of my model to standard matching model is the introduce of the moral hazard issue. Since the time horizon is infinite, I need to solve a dynamic principle-agent problem. The complexity of this problem arises from the fact that a CEO's current period performance will change the board's belief of

[11] Since P is also determined by μ^*, it is possible that a board, anticipating that they will do a good job in monitoring CEOs, set a lower μ^* when screening. So if S is negatively correlated with M, we may observed a negative correlation between S and P. My argument is that firing CEO is very costly(Stoddard and Wyckoff 2008), so when board decides to hire a CEO, they would set a much higher standard than they fire an incumbent one, i.e. $\mu^*_{hire} = \gamma\mu^*_{fire} = \gamma f(M)$, where γ is very small. Therefore S should have the dominate effect in determining P than M.

his match quality, and hence his compensation and turnover risk in next period. Following the literature on career concern (e.g. Gibbons and Murphy,1992), I make two assumptions in CEO compensation package: (1) short-term contracts (i.e., one-period) are linear in output; and (2) long-term (i.e., two-period) contracts are not feasible. Therefore CEO compensation is given as: $W_t = C_t + b_t y_t$,where C_t represents the fixed salary, $b_t \in [0, 1]$ is the pay-for-performance sensitivity at time t and y_t is period t output. The production technology is given by: $y_t = \mu e_t + \epsilon$, where μ represents CEO firm match quality,[12] e_t represents the CEO effort level, and ϵ is a random shock that is normally distributed with mean 0 and variance 1. I primarily interpret μ as CEO's productivity of effort and assume that μ is independent of ϵ . CEO's utility is given by: $exp(-r(W - k(e)))$ where $k(e)$ is the cost function of CEO effort and $k(e) \equiv \frac{e^2}{2}$.

1.2.1 The Time Line

Figure 1 is the time line of my matching model.

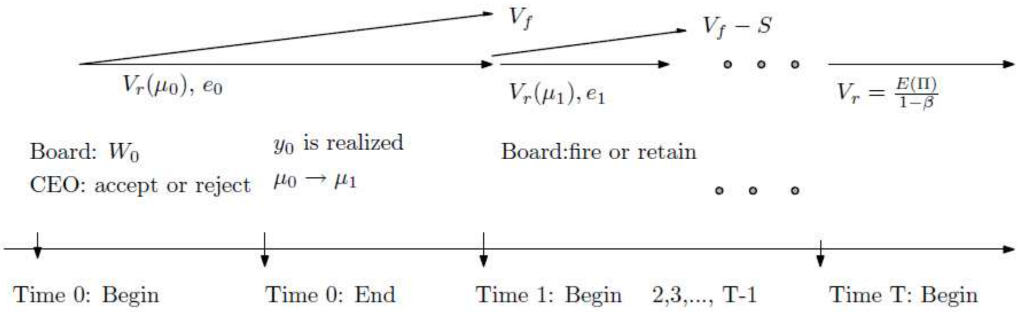


Figure 1: time line of the model

At the beginning of Time 0 The board offers a compensation contract $W_0 = C_0 + b_0 y_0$ to the CEO. The CEO decides whether to accept the wage contract, and if he does, privately chooses an effort level $e_0 \in [0, \infty)$. [13]

At the end of Time 0 Firm's outcome y_0 is realized, $y_0 = \bar{\mu} e_0 + \epsilon, \epsilon \sim N(0, \sigma_\epsilon)$

At the beginning of Time 1 By Bayes's rule, the board updates their belief of the CEO's match quality to μ_1(See Appendix A for details on board's learning process). Based on this posterior

[12]The output should be $y_t = (A + \mu)e_t + \epsilon$. Since I only discuss CEOs of the same talent level, A is ignored for abbreviation. I assume that e and μ are multiplicative in the production function, considering the fact that the CEOs effort is magnified geometrically, affecting the productivity of all who work below her in the organization.

[13]Although the retention/dismissal decision is made at the beginning of next period, after the board get information about the CEO type, the wage contract is written prior to its realization. Hence, when the board set the "take-it-or-leave" offer and when CEOs consider the board's offer, they must assess the expected probability that the CEO will be fired in the future.

estimation, the board may decide to fire the CEO or retain him. In other words, the board need to solve the following problem:

$$V(\mu_1) = max_{retain,fire}\{V_r(\mu_1), \beta V_f\}$$

where $V_r(\mu_1)$ is the firm's value function conditional on retaining the CEO and V_f is the firm's value function conditional on firing the CEO and replacing him with a new CEO. I set it constant over time.

If the board decides to fire the CEO, they will pay him a severance fee and find a replacement CEO whose match quality, μ_R, is a random draw from a normal distribution with mean $\bar{\mu}$ and variance σ^2.

At the end of Time 1 Given the firm's retention policy, there is a chance that either the incumbent CEO will survive until Time 1, or that he will be replaced before Time 1. Therefore the firm's outcome could be:

$$y_1 = \begin{cases} \mu e_1 + \epsilon, & \text{CEO are retained;} \\ \mu_R e_R + \epsilon, & \text{CEO are fired.} \end{cases}$$

The board updated contract (C_0, b_0) to (C_1, b_1) based on their updated belief.

Time 2,3,...,T-1 similar procedure as in Time 0,1.

At the beginning of Time T(T could be ∞) The CEO's match quality is fully revealed and the board's problem changes into:

$$V_r = E(\Pi) + \beta V_r$$

where $E(\Pi)$ is the expected firm value for one period. Therefore the board's value function $V = V_r = \frac{E(\Pi)}{1+\beta}$.(See the Appendix 4.1.2" End of Learning" for details)

1.3 Board's Optimization Problem at Time $t, t < T$

At the beginning of time t, after updating their belief of the CEO's match quality to μ_t, the board has to maximize the firm's value function:

$$V(\mu_t) = max_{retain,fire}\{V_r(\mu_t), \beta V_f\}$$

where $V_r(\mu_t)$ is the firm's value function conditional on retaining the CEO:

$$V_r(\mu_t) = max_{C_t,b_t,e_t}[(1-b_t)\bar{\mu}_t e_t - C_t] + \beta[\underbrace{\delta(t)\int_{\mu^*_{t+1}}^{\infty} V_r(\mu_{t+1})dF(\mu_{t+1}|\mu_t)}_{CEO\,is\,retained} + (\underbrace{\delta(t)Pr(\mu_{t+1} < \mu^*_{t+1}|\mu_t)}_{CEO\,is\,fired} + \underbrace{1-\delta(t)}_{CEO\,retires})V_f]$$

subject to the participation constraint

$$exp(-r[C_t + b_t\bar{\mu}_t e_t + \frac{1}{2}b_t^2\sigma_\epsilon^2 - k(e)]) + \beta[\underbrace{\delta(t)\int_{\mu^*_{t+1}}^{\infty} W_r(\mu_{t+1})dF(\mu_{t+1}|\mu_t)}_{retained} + \underbrace{\delta(t)Pr(\mu_{t+1} < \mu^*_{t+1}|\mu_t)W_f]}_{fired} \leq \bar{U}$$

and the incentive constraint

$$e_t \in argmax_e\{exp(-r[C_t + b_t\bar{\mu}_t e_t + \frac{1}{2}b_t^2\sigma_\epsilon^2 - k(e_t)]) + \beta[\delta(t)\int_{\mu^*_{t+1}}^{\infty} W_r(\mu_{t+1})dF(\mu_{t+1}|\mu_t) + \delta(t)Pr(\mu_{t+1} < \mu^*_{t+1}|\mu_t)W_f]\}$$

V_f is the firm's value function conditional on firing the CEO and replacing him with a new CEO. W_f is the CEO's value function conditional on being fired[14]. $1-\delta(t)$ is the probability for CEO to retire and it is an increasing function of CEO's tenure.[15]

μ^*_{t+1} is the cutoff value of board estimated match quality that triggers the firing option at Time $t+1$, i.e., the board will fire the CEO if $\mu_{t+1} < \mu^*_{t+1}$ and retain if $\mu_{t+1} \geq \mu^*_{t+1}$.

$F(\mu_{t+1}|\mu_t) \sim N(\bar{\mu}_{t+1}, \Sigma_{t+1})$ is the distribution of the expected match quality at time $t+1$ given the match quality at time t and the expected signal s_t the board will get during time t[16]. where

$$\bar{\mu}_{t+1} = \frac{\frac{1}{\sigma_0^2}\bar{\mu}_t + \frac{1}{\sigma_\epsilon^2}s_t}{\frac{1}{\sigma_0^2} + \frac{1}{\sigma_\epsilon^2}}$$

$$\Sigma^2_{t+1} = \frac{1}{\frac{1}{\Sigma_t^2} + \frac{1}{\sigma_\epsilon^2}}$$

1.4 Definition of the Equilibrium

Suppose the market conjectures that the manager's period t effort was $\hat{e}_t$, the equilibrium is the vector $(\{e^*_t\}_{t=1,2,...,}, \{C^*_t\}_{t=1,2,...,}, \{b^*_t\}_{t=1,2,...,}, \{\hat{e}_t\}_{t=1,2,...})$ satisfying the following:

1. The conjecture is correct, i.e. $\hat{e}_t = e^*_t, \forall t = 1,2,...$

[14] It depends on severance fee , $\bar{U}$ and the cost for CEO to search for a new job

[15] Here I assume that CEO receive 0 labor income after retirement.

[16] $s_t = \nu + E_t(y_{t+1}|\mu_t) + \epsilon^M$, where ν is the private information the board will get and $\epsilon^M \sim N(0, \sigma_{\epsilon^M})$, and the precise of this signal depend on the board's monitoring quality $\frac{1}{\sigma_{\epsilon^M}} \propto M$.

2. Given $\{C_t^*\}_{t=1,2,...,}, \{b_t^*\}_{t=1,2,...,}$, the manager's expected utility is maximized at $\{e_t^*\}_{t=1,2,...,}$;

3. The expected profit of the company is maximized at $\{C_t^*\}_{t=1,2,...}, \{b_t^*\}_{t=1,2,...}$.

1.5 Matching Model Predictions

In the following propositions, I will show how the CEO's initial compensation, performance and tenure are affected by the board's screening ability and monitoring ability.

Proposition 3 *(Relation between initial compensation and$\bar{\mu}_0$, S and M)*
Let $\bar{W}_0(S, M)$ be defined as the certainty equivalent value of the initial compensation offered by a board with screening ability S and monitoring ability M , i.e.

$$E(exp\{-r(\bar{W}_0)\}) = E(exp\{-r(W_0 - k(e))\}) = E(exp\{-r(C_0^* + b_0^* y_0^* - k(e_0^*))\}).$$

We have:

$$\frac{\partial \bar{W}_0}{\partial \bar{\mu}_0} \leq 0; \frac{\partial \bar{W}_0}{\partial S} \leq 0; \frac{\partial \bar{W}_0}{\partial M} \geq 0$$

Namely, all other things equal, low S type board will give higher or equal (certainty equivalent) initial compensation than the high S board, while low M type board will give lower or equal (certainty equivalent) initial compensation than the high M board.

Proof 3 *See Appendix B*

Proposition 4 *(Relation between firm outcome y_t and match quality$\bar{\mu}_0$)*
$E(y_t) = f(\bar{\mu}_0)g(b_t), t > T$, where $f(m\bar{u}_0)$ is an increasing function in $\bar{\mu}_0$ and $g(b_t)$ is an increasing function in b_t.

Proof 4 *See Appendix B*

The intuition behind this proposition is that when learning is over ($t > T$), the CEOs don't have career concern any more, and their incentives come mainly from the incentive pay b, so we can use incentive pay to proxy for the CEO's optimal effort level.

Proposition 5 *(Relation between hazard rate and S,M)*
Let $F(t|\bar{\mu}_0)$ be defined as the probability that a CEO with perceived match quality of μ_0 to be fired at time t, then:

1. *there exists some* $t^* \geq 0$*, such that*

$$\frac{\Delta F(t|\bar{\mu}_0)}{\Delta t}\begin{cases} > 0, & t > t^*; \\ \leq 0, & t \leq t^*. \end{cases}$$

(If t^* *equals 0, we only observe* $\frac{\Delta F(t|\bar{\mu}_0)}{\Delta t} \leq 0$*). In other words, the probability of CEO turnover increases (with time) first and then decreases.(or decrease over the CEO tenure).*

2.
$$\frac{dF(t|\bar{\mu}_0)}{dS} < 0, \frac{\Delta|\frac{dF(t|\bar{\mu}_0)}{dS}|}{\Delta t} < 0, \forall t$$

It shows that high S *board will have a lower probability of turnover over the CEO's tenure and this effect is decreasing over time.*

3.
$$\frac{d\frac{\Delta F(t|\bar{\mu}_0)}{\Delta t}}{dM} > 0, \forall t$$

The interpretation of this claim is that high M *board "learns" faster than low* M *board, therefore their speed of discovering unsuitable CEOs and firing them are faster than that of low* M *board. In other words, they have steeper slopes in their hazard rate.*

4. *All the statements above is also true for the hazard rate of CEO turnover.*

$$Hazard(fire\,at\,t) = \frac{Pr(F_t = 1, F_{t-1} = 0, F_{t-2} = 0, ..., F_1 = 0)}{Pr(F_{t-1} = 0, F_{t-2} = 0, ..., F_1 = 0)}$$

$$= \frac{\int F(t|\bar{\mu}_0)\Pi_{i=1}^{t}(1 - F(t|\bar{\mu}_0))f(\bar{\mu}_0)d\bar{\mu}_0}{\int \Pi_{i=1}^{t}(1 - F(t|\bar{\mu}_0))f(\bar{\mu}_0)d\bar{\mu}_0}$$

where $F_t = 1$ *represents that the CEO is fired at* t *and* $F_t = 0$ *represents that CEO is retained at time* t*.*

Proof 5 *See Appendix B*

1.6 An Example – The Simplified Version of The Model

Since it is impossible to get explicit formula for the hazard rate of CEO turnover in the model above, I use a simplified version of the model to generate an approximation of the hazard rate. The simplifications include:

Simplification 1 Match quality $\mu = \begin{cases} \mu_H, & \text{with probability } 0.5; \\ \mu_L, & \text{otherwise.} \end{cases}$, namely there are only two types of match qualities μ_H and μ_L.(originally,$\mu \sim N(\bar{\mu}, \sigma)$);

Simplification 2 Boards all want to select μ_H (Originally $\mu_t^* \geq \mu_{t+1}^*$, see Appendix B,proof 3.)

Recall our discussion in section(1.1), the initial match quality of a CEO selected by a board with screening ability S is:

$$\bar{\mu}_0 = P\mu_H + (1 - P)\mu_L$$

where $1 - P$ is the probability that a board makes mistakes and $P \propto S$.

