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# Where do the talented people work as outside directors?

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# Where Do the Talented People Work as Outside Directors?

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Keywords: Corporate Governance, Board of Directors, Board Quality, Job Search, Matching

# Where do the talented people work as outside directors?

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**Abstract**

This paper develops a matching model in the director market with outside options to explain the equilibrium board quality. Based on Hermalin (2005) and Gabaix and Landier (2007), the board of directors has the function of monitoring and advising to affect the earning of firm assuming that the impact of a CEO's quality increases with the size of the firm under his control. I also consider two possible relationships between the CEO quality and the board quality, complement and substitute, in the firm. This model shows that the big firms make board positions more attractive compared to outside options. Second, when the marginal contribution of the CEO's talent to the performance (the source of reputation value enjoyed by the board member) is large enough, the talented CEO can be matched with the high qualified outside directors. It follows that the board quality increases. Additionally, the model can explain the observed fact that the quality of directors on the same boards is dispersed. The estimations suggest that the talented ongoing CEOs and retired CEOs go to the firms which have the high market capitalization values and the large amount of sales to work as outside directors. The evidence for the effect of the incumbent CEO's talent is mixed. I also find that the firms which have a large amount of sales pay more to outside directors. The compensation for directors, however, does not affect the quality of boards.

**JEL Classification:** D23, G34, G38, J41, J44, J64, L25

**Keywords:** Corporate Governance, Board of directors, Board Quality, Job Search, Matching

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# 1 Introduction

Many researches have explored the characteristic of board and reached the consensus that efficient board should be composed of a majority of outside director. Colley and Stettinius (2003) argue that one of the good attributes of board of director is to have no more than two insiders directors on board. The reason is that board satisfying this criterion can be considered more independent. Since many people believe that outside directors would be more likely to represent the shareholder's preference due to relative independence, this view is widely accepted. It naturally follows that economic literatures analyze the optimal board independence. Boards have two major functions: monitoring and advising on management. We can predict that these two functions are key determinants of board structures. Adams and Ferreira (2007) and Raheja (2005) provide theoretical background for the structure of board. They argue that the board structure optimally respond to the benefit and cost of monitoring and advising. Lehn, Patro and Zhao (2004) and Linck, Netter and Yang (2006a) empirically support this argument.

There exists another important aspect of board, the quality of board. Fama (1980) argues that managers of high-performing firms are more likely to become outside directors of firms because the market values directors according to their efficacy as managers. The market thinks that they have the expertness to guide and monitor managerial behavior. Many research also conclude that firms prefer high qualified directors. (See Fama and Jensen (1983), Gilson (1990), Kaplan and Reishus (1990), Li (1997), Ferris, Jagannathan and Pritchard (2003) and Keys and Li (2004)). A little light, however, has been shed on the determination of the boards quality.

Gabaix and Landier (2007) propose a simple competitive assignment model in the CEO market to explain the CEO compensation. They assume that CEOs have heterogeneous talent level and are assigned to firms competitively. Also, the managerial impact of a CEO's talent increase with the value of the firm under his control and CEOs earn the value of their marginal product. Under these assumptions, they suggest that the best CEO goes to the largest firms and the CEO's pay increases in the size of firm and the size of average firm in the economy. Their empirical finding supports these predictions. The most important determinant of the CEO compensation is the size of firms. Garicano and Rossi-Hansberg (2006) propose a model to explain the organization of work in a knowledge economy. They show a positive sorting in a sense that highly qualified managers are matched with the higher ability subordinates. The main driving force is that the managers can share their ability with the workers under their control. In line with these notions, I ask where the talented candidates go to work as outside directors and whether the good CEOs are matched with the good board members or not.

This paper develops a simple matching model in the director market with outside options to explain the board quality. The quality of outside directors on boards has a direct (advising) and an indirect (monitoring) mechanism to affect the earning of firms assuming that the impact of CEO's quality increase in the value/size of firms

under his control[1] in this model. First, an outside director contributes to the earning of firms directly by advising on the management. In this aspect, I consider two possible relationships between the CEO quality and the board quality, complement and substitute, in the organization of firm. They can interact each other positively, but it could be the case that the CEO can dominate the decision making or the decision of the CEO can be overriden by the board, too. Second, a highly qualified director increases the probability of finding the true quality of incumbent CEO. On the demand side, the firm would like to fill a vacancy with a candidate satisfying the minimum quality level. The minimum quality level is analyzed based on Pissarides (2000). He provides the excellent work for searching and matching in the labor market to incorporate the market condition (matching function). On the supply side, a potential candidate for outside directors compares the money value (board compensation) plus reputation value (depending on the performance of firm) generated by the directorship to the outside option value. If the outside option is so good for the highly qualified candidates, they would not contact the firm which creates a vacancy for the outside director. Henceforth, the quality of boards is determined by random matching between the minimum quality level required by firm and the cutoff (maximum) quality level of the potential candidates who are likely to contact.

This model shows that the size of firms would affect the board quality in the following manner. The larger size makes the earning of firms more sensitive to the board quality, so that the larger sized firms pay more to outside directors. Also, the big firms give more reputation values (generated by the performance of the firm) to board members. Conclusively, the large size makes board positions more attractive to the talented candidates for outside directors. Additionally, only when the marginal contribution of the CEO's talent to the performance of firm is large enough, the more talented CEO can induce the high qualified candidates. Suppose that there is "complementarity" between the quality of CEO and board of directors. When the expected talent of the incumbent CEO rises, the monitoring role becomes less important, but the advising role becomes more important. Thus, when the gain of advising is large enough, the board compensation increases in the expected talent of the incumbent CEO. Even if the board compensation decreases in the expected talent of the incumbent CEO, the large reputational gain generated by the increase in the expected talent of the incumbent CEO can make the board position more attractive. In the "substitute" case, the board compensation decreases in the expected talent of the incumbent CEO becasue the good CEO can dominate the decision-making or the decision of the CEO can be overridden by the board. So, only when the marginal contribution of the CEO's talent to the reputation value enjoyed by outside directors is large enough, the more talented CEO can be matched with the good board member.

[1] We can interpret this assumption in the following manners: (1) The real power comes from the amount of resource which the CEO can allocate. (2) The "Size-Skill Complementarity" exists in the hierarchies of firm. Garicano and Rossi-Hansberg (2006) suggest that the ability of managers could be amplified by the amount of controllable resource in the hierarchies of firm because talented employees can share their ability (or knowledge) with the team under their control. In what follows, the more talented employees hold higher positions in the equilibrium.

Finally, the model suggests the possibility that the talented candidates (good firms) are sometimes matched to the bad (of course, not too bad) firms (candidates) and the quality of directors on the same boards is dispersed.

The empirical evidence supports the prediction of size effect. The estimations show that the talented ongoing CEOs and retired CEOs go to the firms which have the high market capitalization values and the large amount of sales. The evidence for the effect of incumbent CEO's talent is mixed. I also find that the firms which have a large amount of sales pay more to outside directors. Additionally, the statistics shows the dispersion of directors' quality on the same boards.

The rest of the paper is organized as follows. In section 2, I provide a brief review of the related literature. In section 3, I develop a model and provides the empirical predictions. The Section 4 describes the data set and the empirical results. I summarize concluding remarks in Section 5.

## 2 Related literature

This paper is mainly related with a field which studies the quality of boards. They focus on the relationship between the quality of potential candidates for outside directors and the probability of serving as outside directors on boards.

### 2.1 The quality of boards

Fama (1980) argues that managers of high-performing firms are more likely to become outside directors of firms because the market prices directors according to their efficacy as managers. The market thinks that they have attributes necessary to guide and monitor managerial behavior. Kaplan and Reishus (1990) find that the probability of a CEO taking on an outside direct orship is positively related to their firm's performance. Li (1997) provides evidences that the labor market for directors is well functioning and the market prices directors based on their performance as directors. Brickley, Linck and Coles (1999) analyze directorships held by 277 CEOs who retired during 1989-1993 after they retired and show that accounting performance (ROA and industry adjusted ROA) of CEO during the final 4 years in office has an economically significant effect on the number of outside board seats they serve after retirement, but market performance does not explain it.Ferris, Jagannathan and Pritchard (2003) find that the performance of firm which he has served as a director has a positive effect on the number of other appointments (other firms' outside directorships) held by him, which is consistent with Fama and Jensen (1983). Keys and Li (2004) find that professional director are three times more likely to receive additional directorships following a successful tender offer for a firm on which they served as board members. Lee (2007c) analyzes directorships held by 250 CEOs who retired during 1998-2002 in the two years after retirement and finds counter-evidences that pre-retirement accounting performances do not have any explaning power for the number of outside directorships held by CEOs 2 years after

retirement and the firm size in which CEO worked before retirement is directly related to the number of outside directorship.

Overally, many researches about corporate governance focus on the relationship between quality of candidate for outside directors and probability of serving as directors and conclude that the number of directorship a candidate serves increases in his quality level. A little light, however, has been shed on the determination of the quality of boards. The goal of this paper is to explain the board quality using the matching framework.

# 3 Model

## 3.1 Model: Searching and Matching

I construct a searching and matching model in which both potential candidates for outside directorships and firms live forever and are risk neutral. The basic framework stems from Pissarides (2000). There are potential candidates for outside directorships and firms which are normalized to 1. Every potential candidate $i$ with heterogenous quality, $q^i_{new}$, has an outside option,[2] so that their choice is whether to serve as an outside director or enjoy an outside option. The choice of the firm is to decide whether to fill a vacancy for an one outside director on boards or not. Neither quiting nor firing are allowed. The quality, $q^i_{new}$, is $\in [0, 1]$.

The vacancies and potential candidates who would be likely to contact (a subgroup of potential candidates) are assumed to meet each other randomly in the director market. When a vacancy is created, the firm $j$ determines the minimum required quality level and post it. Then, the firm $j$ directs its search effort toward the potential candidates who satisfy this level. Also, the potential candidates who can enjoy the higher value to work as the outside director in the firm $j$ than the outside option value would be likely to contact the firm $j$. The firm $j$ meets potential candidates who would be likely to contact (the candidates below the cutoff level quality) at the rate $\vartheta_j$.[3] I will explore below the nature of steady-state equilibrium and focus on the quality level of outside directors on boards. Hereafter, I omit the subscript $i$ and $j$.

## 3.2 The value function

Firstly, I consider the supply side to develop the value function of a potential candidate for outside directors. I begin with the value of an outside directorship for a potential candidate with quality, $q_{new}$, in the firm requiring minimum quality level, $q^{\min}_{new}$. Neither

[2] This assumption captures the following facts. Many CEOs have several job position opportunities after retirement except outside directorship (community board, goverment organization, officer in private firms, consultant and so on). Ongoing CEOs also have many similar options.

[3] In the classical random searching model, the contacting (meeting) function is given by

$$m(u, v) = m(\frac{v}{u})u = m(\theta)u,\ \theta = \frac{v}{u}$$

where $u$ is the unemployment rate and $v$ is the measure of vacancies. Under the assumptions that all workers are the same and all firms are same, vacancies meet unemployed workers at the rate $\frac{m(\theta)}{\theta}$.

quiting nor firing are allowed.

$$V_c(q_{new}) = \underbrace{W_{BOARD}}_{\text{the money value}} + \underbrace{\eta E[\pi(q_{new})]}_{\text{the reputation value}} + \frac{1}{1+\gamma} V_c(q_{new}),\ q_{new} \geq q_{new}^{\min} \tag{1}$$

The value for a potential candidate of quality, $q_{new}$, who serve as an outside director in the firm requiring minimum quality level, $q_{new}^{\min}$, denoted by $V_c(q_{new})$ equals the sum of the return, wage ($W_{BOARD}$) and the reputation value generated by outside directorship[4] plus $\frac{1}{1+\gamma} V_c(q_{new})$. The reputation value is defined by $\eta E[\pi(q_{new})]$ from the expected performance (profit) of firms, $E[\pi(q_{new})]$ where $\eta$ is the sensitivity parameter[5]. The outside director produces a performance, which requires only one factor, quality denoted by $q_{new}$ and he contributes to the performance of firm by monitoring and advising on management. $V_c^o$ represent the outside option value. $\gamma$ represent the discount rate. We can rewrite above equation by

$$V_c(q_{new}) = \frac{w + \eta E[\pi(q_{new})]}{\gamma} \tag{2}$$

The outside option value is defined by

$$V_c^o(q_{new}) = \lambda q_{new} + \zeta + \frac{1}{1+\gamma} V_c^o(q_{new}) \tag{3}$$

The value for a potential candidate of quality, $q_{new}$, who enjoys an outside option is denoted by $V_c^o(q_{new})$ equals the return of an outside option plus $\frac{1}{1+\gamma} V_c^o(q_{new})$. The return of an outside option is assumed to have a fuctional form denoted by

$$\lambda q_{new} + \zeta,\ \lambda > 0$$

where $\lambda$ is the sensitivity parameter and $\zeta$ is the fixed return from an outside option. This implies the return of outside option increase in the talent of candidates. We can rewrite equation (3) by

$$V_c^o(q_{new}) = \frac{\lambda q_{new} + \zeta}{\gamma} \tag{4}$$

Secondly**,** I consider the vacancy for an outside director. Each firm faces decision whether to fill a vacancy for an one outside director on boards or not. $n$ is the total size of outside board member when a firm does not have any vacancy. The new outside director produces a performance, which requires only one factor, quality denoted by $q_{new}$ and he contributes to the performance of firm by monitoring and advising on management. The value of the firm of filling a vacancy with a new outside director who has the quality

[4]Hambrick and Johnson (2000) said "The majority of outside directors are fully motivated to act conscientiously and vigorously by forces other than a financial stake in the firm: their sense of professionalism, concern for their reputations and stature, and the threat of lawsuit." (Colley and Stettinius (2003), page 61).

[5]The performance of firms actually depends on the average quality level of outside directors on boards when the new director enters into baords. For the sake of exposition, I express the value function in terms of $q_{new}$. I will go in details later.

level, $q_{new}$ with quality requirement, $q_{new}^{\min}$, is given by

$$V_f^{new}(q_{new}) = E[\pi(q_{new})] + \frac{1}{1+\gamma} V_f(q_{new}),\ q_{new} \geq q_{new}^{\min}$$

The return of filling a vacancy is the expected performance of firms with the new director. Then, we can redefine $V_f^{new}$ by

$$V_f^{new}(q_{new}) = \frac{(1+\gamma)E[\pi(q_{new})]}{\gamma},\ q_{new} \geq q_{new}^{\min} \tag{5}$$

The value of not filling a vacancy is given by

$$V_f^s(\overline{q_s}) = E[\pi(\overline{q_s})] + \frac{1}{1+\gamma}\left\{\vartheta V_f^{new}(q_{new}) + (1-\vartheta)V_f^s(\overline{q_s})\right\} \tag{6}$$

where $\vartheta$[6] denotes the arrival rate of potential candidates who try to find an outside director position satisfying the minimum quality level required by firm. $\overline{q_s}$ represents the average quality level of boards when the firm does not fill a vacancy. Rearranging equation (6), we can get

$$V_f^s(\overline{q_s}) = \frac{(1+\gamma)E[\pi(\overline{q_s})] + \vartheta V_f^{new}(q_{new})}{\gamma + \vartheta}$$

### 3.3 The performance of firms

Here, I will derive the expected performance of firm. Based on Weisbach and Hermalin (1998), Holmstrom (1999) and Hermalin (2005) I set up the timing for the following. At the first stage, a firm and a potential candidate for outside directors only have the prior distribution of the quality of the incumbent CEO, $q^{\mu}$[7], has mean $\mu > 0$. In the second stage, the firm and outside board members would be likely to find the ture quality of the CEO, $q^{\mu}$ with the probability which is equal to the average board quality, $\overline{q_n}(or\ \overline{q_s})$. Otherwise, the firm and outside board members learn nothing. If the firm chooses a new outside director with quality level, $q_{new}$, then the firm can find the true quality with probability

$$\overline{q_n} = \frac{(n-1)\overline{q_s} + q_{new}}{n}, \tag{7}$$

but the firm learn nothing about the incumbent CEO with probability $1 - \overline{q_n}$. Finally, the firm decides whether to fire the CEO or not based on the true quality $q^u$ or the prior expectation for the quality of the CEO and then the performance of the firm is realized. This three-stage process is iterated at each period because the quality of CEO is specific to the project implemented at each period and both the firm and outside board members are uncertain about it. Since I focus on the steady-state path there is no dynamic change in the parameters. The quality of potentially replaced CEO is randomly distributed with

[6] Note that $\vartheta$ is endogenously determined. I will discuss about this later on.

[7] This assumption implies that it is uncertain that the CEO's (general) skill would be well matched with the firm-specific project and environment.

mean $0 < \mu$.[8]

As I assumed before, both the firm and outside board members know that the CEO's ability is drawn from a distribution with mean $\mu$ at the first stage, which is the prior expectation of the CEO's quality. If the firm and outside board members find the true quality for the quality of incumbent CEO with probability $\overline{q_n}(or\ \overline{q_s})$, the incumbent CEO is fired if

$$q^{\mu} < 0$$

It is clear that when the firm finds nothing, the incumbent CEO is retained.

### 3.3.1 CEO quality and Board quality

**Case 1: Complement** Now, I will derive the expected performance of firm which depends on the quality of CEO and outside directors. I assume the symmetric complementarities (Becker (1981) and Becker (1993)) between the CEO quality and board quality. Based on Murphy and Zabojnik (2004) and Gabaix and Landier (2007), the expected performance (profit) of firm when a vacancy is filled by a new outside director is given by

$$E[\pi(q^k, \overline{q_n})] = \underbrace{S^{\sigma}\left(E[q^k] * \overline{q_n}\right)}_{revenue} - \underbrace{W_{CEO} - nW_{BOARD}}_{\cos t}, k = u \text{ or } r \tag{8}$$

where $S$ denotes the value/size of the firms[9], $0 < \sigma < 1$. Similarly, the expected performance of firm when a vacancy is not filled

$$E[\pi(q^k, \overline{q_s})] = S^{\sigma}\left(E[q^k] * \overline{q_s}\right) - W_{CEO} - (n-1)W_{board}, k = u \text{ or } r$$

I assume that the expected performance of firm , $E[\pi(q^k, \overline{q_n})]$, mainly depends on the quality of a current CEO in firm, $q^u$, or the quality of a replaced CEO in firm, $q^r = 0$, multiplied by the advising role of outside directors on boards. The expected performance of a firm when a vacancy is filled by a new outside director is defined by

$$\begin{aligned} E[\pi(q^k, \overline{q_n})] &= S^{\sigma}\left(E[q^k] * \overline{q_n}\right) - W_{CEO} - nW_{board} \\ &= \overline{q_n} * S^{\sigma} * F(q^u) * q^u * \overline{q_n} + (1 - \overline{q_n}) * S^{\sigma} * \mu * \overline{q_n} \\ &\quad -W_{CEO} - nW_{board} \end{aligned}$$

where the second line on the right-hand side represents the expected revenue of the firm when the firms find the true quality and the third line represent the expected revenue

[8] This assumption guarantees that a incumbent CEO will not be fired when the firm does not get any information.