Recall $F(t|\bar{\mu}_0)$ is the probability that a CEO to be fired at time t:

$$F(t|\bar{\mu}_0) = PF(t|\bar{\mu} = \mu_H) + (1 - P)F(t|\bar{\mu} = \mu_L)$$

where $F(t|\bar{\mu} = \mu_L)$ is the probability that unsuitable CEOs are fired; $F(t|\bar{\mu} = \mu_H)$ is the probability that suitable CEOs are faultily fired.

Simplification 3 $F^L(t) \equiv F(t|\bar{\mu} = \mu_L) = \left(\frac{t}{D}\right)^\gamma = (Mt)^\gamma$

where D is the variance of the signal a board gets after monitoring, i.e., $D \propto \frac{1}{M}$.$\gamma > 0$ is a scalar, giving curvature to the function of $F(t)$. The fact that $\left(\frac{t}{D}\right)^\gamma$ is increasing in t reflects the increasing possibility of the board observing the CEO's true type. For unsuitable CEOs, this effect drives the probability up. And $\left(\frac{t}{D}\right)^\gamma$ is decreasing in D is consistent with the idea that overt time, the board will get more precise knowledge about the CEO's match quality and therefore are more likely to fire unsuitable CEOs (see Appendix B, Proof 3 for details).

Simplification 4 $F(t|\bar{\mu} = \mu_H) = 0$

$F(t|\bar{\mu} = \mu_H)$ is in fact the probability that the board observes sequentially bad realization of ϵ. Since it is very small and ignoring it doesn't change our results, for simplification, I set $F(t|\bar{\mu} = \mu_L) = 0$.

The hazard rate of CEO turnover is:

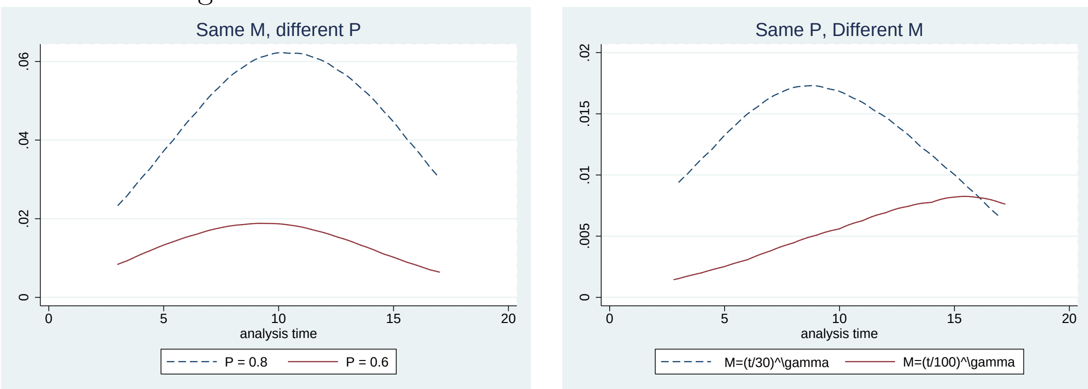
$$h = \frac{\text{fired at t}}{\text{survived after t-1}} = \frac{(1-P)[\Pi_{i=1}^{t-1}(1 - F^L(i))]F^L(t)}{1 - (1-P)[\Pi_{i=1}^{t-1}(1 - F^L(i))]F^L(t)}$$

$$\Leftrightarrow \frac{(1-P)[\Pi_{i=1}^{t-1}(1 - F^L(i))]F^L(t)}{P + (1-P)[\Pi_{i=1}^{t-1}(1 - F^L(t))]}$$

Now I will show that h satisfies all the three properties of the hazard rate generated by my original model. It is straight forward to see $\frac{dh}{dS} < 0, \frac{d\frac{\Delta h}{\Delta t}}{dM} > 0$, next I need to show that the hazard rate h is indeed inverted U shape.

There are two effects that drive the hazard rate. The first is the increasing possibility of the board observing the CEO's true type, i.e. $F^L(t)$ is increasing in t. Therefore this effect drive the hazard rate up. On the other hand, as unsuitable CEOs are fired over time, the average level of match quality of retained CEO goes up, i.e., $\frac{(1-P)\Pi_i^{t-1}(1-F^L(i))}{P+(1-P)\Pi_i^{n-1}(1-F^L(i))}$ is decreasing in t, which implies less CEO turnover, hence the hazard rate decreases. At the beginning of the CEO tenure, the first effect dominates the second, therefore we will observed a rise in the hazard of CEO turnover. After the learning process, the change in $F^L(t)$ on t becomes much smaller and therefore we will observe a drop in hazard rate. Figure 2 shows the simulated hazard rate.

Figure 2: Simulated Hazard Rate for different P and M



Another observation is that the impact CEO match quality on hazard rate is decreasing, as revealed by the left picture in figure(2). For different Ps, the difference of hazard rate goes up first and then decrease. I can show analytically this is in general true. (Rearranging terms we will get $\frac{[\Pi_{i=1}^{n-1}(1-F^L(i))]F^L(n)}{\frac{1}{\frac{1}{P}-1}+[\Pi_{i=1}^{n-1}(1-F^L(i))]}$, easy to see that the coefficient in front of P increases first and then decrease over time).

1.7 Hypothesis Development

To summarize, the model delivers three sets of empirical implications.(Here I only show the hypotheses for the designated successors. Hypotheses for the CEO's with different prior-occupation and board's screening ability can be derived in the same way.)

Hypothesis 1 *Designated successors acquire equal or less (certainty equivalent) initial compensation* *than other successors, ceteris paribus.*

As we discussed in Proposition (1), designated successors have higher CEO match qualities, and from Proposition (3), we know that CEOs with higher match qualities will acquire equal or less initial compensation.

Hypothesis 2 *Designated successors should have a positive effect on firm performance after learning is over, controlling for the incentive pay;*

This hypothesis comes from Proposition (1) and Proportion (4). There is one concern regarding this hypothesis. Literature studying incentive pay argue that sometimes incentive pay doesn't provide incentive or provide wrong incentives. For example, Benmelech et al (2007) found that although stock-based compensation causes managers to work harder, it also induces them to hide any worsening of the firm's investment opportunities by following largely sub-optimal investment policies. Barron (2008) argue that a higher exercise price moves the executive's decision criterion away from first-best but provides leverage that moves the executive's effort toward first-best. According to this literature, suitable CEOs may perform to the firm's best because they are badly motivated. But this doesn't affect my analysis, because this disincentive problem will happen to suitable CEOs as well as unsuitable ones. Therefore the difference in their performance won't change.

Hypothesis 3 *Designated Successors should have a negative effect on the hazard rate of CEO turnover in their early tenure, controlling for board monitoring ability and market condition.*

In the remaining of the paper, after describing the data in the next section, these implications will be tested empirically.

2 Econometric Methods and Results

2.1 Data Sources and Sample Construction

This section describes the data and proxies used in my study, and reports the summary statistics for the key variables.

My initial sample is from EXECUCOMP for 1992 through 2008. The EXECUCOMP data contains compensation and basic demographic information for the highest-paid executives in all S&P 500, Mid-Cap 400 and Small-Cap 600 companies (this is known as the S& P 1500). These firms account for about 80 percent of the total market cap of all US publicly-traded firms. I combine the EXECUCOMP data with financial data from Compustat , stock return data from the Center for Research and Security Prices (CRSP), board information from RiskMetrics , CEO succession plans information from 10 K wizard dataset(Now Morningstar Document Research) and hand-collected data about CEO personal information, such as education background, previous job position etc. The RiskMetrics data contains detailed board information for S&P1500 firms for the proxy seasons of 1997-2007. Specifically, it covers director identity and affiliation, director gender, age, director tenure, committee membership and much more. The 10K Wizard dateset offers a search engine for SEC filings, where I can identify companies which have words like "succession plan" or "succession planning" or "executive succession" or "CEO succession" in any of their SEC filings.

I eliminate utilities (Standard Industrial Classification (SIC) codes 4800–4999) because they were in the process of deregulation during this time. I also eliminate financial firms (SIC codes 6000–6999) and firms for which there is only one observation. After merging these sources of data there are 3297 CEO-firm matches and 9713 CEO-firm-year observations. The particular sample size, however, reduce to 4674 CEO-firm year observations due to the availability of CEO incentive pay and initial compensation data. Since the reduced dataset have similar summary statistics as the original one, I will only report the results of the reduced dataset and use the full dateset for robustness check when necessary.

In Appendix B, I will explain in details the measurements of all regression variables. Here I focus on my proxies for match quality, which includes:

"Insider/Outsider" An indicator variable, insider, is set equal to 1 if the CEO has worked in the company for at least 3 years before he takes office. This wills serve as a benchmark to for us to compare the results with insider/outsider literature.

"Designated Successors" An indicator variable, Plan, is set equal to 1 if the CEO was selected in a company which has a succession plan in at least 3 years before he takes office. Apparently, this indicator is not good enough to serve for a proxy for higher match quality : some firms may just mention that they have a "succession plan", but do not have a CEO candidate in place. Following is an example. Boeing Corp. mentions that they have a "CEO succession plan" in their annual report in all the year between 1995-2008.

> The Board of Directors views CEO selection as one of its most important responsibilities. The CEO reports annually to the Governance and Nominating Committee on planning for CEO succession either in the event of a sudden emergency or, longer range, when it is time for the CEO's retirement. When

> a succession of the CEO occurs, this Committee manages the process of identifying and selecting the new CEO with the full participation of each of the non-employee directors.

However, in year 2005, after their CEO Harry Stonecipher resigns, they mentioned in their annual report as follows:

> ... The Board has a robust succession planning process in place and will accelerate the search for a permanent CEO. Candidates both inside and outside the company are being considered.

This search starts in a hurry, which really do not capture the benefit of a CEO succession plan (longer time horizon for searching). In order to take account of such bias, I use two subset of this variable: 1) "Designated Successors": who are insiders from the firm with a CEO succession plan.Since the firms talk about CEO successions in their annual report and eventually an insider succeeds. This indicates that to some extend, this insider should be under the board's consideration and evaluation for a while; 2) "Heir Apparent": successors who were chief operating officer (COO) and/or president of their firm. In Vancil (1987)'s detailed qualitative study of CEO succession, he found that heirs apparent virtually always hold the title(s) of president and/or COO.

"Heir Apparent" An indicator variable, COO(President,VP), is set equal to 1 if the CEO was COO(President,Vice President or Vice Chairman) from other S& P 1500 companies or his own company before he takes office. In our sample, 98% companies have "President" or "Vice president" in their top management team. Although CEOs are usually President in the same time, there is a clear trend for companies to set a seperate "COO" or "President" before CEO retirement. In addition, Vancil (1987) also found that only 1/3 heir apparent becomes CEO eventually. It clearly shows that there is a screening process going on.

2.1.1 Summary Statistics

To alleviate the concern of outliers, the CEO compensation variables, Tobin's Q and all the financial ratios, including corporate policy variables, are winsorized at 1% percentile. Table (1) provides the winsorized summary statistics for the key variables in the study. The average number of "designated successors" is 0.127, with a standard deviation of 0.334, suggesting that the presence of CEO succession plan is not a common phenomenon and that there are large variations across firms for such presence. The percentage of insiders is 68 % and matches the sample mean values in the insider/ outsider literature(see e.g. Agrawal et al,2006).

I include the cross tabulation of insiders and other match quality measures in Part B of Table(1). First we can see that only 16% (345/2031) insiders are designated successors, which is consistent with our conjecture that inside designated successors are a refined subset of insiders. On the other hand, 62% firms with a CEO succession plan pick insiders as their new CEOs. This number is about the same size of the fraction of insiders over total successors, therefore it shows that CEOs with a succession plan does not have a preference for insiders. A more strong conjecture is that they pick insiders only when they find the quality of insiders really dominate that of outsiders. And this is what we will test in our econometric analysis. Not surprisingly, CEOs with prior title CEOs are mainly from other companies, while those insider prior-CEOs are basically CEOs in sub firms. Consistent with the findings in literature(see e.g. Agrawal et al 2006), longer tenured former CEOs are more likely to pick insiders and forced turnoverd former CEOs will lead the company to pick outsiders.

Panel A of Table (3) provides a more detailed description of the background information of new CEOs in each year. A striking observation is that the fraction of designated successors over all successors is increasing over time, which indicates a improvement in corporate governance over time and especially after the passage of the Sarbanes-Oxley Act (SOX). The fractions of other type of successors (Insiders, Prior-COOs) are stable over time, which shows that they are likely to be determined by firm organizational form, instead of corporate governance structure.

2.2 Econometric Methods

My econometric model includes the following three regressions:

$$\begin{cases} Pay_{ij,t=0} = \alpha_1 Match\,Quality_{ij,t=0} + \alpha_2 Firm\,Size_{i,t=0} + \alpha_3 Risk\,in\,Comp_{ij,t=0} + dummy_{ind} + dummy_t + \epsilon_i, (1) \\ log(Tobin'sQ_{it}) = f(\beta_1 Match\,Quality_{ij}, log(\text{Incentive Pay}_{ijt}), X_{ijt}, dummy_i, dummy_t) + \epsilon_{ijt}, (2) \\ Hazard(turnover_{ijt}) = h(t)exp(\gamma_1 \text{Match Quality}_{ij} + \gamma_2 Y_{ijt} + \gamma_3 dummy_{ind}) + \epsilon_{ijt}, (3) \end{cases}$$

where subscripts i, j and t indicate firm i ,CEO j and time t , $dummy_{ind}$ and $dummy_t$ are 2-digit SIC ind- and year- fixed effects. Based on Hypothesis 1-3, the null hypothesis is:

$$\alpha_1 < 0, \beta_1 > 0, \gamma_1 < 0$$

Regression on CEO initial compensation are for CEO-begin year data, therefore only have 1278 observations. Control variables include proxies for CEO talent (log(total assets), firm rank in industry) and risk in compensation (defined as Risk in Compensation = (total compensation-salary)/total compensation. Since we want to compare the "centainty equivalent" compensation, we need to control for the risk in each compensation package.) In robustness check, I also include CEO education background, their prior firm's 3 year stock performance before they take office, measure of their current firm's distress level when they took office as control variables.

For firm performance, I run a firm-fixed effect regression following the literature on firm performance and CEO ownership. I use Tobins Q as the performance measure. Control variables(X_{ij}) are based on a survey of prior literature (Gompers, Ishii, and Metrick,2003; Coles, Daniel, and Naveen,2006; Graham, Hazarika, and Narasimhan,2007), including firm level variables related to CEO talent(firm size, firm rank in industry), firm productivity (Investment, Leverage, ROA, firm age), moral hazard(R& D, Advertising Expenditure) and risk averse (firm idiosyncratic risks) that may influence the optimal share ownership. In the baseline regression, I assume multiplicative production function as in the model assumption $y_t = \mu e_t + \epsilon$. In the robustness test section(section(2.4)), I test the results for quadratic form as in firm value and CEO ownership literature (see McConnell and Servaes 1990), Cobb-Douglas form(Coles at al 2007), dynamic panel data form(Blundell and Bond 1998). I also run a 3 stage least square regression to take the simultaneous issue of incentive pay, Tobin's Q, and investment in to account.