[9] This set-up reflects the "Size-Skill Complementarity". See Gabaix and Landier (2007) for more details.

when the firms find nothing. $\overline{q_n}$ is the average quality of outside directors on boards. $F(q^u)$ is the retaining probability of the incumbent CEO. We can easily find $E[\pi(q^k, \overline{q_s})]$ by similar method. Finally, we can get $E[\pi(q^k, \overline{q_i})]$ by [10]

$$E[\pi(q^k, \overline{q_i})] = \Omega \overline{q_i}^2 + S^\sigma \mu \overline{q_i} - W_{CEO} - n(\text{or } n-1) W_{BOARD}, i = n \text{ or } s \tag{9}$$

where

$$\Omega(\mu, S) = S^\sigma \left[F(q^u) q^u - \mu\right] < 0$$

Here, I assume that $q^u < \frac{\mu}{F(q^u)}$. Otherwise, there is no firing because the ture quality of the incumbent CEO is always greater than the prior expectation of the potentially replaced CEO.

**Case 2: Substitute** Let me suppose that CEO quality and Board quality are substitutes[11]. By adopting the production function originally introduced by Sah and Stiglitz (1986), the expected performance of firm, $E[\pi(q^k, \overline{q_n})]$, is given by

$$\begin{aligned} E[\pi(q_c^k, \overline{q_i})] &= \overline{q_i} * F(q^u) * S^\sigma \left[a - (q^u_{\max} - q^u)(1 - \overline{q_i})\right] \\ &\quad + (1 - \overline{q_i}) * S^\sigma \left[c - (u_{\max} - u)(1 - \overline{q_i})\right] \\ &\quad - W_{CEO} - n(\text{or } n-1) W_{BOARD}, i = n \text{ or } s \end{aligned} \tag{10}$$

where $a$ and $c$ are given constant. $q^u_{\max}$ and $u_{\max}$ represent the maximum value of the true quality of the incumbent CEO and the maximum of the mean of the prior expectation for the incumbent CEO's talent, respectively.

### 3.3.2 The implications for the board compensations

**Case 1: Complement** The compensation to each board member is assumed to be equal to the marginal productivity of the average board quality by

$$W_{BOARD} = \frac{2\Omega(\mu, S)\overline{q_i} + S^\sigma \mu}{n \ (or \ n-1)}, \tag{11}$$

The marginal productivity of the board quality by the monitoring is expressed by $\Omega(\mu, S)\overline{q_i}$, which represents the expected gain from the perfect information for the incumbent CEO minus the expected gain from the prior information. The marginal productivity by the advising is given by

$$\Omega(\mu, S)\overline{q_i} + S^\sigma \mu > 0$$

[10] You can find the similar setting in Hermalin (2005).

[11] Eric Rasmusen points out that CEO quality and board quality can be substitutes in a sense that the good CEO can dominate the decision-making or the decision of CEO can be overriden by the good board.

**Proposition 1** *(1) The compensation for directors increases in the value/size of firms. (2) The compensation for directors increases in the prior expectaion for the quality of incumbent CEOs if the average board quality is less than 1/2.*

**Proof.** See in Appendix ■

It is straightforward that the high value/size of firm makes the role of monitoirng and advising on boards more valuable. The increase in the prior expectation for the incumbent CEO talent ($\mu$) makes the quality of board less important in terms of the monitoring. Simply, we can interpret the marginal productivity of monitoring as the expected revenue (gain) from finding the true quality minus the expected revenue (gain) from finding nothing. From the view point of the monitoring, the increase in the expected talent of the incumbent CEO makes the board less important, but the marginal productivity of advising goes up when the expected talent of the incumbent CEO increases. Here, the point is that the increase in the marginal productivity of advising diminishes when the board quality rises. Conclusively, the marginal productivity of board quality increases when the average board quality is less than 1/2.

**Case 2: Substitute** In this case, the compensation to each board member is given by

$$W_{BOARD} = \frac{S^{\sigma}\left(F(q^u) * [a - (q^u_{\max} - q^u)(1-\overline{q_i})] - [c - (u_{\max} - u)(1-\overline{q_i})]\right)}{n \ (or \ n-1)} + \frac{S^{\sigma}\overline{q_i}F(q^u)(q^u_{\max} - q^u) + S^{\sigma}(1-\overline{q_i})(u_{\max} - u)}{n \ (or \ n-1)} \quad (12)$$

**Proposition 2** *(1) The compensation for directors increases in the value/size of firms. (2) The compensation for directors decreases in the prior expectaion for the quality of incumbent CEOs.*

**Proof.** Omitted ■

It is also straightforward that the high value/size of firm makes the role of monitoirng and advising on boards more valuable. Be careful that the advising role becomes less important when the prior expectation for the CEO quality rises. Since we assume that the good CEO can dominate the decision making or the CEO's decision can be overridden by the board, the highly talented CEO can make the board less important even in terms of advising.

### 3.3.3 The implications for the CEO compensations

**Case 1: Complement** Here, we can have two different implications for the effect of board quality on the incumbent CEO's compensations. The above executive compens-

ations ($W_{CEO}$) is composed of two parts, given by

$$W_{CEO} = W^u_{CEO} + W^r_{CEO}$$

$W^u_{CEO}$ is the compensation level of the incumbent CEO[12], and $W^r_{CEO}$ denotes the wage level of the potentially replace CEO. Here, I only focus on the wage level of the incumbent CEO. Suppose that given the board quality, the wage of the incumbent CEO ($W^u_{CEO}$) is equal to the expected marginal productivity of the incumbent CEO's quality when he is not fired, denoted by

$$W^u_{CEO} = -S^\sigma \overline{q_i}^2 + S^\sigma \overline{q_i} \tag{13}$$

Then, the good quality boards pay more to the incumbent CEO if the average board quality is higher than 1/2. It implies that when the effect of the advsing is high enough, the marginal productivity of the incumbent CEO increases with respect to the board quality.

**Case 2: Substitute** From the equation (10), ($W^u_{CEO}$) is given by

$$W^u_{CEO} = (1 - \overline{q_i})^2 * S^\sigma \tag{14}$$

Then, the good quality boards pay less to the incumbent CEO. First of all, when the board quality increases, the probability of the incumbent CEO's firing increases. Second, the good board makes the CEO less valuable because the good board can dominate the decision.

In a totally different angle, we can predict that the high quality boards make the firms pay more to incumbent CEOs based on Hermalin (2005)[13]. He assumes that a CEO will accept the wage level, $W^u_{CEO}$ , if his expected utility is greater than some reservation utility, $\overline{U}$. He also assumes that if a CEO will not be fired, he enjoys some additional benefits, $b$. Then, he accepts $W^u_{CEO}$ only if

$$W^u_{CEO} + b\left\{\overline{q_i}F(q^u) + (1 - \overline{q_i})\right\} \geq \overline{U}$$

Under the assumptions that the above constraint is binding, the CEO compensation is given by

$$W^u_{CEO} = \overline{U} - b\left\{\overline{q_i}F(q^u) + (1 - \overline{q_i})\right\}$$

Then, $\frac{\partial W^u_{CEO}}{\partial \overline{q_i}} > 0$, which implies that the CEO compensations increase in the board quality.

[12] I assume that $W^u_{CEO}$ is given to the incumbent CEO before finding a good information or bad information.

[13] See Hermalin (2005), page 2369.

### 3.4 The cutoff quality of searching

Now, I will derive the endogenous cutoff quality level of searching an outside director position, denoted by $q_{new}^{cut}$. To that purpose, I solve the following equation which characterizes the cutoff level

$$B(q_{new}^{cut}) = W_{BOARD} + \eta E[\pi(q_c^k, q_{new}^{cut})] = \lambda q_{new}^{cut} + \zeta = C(q_{new}^{cut}), \tag{15}$$

$$\frac{\partial B(q_{new}^{cut})}{\partial q_{new}^{cut}} > 0, \ \frac{\partial C(q_{new}^{cut})}{\partial q_{new}^{cut}} > 0$$

For the simplicity, I supress the cost part of $E[\pi(q_c^k, q_{new}^{cut})]$ in the equation (9)[14] and assume that $\eta = 1$. The left side represents the benefit of outside directorship and the right side of the cost of outside directorship. The cutoff level is determined to equate above equation.

**Proposition 3** *Under some restrictions for the parameters, there exist a unique cutoff quality level which guarantees that the potential candidates with $q_{new} \leq q_{new}^{cut}$ are likely to contact. Then, (1) the cutoff quality level increases in the value/size of the firms in the both "complement" and "substitute" case. (2) The cutoff quality level increases in the prior expectation for the quality of incumbent CEOs if the average board quality is less than $\frac{(n-2)+\sqrt{n^2+4}}{2n}$ in the "complement" case and less than $\frac{n-2}{n}$ in the "substitute" case.*

**Proof.** See in Appendix. ■

The driving force behind the increase in the cutoff quality level is straightforward. As shown above, the potential candidates maximize the money value plus the reputation value generated by outside directors, given by

$$\underbrace{W_{BOARD}}_{\text{the money value}} + \underbrace{E[\pi(q_c^k, q_{new}^{cut})]}_{\text{the reputation value}} = 2\Omega(\mu, S)\overline{q_i} + S^\sigma \mu + \eta\left(\Omega\overline{q_i}^2 + S^\sigma \mu \overline{q_i}\right)$$

The marginal productivity of average board quality, increases in the value of firms ($S$). The logic behind this is for the following. Gabaix and Landier (2007) assume that the managerial impact of CEO increases when the resource under his control increases. In line with this notion, the effect of the board becomes large in the large firm due to the increase in the impact of monitoring and advising. Henceforth, both the money value and the reputation value increases, which makes the board position more attractive. The increase in the prior expectation for the quality of incumbent CEOs makes board positions more valueable. Intuitively, when the expected talent of the incumbent CEO is good, the monitoring becomes less useless. However, the impact of the advising becomes more important due to the complementarity between the quality of the CEO and board of directors. If the board quality is low enough, the increased gain in the advising outweighs the increased loss in the monitoring.

[14] Whether supressing the cost part or not does not affect the prediction of this model.

### 3.5 The minimum quality level

The minimum quality level for a new outside director required by the firm is endogenously determined to equate the following equation[15].

$$C(q_{new}^{\min}) : E[\pi(q_c^k, q_{new}^{\min})] = \gamma \left\{ \frac{(1+\gamma)\left\{E[\pi(q_c^k, \overline{q_s})] + \vartheta\left(\frac{E[\pi(q_c^k, q_{new}^{\min})]}{\gamma}\right)\right\}}{\gamma + \vartheta} \right\} : B(q_{new}^{\min}) \tag{16}$$

I also suppress the cost part of $E[\pi(q_c^k, q_{new}^{\min})]$ in the equation (9). The left side represents the cost of one more searching and the right side denotes the benefit of one more searching. I focus on the case that there exist a unique and interior cutoff quality level which guarantees that the potential candidates with $q_{new} \leq q_{new}^{cut}$ are likely to contact. Now, I will define the functional form of the arrival rate. For the simplicity, suppose that each candidate in $q_{new}^{\min} \leq q_{new} \leq q_{new}^{cut}$ might be equally or unequally acceptable to a subset of firms which create a vacancy. Then, the arrival rate of a potential candidate $i$ with quality, $q_{new}^i$ in $q_{new}^{\min} \leq q_{new} \leq q_{new}^{cut}$ to firm $j$ denoted by $\vartheta_{j,i}$ can be assumed to be given by

$$\vartheta_{j,i}(q_{new}^i) = \chi \psi_i h(q_{new}^i)^{16}$$

where $\psi_i$ captures the property that each candidate in $q_{new}^{\min} \leq q_{new} \leq q_{new}^{cut}$ might be equally or unequally acceptable to a subset of firms which create a vacancy[17]. $h(q_{new}^i)$ represents the density of potential candidates with quality, $q_{new}^i$. Then the aggreate arrival rate which satisfies $q_{new}^{\min} \leq q_{new} \leq q_{new}^{cut}$ is given by

$$\vartheta_j = \int_{q_{new}^{\min}}^{q_{new}^{cut}} \chi \psi_i h(q_{new}^i) dq_{new}^i, \ \frac{\partial \vartheta_j}{\partial q_{new}^{cut}} > 0, \ \frac{\partial \vartheta_j}{\partial q_{new}^{\min}} < 0 \tag{17}$$

Plugging equation (17) into (16) we can get

$$\begin{aligned} & E[\pi(q_c^k, q_{new}^{\min})] \\ = \ & \gamma \left\{ \frac{(1+\gamma)\left[E[\pi(q_c^k, \overline{q_s})] + \left(\int_{q_{new}^{\min}}^{q_{new}^{cut}} \chi \psi_i h(q_{new}^i) dq_{new}^i\right)\left(\frac{E[\pi(q_c^k, q_{new}^{\min})]}{\gamma}\right)\right]}{\gamma + \int_{q_{new}^{\min}}^{q_{new}^{cut}} \chi \psi_i h(q_{new}^i) dq_{new}^i} \right\} \end{aligned} \tag{18}$$

**Proposition 4** *Under the some restrictions for parameters, there exist a unique quality level which guarantees that the firm would like to fill a vacancy with a potential candidate satisfying* $q_{new}^{\min} \leq q_{new}$. *Also, (1) the minimum quality level increases in the value/size of*

[15] See Ljungqvist and Sargent (2004), page 88.

[16] We can think that the arrival rate has a simple functional form of $\sigma \frac{u}{v}$ ($\sigma$ is constant), where $u$ is the unemployed rate and $v$ is the measure of vacancy. $\psi(q_{new}^i)$ can be interpreted as $\frac{1}{v}$.

[17] If each candidate in $q_{new}^{\min} \leq q_{new} \leq q_{new}^{cut}$ is unequally acceptable to a subset of firms which create a vacancy $\psi_i$ is the function of $q_{new}^i$. For instance, if highly qualified candidates are acceptable to a large subset of firms which create a vacancy, $\psi_i$ is decreasing in $q_{new}^i$. If each candidate in $q_{new}^{\min} \leq q_{new} \leq q_{new}^{cut}$ is equally acceptable to a subset of firms which create a vacancy $\psi_i$ can be assumed to be invariant across $q_{new}^i$.

*firms, $S$. (2) The minimum quality level increases in the prior expectation for the incumbent CEOs, $\mu$, if the average board quality is less than $\frac{(n-2)+\sqrt{n^2+4}}{2n}$ in the "complement" case and less than $\frac{n-2}{n}$ in the "substitute" case.*

**Proof.** See in Appendix ■

When the value/size of firms increases, both the cost and benefit of one more searching rise. However, the increase in the benefit outweighs the increase in the cost of benefit. Conclusively, the minimum quality level increases in the size/value of firms. More concretely, the cutoff quality level increases in the value/size of firms and this causes the minimum quality level to increase. When the cutoff level rises, the aggregate arrival rate $\vartheta_j$ increase, which implies that the firms are more likely to meet talented candidates in the future. Henceforth the firms can set up the high minimum quality level. This logic also could be applied to the increase in the prior expectation for the quality of incumbent CEOs.

### 3.6 The steady-state equilibrium quality of boards

I will focus on the case that there exist a unique and interior cutoff quality level which guarantees that the potential candidates with $q_{new} \leq q_{new}^{cut}$ would be likely to contact the firm. The matching is randomly consummated between the potential candidate in $q_{new}^{\min} \leq q_{new} \leq q_{new}^{cut}$ and the firm requiring $q_{new}^{\min}$ because all matches satisfies the following conditions:

$$V_c(q_{new}) + V_f^{new}(q_{new}) > V_c^o(q_{new}) + V_f^s(q_{new}),\ q_{new}^{\min} \leq q_{new} \leq q_{new}^{cut}$$

The equilibrium quality of a new director $q_{new}^*$ is defined by

$$q_{new}^* = \left( \int_{q_{new}^{\min}}^{q_{new}^{cut}} \Phi_{i,j}^{\Xi}(q_{new}^i) q_{new}^i dq_{new}^i \right)$$

where $\Phi_{i,j}^{\Xi}(q_{new}^i)$ represents the de-genereated probability that a potential candidate $i$ with $q_{new}^i$ in $\Xi = \{q_{new} \mid q_{new}^{\min} \leq q_{new} \leq q_{new}^{cut}\}$ firstly meets the firm $j$. Clearly, $\int_{q_{new}^{\min}}^{q_{new}^{cut}} \Phi_{i,j}^{\Xi}(q_{new}^i) dq_{new}^i = 1$. Henceforth, the equilibrium quality of boards is given by

$$\overline{q_n}^* \left( q_{new}^{cut}(\mu, S),\ q_{new}^{\min}(\mu, S) \right)$$

$$= \left\{ \frac{(n-1)\overline{q_s} + \left( \int_{q_{new}^{\min}}^{q_{new}^{cut}} \Phi_{i,j}^{\Xi}(q_{new}^i) q_{new}^i dq_{new} \right)}{n} \right\}$$

### 3.7 Comparative statics and empirical prediction

For the sake of exposition, I assume that the de-genereated probability that a potential candidate $i$ with $q_{new}^i$ in $\Xi = \{q_{new} \mid q_{new}^{\min} \leq q_{new} \leq q_{new}^{cut}\}$ firstly meets the firm $j$ has

the functional form of

$$\Phi_{i,j}^{\Xi}(q_{new}^{i}) = \left(\frac{1}{q_{new}^{cut} - q_{new}^{\min}}\right)$$