To find the determinants of hazard rate of CEO turnover, I run a COX proportional hazard regression for CEOs whose tenures are less than 5 years(reported) and more than 5 years (not reported) separately, to allow the impact of the hazard rate of early turnover and initial match quality variables to vary over CEO tenure. And the significant negative effect of designated successor is robust even if I choose different cutting points at tenure=3, tenure=7. I include the following control variables(Y_{ijt}: ln(Total Assets),3 year current firm performance before the CEO takes office, Board size /ln(Board Size), Board Independence, Democracy Firm, Dictatorship Firm ,market index(makind)(Appendix B has a description of each variable and its expected relation). In the robustness check, I also run a probit model on CEO forced turnover following the CEO turnover literature.

2.3 Results

Table (3) reports the baseline regression estimates. Panel A reports the effects of insider on initial compensation, firm performance and hazard rate of early turnover. This is to serve as a benchmark for us to compare the result with the insider/ outsider literature. Panel B includes both insiders and designated successors (insider $\times$ plan) Panel C includes insiders, insider designated successor (insider $\times$ plan), and outsider designated successor (outsider $\times$ plan).

Panel B and C in Table (3) suggest that only insider designated successor has a better initial CEO-firm match quality. Insider designated successors have 1) \$ 2,047,000 less excess initial compensation; 2)$e^{0.06\frac{std(ds)}{std(lnTQ)}} = 1.036$,i.e. 4% higher productivity of effort; 3)$e^{-0.4\frac{std(ds)}{std(tenure)}} = 0.66, i.e.$35% lower hazard rate of early turnover. Comparing Panel B with Panel A, we can see that the non significant effect of insider dummy on firm performance in Panel A is separated into two parts in Panel B: the significant **positive** effect of insider designated successor on firm performance and the **negative** effect of insider non designated successor +outsiders. This is consistent with my conjecture that insider designated successors are better proxy for match quality than insiders.

In order to compare with relative literature, the dominate determinants of initial compensation (firm size), firm performance (firm size and log incentive pay) and turnover (CEO age) are also reported in the table. As we can see, the economic impact of firm size on initial compensation ($1435 * \frac{std(lna)}{std(initialcompensation)}$) and CEO age on hazard rate ($e^{1\frac{std(ds)}{std(tenure)}} = 2.7$) are about the same magnitude of that of insider designated successors ($-2047 * \frac{std(lna)}{std(initialcompensation)}, e^{-0.4\frac{std(ds)}{std(tenure)}} = 0.66$), but the firm size effects on firm performance ($e^{-0.3*\frac{std(lna)}{std(lnTQ)}} = 0.4$) are ten times larger than that of insider designated successor. This makes sense because the dominant effect for firm performance should be firm characteristics, not CEO characteristics.

In Table(4), I explore further to see among insider designated successors, whether successors' background before becoming CEOs make a difference in their initial match qualities. As we can see, successors who have been a COO have a better match qualities This is consistent with my conjecture that all other things equal, CEOs who hold more similar positions before they take office will send more precise signals to the board, and therefore have better match qualities.

In Table(5), I run all the three regressions on different prior-CEO job titles to see if the similarity of prior-CEO job titles implies better match quality. The results are not as strong as that of insider designated successors. This may be because that prior-CEO job title is not a good proxy for match quality as insider designated successors.

Overall the results for designated successors suggest that match quality does play a role in determining firm's performance, CEO turnover and initial play.

Graph Check for CEO turnover

In addition to estimation, I here briefly present a graphical analysis of the hazard rate of designated successors and non-designated successors. Figure (3) demonstrates the different likelihood of exit of designated successor and non-designated successor over their tenure. Consistent with Hypothesis 1, designated successors are less likely to turnover than the non-designated successors. Also the hazard rate of turnover varies over a CEOs tenure, increasing steadily in the early years, peaking in the fifth year and declining thereafter. This is a pattern that we will expect to see with learning about match quality.

Figure 3: hazard rate of designated successors and non-designated successors

2.4 Robustness Tests

2.4.1 Endogenelity Issue with The Proxy of Match Quality

The positive relation between designated successors and Tobin's Q could be spurious because one can argue that only firms with higher Tobin's Q have the incentive to adopt a CEO succession plan. I address this endogeneity issue by two approaches. First, I add more control variables which are found to determine the firms' choice of CEO succession in the literature (see e.g. Naveen 2009). Then I use the passage of Sarbanes-Oxley Act as a natural experiment to show that Firms which starts to adapt a CEO succession plan after SOX do pick CEOs with higher initial match quality.

Panel A in Table (6) shows the results of our baseline regressions by adding additional control variables. One will argue that CEO succession plans are more valuable for firms where firm-specific human capital is more important (therefore the managerial productivity is larger) and firms perform well; firms in more homogenous industry (where outsider successors are easier to find) are less likely to adopt CEO succession plans. Therefore I include former CEO's tenure, type of turnover (fire or retire), firm performance in three years before the CEO takes office and industry homogeneity.

Panel B and C in Table(6) show the result of our baseline regressions for all the firms start to adopt CEO succession plans in post SOX period(Switchers). As we can see from Table(6), the impact of match quality (proxied by "designated successors" in Panel B and "plan" in Panel C) on firm performance increases (the coefficient was 0.103 in Panel A, but 0.16-0.25 in Panel B and C), but the impact on initial compensation and early turnover decreases(the coefficient on initial compensation change from -1900 to -1070-(-1805), and the coefficient on early turnover becomes small and even insignificant). This is consistent with a story that the board's monitoring ability are increasing in post-SOX period. Although designated successors still have better match quality, the improvement of monitoring strength will enforced the match quality's impact on firm performance, but offset the match quality's impact on initial compensation and early turnover.

Are these results only due to the improvement of the monitoring environment of switchers? Not likely, because without no improvement in new CEO's match quality, a stricter monitoring environment will imply that the hazard of CEO's early turnover is higher than before. Now we observe a much lower hazard rate for switchers, and the only reasonable explanation for this is that the CEO firm's match quality are improved.

Overall, the results show that firm's better performance, lower CEO turnover rate and initial compensation are caused by adopting CEO succession plan.

2.4.2 Alternative Model Specification

Here I check the robustness of the estimation of Panel A in Table (3) under different model specifications. The results are reported in Table (7). In Panel A, I include other determinants of CEO compensation used in the literature(): CEO education background, 3 year stock performance of their prior firm before they take office, measure of their current firm's distress level when they took office in the regression of initial compensation on insider designated successors.

Panel B-E are re-examine the impact of CEO match quality on firm performance under different specification of firm production functions. Panel B, Quadratic function(McConnell and Servaes (1990)); Panel C, Cobb-Douglas (Coles et al(2007)); Panel E, dynamic linear(Blundell and Bond 1998).

Panel B: $TobinQ_{it} = \beta_1 Match\,Quality_{ij} + \beta_2 Incentive\,Pay_{it} + \beta_3 Incentive\,Pay_{it}^2 + \beta_3 X_{it} + Dummy_i + Dummy_t + \epsilon_{it}$

Panel C: $ln(TQ)_{it} = \beta_1 Match\,Quality_{ij} \times log(Inc_{it}) + \beta_2 Insider_{ij} \times log(Inc_{it}) Dummy_i + Dummy_t + \epsilon_{it}$

Panel D: $ln(TQ)_{it} = \beta_0 ln(TQ)_{i,t-1} + \beta_1 Match\,Quality_{it} + \beta_2 Incentive\,Pay_{it} + \beta_3 X_{it} + Dummy_t + \epsilon_{it}, t > 5$

Panel E: $ln(TQ)_{it} = \beta_0 ln(TQ)_{i,t-1} + \beta_1 Match\,Quality_{it} + \beta_2 Incentive\,Pay_{it} + \beta_3 X_{it} + Dummy_i + Dummy_t + \epsilon_{it}$

where $Dummy_i$ is firm fixed effect and $Dummy_t$ is year fixed effect. I also including Robust OLS regression in Panel D. According to Hypothesis 2, the performance of high match quality CEOs should still be better than that of low match qualities after the learning process is over. Since it will be two few data in fixed effect estimation if we only use after-5 year tenure, I run a OLS regression with robust cluster standard errors to check the hypothesis. In addition, I also use ROA, OSOA as a proxy for firm performance (to replace Tobin's Q) and run all the regressions(baseline regression and Panel B-E). The results I find in Tobin's Q are robust under such accounting measures (the results are not reported to save space).

In Panel F, I follow the CEO turnover literature to see if designated successor has a predict power in forced turnover.

The regression results in Table(7) shows that insider designated successor is a good proxy for match quality under different model specifications. We can see that the magnitude of the impact of insider designated successors on compensation,performance and turnover hazard has changed. Combined with the results from our baseline regression, I can say that insider designated successors have 1) $\$900,000 \sim 1,500,000$ less excess initial compensation; 2)$e^{0.06\frac{std(ds)}{std(lnTQ)}} = 1.036 \sim e^{0.24\frac{std(ds)}{std(lnTQ)}} = 1.12$,i.e. $4\% \sim 12\%$ higher productivity of effort;3)34% lower hazard rate of early turnover.

2.4.3 Reverse Causality between CEO Ownership and Valuation

It is well documented in the literature that incentive pay depend on Tobin's Q as well(see e.g. Palia 2001). Although I only take log(incentive pay) as a control variable, I still need to take this endogeneity into consideration, because the coefficient in front of designate successor is also biased if we run a single fixed-effect regression. I use a simultaneous equation approach to address the endogeneity issue to the Tobin's Q and incentive pay question. The following is the regression and the results are reported in Table (8).

$$\begin{cases} log(Tobin'sQ_{it}) = \beta_1^1 Match\,Quality_{ij} + \beta_2^1 log(\text{incentive pay}_{ijt}) + \beta_3^1 Investment + \beta_4^1 Firm\,Characteristics + dummy_i + dummy_t + \epsilon_{ijt} \\ log(Inc\,pay_{ijt}) = \beta_1^2 Match\,Quality_{ij} + \beta_2^2 log(Tobin'sQ_{it}) + \beta_3^2 Investment_{it} + \beta_4^2 CEO\,power_{ijt} + \beta_5^2 Firm\,Risk_{it} + dum_i + dum_t + \epsilon_{ijt} \\ Investment_{it} = \beta_1^3 Match\,Quality_{ij} + \beta_2^3 log(Tobin'sQ_{it}) + \beta_2^2 log(IncentivePay_{ijt}) + \beta_4^3 Firm\,Risk_{it} + dummy_i + dummy_t + \epsilon_{ijt} \end{cases}$$

Following the literature of CEO ownership and firm valuation (see e.g. Palia 2001), I include CEO power(CEO=Chair, intership), Corporate governance(board size, board independence ,dictator, democratic), Risk aversion(firm specific risk) as the exclusion control variables in incentive pay regression (Appendix B has a description of each variable and its expected relation).

The estimation results in Table (8) do not rule out the possibility that Tobins Q affects CEO ownership and investments. However, the impact of insider designated successor on Tobins Q remains significant. This is true regardless of whether the match quality is measured by insider designated successors or designated successors and whether we control for $ex\_tenure, ex\_forced, int\_TQ$, industry homogeneity or not (unreported).

2.4.4 Correlation between Match Quality and Board's Monitory Ability

It's likely that designated candidate indicator is also correlated with board's monitoring ability M. That is, the board, which does not succeed in constructing a CEO succession plan, is also likely to be a weak monitor. In order to isolate the match quality effects from the monitoring effects, I will estimate the parameters of my simplified model directly. I use maximum likelihood method to estimate P(probability of correctly selecting a suitable CEO) and M(monitoring ability) (Recall our discussion in section(1.1) and section(1.6)). Since I assume designated candidates is a proxy for high match quality, my null hypothesis would be $P_{designated\,successors} > P_{nondesignated\,successors}$. This part is still working in progress and some preliminary results will be shown in appendix.

3 Which board are more likely to pick up better CEOs?

If board matters for CEO selection, then the CEO firm match quality should be a function of the board's characteristics, namely, we will have:[17]

$$\begin{cases} S = f(\text{board size}_{year-1}, \text{board independence}_{year-1}, \text{CEO from outside company}_{year-1}, \text{Board Network}_{-1}) \\ M = f(\text{board size}_{-1}, \text{board independence}_{-1}, \text{CEO from outside company}_{-1}, \text{Board Network}_{-1}) \end{cases}$$

where S is the board's screening ability and M the monitoring ability. Since our goal of this paper is to study the board role in CEO selection, I use the board characteristics before the CEOs were chosen. Therefore these board characteristics are correlated with the monitor effects indirectly. That is, since the board structure changes very slow, board characteristics in $year - 1$ are in general correlated with board characters in later years.

Following are three hypotheses developed from the model's predictions.

Hypothesis 4 *(Relation between initial compensation and P and M) Boards with higher screening abilities or weaker monitoring abilities acquire equal or less (centainty equivalent) initial compensation, all other things equal.*

Hypothesis 5 *(Relation between firm performance and P and M)Boards with higher screening abilities or higher monitoring abilities have a positive effect on firm performance after learning is over, controlling for the incentive pay;*

[17] Board size=1 if the total number of directors on the board$>$ 6. Board independence =1 if the percentage of outside directors $> 60\%(median)$. CEOonBoard=1 if the percentage of CEOs from other companies on the board $> 20\%$; Board Network=1 if the average outside directorships of each directors > 0.5.

Hypothesis 6 *(Relation between hazard rate of CEO turnover and P and M)Boards with higher screening abilities or weaker monitoring abilities should have a negative effect on the hazard rate of CEO turnover in their early tenure, controlling for CEO age and market condition.*

I run the following regressions:

$$\begin{cases} tdc1_{ij} = \alpha_1 Board\,Types_{ij,-1} + \alpha_2 Firm\,Size_i + \alpha_3 Risk\,in\,Compensation_{ij} + Industry\,dummy + year\,dummy + \epsilon_{ij} \\ TobinQ_{it} = \beta_1 Board\,Types_{ij,-1} + \beta_2 Incentive\,Pay_{ijt} + \beta_3 Incentive\,Pay^2_{ijt}\beta_4 X_{it} + firm\,dummy + year\,dummy + \epsilon it \\ Hazard\,Rate\,of\,CEO\,turnover_{ijt} = \gamma_1 Board\,Types_{ij,-1} + \gamma_2 CEOAge_{jt} + \gamma_3 Y_{ijt} + Industry\,Dummy + \epsilon_{it} \end{cases}$$

The null hypothesis and predicted sign of the regression are listed in Panel A in Table (9).

Comparing the estimated results in Part B in Table (**??**) to the model prediction in Part A, we find that:1) boards with more outside directors and more directors holding outside directorships are stronger screeners and stricter monitors; 2)board with more CEOs from other companies are both weaker screeners and looser monitors; 3) The size of the board may be not a good proxy for match quality.

4 Conclusion

This paper derives a search-matching model that explicitly capturing board's role in screening CEO candidates and monitoring CEOs. The model predicts that the longer time horizon the board plans to spend in CEO succession, the higher expected value of the CEO firm match quality will be. And higher match quality implies lower CEO initial compensation, better performance and lower hazard rate of CEO early turnover. Therefore my model predicts that designated successors should performance better, stay longer and ask for less pay, ceteris paribus.

Consistent with the model's prediction, I find that designated successors have 1) \$1, 000, 000 less initial compensation, 2) 10% higher productivity of effort, and 3) 30% lower hazard rate of early turnover than outsiders and other insider successors. These results are robust under different measure of designated successor, more control variables, model specifications and structural model estimation. I also use the passage of Sarbanes-Oxley Act(SOX) as a natural experiment to see if the CEO succession plan are really a causality effect for better firm performance. Among all the 1084 firms, 115 are new switcher, namely, they are the firms never mention CEO succession plans in their annual reports before year 2002, but start to arrange their CEO successions under planning in post SOX period. Such changes are more likely to be caused by an exogenous shock, not the firms' own optimal choice. As a result, if we find positive(negative) correlation between firm performance (initial compensation, turnover) and designated successor indicator, we can claim that these effects are caused by adopting CEO succession plan. In fact, we do find statistically and economically significant effects of designated successors on their firm performance, initial compensation and turnover.

The second step is to answer the question "which types of the board are better screeners". Since strong screener and strong monitor boards all lead to better firm performance, it provides an empirical challenge to answer this question. My model solves this problem by giving additional predictions besides firm performance. If a board is a strong monitor but a weak screener, the hazard rate of CEO early turnover should be high and the CEO's initial compensation is high too, ceteris paribus. Moreover, if we use a structural model to estimate the model, we can explicitly estimate the board's learning speed and hence to backtrack board's monitoring ability. Some preliminary results have been given in this paper and it shows that more independent board and board with larger network are more likely to pick up CEOs' with higher match quality. More research in this direction can give some useful policy implication for the legal notice from SEC dated October 27th 2009, which signaled increased concern about CEO succession planning among corporate boards and for the first time allows shareholders to request more disclosure from companies' CEO succession plans.

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Table 1: Summary Statistics I: All Regression Variables

Panel A: Summary Statistics of All Regression Variables

Variable	Obs	Mean	Std. Dev.	Min	Max
Proxies for Match Quality					
Insider	5245	.6547188	.4755052	0	1
Plan	4814	.2696302	.4438138	0	1
Designated S	5245	.12755	.3336199	0	1
CEO	4959	.097802	.2970767	0	1
COO	4959	.1203872	.3254466	0	1
President	4959	.1296632	.3359664	0	1
Vice Pre/Cha	4959	.1094979	.3122944	0	1
Regression Variables for Test of Hypothesis 1					
compensation	1459	4358.174	6576.264	0	75435.92
risk in pay	1458	.7242603	.2209975	0	1
Regression Variables for Test of Hypothesis 2					
log Tobin´ Q	5245	-.1620019	.4974536	-2.041979	2.662039
log Ince Pay	5245	10.95666	1.744047	-1.170538	18.01872
log Assets	5245	7.215236	1.617943	1.233143	13.5285
Investment	5245	.0548524	.049295	0	.596603
R&/Asset	5245	.0156267	.0426958	0	.5060764
R&D dummy	5245	.9988561	.0338062	0	1
Adv/Assets	5245	.0354695	.0731474	0	1.789463
ADdummy	5245	.8699714	.336367	0	1
Leverage	5245	.2239346	.204739	0	4.909904
Free Cash Fl	5245	.1301731	.1485565	-2.989248	.9175178
Capital Stoc	5245	.5537261	.3812162	.0072142	3.636627
Ind Homogene	5245	18117.64	15753.68	1381.381	63405.61
firm_age	5245	9.238894	3.198781	1	15
Regression Variables for Test of Hypothesis 3					
tenure	5245	2.999428	2.330076	0	11
turnover	5245	.0934223	.2910511	0	1
duration1	1459	5.490747	2.816353	1	14
retire	5245	.1393708	.3463661	0	1
Board Size	4262	9.303144	2.384154	3	25
Outside Dir	4262	.6806411	.1611694	0	1
dictator	5245	.5889418	.4920727	0	1
democrat	5245	.0560534	.2300467	0	1
mkindex	5245	20.05244	7.157305	0	30.83429

Panel B: Cross Tabulation of Insider(Outsider) and Other Proxies for Match Quality

	DS	Insider DS	CEO	COO	President	VP	Others	ex_tenure_5	ex_forced	Total
Outsider	205		156	153	190	152	13	711	184	1035
	(37.27)		(50.65)	(20.40)	(29.19)	(25.17)	(17.33)	(28.90)	(55.09)	
Insider	345	345	152	597	461	452	62	1749	150	2031
	(62.73)	(100)	(49.35)	(79.60)	(70.81)	(74.83)	(82.67)	(71.10)	(44.91)	
# CEO-firm pair	550	345	308	750	651	604	75	2460	334	3066

percentage in parentheses

Inside=1 if the CEO has worked in the company for at least 3 years before he takes office. Plan =1 if the CEO has worked in the company which has a succession plan at least 3 years before he takes office. DS(designated successor)=1 if Plan=1 and CEO is a insider. CEO(chief executive officer), COO(chief operating officer), Pred(president), VP(vice president or vice chairman), Others(CFO or managers of marketing etc) =1 if the CEO was CEO(COO,Pred,VP,Others) before he takes office. ex_tenure_long=1 if the former CEO's tenure is longer than 5 years; ex_forced =1 if the former CEO was fired, not retire.

Table 2: Summary Statistic II: Summary Statistics For Proxies of Match Qualities

Panel A: Percentage of New CEOs with Different Background for Each Year

Year CEO takes office	Insider	Designated Successor	CEO	COO	President	VP	CFO	ex_tenure	ex_forced
1995	0.715	0.00397	0.0992	0.337	0.473	0.329	0.0516	11.48	0.213
1996	0.645	0.0872	0.0872	0.308	0.349	0.311	0.0490	11.90	0.233
1997	0.668	0.0958	0.0820	0.328	0.436	0.339	0.0447	9.104	0.159
1998	0.611	0.0907	0.108	0.423	0.511	0.442	0.0809	8.657	0.193
1999	0.605	0.144	0.145	0.339	0.518	0.429	0.117	10.31	0.227
2000	0.664	0.161	0.132	0.439	0.628	0.533	0.0937	9.343	0.173
2001	0.622	0.206	0.0823	0.385	0.553	0.391	0.119	8.981	0.174
2002	0.579	0.196	0.146	0.416	0.570	0.565	0.0747	10.48	0.135
2003	0.639	0.258	0.155	0.448	0.624	0.555	0.103	9.028	0.194
2004	0.527	0.321	0.123	0.379	0.528	0.440	0.125	7.476	0.114
2005	0.538	0.303	0.166	0.407	0.556	0.507	0.0941	9.649	0.208
2006	0.579	0.332	0.127	0.397	0.580	0.508	0.101	9.092	0.316
2007	0.514	0.254	0.131	0.336	0.557	0.582	0.139	8.948	0.444
2008	0.615	0.375	0.125	0.313	0.688	0.500	0	11.50	0.700
Observations	9181	9713	9713	9713	9713	9713	9713	7204	5965

Inside=1 if the CEO has worked in the company for at least 3 years before he takes office. Plan =1 if the CEO has worked in the company which has a succession plan at least 3 years before he takes office. DS(designated successor)=1 if Plan=1 and CEO is a insider. CEO(chief executive officer), COO(chief operating officer), Pred(president), VP(vice president or vice chairman), Others(CFO or managers of marketing etc) =1 if the CEO was CEO(COO,Pred,VP,Others) before he takes office. ex_tenure_long=1 if the former CEO's tenure is longer than 5 years; ex_forced =1 if the former CEO was fired, not retire.

Panel B: Summary Statistics of Regression Variables for Firms before/after 2002

	Firms have Plan before 2002				Firms don't have Plan before 2002			
	Have Plan after 2002		Don't Have Plan after 2002		Have Plan after 2002		Don't Have after 2002	
	DS=1	DS=0	DS=1	DS=0	DS=1	DS=0	DS=1	DS=0
# CEO-Firm-Year Observations								
Before 2002	1,297	2,618				260		2,289
After 2002	1,213	123			73	260		595
Mean of lnTQ								
Before 2002	-.10282733	-.16047725			.	-.31588928		-.23902722
After 2002	-.16095887	-.26317619			-.12954374	-.14307258		-.15454551
Mean of ROA								
Before 2002	.14917664	.13749029			.	.12523116		.09346948
After 2002	.13396488	.09624909			.1213579	.11328096		.08284212

Table 3: Baseline Model: Designated Successor and Initial Compensation, Firm Performance and Hazard Rate of Early Turnover

VARIABLES	Panel A : Compensation	Insider Only Performance	Hazard	Panel B: Compensation	Insider+Inside DS Performance	Hazard	Panel C: Compensation	Insider+Inside DS Performance	+Outside DS Hazard
Insider(I)	-1503***	-0.00779	-0.0796	-1010***	-0.0260	-0.0105	-1095***	-0.0289	0.00358
	(0)	(0.678)	(0.541)	(0.00518)	(0.215)	(0.937)	(0.00528)	(0.187)	(0.980)
Plan× I				-2047***	0.0552*	-0.381*	-2080***	0.0506*	-0.379*
(Designated Successors)				(0)	(0.0510)	(0.0628)	(0)	(0.0927)	(0.0646)
Plan× Outsider(O)							-351.4	-0.0175	0.0628
							(0.578)	(0.653)	(0.794)
Firm Size	1371***	-.284***		1435***	-.284***		1440***	-0.279***	-0.0198
	(0)	(0)		(0)	(0)		(0)	(0)	(0.694)
ln_inc		0.0607***			0.0609***			0.0608***	
		(0)			(0)			(0)	
retire			1.026***			1.011***			1.012***
			(0)			(0)			(0)
Industry Fixed	YES		YES	YES		YES	YES		YES
Year Fixed	YES	YES		YES	YES		YES	YES	
Firm Fixed		YES			YES			YES	
Firm CEO Char	YES	YES	YES	YES	YES	YES	YES	YES	YES
Market Cond			YES			YES			YES
Governance			YES			YES			YES
Observations	1278	4676	3377	1278	4676	3377	1278	4676	3377
R^2	0.382	0.242		0.391	0.242		0.391	0.243	
Number of Firms		966			966			966	

p-values in parentheses
*** p<0.01, ** p<0.05, * p<0.1

For specification:

$$\begin{cases} tdc1_{ij} = \alpha_1 Match\,Quality_{ij} + \alpha_2 Firm\,Size_i + \alpha_3 Risk\,in\,Compensation_{ij} + Industry\,dummy + year\,dummy + \epsilon_{ij} \\ ln(TQ)_{it} = \beta_1 Match\,Quality_{ij} + \beta_2 Incentive\,Pay_{ijt} + \beta_3 X_{it} + firm\,dummy + year\,dummy + \epsilon it \\ Hazard\,Rate\,of\,CEO\,turnover_{ijt} = \gamma_1 Match\,Quality_{ij} + \gamma_2 Retire_{jt} + \gamma_3 Y_{ijt} + Industry\,Dummy + \epsilon_{it} \end{cases}$$

Inside=1 if the CEO has worked in the company for at least 3 years before he takes office. Plan=1 if the CEO has worked in the company which has a succession plan at least 3 years before he takes office. DS=1 if the CEO is both insider and Plan=1. retire =1 if the CEO is older than 60. X_{it}includes firm level variables related to CEO talent(firm size, firm rank in industry), firm productivity (Investment,Leverage, ROA, firm age), moral hazard(R& D, Advertising Expenditure) and risk averse (firm idiosyncratic risks) that may influence the optimal share ownership. Y_{ijt} includes corporate governance(Y_{ijt}) variables(board size, board independence, dictator,democrat) and market condition (market index, industrial return)(coefficient on firm size are not reported in regression 3 due to insignificance)

Table 4: Heir Apparent and Initial Compensation, Firm Performance and Hazard Rate of Early Turnover

	Panel A			Panel B			Panel C			Panel D		
	Comp.	Performance	Haz.	Comp.	Performance	Haz.	Comp.	Performance	Haz.	Comp.	Performance	Haz.
Insider	-1018***	-0.00628	-0.0166	-1015***	-0.00660	-0.0157	-1008***	-0.00543	-0.0169	-1015***	-0.00476	-0.0174
	(0.00736)	(0.785)	(0.906)	(0.00756)	(0.775)	(0.911)	(0.00793)	(0.814)	(0.904)	(0.00756)	(0.837)	(0.901)
DS×I	-1933***	0.0713**	-0.374*	-1480*	0.0497	-0.260	-2131***	0.0637*	-0.395*	-1777***	0.0818**	-0.496**
	(0.000425)	(0.0319)	(0.0951)	(0.0657)	(0.254)	(0.466)	(0.000280)	(0.0611)	(0.0991)	(0.00172)	(0.0139)	(0.0422)
CEO×I×DS	77.23	0.0575	-44.22									
	(0.979)	(0.611)	(0.9)									
COO×I×DS				-2102***	0.0809**	-0.471*						
				(0.000819)	(0.0232)	(0.0785)						
Pred×I×DS							-930.4	0.102*	-0.441			
							(0.358)	(0.0617)	(0.393)			
VP×I×DS										-2701**	-0.0303	0.129
										(0.0364)	(0.638)	(0.785)
Size	1495***			1500***			1504***			1500***		
	(0)			(0)			(0)			(0)		
ln_inc		0.0606***			0.0606***			0.0607***			0.0608***	
		(0)			(0)			(0)			(0)	
retire			0.826***			0.828***			0.827***			0.820***
			(0)			(0)			(0)			(0)
Industry Fixed	YES		YES	YES		YES	YES		YES	YES		YES
Year Fixed	YES	YES		YES	YES		YES	YES		YES	YES	
Firm Fixed		YES			YES			YES			YES	
Firm CEO Char	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Market Cond			YES			YES			YES			YES
Governance			YES			YES			YES			YES
Obs	1214	4379	3160	1214	4379	3160	1214	4379	3160	1214	4379	3160
R^2	0.395	0.235		0.395	0.235		0.396	0.235		0.395	0.236	
Firms		954			954			954			954	

p-values in parentheses
*** p<0.01, ** p<0.05, * p<0.1

For specification:

$$\begin{cases} tdc1_{ij} = \alpha_1 Match\,Quality_{ij} + \alpha_2 Firm\,Size_i + \alpha_3 Risk\,in\,Compensation_{ij} + Industry\,dummy + year\,dummy + \epsilon_{ij} \\ ln(TQ)_{it} = \beta_1 Match\,Quality_{ij} + \beta_2 Incentive\,Pay_{ijt} + \beta_3 X_{it} + firm\,dummy + year\,dummy + \epsilon it \\ Hazard\,Rate\,of\,CEO\,turnover_{ijt} = \gamma_1 Match\,Quality_{ij} + \gamma_2 Retire_{jt} + \gamma_3 Y_{ijt} + Industry\,Dummy + \epsilon_{it} \end{cases}$$