It implies that (1) the probability is invariant across the quality of directors in $\Xi = \{q_{new} \mid q_{new}^{\min} \leq q_{new} \leq q_{new}^{cut}\}$, and (2) if the pool of potential candidates satisfying $q_{new}^{\min} \leq q_{new} \leq q_{new}^{cut}$ increases, the probability that each potential candidate $i$ with $q_{new}^{i}$ in $q_{new}^{\min} \leq q_{new} \leq q_{new}^{cut}$ firstly meets the firm $j$ decreases, denoted by $\frac{\partial \Phi_{i,j}^{\Xi}}{\partial q_{new}^{\min}} > 0$, $\frac{\partial \Phi_{i,j}^{\Xi}}{\partial q_{new}^{cut}} < 0$. Then, the equilibrium quality of a new director $q_{new}^{*}$ boils down to

$$q_{new}^{*}(\mu, S) = \frac{\left\{q_{new}^{cut}(\mu, S) + q_{new}^{\min}(\mu, S)\right\}}{2}$$

and the equilibrium quality of boards boils down to

$$\overline{q_n}^{*}\left(q_{new}^{cut}(\mu, S),\ q_{new}^{\min}(\mu, S)\right)$$

$$= \frac{(n-1)\overline{q_s}}{n} + \frac{1}{n}\left(\frac{q_{new}^{cut}(\mu, S) + q_{new}^{\min}(\mu, S)}{2}\right)$$

**Proposition 5** *(1) The equilibrium quality of a new director $q_{new}^{*}$ would increase in the value/size of firm, S (2) The equilibrium quality of a new director $q_{new}^{*}$ would increase in the prior expectation for the incumbent CEOs, if the average board quality is less than $\frac{(n-2)+\sqrt{n^2+4}}{2n}$ in the "complement" case and less than $\frac{n-2}{n}$ in the "substitute" case.*

**Proof.** See in Appendix ■

We already discussed the driving force behind the increase in the cutoff quality level and minimum quality level. The equilibrium quality of a new director $q_{new}^{*}$, is determined by the random matching between $q_{new}^{\min}$ and $q_{new}^{cut}$, so it is clear that the increase in the value of firms and the prior expectation for the talent of incumbent CEOs make the boards highly qualified.

# 4 Data and empirical result

## 4.1 Proxy for quality of boards

The Board members are usually composed of firm's executives (CEO, CFO etc.,), other firms' CEOs, executives, retired CEOs, lawyers, professors and so on. In this paper, I focus on the quality of outside directors, specially ongoing CEOs and retired CEOs from other firms. When we proxy the quality of retired CEOs and current CEOs, there are two possible candidates.

The first one is the total compensations paid to them when they worked/are working as CEOs. Gabaix and Landier (2007) develop the model which shows that the best CEO goes to the largest firm in a competitive assignment market and the larger firms pay more to CEOs. Their empirical finding supports this argument. In this sense, the total

compensation level paid to them when they worked/are working as CEOs could reflect thier quality[18]. Secondly, the firm size at which they worked before retirements/are working is a good proxy for the quality. Gabaix and Landier (2007) empirically show that the firm size is the most important observable determinant of CEO compensations. Lee (2007c) analyzes directorships held by 250 CEOs who retired during 1998-2002 in the two years after retirement. He finds that the firm size (total assets) in which CEO worked before retirement is directly related to the number of outside directorships[19]. The firms prefer retired CEOs from large firms as outside board members. In this sense, we can use the firm size at which retired CEOs worked as a proxy for the quality[20].

### 4.2 Overall quality of boards: sample selection

I select 266 firms among *Fortune 500* U.S firms in 2005 year and collect board profiles of those firms in 2005 year. I collect board informations from the *Securities and Exchange Commission (SEC) filings* to search each firm's proxy statement (*filing form: DEF 14A*)[21]. I, first, classify board members into insiders and outsiders. I adopt the following classification method[22].

$$Inside\ director\ =\ current\ employee + former\ employee$$

$$Outside\ director = \ All\ other\ directors$$

The outside directors are mainly composed of other firms' ongoing CEO, retired CEO, executives, lawyer and professors. *Table 1* shows descriptive statistics for our sample.

*Table* 1

Almost half of the outside directors on boards is ongoing CEOs in other firms plus retired CEOs from other company. The boards tend to contain more retired CEOs (2.5) than

[18] In a slightly different angle, Garicano and Rossi-Hansberg (2006) show that the equilibrium wage is increasing and convex in the ability of agents in the hierarchies of firms because the top managers share their ability with a team under their control. The firms pay top managers more than proportional to their talent. So, the log value of the wage could be the better proxy for the quality of ongoing/retired CEOs.

[19] Brickley, Linck and Coles (1999) also show that the firm size in which CEOs worked before retirement well explains the number of outside directorship held by CEOs 2 years after retirement.

[20] Additionally, the accounting performance is the possible candidate. Brickley, Linck and Coles (1999) analyze directorships held by 277 CEOs who retired during 1989-1993 after they retired and show that the accounting performance (ROA and industry adjusted ROA) of CEOs during the final 4 years in office has an economically significant effect on the number of outside board seats they hold after retirement. The final one is the change in the market capitalization of firms they worked/are working as CEOs. The stock return during tenure is the another possibilty, but Eric Rasmusen provides the helpful comments about this. He said " The stock return of the old company is not good enough. If a CEO is predicted when he begins his job to be good, then his company should just have a normal market return, not above-market. An above-market return only indicates he is doing better than expected."

[21] The Investor Responsibility Research Center (IRRC) provides board and committee information. We, however, need more detailed information for board members, so I handy-collect profiles from *SEC* filings.

[22] This classification is used in Linck, Netter and Yang (2006a). Lehn, Patro and Zhao (2004) classify directors into three categories: (1) inside directors, (2) outside directors, and (3) gray directors

ongoing CEOs (1.99).

I use the CEO compensations/size of firm (market capitalization value[23]) as the proxy for the quality of boards in this paper. I find the executive compensation data for 487 ongoing/retired CEOs and the firm size (market capitalization value) of 659 ongoing/retired CEOs on boards. In case of ongoing CEOs, I use the compensation values/market capitalizations in 2004. For retired CEOs, I use the compensation values/market capitalizations one year before retirements and convert all values into 2004 year values, using the median growth rate of CEO compensations. For instance, if A directors retired in 2002, his quality is

*The quality of A director*

$=$ *(The compensation as the CEO in 2001)*

$*$*(1+The median growth rate of CEO compensations between 2001 to 2004)*

The median growth rate of executive compensations and market capitalizations are reported in *Table 2.*

*Table* 2

*Table 3* shows the descriptive statistics for the quality of boards. Here, the proxies for the quality of boards is the averaged CEO compensation levels as CEOs (See *Table 3-A*). The Wilcoxon rank-sum test shows that the quality of boards only averaged over retired CEOs on boards is significantly higher than the quality of boards averaged over ongoing CEOs on boards. *Table 3-B* also supports this finding. The mean quality of retired CEOs who work as outside directors in 2005 is significantly higher than the mean quality of ongoing CEOs on boards. The fifth and last column of *Table 3-A* provide evidence that the quality of directors on the same board is dispersed. For instance, the mean level of the ranking difference between the highest talented director and the lowest one on the same board is 226.88.

*Table* 3

### 4.3 Overall quality of boards: empirical result

Based on Proposition 5, the specification is given by

$$\overline{q_i}^* = G(S_i,\ u_i,\ \beta) + \epsilon$$

where $\overline{q_i}^*$ is the average board quality of firm $i$, $S_i$ is the value/size of firm $i$ and $u_i$ is the prior expectation for quality of the incumbent CEO in the firm $i$. The proxy for the value/size of firm is (1) the market capitalization, (2) the amount of sales, and (3) the

[23] Following Gabaix and Landier (2007), the market capitalization value is defined as the sum of market value of equity and book value of debt.

total assets. The proxy for the prior expectation for quality of the incumbent CEO is the wage paid to the incumbent CEO.

*Table 4* shows the main outcome. The dependent variable in *Table 4* is the quality of other firms' ongoing CEOs and retired CEOs as outside directors on boards which is proxied by the natural log value of the averaged compensations as CEO. The independent variables are the characteristics of firms which ongoing CEOs and retired CEOs work as board members. Overally, the talented candidates work (as outside directors) at firms which have a large amount of sales.[24] In the *Table 5*, I iterate the same regression with the different proxy for the quality, the market capitalization. The outcome is qualitatively similar as the outcome of *Table 4*.

*Table* 5

### 4.4 Quality of new board members: sample selection

The drawback of previous approach is that I do not take into account the joining year of each outside director on boards. For instance, A director joins on boards in 2005, B director in 2003, and C director in 2001. To fix this problem, I construct another data set. I download the 2001-2005 board profiles of U.S firms which have total asset values greater than $1,000 million in 2004 from The Investor Responsibility Research Center (IRRC) data base Then, I select ongoing CEOs who newly join the boards as outside directors during 1995-2005.[25]

[24] I also use the quantile regression to capture the different effect of the explanatory variables across the different quantile range of the board quality. The outcome is that (1) the sale is important, and (2) the board compensation is positively significant only in the lower-middle quantile range. The $q$th quantile regression estimator $\hat{\beta}_q$ minimizes

$$\sum_{i:y_i \geq x_i^{'}\beta}^{N} q \mid y_i - x_i^{'}\beta \mid + \sum_{i:y_i \leq x_i^{'}\beta}^{N} (1-q) \mid y_i - x_i^{'}\beta \mid$$

See Cameron and Trivedi (2004) on page 87.

[25] In the regressions, I only use the data for the newly joined directors during 200-2005 because of the data availability.

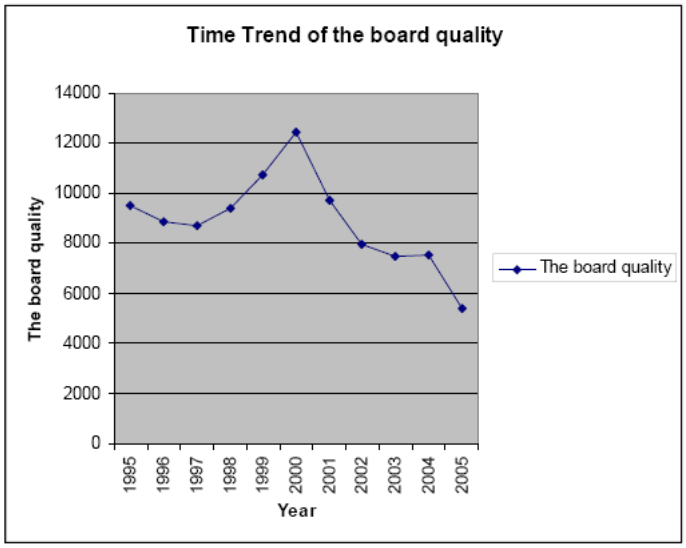


Figure 2: Time trend of the newly joined directors' quality

*Table 6/Figure 2* show the time trend of directors' quality during 1995-2005. It shows that the quality of newly joined directors had increased during 1995-2000, but it shows the break in 2001. The quality had decreased during 2001-2005.

*Table* 6

### 4.5 Quality of new board member: empirical result

Similar as before, the specification is based on Proposition 5, given by

$$q^*_{new,j} = G(S_i,\ u_i,\ \beta) + \epsilon$$

where $q^*_{new,j}$ is the quality of newly joined director $j$ on board $i$, $S_i$ is the value/size of firm $i$ and $\mu$ is the prior expectation for quality of the incumbent CEO of firm $i$.

*Table 7* provides the outcome of the regression.[26] The approach is the same as *Table 4*. In *Table 7-A and 7-B*, the dependent variable is the quality of the newly joined director $j$ on board $i$ proxied by the compensation level as CEO and the market capitalization of the CEO's original firm one year before joining the boards, respectively. Overally, the coefficients of the market capitalizations of firm $i$ is positively significant.

*Table* 7

We can interprete that the talented ongoing CEOs go to firms which have the big size to work as outside directors on boards. However, the effect of talented incumbent CEO is ambiguous. In the OLS estimations, the coefficient of the *Ln(CEO compensation)* is positively significant. However, there might be an endogeneity problem. From equation (10) and (11), we can see that the board quality might affect the CEO compensation.

[26] I do not report the outcome of 2SLS and 2SLAD, but the outcome is qualitatively similar as the outcome in *Table 4-C and 4-D*.

To test this, I use 2SLS. Based on Core and Larcker (1999), I use the dummy variable whether the CEO also takes the chariman position or not as the instrument for the CEO compensaion. I also use the tenure as the CEO. The market capitalization is still positively significant, but the effect of the incumbent CEO's talent disappears.

### 4.6 Quality vs Experience

Here, an issue could be raised. Simply, we can have two possible theories to explain the emprical evidence: (1) Ongoing and former CEO's of big companies make better directors for any company, and (2) Ongoing and former CEO's of big comanies make good directors of big companies, but not small companies[27]. The argument of this paper is the first one. In the second theory, the matching is consummated between the ongoing (former) CEOs of big company and the big company because the experience of big companies' ongoing (former) CEOs is more valued only in the big companies' boards, which implies that the driving force behind the matching is not the quality, but the experience[28]. To test this, I adopt the following strategy: I calculate the predicted board quality based on the first OLS estimation in *Table 7-A*. Then, I measure the error term by

$$Error = y - y_{predicted}$$

The high error term indicates the firms which have ongoing (former) CEOs of bigger companies as outside directors than expected. The Wilcoxon rank-sum test shows that the return on asset (ROA) of firms which are in the range of upper 75% error term is significantly higher than complements. The firms which perform well can get big firms' ongoing (former) CEOs, which provides evidence that the deriving force behind the match in the directorship market is not the experience.

[27] Eric Rasmusen enlights me that we can have two different interpretations for the outcome of regressions.

[28] Konstantin Tyurin provides fruitful comments about this. He comments that " To put it plainly, your theory makes, among other things, a testable prediction about the relationship between quality of the company board and the size of the company. So ultimately you are testing whether the size of the company where a given former (or ongoing) executive is a currently a board member is positively related to the average size of the companies where he served (is serving) as CEO in the past (now). This is exactly the matching story you're trying to explore in your theoretical part. However, the matching may have nothing (or little) to do with quality of CEOs, but rather be explained by the fact that experience accumulated as a CEO in a jumbo company would be more valuable if the same person serves on board of another jumbo company, and, conversely, experience accumulated as a CEO is a smaller-sized company would be more valuable if the same individual serves on board of another smaller-sized company upon retirement. Then you have changed the story that you're trying to test: it's nothing to do with quality but has a lot to do with finding a good match. To make an analogy with other markets (like marriage market), it's not the quality that is driving the outcome but rather the driving force is a good match. In other words, smaller-size companies' CEOs and board members may not be inferior in quality, but simply the experience accumulated in such smaller companies may be different from the experience in supersize companies. Then, it's not the quality that matters but the type of experience."

### 4.7 The board quality and CEO compensations

Here, I explore the effect of board quality on the CEO compensations. There is academic discussion about the relationship between the corporate governance (or board structure) and the CEO compensations. Core and Larcker (1999) suggest that the firms with weak board sturctures pay more to CEOs. Bebchuk and Fried (2003) argue that the current increase in the CEO compensations can be explained by the increase in managerial entrenchment. Conversely, Hermalin (2005) suggests that the increase in CEO pay is due to the tighter corporate governance. Gabaix and Landier (2007) provide evidence that the rise in CEO pay is partly due to the weak corporate governance, but the effect is relatively small.

First, I run the regression of the CEO compensations on the size, performances, and the board structures of firms. Based on the equations (13) and (14), the basic specification is

$$\ln(W_{CEO,i}) = \alpha_1 \ln(S_i) + \alpha_2 \ln(u_i) + \alpha_3 \ln(\overline{q}_i) + \epsilon$$

where $W_{CEO,i}$ denotes the CEO compensation of firm $i$, $S_i$ is the value/size of firm $i$, $u_i$ is the prior expectation for the incumbent CEO's quality of firm $i$, and $\overline{q}_i$ denotes the average board quality of firms $i$.

*Table* 8

*Table 8* provides OLS estimations to focus on the relationships between the CEO pay and board quality. Previously, I measure the average board quality of approximately 200 U.S firms in 2005, which is proxied by the compensation levels. Here, I use it as the explanatory variable. The dependent varible is the CEO compensations (*TDC 1* on Compustat data base) in 2005 and other explanatory variables are the 2004 year values except the quality of boards, the tenure as a CEO, and other board structures. The coefficient on the quality of boards is positively significant, which implies that the strong boards pay more to CEOs.

There might be an endogeneity problem, again. The CEO compensation might have an effect on the board quality. To test this, I design the following simultanuous equations:

$$\ln(W_{CEO,i,2005}) = \alpha_1 \ln(X_{i,2004}) + \alpha_2 I_{2004} + \alpha_3 \ln(Z_{i,2005}) + \alpha_4 \overline{q}^*_{i,2005} + \epsilon$$

$$\overline{q}^*_{i,2005} = \beta_1 \ln(X_{i,2004}) + \beta_2 \ln(Y_{i,2004}) + \beta_2 \ln(W_{CEO,i,2005}) + \varepsilon$$

where $W_{CEO,i,2005}$ denotes the CEO compensation of firm $i$ in 2005 and $\overline{q}^*_{i,2005}$ is the board quality of firm $i$ in 2005. $X_{i,2004}$ includes the market capitalization, total assets, and total sales. $I_{2004}$ is the ROA, market-to-book ratio, and the long-term debt divided by the total assets. $Z_{i,2005}$ is the tenure as a CEO, and other board structures. $Y_{i,2004}$ is the compensation for directors. The outcome of 2SLS is also reported in *Table 8*. The instrument for the board quality is the board compensation, $Y_{i,2004}$. It shows that the board quality does not affect the CEO compensation, but "Durbin-Wu-Hausman" test shows that OLS estimator is not hurt by the endogeneity.