Inside=1 if the CEO has worked in the company for at least 3 years before he takes office. Plan=1 if the CEO has worked in the company which has a succession plan at least 3 years before he takes office. DS=1 if the CEO is both insider and Plan=1. retire =1 if the CEO is older than 60. X_{it}includes firm level variables related to CEO talent(firm size, firm rank in industry), firm productivity (Investment,Leverage, ROA, firm age), moral hazard(R& D, Advertising Expenditure) and risk averse (firm idiosyncratic risks) that may influence the optimal share ownership. Y_{ijt} includes corporate governance(Y_{ijt}) variables(board size, board independence, dictator,democrat) and market condition (market index, industrial return)(coefficient on firm size are not reported in regression 3 due to insignificance)

Table 5: CEO's Prior Job Experience and Initial Compensation, Firm Performance and Hazard Rate of Early Turnover

	Panel A			Panel B			Panel C			Panel D		
	Comp.	Performance	Haz.	Comp.	Performance	Haz.	Comp.	Performance	Haz.			
Insider	-1265***	0.0461**	-0.0560	-1148***	0.0331	-0.0744	-1101***	0.0393*	-0.124	-1188***	0.0458**	-0.0844
	(0.000152)	(0.0318)	(0.674)	(0.000661)	(0.134)	(0.581)	(0.00111)	(0.0831)	(0.363)	(0.000402)	(0.0382)	(0.531)
CEO×I	-1367***	-0.0180	-1.568***									
	(0.00886)	(0.596)	(0)									
COO×I				-1672***	0.0339	-0.811***						
				(0.000694)	(0.305)	(0.00168)						
Pred×I							-1791***	0.00943	-0.375*			
							(0.000203)	(0.775)	(0.0819)			
VP× I										-1609***	-0.0130	-0.818***
										(0.00149)	(0.693)	(0.00244)
Size	1465***			1474***			1501***			1469***		
	(0)			(0)			(0)			(0)		
ln_inc		0.0602***			0.0603***			0.0603***			0.0602***	
		(0)			(0)			(0)			(0)	
retire			0.907***			0.916***			0.934***			0.931***
			(0)			(0)			(0)			(0)
Industry Fixed	YES		YES	YES		YES	YES		YES	YES		YES
Year Fixed	YES	YES		YES	YES		YES	YES		YES	YES	
Firm Fixed		YES			YES			YES			YES	
Firm CEO Char	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Market Cond			YES			YES			YES			YES
Governance			YES			YES			YES			YES
Observations	1359	4959	3405	1359	4959	3405	1359	4959	3405	1359	4959	3405
R^2	0.390	0.239		0.393	0.239		0.394	0.239		0.392	0.239	
Number of gvkey		1089			1089			1089			1089	

p-values in parentheses
*** p<0.01, ** p<0.05, * p<0.1

For specification:

$$\begin{cases} tdc1_{ij} = \alpha_1 Match\,Quality_{ij} + \alpha_2 Firm\,Size_i + \alpha_3 Risk\,in\,Compensation_{ij} + Industry\,dummy + year\,dummy + \epsilon_{ij} \\ ln(TQ)_{it} = \beta_1 Match\,Quality_{ij} + \beta_2 Incentive\,Pay_{ijt} + \beta_3 X_{it} + firm\,dummy + year\,dummy + \epsilon it \\ Hazard\,Rate\,of\,CEO\,turnover_{ijt} = \gamma_1 Match\,Quality_{ij} + \gamma_2 Retire_{jt} + \gamma_3 Y_{ijt} + Industry\,Dummy + \epsilon_{it} \end{cases}$$

Inside=1 if the CEO has worked in the company for at least 3 years before he takes office. Plan=1 if the CEO has worked in the company which has a succession plan at least 3 years before he takes office. DS=1 if the CEO is both insider and Plan=1. retire =1 if the CEO is older than 60. X_{it}includes firm level variables related to CEO talent(firm size, firm rank in industry), firm productivity (Investment,Leverage, ROA, firm age), moral hazard(R& D, Advertising Expenditure) and risk averse (firm idiosyncratic risks) that may influence the optimal share ownership. Y_{ijt} includes corporate governance(Y_{ijt}) variables(board size, board independence, dictator,democrat) and market condition (market index, industrial return)(coefficient on firm size are not reported in regression 2,3 due to insignificance)

Table 6: Robustness Test I: Endogeneity Issue of Match Quality Measure

VARIABLES	Compensation	Panel A Performance	Former CEO's Information Haz.	Compensation	Panel B Performance	Switchers after SOX Haz.	Compensation	Panel C Performance	Switchers after SOX Haz.
Insider	-1465***	-0.0443*	0.000283	-855.9	-0.00651	0.0625	-1241	0.0607	-0.265
	(0.000536)	(0.0841)	(0.999)	(0.453)	(0.907)	(0.840)	(0.248)	(0.201)	(0.535)
DS× I	-1900***	0.103***	-0.527**	-1077	0.254***	-2.213**			
	(0.000682)	(0.00438)	(0.0437)	(0.481)	(0.00343)	(0.0495)			
Plan							-1805*	0.160**	-1.958***
							(0.0825)	(0.0457)	(0.00575)
ex_tenure	3.881	0.000494	-0.0133		-0.00351			0.000609	0.00414
	(0.871)	(0.785)	(0.236)		(0.230)			(0.843)	(0.873)
ex_forced	506.0	-0.100***	0.223		-0.0985*			-0.0498	-0.638
	(0.287)	(0.000433)	(0.264)		(0.0736)			(0.357)	(0.264)
int_TQ	771.7***	0.0358***	-0.0243		0.103***	0.183**		0.0879***	0.255**
	(0)	(0.00168)	(0.546)		(0.000377)	(0.0160)		(0.00177)	(0.0418)
lna	1781***	-0.252***	-0.0236	2209***	-0.235***	0.0122	2238***	-0.219***	-0.0568
	(0)	(0)	(0.706)	(0.000500)	(0)	(0.927)	(0.000442)	(0)	(0.760)
ln_inc		0.0552***			0.0402***			0.0409***	
		(0)			(0.00224)			(0.00213)	
retire			1.040***			0.430			0.481
			(0)			(0.202)			(0.291)
Industry Fixed	YES		YES	YES		YES	YES		YES
Year Fixed	YES	YES		YES	YES		YES	YES	
Firm Fixed		YES			YES			YES	
Firm CEO Char	YES	YES	YES	YES	YES	YES	YES	YES	YES
Market Cond			YES			YES			YES
Governance			YES			YES			YES
Observations	946	3458	2537	235	558	659	234	558	440
R^2	0.459	0.234		0.394	0.397		0.402	0.390	
Number of Firms		752			115			115	

p-values in parentheses
*** p<0.01, ** p<0.05, * p<0.1

For specification:

$$\begin{cases} tdc1_{ij} = \alpha_1 Match\,Quality_{ij} + \alpha_2 Firm\,Size_i + \alpha_3 Risk\,in\,Compensation_{ij} + \alpha_4 formerCEO'sinformation + dummy_{ind} + dummy_t + \epsilon_{ij} \\ ln(TQ)_{ijt} = \beta_1 Match\,Quality_{ij} + \beta_2 log(Incentive\,Pay_{ijt}) + +\beta_3 formerCEO'sinformatio + \beta_4 X_{ijt} + dummy_i + dummy_t + \beta_{it} \\ Hazard\,Rate\,of\,CEO\,turnover_{ijt} = \gamma_1 Match\,Quality_{ij} + \gamma_2 CEOAge_{jt} + \gamma_3 formerCEO'sinformatio + \gamma_4 Y_{ijt} + Dummy_{ind} + \epsilon_{it} \end{cases}$$

where i,j and t represents firm i, CEO j and year t.
Inside=1 if the CEO has worked in the company for at least 3 years before he takes office. Plan=1 if the CEO has worked in the company which has a succession plan at least 3 years before he takes office. DS=1 if the CEO is both insider and Plan=1. retire =1 if the CEO is older than 60. Former CEO's information includes former CEO's turnover type(forced or retire)(ex_forced), former CEO's tenure(ex_tenure), and firm's performance in year -3 to -1(int_TQ). X_{it}includes firm level variables related to CEO talent(firm size, firm rank in industry), firm productivity (Investment,Leverage, ROA, firm age,ROA), moral hazard(R& D, Advertising Expenditure) and risk averse (firm idiosyncratic risks) that may influence the optimal share ownership. Y_{ijt} includes corporate governance(Y_{ijt}) variables(board size, board independence, dictator,democrat) and market condition (market index, industrial return)(coefficient on firm size are not reported in regression 3 due to insignificance) Samples for Panel B and C only include firms which don't plan CEO succession in advance before 2002 , but start to plan after 2002.

Table 7: Robustness Test II: Different Model Specification

VARIABLES	Panel A Compensation	Panel B TobinQ	Panel C lnTQ	Panel D lnTQ	Panel E lnTQ	Panel F forced turnover
Insider		-0.155*		-0.0175	-0.0142	-0.323*
		(0.0882)		(0.581)	(0.700)	(0.0947)
Insider× ln_inc			0.0406***			
			(0)			
DS×I	-912.9*	0.244**	0.102***	0.140***	0.0693*	-0.470
	(0.0960)	(0.0469)	(0.00806)	(0.00200)	(0.0901)	(0.109)
DS×I × ln_inc			-0.00250			
			(0.832)			
ln_inc				0.0614***	0.0412***	
				(0)	(0)	
L.ln_inc					-0.00444	
					(0.633)	
wealth		0.210***				
		(0)				
wealth2		-0.00231***				
		(0)				
retire						-0.122
						(0.605)
lna	1533***	-1.280***	-0.277***		-0.367***	
	(0)	(0)	(0)		(0)	
trs3yr	24.99***					
	(0.000339)					
new_general_skills	1055***					
	(0.00655)					
altman_z	139.2***					
	(0)					
forced	1661***					
	(0.00570)					
L.lnTQ					0.299***	
					(0)	
L2.lnTQ					-0.00799	
					(0.767)	
Firm CEO Char	YES	YES	YES	YES	YES	YES
Market Condition						YES
Corporate Govern						YES
Firm Dummy		YES	YES		YES	
Industry Dummy	YES					YES
Year Dummy	YES	YES	YES	YES	YES	
Observations	749	5587	5469	875	3432	340
R^2	0.502	0.172	0.208	0.637		
Number of gvkey		1158	1146		856	

p-values in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Panel B:Quadractic Production Function:
$TobinQ_{it} = \beta_1 Match\,Quality_{ij} + \beta_2 Incentive\,Pay_{it} + \beta_3 Incentive\,Pay^2_{it} + \beta_3 X_{it} + Dummy_i + Dummy_t + \epsilon_{it}$
Panel C:Cobb-Douglas Production Function
$ln(TQ)_{it} = \beta_1 Match\,Quality_{ij} \times log(Inc_{it}) + \beta_2 Insider_{ij} \times log(Inc_{it}) Dummy_i + Dummy_t + \epsilon_{it}$
Panel D:OLS with Clusted-Robust Standard Error
$ln(TQ)_{it} = \beta_1 Match\,Quality_{ij} + log(Inc_{it}) + Dummy_t + \epsilon_{it}$
Panel E:Dynamic Panel Data Model
$ln(TQ)_{it} = \beta_0 ln(TQ)_{i,t-1} + \beta_1 Match\,Quality_{it} + \beta_2 Incentive\,Pay_{it} + \beta_3 X_{it} + Dummy_i + Dummy_t + \epsilon_{it}$

Inside=1 if the CEO has worked in the company for at least 3 years before he takes office. DS×Insider =1 for insider designated successors. lna=log(total assets).ln_inc=log(incentive pay). retire =1 if the CEO is older than 60.CEO Performance -3 is the 3 year stock return of CEO's prior firm before he becomes CEO(for insider successors, it is their current firm's performance). General Skill: CEO's education level and whether he has CPA etc. Distress -1: the altman z score for bankruptcy at year -1(one year before CEO takes office). Former CEO's information includes former CEO's turnover type(forced or retire)(ex_forced), former CEO's tenure(ex_tenure), and firm's performance in year -3 to -1(int_TQ). X_{it}includes firm level variables related to CEO talent(firm size, firm rank in industry), firm productivity (Investment,Leverage, ROA, firm age,ROA), moral hazard(R& D, Advertising Expenditure) and risk averse (firm idiosyncratic risks) that may influence the optimal share ownership. Y_{ijt} includes corporate governance(Y_{ijt}) variables(board size, board independence, dictator,democrat) and market condition (market index, industrial return)(coefficient on firm size are not reported in regression 3 due to insignificance) Samples for Panel B and C only include firms which don't plan CEO succession in advance before 2002 , but start to plan after 2002.