### 4.8 The director compensations

Based on Proposition 1, I now regress the board compensations on the characterstics of firms. In the "complement" case, the board compensations are given by

$$W_{BOARD} = \frac{2\Omega(\mu, S)\overline{q_i} + S^{\sigma}\mu}{n \ (or \ n-1)}$$

and in the "substitute" case, the board compensations are given by

$$\begin{aligned} W_{BOARD} &= \frac{S^{\sigma}\left(F(q^u) * [a - (q^u_{\max} - q^u)(1-\overline{q_i})] - [c - (u_{\max} - u)(1-\overline{q_i})]\right)}{n \ (or \ n-1)} \\ &+ \frac{S^{\sigma}\overline{q_i}F(q^u)(q^u_{\max} - q^u) + S^{\sigma}(1-\overline{q_i})(u_{\max} - u)}{n \ (or \ n-1)} \end{aligned}$$

If follows that the basic empirical estimation is

$$\ln(W_{BOARD,i}) = \phi_1 \ln(S_i) + \phi_2 \ln(\mu_i) + \varepsilon$$

where $W_{BOARD,i}$ represents the board compensation of firm $i$, $S_i$ is the value/size of firm $i$ and $\mu_i$ is the prior expectation for the incumbent CEO in the firm $i$. I download the board compensations data of U.S firms which have total asset values greater than \$5, 000 million in 2005. The board compensations are the annual director fees in 2005 (\$ thousand). All characteristics of firms are 2004 year values.

*Table* 9

*Table 9* shows the descriptive statistics[29] and the distribution of board compensations[30].

*Table* 10

*Table 10* provides OLS and quantile estimation results. Overall, the firms which have a large amount of sales and which have the good CEO pay more to board members. When the amount of sale increases by 1%, the board compensations increases by 0.66%. However, the effect of sale is diminishing.

[29] You can find another statistics for the board compensation in Adams (2003) and Linck, Netter and Yang (2006b).

[30] The median annual director fee per board meeting is 7.28 in \$ thousand. I calculate the annual director fee per board meeting by

$$\frac{\text{Median annual director fee}}{\text{Median number of board meeting}}.$$

The median number of board meeting is based on Linck, Netter and Yang (2006b). For the comparison, the median total cash compensation of CEO per day is 9.62 in \$ thousand which is calculated by

$$\frac{\text{The median total cash compensation of CEO}}{\text{working day } (\approx 250)}$$

# 5 Conclusion

I construct a searching and matching model to explain the quality of outside directors on boards as an equilibrium phenomena. I assume that the quality of the CEO and board member interact with the value/size of firms under their control. The model shows that the main determinants of board quality are the value/size of firms and the expected talent of the incumbent CEO. This model also explains two observed facts that the talented candidates (good firms) are sometimes matched to the bad (of course, not too bad) firms (candidates) and the quality of directors on the same boards is dispersed.

The empirical evidence supports the prediction of size effect. The talented ongoing CEOs and retired CEOs go to the firms which have the high market capitalization values and the large amount of sales. However, the effect of incumbent CEO's talent is ambiguous. I also find that the firms which have a large amount of sale pay more to outside directors, but the board compensation is not related with the board quality.

# References


Adams, Renee B. 2003. "What do boards do? Evidence from Board Committee and Director Compensation Data." *EFA 2005 Moscow Meetings Paper* .

Adams, Renee B. and Daniel Ferreira. 2007. "A Theory of Friendly Board." *Journal of Finance, Forthcomming* .

Bebchuk, Lucian Arye and Jesse M. Fried. 2003. "Executive Compensations as an Agency Problem." *The Journal of Economic Perspectives* 17:71–92.

Becker, Gary. 1981. *Treatise on the Family*. Cambridge: Harvard University Press.

Becker, Gary. 1993. *Human Capital*. Chicago: University of Chicago Press.

Brickley, James A., James S. Linck and Jeffrey L. Coles. 1999. "What Happens to CEOs After They Retire? New Evidence On Career Concern, Horizon Problem, and CEO Incentives." *Journal of Financial Economics* 52:341–377.

Cameron, A.C. and Pravin K. Trivedi. 2004. *Microeconometric: Methods and Applications*. Cambridge, New York: Cambridge University Press.

Colley, John L., Jacqueline L. Doyle George W. Logan and Wallace Stettinius. 2003. *Corporate Governance*. New-York: Mcgraw-Hill.

Core, John E., Robert W. Holthasusen and David F. Larcker. 1999. "Corporate governance, CEO compensation, and firm performance." *Journal of Financial Economics* 51:371–406.

Fama, E. 1980. "Agnecy Problem and The Theory of The Firm." *Journal of Political Economics* (88):288–307.

Fama, E. and Michale Jensen. 1983. "Seperation of Ownership and Control." *Journal of Law and Economics* (26):301–325.

Ferris, S. P, M. Jagannathan and A. C. Pritchard. 2003. "Too Busy to Mind the Business? Monitoring by Directors with Multiple Board Appointment." *Journal of Finance* (58):1087–1111.

Gabaix, Xavier and Augustin Landier. 2007. "Why Has CEO Pay Increased So Much?" *Journal of Political Economy, Forthcomming* .

Garicano, Luis and Esteban Rossi-Hansberg. 2006. "Organization and Inequality in a Knowledge Economy." *Quarterly Journal of Economics* pp. 1383–1435.

Gilson, S. 1990. "Bankruptcy, Boards, Banks, and Blockholders: Evidence on Change in Corporate Ownership When Firm Default." *Journal of Financial Economics* 27:355–387.

Hambrick, Donald C and Eric M. Johnson. 2000. "Outsider directors with a stake: The Linchpin in improving governance." *California Management Review* 42:108–127.

Hermalin, Benjamin E. 2005. "Trends in Corporate Governance." *Journal of Finance* pp. 2351–2384.

Holmstrom, Bengt. 1999. "Managerial Incentive Problem: A dynammic Perspective." *Review of Economic Studies* 66:169–182.

Kaplan, Steven N. and David Reishus. 1990. "Outside Directorships and Corporate Performance." *Journal of Financial Economics* 27(2):389–410.

Keys, P. and J. Li. 2004. "Evidence on the Market for Professional Directors." *Journal of Financial Research* .

Lee, Changmin. 2007c. "What's happened over the past 10 years to the selection of retired CEOs as board members?" *CAEPR Working Paper* available at SSRN: http://ssrn.com/abstract=988162(2007-007).

Lehn, Kenneth, Sukesh Patro and Mengxin Zhao. 2004. "Determinant of the size and structure of corporate boards:1935-2000." *Working Paper* .

Li, J. 1997. "Board of Directors in the Context of Corporate Governance: Two Essays." *Ph.D. Thesis, Florida State University* .

Linck, James S., Jeffry M. Netter and Tina Yang. 2006a. "The Determinant of Board Structure." *Working paper* .

Linck, James S., Jeffry M. Netter and Tina Yang. 2006b. "Effects and Unintended Consequences of the Sarbanes-Oxley Act on Corporate Boards." *AFA 2006 Boston Meetings Paper* .

Ljungqvist, Lars and Thomas J. Sargent. 2004. *Recursive Macroeconomic Theory.* second ed. The MIT Press.

Murphy, Kevin and Jan Zabojnik. 2004. "CEO Pay and Appointment: A Market-Based Explanation for Recent Trends." *American Economic Review Papers and Proceedings* 94(2):192–196.

Pissarides, Christopher A. 2000. *Equilibrium Unemployment Theory.* Cambridge, Massachusetts: MIT press.

Raheja, Charu G. 2005. "Determinants of board size and composition." *Journal of Financial and Quantitative Analysis* 40:283–306.

Sah, Raaj and Joseph Stiglitz. 1986. "The Architecture of Economic Systems: Hierarchies and Polyarchies." *American Economic Review* 76:716–727.

Weisbach, Michale and B. Hermalin. 1998. "Endogenously Chosen Boards of Directors and Their Monitoring of Management." *American Economic Review* 88:96–118.

# 6 Appendix

**Proof.** of the proposition 1: Taking derivative the compensation of the board with respect to the size of the firm, we can get

$$\begin{aligned}\frac{\partial W_{BOARD}}{\partial S} &= \frac{\partial\left(2S^{\sigma}\left[F(q^{u})q^{u}-\mu\right]\overline{q_{i}}+S^{\sigma}\mu\right)}{\partial S}\\ &= \frac{\partial\left(S^{\sigma}\left(2\left[F(q^{u})q^{u}-\mu\right]\overline{q_{i}}+\mu\right)\right)}{\partial S}\end{aligned}$$

Since we assume that $\overline{q_i} < \frac{-\mu}{2(F(q^u)q^u-\mu)}$, $\frac{\partial W_{BOARD}}{\partial S} > 0$. When we take derivative the compensation of the board with respect to the prior expectation of the incumbent CEO, it is given by

$$\begin{aligned}\frac{\partial W_{BOARD}}{\partial \mu} &= \frac{\partial\left(2S^{\sigma}\left[F(q^{u})q^{u}-\mu\right]\overline{q_{i}}+S^{\sigma}\mu\right)}{\partial \mu}\\ &= \frac{\partial\left(S^{\sigma}\left(2\left[F(q^{u})q^{u}-\mu\right]\overline{q_{i}}+\mu\right)\right)}{\partial \mu} = S^{\sigma}\left(-2\overline{q_{i}}+1\right)\end{aligned}$$

Thus, if $\overline{q_i} < \frac{1}{2}$,then the board compensation increases in the prior expectation of the incumbent CEO. ■