Table 8: Robustness Test III: 3SLS Regression of LN(Tobin's Q), LN(Incentive Pay) and Investment

VARIABLES	lnTQ	ln_inc	Investment
Insider	0.0901	0.137	-0.00676
	(0.147)	(0.470)	(0.229)
DS × I	0.128**	-0.550***	0.00339
	(0.0317)	(0.000282)	(0.482)
ln_inc	0.159***		0.0140***
	(0.00606)		(0)
Investment	-7.070**	25.74***	
	(0.0113)	(0)	
lnTQ		-0.193	0.0226***
		(0.458)	(0.000115)
Assets	-0.241***		
	(0)		
Market Value		7.36***	
		(0)	
Firm Fixed Effects	YES	YES	YES
Year Dummy	YES	YES	YES
Firm and CEO Characteristics	YES		
CEO Power		YES	
Corporate Governance		YES	
Risk Attitude		YES	YES
Observations	2025	2025	2025
R^2	0.495	0.480	0.176

p-values in parentheses
*** p<0.01, ** p<0.05, * p<0.1

For specification:

$$\begin{cases} log(Tobin'sQ_{it}) = \beta_1^1 Match\,Quality_{ij} + \beta_2^1 log(\text{incentive pay}_{ijt}) + \beta_3^1 Investment + \beta_4^1 Firm\,Characteristics + dummy_i + dummy_t + \epsilon_{ijt} \\ log(Inc\,pay_{ijt}) = \beta_1^2 Match\,Quality_{ij} + \beta_2^2 log(Tobin'sQ_{it}) + \beta_3^2 Investment_{it} + \beta_4^2 CEO\,power_{ijt} + \beta_5^2 Firm\,Risk_{it} + dum_i + dum_t + \epsilon_{ijt} \\ Investment_{it} = \beta_1^3 Match\,Quality_{ij} + \beta_2^3 log(Tobin'sQ_{it}) + \beta_2^2 log(IncentivePay_{ijt}) + \beta_4^3 Firm\,Risk_{it} + dummy_i + dummy_t + \epsilon_{ijt} \end{cases}$$

where i,j and t represents firm i, CEO j and year t.

Former CEO's information includes former CEO's turnover type(forced or retire)(ex_forced), former CEO's tenure(ex_tenure), and firm's performance in year -3 to -1(int_TQ). X_{it}includes firm level variables related to CEO talent(firm size, firm rank in industry), firm productivity (Investment,Leverage, ROA, firm age,ROA), moral hazard(R& D, Advertising Expenditure) and risk averse (firm idiosyncratic risks) that may influence the optimal share ownership. Y_{ijt} includes corporate governance(Y_{ijt}) variables(board size, board independence, dictator,democrat) and market condition (market index, industrial return)(coefficient on firm size are not reported in regression 3 due to insignificance) Samples for Panel B and C only include firms which don't plan CEO succession in advance before 2002 , but start to plan after 2002.

Table 9: The Relation Between Board Types and Initial Compensation, Firm Performance and Hazard Rate of Early Turnover

Part A: The Predicted Sign of Regressions

	Initial Compensation	Firm Performance	Hazard Rate
Strong *Screener*[a]	-	+	-
Strong *Monitor*[b]	+	+	+
Strong Screener, Strong Monitor	?	+	?
Strong Screener, Weak Monitor	-	?	-
Weak Screener, Strong Monitor	+	?	+
Weak Screener, Week Monitor	?	-	?

a:no difference in monitoring ability,or the screening effects dominates the monitoring effects
b:no difference in screening ability,or the monitoring effects dominates the screening effects

Part B:The Regressions

VARIABLES	(1) Initial Compensation	(2) Performance(TobinQ)	(3) Hazard Rate
Board Size	-1049**	0.0982	0.309**
	(0.0150)	(0.351)	(0.0156)
Board Independence	-65.86	0.187**	-0.107
	(0.856)	(0.0440)	(0.329)
CEOonBoard	62.01	-0.160*	-0.0626
	(0.873)	(0.0730)	(0.578)
Board Network	-241.8	0.235**	-0.252**
	(0.568)	(0.0347)	(0.0320)
inc		0.347***	
		(0)	
inc2		-0.001***	
		(0)	
lna	1495***	-0.830***	-0.0298
	(0)	(0)	(0.490)
retire			0.892***
			(0)
Firm CEO Characteristics	YES	YES	YES
Market Condition			YES
Corporate Governance			YES
Firm Fixed Effects		YES	
Industry Fixed Effects	YES		YES
Year Fixed Effects	YES	YES	
Observations	1688	4123	3965
R^2	0.259	0.222	
Number of gvkey		966	

p-values in parentheses
*** p<0.01, ** p<0.05, * p<0.1

For specification:

$$\begin{cases} tdc1_{ij} = \alpha_1 Board\,Types_{ij,-1} + \alpha_2 Firm\,Size_i + \alpha_3 Risk\,in\,Compensation_{ij} + Industry\,dummy + year\,dummy + \epsilon_{ij} \\ TobinQ_{it} = \beta_1 Board\,Types_{ij,-1} + \beta_2 Incentive\,Pay_{ijt} + \beta_3 Incentive\,Pay^2_{ijt}\beta_4 X_{it} + firm\,dummy + year\,dummy + \epsilon it \\ Hazard\,Rate\,of\,CEO\,turnover_{ijt} = \gamma_1 Board\,Types_{ij,-1} + \gamma_2 CEOAge_{jt} + \gamma_3 Y_{ijt} + Industry\,Dummy + \epsilon_{it} \end{cases}$$

Board types includes board size, board independence, percentage of CEOs from other companies on the board (CEOonBoard), average outside directorships of each directors(Board Network). Board size=1 if the total number of directors on the board¿6;=0 otherwise. Board independence =1 if the percentage of outside directors > 60%$(median)$. CEOonBoard=1 if the percentage of CEOs from other companies on the board> 20%; Board Network=1 if the average outside directorships of each directors > 0.5.

Firm Characteristics(X_{it}) includes firm size(ln(total assets), firm performance at year -1. Corporate governance(Y_{ijt}) variables(board size, board independence, dictator,democrat) and Market Condition includes market index, industrial return.

Appendix

4.1 Appendix A: Notes on Board's Learning

4.1.1 Board's Learning

In each period t, boards update their beliefs about match quality μ using Bayes' rule when they acquire new information s_t.The posterior distribution of the CEO and firm's match quality is normal with mean $\bar{\mu}_{t+1}$ and variance Σ^2_{t+1}:

$$\bar{\mu}_{t+1} = \frac{\frac{1}{\sigma_0^2}\bar{\mu}_t + \frac{1}{\sigma_\epsilon^2}s_t}{\frac{1}{\sigma_0^2} + \frac{1}{\sigma_\epsilon^2}}$$

$$\Sigma^2_{t+1} = \frac{1}{\frac{1}{\Sigma_t^2} + \frac{1}{\sigma_\epsilon^2}}$$

The point I want to make here is that the distribution of μ_{t+1} conditional on μ_t $F(\mu_{t+1}|\mu_t) \propto Prob(y_t) = Prob(e_t)$. That is, the CEO has career concerns in his early term, namely, he want to put more effort to improve his probability of retain.

4.1.2 End of Learning

At time t, the board has already collect t independent signals:

$$\bar{\mu}_t = \frac{\frac{1}{\sigma_0^2}\bar{\mu}_0 + \frac{1}{\sigma_\epsilon^2}\sum_{i=1}^t s_i}{\frac{1}{\sigma_0^2} + \frac{t}{\sigma_\epsilon^2}}$$

$$\Sigma_t^2 = \frac{1}{\frac{1}{\sigma_0^2} + \frac{t}{\sigma_\epsilon^2}}$$

From above equations we can see that the evolution of Σ_t is deterministic and does not depend on the value of the signals received. It also shows that $\Sigma_t > \Sigma_{t-1}$ for each $t > 0$. The posterior mean of beliefs $\bar{\mu}_t$ is a precision-weighted average of the prior mean $\bar{\mu}_{t-1}$ and the most recent signal y_t. Since the precision of signals $(\frac{1}{\sigma_\epsilon^2})$ is constant but the precision of beliefs $(\frac{1}{\Sigma_t})$ increases with tenure, each new signal is given successively smaller weight in the update. Asymptotically, beliefs converge to unit mass at true match quality. That is,

$$lim_{t\to\infty}\bar{\mu}_t = \bar{\mu}, lim_{t\to\infty}\Sigma_t^2 = 0$$

This is a standard result for Bayesian learning with rational priors. And I can say for certain large T, the belief of the board is so close to the true value that we can assume that $\mu_T = \mu$ and the board will not fire the CEO after T if they don't fire him at T. Suppose the expected firms' profit at time T is $E(\Pi)$, we will have:

$$V_{r,T} = E(\Pi) + \beta V_{r,T+1} = E(\Pi) + \beta V_{r,T} \Rightarrow V_{r,T} = \frac{E(\Pi)}{1-\beta}$$

4.2 Appendix B: Proofs of Propositions

4.2.1 Proof of Proposition 1

I start with the simplest case and then show the result still holds under more complicated situation. Assuming that the CEO labor market is competitive and CEOs know the boards' type completely ($\xi = 1$).

Denote the certainty equivalent compensation for CEO at time t by $\bar{W}_t$, i.e., $E(exp\{-r(\bar{W}_t)\}) = \bar{U}_t$, where $\bar{U}_t$ is the outside offer a CEO will get at time t. From our discussion in section (**??**), we know that $\bar{W}_t \geq \bar{w}$, where $\bar{w} \equiv \bar{w}(A)$ is the reservation wage of CEO with talent A.

The CEO's expected utility at time 0 is:

$$U = \bar{W}_0 + U_1$$

where $U_1 = \beta\delta(1)P(retain\,at\,time\,1)\bar{W}_1 + \delta(1)\beta[1 - P(retain\,at\,time\,1)]\bar{W}_f + ... + \delta(T)\beta^{T+1}\bar{W}_{T+1} + ...$

Here $1-\delta(t)$ is the probability of CEO retirement and it is an increasing function of CEO's tenure $t.P(retain\,at\,time\,t)$ is the CEO's expectation (at time 0) of being retained at time t. $\bar{W}_f$ is the certainty equivalent compensation the CEO will get if he is fired.

In order to show $\bar{W}_0$ is a decreasing function of board's screening ability S, I need to show that all other things equal, $W_0^H < W_0^L$, W_0^H (W_0^L) represents the initial certainty equivalent compensation offered by high(low) S board. In equilibrium, the CEO will be indifferent between different offers, i.e., $U^H = U^L$. Therefore showing $W_0^H < W_0^L$ is equivalent to showing that $U_1^H > U_1^L$. Since the CEOs know the board's type and by the definition of S, we already know that[18]

$$P(retain\,at\,time\,t; S_H) > P(retain\,at\,time\,t; S_L)$$

Due to the assumption that the labor market is competitive, the CEO can always walk away to a better match with no cost and the board will give a counter offer to retain the CEO. Since the CEOs in low S board and high S board face the same outside opportunities, $W_t^H = W_t^L$. Now we have $U^H > U^L$, and the proof is done.

Now suppose the CEOs have some knowledge about the board's type, but are not fully informed ($\xi < 1$). Easy to see, the argument above still applies. The difference only happens when there is full information asymmetric ($\xi = 1$), meaning CEOs don't have any information about the board. As a result, all boards are identical to the CEOs and CEOs are identical to the boards, therefore there is no reason for the boards to make different initial compensation offers, i.e. $W_0^H = W_0^L$.

Suppose there exist frictions in the labor market that prevent the board and the CEO candidate from meeting instantaneously and leads to positive rents associated with formed matches. Assume that the CEO and shareholder split the firm's outcome, i.e., $W_t = \gamma y_t$, where $\gamma \in [0, 1]$ represents CEO's bargaining power. Since $E(y_t|S_H) = \bar{\mu}_0^H e_H^* > E(y_t|S_L) = \bar{\mu}_0^L e_L^*$[19], we know that

$$\bar{W}_t^H > \bar{W}_t^L \Rightarrow U_1^H > U_1^L \Rightarrow \bar{W}_0^H < \bar{W}_0^L$$

Similar argument can be applied to M.

4.2.2 Proof of Proposition 2

The board's problem at time T is to maximize $\frac{1}{1-\beta}E_T[y_T - W_T]$, therefore we only need to solve a one-period principal-agent problem at T:

$$\begin{aligned}
&max_{b_T,C_T} E_T[y_T - W_T] \\
&s.t. E(exp\{-r[C_T + b_T(\bar{\mu}_{T-1}e + \epsilon) - k(e)]\}) \geq \bar{U}_T \\
&e^* = argmaxE(exp\{-r[C_T + b_T(\bar{\mu}_{T-1}e + \epsilon) - k(e)]\})
\end{aligned}$$

$\bar{U}_T$ is the outside option and $k(e) \equiv \frac{e^2}{2}$.

Using standard solution techniques, the optimal solution to the above problem is given by (see e.g. Bolton and Dewatripont(2005)) :

$$e_T^* = b_T(\bar{\mu}_{T-1});\ b_T^* = \frac{1}{1+r(\bar{\mu}_{T-1})^{-2}\Sigma^2};\ E(\Pi) = \frac{\frac{1}{2}(\bar{\mu}_{T-1})^2}{(1+r(\bar{\mu}_{T-1})^{-2}\Sigma^2)^2} - \bar{W}_T$$

[18] At time 0, the CEO's expectation of the future outcome is: $y_t = \bar{\mu}_0 e_t + \epsilon$, therefore we have (see Appendix A) $\bar{\mu}_t = \bar{\mu}_0 + \frac{\frac{t}{\sigma_\epsilon^2}\epsilon}{\frac{1}{\sigma_0^2}+\frac{t}{\sigma_\epsilon^2}}$. For a given threshold μ_t^*, the probability of retaining at time t is

$$P(retain\,at\,time\,t) = Prob(\bar{\mu}_t > \mu_t^*)$$

$$= Prob(\bar{\mu}_0 + \frac{\frac{t}{\sigma_\epsilon^2}\epsilon}{\frac{1}{\sigma_0^2}+\frac{t}{\sigma_\epsilon^2}} > \mu_t^*)$$

Since $E(\mu_0|S_H) > E(\mu_0|S_L)$, we will have $P(retain\,at\,time\,t; S_H) > P(retain\,at\,time\,t; S_L)$

[19] In Bolton and Dewatripont(2005)(P 496), they show that multiplicative production function $y = \mu e + \epsilon$ implies a complementarity between match quality and effort. In this case, match quality matters more, the higher the effort, that is, it makes a difference especially when the agent "tries to make things happen.This can then lead to multiple equilibria: If the market puts a lot of weight on the agents performance, she is induced to work hard, which in turn leads the market to pay attention to her performance. And conversely in the case of low effort. Here I assume only the first equilibrium exists.

where $E(\Pi)$ is the expected profit for the principle (the board) and $\Sigma^2_{T-1} = \sigma^2_{T-1} + \sigma^2_\epsilon, \bar{W}_T$ is given by $\bar{U}_T = E(exp\{-r(\bar{W}_T)\})$

Easy to see, $E(y^*) = E((\bar{\mu}_{T-1} + e_{T-1})e^* + \epsilon) = (\bar{\mu}_{T-1} + e_{T-1})^2 b_T \equiv f(\mu)g(b^*)$.

4.2.3 Proof of Proposition 3

Recall $S \propto \bar{\mu}_0$(Section (1.1)), $M \propto \frac{1}{\sigma^2_\epsilon}$(by definition), hence the original proposition can be restated as follows:

1. there exists some $t^* \geq 0$, such that $\frac{\Delta F(t)}{\Delta t} > 0$ if $t > t^*$, and $\frac{\Delta F(t)}{\Delta t} \leq 0$ if $t \leq t^*$ (If t^* equals 0, we only observe $\frac{\Delta F(t)}{\Delta t} \leq 0$).
2. $\frac{dF(t)}{d\bar{\mu}_0} < 0, \frac{\Delta|\frac{dF(t)}{d\bar{\mu}_0}|}{\Delta t} < 0, \forall t$
3. $\frac{\Delta^2 F(t)}{\Delta t \Delta \sigma^2_\epsilon} < 0,$

where $F(t)$ is defined as the expected probability that a CEO with perceived match quality of μ_0 is fired at time t.(If there is no confusion, I will use $F(t) = F(t|\bar{\mu}_0$ for short.)

Since $F(t) = Pr(\bar{\mu}_t < \mu^*)$, we need to know the formulas of μ_t and μ^*.

Recall that in Appendix A, I have shown that the distribution of $\bar{\mu}_t$ is:

$$\bar{\mu}_t = \frac{\frac{1}{\sigma^2_0}\bar{\mu}_0 + \frac{1}{\sigma^2_\epsilon}\sum_{i=1}^t s_i}{\frac{1}{\sigma^2_0} + \frac{t}{\sigma^2_\epsilon}}$$

$$\Sigma^2_t = \frac{1}{\frac{1}{\sigma^2_0} + \frac{t}{\sigma^2_\epsilon}}$$

$F(t) = \Phi(\frac{\mu^*_T - \bar{\mu}_t}{\sqrt{\Sigma^2_t}})$
$= \Phi(\mu^*_T \frac{1}{\sqrt{\Sigma^2_t}} - [\frac{1}{\sigma^2_0}\bar{\mu}_0 + \frac{1}{\sigma^2_\epsilon}\sum_{i=1}^t s_i]\sqrt{\Sigma^2_t})$
$= \Phi(\mu^*_T \frac{1}{\sqrt{\Sigma^2_t}} - [\frac{1}{\sigma^2_0}\bar{\mu}_0 + \frac{t}{\sigma^2_\epsilon}\frac{1}{t}\sum_{i=1}^t s_i]\sqrt{\Sigma^2_t}) = \Phi(\mu^*_T \frac{1}{\sqrt{\Sigma^2_t}} - m\sqrt{\Sigma^2_t}),$
where $m \equiv [\frac{1}{\sigma^2_0}\bar{\mu}_0 + \frac{t}{\sigma^2_\epsilon}\frac{1}{t}\sum_{i=1}^t s_i]$.

Claim 1 *There exists some $t^* \geq 0$, $\frac{\Delta F(t)}{\Delta t} > 0$ if $t > t^*$, and $\frac{\Delta F(t)}{\Delta t} \leq 0$ if $t \leq t^*$ (If t^* equals 0, we only observe $\frac{\Delta F(t)}{\Delta t} \leq 0$)*

Proof 6 *To find the relation between the probability of job separation and tenure, we need to solve:*

$$\frac{\Delta F(t)}{\Delta t} = \frac{\Delta F(t)}{\Delta m}\frac{\Delta m}{\Delta t} + \frac{\Delta F(t)}{\Delta \Sigma^2_t}\frac{\Delta \Sigma^2_t}{\Delta t} + \frac{\Delta F(t)}{\Delta \mu^*}\frac{\Delta \mu^*}{\Delta t}$$

There are three effects that drive the probability of firing. The first is the increasing possibility of the board observing the CEO's true type, i.e. $\frac{1}{t}\sum_{i=1}^t s_i$ gets more weights ($\frac{t}{\sigma^2_\epsilon}$) over time t. For unsuitable CEOs, this effect drives the probability up. The second is that the board has more precise knowledge about the CEO's match quality and therefore are more likely to fire unsuitable CEOs($\frac{\Delta F(t)}{\Delta \Sigma^2_t} < 0$ if $\bar{\mu}_t < \mu^*$, $\frac{\Delta \Sigma^2_t}{\Delta t} < 0$). The last is the change of threshold. Later on I will show that the threshold is decreasing over time(Lemma 2), reflecting the fact that as unsuitable CEOs are fired over time, the average level of match quality of retained CEO goes up(see Jovanovic 1979)[20].

[20] The last effect is more significant when we compute the hazard rate.

$$Hazard(fire\, at\, t) = \frac{Pr(F_t = 1, F_{t-1} = 0, F_{t-2} = 0, ..., F_1 = 0)}{Pr(F_{t-1} = 0, F_{t-2} = 0, ..., F_1 = 0)}$$

In order to determine the sign of $\frac{\Delta F(t)}{\Delta t}$*, I need to compare the magnitude of the three parts.*
$\frac{\Delta F(t)}{\Delta m}\frac{\Delta m}{\Delta t} = -\frac{\Delta \frac{1}{t}\sum_{i=1}^{t} s_i}{\Delta t}\sqrt{\Sigma_t^2}\frac{1}{\sigma_\epsilon^2}$[21]
$\frac{\Delta F(t)}{\Delta \Sigma_t^2}\frac{\Delta \Sigma_t^2}{\Delta t} = \frac{\mu^*-\bar{\mu}_t}{\Sigma_t^2}\frac{1/2}{\sqrt{\Sigma_t^2}}(\Sigma_t^2)^2\frac{1}{\sigma_\epsilon^2} = \frac{1}{2}(\mu^*-\bar{\mu}_t)\sqrt{\Sigma_t^2}\frac{1}{\sigma_\epsilon^2}$
$\frac{\Delta F(t)}{\Delta \mu^*}\frac{\Delta \mu^*}{\Delta t} = \frac{1}{\sqrt{\Sigma_t^2}}\frac{\Delta \mu^*}{\Delta t} < 0.$

Observations:

1. *At* $t \to \infty$, $\Sigma_t^2 \to 0$*, the third term will dominate and* $F(t)$ *declines eventually.*
2. *When* t *is small, for a unsuitable CEO(defined as* $\mu_0 > \mu_0^*, \bar{\mu} < \mu_0^*$*), it's likely that we will observe* $\frac{\Delta \frac{1}{t}\sum_{i=1}^{t} s_i}{\Delta t} < 0$*, but* $\bar{\mu}_t > \mu_t^*$*. That is, the board start to observe bad outcomes, so the expectation of the match quality(*$\frac{1}{t}\sum_{i=1}^{t} s_i$*) start to go down; In the mean time, the board still believes that it is a suitable match, i.e.* $\bar{\mu}_t > \mu_t^*$*. Therefore the first two terms are all positive and they dominate the third term and drives the probability up(assuming* $\sqrt{\Sigma_t^2}\frac{1}{\sigma_\epsilon^2} > \frac{1}{\sqrt{\Sigma_t^2}}$ *for small t,)*

In sum, the relation of $F(t)$ *and tenure will either be a invested U shape or decline all over tenure(See Jovanovic (1979) for a continues-time version for this statement).*

Claim 2 $\frac{dF(t)}{d\bar{\mu}_0} < 0, \frac{\Delta |\frac{dF(t)}{d\bar{\mu}_0}|}{\Delta t} < 0, \forall t$

Proof 7 *Recall* $F(t) = \Phi(\frac{\mu_T^*-\bar{\mu}_t}{\sqrt{\Sigma_t^2}})$*, therefore*

$$\frac{dF(t)}{d\bar{\mu}_0} = \frac{\partial F(t)}{\partial \bar{\mu}_t}\frac{\partial \bar{\mu}_t}{\partial \bar{\mu}_0}$$

and $\frac{\partial F(t)}{\partial \bar{\mu}_t} = -\frac{1}{\sqrt{\Sigma_t^2}}$, $\frac{\partial \bar{\mu}_t}{\partial \bar{\mu}_0} = \frac{\frac{1}{\sigma_0}}{\frac{1}{\sigma_0}+\frac{t}{\sigma_\epsilon^2}}$
Easy to see $\frac{\partial F(t)}{\partial \bar{\mu}_t} < 0, \frac{\partial \bar{\mu}_t}{\partial \bar{\mu}_0} > 0,$*we will have* $\frac{dF(t)}{d\bar{\mu}_0} < 0.$
And $\frac{\Delta \frac{dF(t)}{d\bar{\mu}_0}}{\Delta t} = \frac{\Delta - \frac{1}{\sqrt{\Sigma_t^2}} * \frac{\frac{1}{\sigma_0}}{\frac{1}{\sigma_0}+\frac{t}{\sigma_\epsilon^2}}}{\Delta t} = \frac{|-\Delta \frac{1}{\sigma_0}\sqrt{\Sigma_t^2}|}{\Delta t} < 0$

Claim 3 $\frac{d\frac{\Delta F(t)}{\Delta t}}{d\sigma_\epsilon^2} < 0$

Proof 8 *Recall*

$$\frac{\Delta F(t)}{\Delta t} = \frac{\Delta F(t)}{\Delta m}\frac{\Delta m}{\Delta t} + \frac{\Delta F(t)}{\Delta \Sigma_t^2}\frac{\Delta \Sigma_t^2}{\Delta t} + \frac{\Delta F(t)}{\Delta \mu^*}\frac{\Delta \mu^*}{\Delta t}$$

where $m \equiv [\frac{1}{\sigma_0^2}\bar{\mu}_0 + \frac{t}{\sigma_\epsilon^2}\frac{1}{t}\sum_{i=1}^{t} s_i]$;
$\frac{\Delta F(t)}{\Delta m}\frac{\Delta m}{\Delta t} = -\frac{\Delta \frac{1}{t}\sum_{i=1}^{t} s_i}{\Delta t}\sqrt{\Sigma_t^2}\frac{1}{\sigma_\epsilon^2}$
$\frac{\Delta F(t)}{\Delta \Sigma_t^2}\frac{\Delta \Sigma_t^2}{\Delta t} = \frac{\mu^*-\bar{\mu}_t}{\Sigma_t^2}\frac{1/2}{\sqrt{\Sigma_t^2}}(\Sigma_t^2)^2\frac{1}{\sigma_\epsilon^2} = \frac{1}{2}(\mu^*-\bar{\mu}_t)\sqrt{\Sigma_t^2}\frac{1}{\sigma_\epsilon^2}$
$\frac{\Delta F(t)}{\Delta \mu^*}\frac{\Delta \mu^*}{\Delta t} = \frac{1}{\sqrt{\Sigma_t^2}}\frac{\Delta \mu^*}{\Delta t} < 0.$

For small $t > 1, \frac{1}{\sigma_\epsilon^2} < \frac{1}{\sqrt{\Sigma_t^2}} < \sqrt{\Sigma_t^2}, \frac{\Delta F(t)}{\Delta t} > 0$*, we know that* $\frac{d\frac{\Delta F(t)}{\Delta t}}{d\sigma_\epsilon^2} > 0$
For large t, $\frac{1}{\sigma_\epsilon^2} < \sqrt{\Sigma_t^2} < \frac{1}{\sqrt{\Sigma_t^2}}, \frac{\Delta F(t)}{\Delta t} < 0$*, we will have* $\frac{d\frac{\Delta F(t)}{\Delta t}}{d\sigma_\epsilon^2} > 0$

$$= \frac{\int F(t)\Pi_{i=1}^{t}(1-F(t))f(\bar{\mu}_0)d\bar{\mu}_0}{\int \Pi_{i=1}^{t}(1-F(t))f(\bar{\mu}_0)d\bar{\mu}_0} \geq \int F(t)f(\bar{\mu}_0)d\bar{\mu}_0$$

where $F_t = 1$ represents that the CEO is fired at t and $F_t = 0$ represents that CEO is retained at time t. The second inequality is due to Jensen's inequality.

[21] In fact, $\frac{\Delta F(t)}{\Delta m}\frac{\Delta m}{\Delta t} = -\Phi'(\mu_T^*\frac{1}{\sqrt{\Sigma_t^2}} - m\sqrt{\Sigma_t^2})\frac{\Delta \frac{1}{t}\sum_{i=1}^{t} s_i}{\Delta t}\sqrt{\Sigma_t^2}\frac{1}{\sigma_\epsilon^2}$. Since $\Phi'(\dot{})$ is the same for all the three equations, I ignore that part.

I need the following definition and lemma before I start to prove $\mu_{t+1}^* \leq \mu_t^*$.

Definition 1 *For random variables M_1 and M_2, M_2 is called a mean-preserving spread of M_1 if we can write*

$$M_2 = M_1 + Y$$

where Y is some random variable with mean zero.

Lemma 1 *If M_2 is a mean-preserving spread of M_1, then for any convex function $f(x)$,*

$$E[f(M_1)] \leq E[f(M_2)]$$

Proof 9 *By the law of iterated expectations and the definition of a mean-preserving spread*

$$E[f(M_2)] = EE[f(M_2)|M_1] = EE[f(M_1 + Y)|M_1] \geq E[f(E[M_1 + Y|M_1])] = E[f(M_1)]$$

where Y is a random variable with mean zero, and the weak inequality comes from (the conditional version of) Jensens Inequality.

Lemma 2

$$\mu_{t+1}^* \leq \mu_t^*$$

Proof 10 *In our normal learning model,the posterior mean of match quality evolves according to*

$$\bar{\mu}_{t+1} = \frac{\frac{1}{\sigma_0^2}\mu_t + \frac{1}{\sigma_\epsilon^2}(s_t - \bar{\mu}_t)}{\frac{1}{\sigma_0^2} + \frac{1}{\sigma_\epsilon^2}} = \bar{\mu}_t + \frac{\frac{1}{\sigma_\epsilon^2}s_t}{\frac{1}{\sigma_0^2} + \frac{1}{\sigma_\epsilon^2}}$$

The second term clearly has expectation zero (this is the martingale property of the posterior mean)and positive variance, so that learning induces a mean-preserving spread.

Next I need to show that

$$V_r(\mu_t) = max_{C_t,b_t,e_t}[(1 - b_t)\bar{\mu}_t e_t - C_t] + \beta E[V(\mu_{t+1})|\mu_t]$$

is a convex function of μ_t. Since the first part is linear, I only need to show that $V(\mu_{t+1})$ is convex. I start to show it by backward induction. From Proof 2 we know that

$$V_T = \frac{1}{1-\beta}E(\Pi) = \frac{1}{1-\beta}\frac{\frac{1}{2}(\bar{\mu}_{T-1})^2}{(1 + r(\bar{\mu}_{T-1})^{-2}\Sigma^2)^2} - \bar{W}_T$$

Apparently, it is a convex function of μ_{T-1}. And I assume V_f is a constant. The board's value function at time T is $V_T(\mu_t) = max\{V_r, V_f\}$. Since V_f and V_r are (weakly) convex in μ , so is V. As a result we can see that

$$V_r(\mu_{T-1}) = max_{C_{T-1},b_{T-1},e_{T-1}}[(1 - b_{T-1})\bar{\mu}_{T-1}e_{T-1} - C_{T-1}] + \beta E[V(\mu_T)|\mu_{T-1}]$$

is convex.

Applying the similar argument to $V_r(\mu_t), t = T-2, T-3, ..., 1$, I have shown that $V_r(\mu_t)$ is a convex and non decreasing function of μ_t.

Apply the lemma, we have:

$$E[V_r(\mu_{t+1})] \leq E[V_r(\mu_t)]$$

Since μ_t^* is the solution to $E[V_r(\mu_{t+1})] = \beta V_f$, we will have $\mu_{t+1} \geq \mu_t$.

4.3 Appendix B: Description of Variables

This is a discussion of our control variables and their expected relations with hazard rate of CEO turnover and performance.

Firm Characteristics Some firm characteristics may have a systematic influence on the uncertainty attached to the quality of the match at the moment when the employment contract is signed and, hence, on subsequent job mobility.

Firm Size (Total Assets) To measure firm size, we use the book value of total assets in millions (in our regressions, we use the log of this variable).

Firm Age I measure firm age as the number of years since its share price first appeared on the CRSP database.

Growth Opportunities (MB) To measure growth opportunities, we take the ratio of the market value of equity to the book value of equity plus deferred taxes (in our regressions, we use the log of this variable).

Tobin's Q is adjusted by industry mean.

$$Tobin'sQ = \frac{TA + MVE * CSHO - TCE - DT}{TA}$$

where TA is total assets; MVE(Market Value of Equity):Stock Price Fiscal Year Close (Compustat Annual Item $PRCC_F$)
CSHO(Common Shares Outstanding): Compustat Annual Item CSHO
TCE(Total Common Equity): Compustat Annual Item CEQ
DT(Deferred Taxes (Balance Sheet)):Com pustat Annual Item TXDB

The Industry-Adjusted Return on Assets (ROA) is the ratio of earnings before interest, taxes, depreciation and amortization (COMPUSTAT data item EBITDA) to total assets , less the value-weighted average of that ratio for all firms in the same industry in the same fiscal year.

The Market-Adjusted Annual Return(RET) is the difference between the firm-specific buy-and-hold annual stock return and the value-weighted industry portfolio return in the same 12-month period.

Operating Margin (OROS) = operating income (oiadp)/saless.

Variance of Residuals (σ^2) To proxy for firm-specific risk, we calculate the variance of the residuals from the market-model regression over the past five-year period.

Macroeconomics conditions can influence the CEO turnover and firm performance.

Market Return weighted average stock return of all the firm in EXECUCOMP.

Industry Return weighted average stock return for each industry.

Ownership Structure I employ four measures for the ownership structure of the firm.

CEO ownership I also control for the percentage of the companys shares that are owned by the CEO. Some hypothesize that

Director Ownership similar to Allen (1981), we also determine whether there exists a non-CEO internal board member (who is also not a member of the CEO's family) that owns at least 5 percent of the outstanding shares. In general, CEO entrenchment should be reduced if another internal board member has substantial equity holdings in the firm.

Democracy/Dictatorship Firm Following Gompers, Ishii, and Metrick (2003), Democracy Firm is a dummy that equals one if the firms GIM index is less than or equal to five, and zero otherwise. Dictatorship Firm is a dummy that equals one if the firms GIM index is greater than or equal to 14, and zero otherwise. A firms GIM index takes on a value between 0 and 24, accruing one point for each provision that increases managerial power or depresses shareholder activism. I expect that firms with higher indices award higher levels of compensation.

Compensation Total Compensation CEO total compensation (EXECUCOMP data item TDC1) comprises salary, bonus, other annual, total value of restricted stock granted, total Black-Scholes value of stock options granted, long-term incentive payouts and all other total.

CEO salary (EXECUCOMP data item Salary) is defined as the dollar value of the base salary (cash and non-cash).

Board Characteristics I proxy for the effectiveness of monitoring by the board of directors by using eight measures that characterize the composition of the board.

CEO=Chairman This is a dummy that equals one if the CEO also serves as the chairman of the board, and zero otherwise. If the CEO is also the chairman of the board, the board could be easier for the CEO to control, a hypothesis that is empirically supported by Yermack (1996) and Core, Holthausen, and Larcker (1999), among others.

Size The size of the board of directors is expected to be associated with less effective board monitoring, based on the argument that larger boards are less effective and more susceptible to the influence of the CEO (Jensen, 1993; Yermack 1996). Lipton and Lorsch (1992) argue that larger boards are more susceptible to managerial control and have increased coordination and free-rider problems, and Yermack (1996) finds that firm value is decreasing in board size. To the contrary, Coles, Daniel, and Naveen (2008) find that firms with greater advisory needs exhibit a positive association between board size and firm value.

Inside Directors Pfeffer (1981) argues that internal board members are more loyal to management, and thus the CEO can exert relatively more influence over internal (as opposed to outside) board members.

Independent outside directors The IRRC database has a variable that classifies a director as an independent director.IRRC defines an independent director as a director who is neither affiliated nor currently an employee of the company. An affiliated director is a former employee of the company or of a majority-owned subsidiary; a provider of professional servicessuch as legal, consulting, or financialto the company or an executive; a customer of or supplier to the company; a designee, such as a significant shareholder, under a documented agreement between the company and a group; a director who controls more than 50 percent of the companys voting power (and thus would not be considered to represent the broader interests of minority shareholders); a family member of an employee; or an employee of an organization or institution that receives charitable gifts from the company.

Busy Directors Finally, some reform advocates suggest that many directors serve on too many boards to attend to their duties adequately. Consistent with recent NACD guidelines (1996), we define an outside director to be "busy" if he serves on three or more other corporate boards (six or more other boards if the director is retired). I measure busy outside directors as a percentage of outside directors. Other researchers such as Shivdasani (1993) have employed the average number of additional directorships as a measure of director quality and found a negative association with agency problems. By concentrating on an excess number of directorships, we create a variable over the range where we expect that increases in the number of directorships do not measure increases in director quality, but instead measure reductions in the director's ability to attend to his duties.

CEO from Other Company This is a dummy that equals one if at least one of the directors is the CEO of another firm, and zero otherwise.

CEO Talent Level and Productivity firm size lna (log(Total Assets),MKTval(market value of common equity)), firm age, firm investment opportunities (Capital expenditures divided by the book value of total assets).

Moral Hazard **Firm Size** Following Demsetz and Lehn (1985) who argue that firm size has non-linear effects on the scope of moral hazard, I include lna and lna2 (lna^2) to control for the non-linear size effect.

the ratio of property, plant, and equipment (PPE) to total assets (CAP) CAP and its square, CAP2, are included to measure the relative importance of fixed capital, which presumably is easier to monitor and hence calls for a lower optimal level of managerial ownership.

Intangible Capital intangible assets and discretionary spending are harder to monitor and may lead to a higher desired level of ownership. I include the ratio of R & D expenses to total assets(RDA), R& D dummy (RDdummy), ratio of Advertising expense to total assets(AVA), Advertising dummy (AVdummy), ratio of expenditures on fixed plant and equipment to total assets(FCA).

capital expenditures divided by PPE(I/K) and operating income normalized by sales(Y/S) Himmelberg et al. use them to proxy for the link between high growth and discretionary investment opportunities and for free cash flow, respectively.

Leverage ratio of long term debt to total assets.

Liquidity Cash flow divides the book value of total assets.

CEO characters CEO age

CEO power interlocking directorships,CEO=Chairman

Corporate Governance ln(Board Size)/Board Size, Busy Board, CEO from Other Company on the board, Democracy Firm, Dictatorship Firm

Risk Averse To control for risk aversion, we include SIGMA, a measure of firm idiosyncratic risk. Because holding company stock reduces diversification, everything being equal, the riskier the company stock, the less will be owned by risk averse managers. In addition, I set missing values of SIGMA equal to zero.

Others industry dummy

Measuring CEO turnover An indicator variable, TURNOVER, is set equal to 1 if there is a CEO change in the firm. Turnovers due to mergers are excluded from the sample (¡ 5% of observations). Interim successions (where the CEOs are nominated in an interim capacity and hold office for less than a year) are not considered as turnovers. I identify forced departures similar to Parrino et al (1997). I include all CEO departures that are reported as forced. Also, a departure is identified as forced when the CEO is under 60 and leaves for reasons unrelated to death, illness, or acceptance of any position within or outside the firm. Turnover announcements are obtained from the Wall Street Journal,Lexis/Nexis and etc.

Measuring firm performance Tobin's Q is frequently used in the literature of CEO ownership and firm value as an indicative of good management and governance (Palia 2001). However, alternative interpretations of a high Tobin's Q are equally plausible. In particular, if financial or liquidity constraints cause some firms to underinvest, the potential value of unexploited investments may lead to a high marginal Tobins Q. I address this issue by using a number of controls for investment opportunities.

I recognize that all measures are subject to measurement error. Therefore, I also supplement the Tobin's Q tests with similar models estimating operating performance. Since historical operating performance does not employ market prices, this measure is unlikely to reflect the value of future investment opportunities. In addition, we suspect that financial constraints are less likely to be predominant in our sample, which consists of the largest U.S. corporations during the time period studied.

Measuring pay and pay-performance sensitivity I measure CEO equity incentives with the pay-for-performance sensitivity of CEO options and stocks portfolio including previously granted options and stocks (Core and Guay 1999). Following Core and Guay (1999), I use a percentage-change measure of CEO equity incentives (INC) as my dependent variable that shall capture the dollar changes (in thousands) in CEO wealth for a 1% change in stock price. An alternative measure could be the dollar change in CEO wealth for a dollar change in firm value (Jensen and Murphy 1990). In order to ensure that my results are robust to the alternative measure of incentives, I also use the Jensen and Murphy (1990) fractional measure of incentives(INC2).

4.3.1 Appendix D: Primary Results from Direct Test: Estimate the Parameters of the Simplified Model

The parameters of the simplified model are estimated with maximum likelihood using data on the tenure and firm performance of a panel of CEOs. Assuming there is no unobserved heterogeneity besides the match quality, CEO i's contribution to the likelihood function is

$$l_i = l_{1,i}^{I(designated\,successor=1} l_{2,i}^{I(designated\,successor=0)}$$

where

$$l_{1,i} = [\Pi_{t=1}^{5} Pr(tenure_i = t|P_1, F_1)^{I(censored_i=0)} Pr(tenure_i > t|P_1, F_1)^{I(censored_i=1)]}$$
$$\times[\Pi_{t=6}^{T}\{P_1\phi(y_{it} - X_{it}\beta - (\mu_H - \mu_L)) + (1-P_1)[\Pi_{n=1}^{5}(1-F_1(n))]\phi(y_{it} - X_{it}\beta)\}]$$

$$l_{2,i} = [\Pi_{t=1}^{5} Pr(tenure_i = t|P_2, F_2)^{I(censored_i=0)} Pr(tenure_i > t|P_2, F_2)^{I(censored_i=1)]}$$
$$\times[\Pi_{t=6}^{T}\{P_2\phi(y_{it} - X_{it}\beta - (\mu_H - \mu_L)) + (1-P_2)[\Pi_{n=1}^{5}(1-F_2(n))]\phi(y_{it} - X_{it}\beta)\}]$$

where $Pr(tenure_i = t)^{I(censored_i=0)}$ is the probability of observing a uncensored spell with tenure equals $t, t \leq 5$. This represents early turnover CEOs. (5 year is the cutting point for learning process) According to the model, it is of the formula:$Pr(tenure = t) = (1-P)\Pi_{n=1}^{t-1}(1-F(n))F(t)$

$Pr(tenure_i > t)^{I(censored_i=1)}$ is the probability of observing a right censored spell with tenure equals $t, t \leq 5$. It implies that CEO i has a tenure longer than t. According to the model, $Pr(tenure > t) = P + (1-P)\Pi_{n=1}^{t}(1-F(n))$.

$\Pi_{t=6}^{T}\{P_1\phi(y_{it} - X_{it}\beta - (\mu_H - \mu_L)) + (1-P_1)[\Pi_{n=1}^{5}(1-F_1(n))]\phi(y_{it} - X_{it}\beta)\}, t > 5$ is for spells last more than 5 years. It shows that among CEOs who survive after the learning process, with probability P their true type are μ_H and with probability $(1-P)[\Pi_{n=1}^{5}(1-F(n))]$ their types are μ_L (ϕ is the normal probability density function of $\epsilon \sim N(0,1)$.

Take $F = (\frac{t}{D})^{\gamma}$, the parameters P_i ,γ_i D , $\Delta\mu \equiv \mu_H - \mu_L$ and βs are what we need to estimate.

4.3.2 Identification

P, γ and D are identified primarily from CEO tenure, though the firm performance data also help identify these parameters. For example, the ratio of first and second year turnover rate and the ratio of second and third year turnover rate identify D and γ. ($ratio_{1,2} = \frac{(1-P)M(1)}{(1-P)(1-M(1))M(2)} = \frac{\frac{1}{D}^{\gamma}}{(1-\frac{1}{D}^{\gamma})\frac{2}{D}^{\gamma}}$
$ratio_{2,3} = \frac{(1-P)(1-M(1))M(2)}{(1-P)(1-M(1))(1-M(2))M(3)} = \frac{\frac{2}{D}^{\gamma}}{(1-\frac{2}{D}^{\gamma})\frac{3}{D}^{\gamma}}$
Solve the equations in the same time,we can identify D and γ.)

$\Delta\mu \equiv \mu_H - \mu_L$ and βs are identified primarily from the firm performance function in the typical manner.

4.3.3 Estimation Results

$$P_{designated\,successor} = 0.9054, P_{nondesignated/,successor} = 0.8815$$
$$D_{designated\,successor,t} = (\frac{t}{6.1910})^{1.5}, D_{nondesignated/,successor,t} = (\frac{t}{7.1247})^{1.5}$$
$$\Delta\mu = 0.035$$

.

As we can see, the designated successors do have bigger P value than the nondesignated successors. The small difference between these two parameters is due to that 1) CEO turnover rate is very low (2%) and 2)there are endogeneity and selection bias problems when estimating the CEO's productivity of effort. We can certainly improve the estimation by adding more specifications into out maximum likelihood in order to get better estimation of the magnitude, but this is not what we care about. Our goal is to test wether our model can generate $P_{designated\,successor} > P_{nondesignated/,successor}$, which is consistent with our assumption that designated successors have a better match quality. Since the estimated bias are true for both designated successors and non designated successor, the relation between $P_{designated\,successor}$ and $P_{nondesignated/,successor}$ are estimated correctly. Also from

$$D_{designated\,successor} < D_{nondesignated/,successor}$$

we can infer that the board which can successfully conduct a CEO succession plan is also a board with strong monitor abilities, which is consistent with our intuition.