**Proof.** of Proposition 3: Rewritting the benefit and cost of the outside directorships by

$$B(q_{new}^{cut}) = W_{BOARD} + \eta E[\pi(q_c^k, q_{new}^{cut})]$$

and

$$C(q_{new}^{cut}) = \lambda q_{new}^{cut} + \zeta$$

Since$\frac{\partial B(q_{new}^{cut})}{\partial q_{new}^{cut}} > 0$, $\frac{\partial^2 B(q_{new}^{cut})}{\partial q_{new}^{cut}\partial q_{new}^{cut}} < 0$, and $\frac{\partial C(q_{new}^{cut})}{\partial q_{new}^{cut}} > 0$, there exist a unique cutoff quality level which guarantees that the potential candidates with $q_{new} \leq q_{new}^{cut}$ are likely to contact if $\frac{\alpha_{CEO}S^{\sigma}\mu}{n\ (or\ n-1)} > \zeta$ and $\frac{2\Omega(\mu,S)+\alpha_{CEO}S^{\sigma}\mu}{n\ (or\ n-1)} + \eta(\Omega + \alpha_{CEO}S^{\sigma}\mu) < \lambda + \zeta$. Taking the partial derivative of the benefic and cost of the outside directorships with respect to the size of the firm in the "complement case", we can get

$$\frac{\partial B(q_{new}^{cut})}{\partial S} = \frac{\partial W_{BOARD}}{\partial S} + \frac{\Omega\overline{q_i}^2 + \alpha_{CEO}S^{\sigma}\mu\overline{q_i}}{\partial S}$$

and

$$\frac{\partial C(q_{new}^{cut})}{\partial S} = 0$$

Replacing $W_{BOARD}$ by the equations (7) or (10), it can be easily shown that $\frac{\partial B(q_{new}^{cut})}{\partial S} > 0$,

which implies that $\frac{\partial q_{new}^{cut}}{\partial S} > 0$. Similarly, we can find that $\frac{\partial q_{new}^{cut}(\mu,S)}{\partial \mu} > 0$ if

$$\overline{q_i} < \frac{(n-2)+\sqrt{n^2+4}}{2n}$$

By similar method, it can be easily shown that $\frac{\partial q_{new}^{cut}}{\partial S} > 0$ and $\frac{\partial q_{new}^{cut}(\mu,S)}{\partial \mu} > 0$ if

$$\overline{q_i} < \frac{n-2}{n}$$

■

**Proof.** of Proposition 4: The left-hand side of the equation (16) is the cost of one more searching. It can be easily shown that

$$\frac{\partial E[\pi(q_c^k, q_{new}^{\min})]}{\partial q_{new}^{\min}} > 0$$

The right-hand side represents the benefit of one more searching. For simplicity, let $\vartheta_j(q_{new}^{cut}, q_{new}^{\min}) = \int_{q_{new}^{\min}}^{q_{new}^{cut}} \chi\psi_i h(q_{new}^i) dq_{new}^i$.Taking the derivative with respect to $q_{new}^{\min}$

$$\begin{aligned}
\frac{\partial B(q_{new}^{\min})}{\partial q_{new}^{\min}} &= \gamma(1+\gamma)\left\{\frac{\left(\frac{\partial \vartheta_j(q_{new}^{cut},q_{new}^{\min})}{\partial q_{new}^{\min}}\right)\left(\frac{E[\pi(q_c^k,q_{new}^{\min})]}{\gamma}\right)\left(\gamma+\vartheta_j(q_{new}^{cut},q_{new}^{\min})\right)}{\left(\gamma+\vartheta_j(q_{new}^{cut},q_{new}^{\min})\right)^2}\right\} \\
&\quad +\gamma(1+\gamma)\left\{\frac{\frac{1}{\gamma}\vartheta_j(q_{new}^{cut},q_{new}^{\min})\left(\frac{\partial E[\pi(q_c^k,q_{new}^{\min})]}{\partial q_{new}^{\min}}\right)\left(\gamma+\vartheta_j(q_{new}^{cut},q_{new}^{\min})\right)}{\left(\gamma+\vartheta_j(q_{new}^{cut},q_{new}^{\min})\right)^2}\right\} \\
&\quad -\gamma(1+\gamma)\left\{\frac{\left\{E[\pi(q_c^k,\overline{q_s})]+\vartheta_j(q_{new}^{cut},q_{new}^{\min})\left(\frac{E[\pi(q_c^k,q_{new}^{\min})]}{\gamma}\right)\right\}\frac{\partial \vartheta_j(q_{new}^{cut},q_{new}^{\min})}{\partial q_{new}^{\min}}}{\left(\gamma+\vartheta_j(q_{new}^{cut},q_{new}^{\min})\right)^2}\right\}
\end{aligned}$$

Rearranging above equation,

$$\begin{aligned}
\frac{\partial B(q_{new}^{\min})}{\partial q_{new}^{\min}} &= \gamma(1+\gamma)\left\{\frac{\frac{\partial \vartheta_j(q_{new}^{cut},q_{new}^{\min})}{\partial q_{new}^{\min}}\left(E[\pi(q_c^k,q_{new}^{\min})]-E[\pi(q_c^k,\overline{q_s})]\right)}{\left(\gamma+\vartheta_j(q_{new}^{cut},q_{new}^{\min})\right)^2}\right\} \\
&\quad +\gamma(1+\gamma)\left\{\frac{(\frac{1}{\gamma})\vartheta_j(q_{new}^{cut},q_{new}^{\min})\left(\frac{\partial E[\pi(q_c^k,q_{new}^{\min})]}{\partial q_{new}^{\min}}\right)\left(\gamma+\vartheta_j(q_{new}^{cut},q_{new}^{\min})\right)}{\left(\gamma+\vartheta_j(q_{new}^{cut},q_{new}^{\min})\right)^2}\right\} < 0 \text{ if } q_{new}^{\min} \geq \overline{q_s}
\end{aligned}$$

It is straightforward that $C(\overline{q_s}) < B(\overline{q_s})$. So, if $C(q_{new}^{cut}) \geq B(q_{new}^{cut})$, there exist a unique minimum quality level which guarantees that the firm would like to fill a vacancy with a potential candidate satisfying $q_{new}^{\min} \leq q_{new} \leq q_{new}^{cut}$. Next, we consider the effect of the firm value/size on the minimum quality level. Let me revist the equation (16). Taking

the total derivative of $C(q_{new}^{\min})$ and $B(q_{new}^{\min})$ with respect to the firm value, $S$

$$\frac{dC(q_{new}^{\min})}{dS} = \frac{\partial E[\pi(q_c^k, q_{new}^{\min})]}{\partial q_{new}^{\min}} \left( \frac{dq_{new}^{\min}}{dS} \right) + \frac{\partial E[\pi(q_c^k, q_{new}^{\min})]}{\partial S}$$

and

$$\begin{aligned}
\frac{dB(q_{new}^{\min})}{dS} &= \gamma(1+\gamma) \left\{ \frac{\frac{\partial E[\pi(q_c^k, \overline{q_s})]}{\partial S} \left( \gamma + \vartheta_j(q_{new}^{cut}, q_{new}^{\min}) \right)}{\left( \gamma + \vartheta_j(q_{new}^{cut}, q_{new}^{\min}) \right)^2} \right\} \\
&\quad + \gamma(1+\gamma) \left\{ \frac{\frac{\partial \vartheta_j(q_{new}^{cut}, q_{new}^{\min})}{\partial S} \left( E[\pi(q_c^k, q_{new}^{\min})] - E[\pi(q_c^k, \overline{q_s})] \right)}{\left( \gamma + \vartheta_j(q_{new}^{cut}, q_{new}^{\min}) \right)^2} \right\} \\
&\quad - \gamma(1+\gamma) \left\{ \frac{(\frac{1}{\gamma}) \vartheta_j(q_{new}^{cut}, q_{new}^{\min}) \left( \frac{\partial E[\pi(q_c^k, q_{new}^{\min})]}{\partial S} \right) \left( \gamma + \vartheta_j(q_{new}^{cut}, q_{new}^{\min}) \right)}{\left( \gamma + \vartheta_j(q_{new}^{cut}, q_{new}^{\min}) \right)^2} \right\}
\end{aligned}$$

At the minimum quality level, $B(q_{new}^{\min}) \equiv C(q_{new}^{\min})$. Then,

$$\begin{aligned}
&\frac{dC(q_{new}^{\min})}{dS} - \frac{dB(q_{new}^{\min})}{dS} \\
&= \frac{\partial E[\pi(q_c^k, q_{new}^{\min})]}{\partial q_{new}^{\min}} \left( \frac{dq_{new}^{\min}}{dS} \right) + \frac{\partial E[\pi(q_c^k, q_{new}^{\min})]}{\partial S} - \gamma(1+\gamma) \left\{ \frac{\frac{\partial E[\pi(q_c^k, \overline{q_s})]}{\partial S} \left( \gamma + \vartheta_j(q_{new}^{cut}, q_{new}^{\min}) \right)}{\left( \gamma + \vartheta_j(q_{new}^{cut}, q_{new}^{\min}) \right)^2} \right\} \\
&\quad - \gamma(1+\gamma) \left\{ \frac{\frac{d\vartheta_j(q_{new}^{cut}, q_{new}^{\min})}{dS} \left( E[\pi(q_c^k, q_{new}^{\min})] - E[\pi(q_c^k, \overline{q_s})] \right)}{\left( \gamma + \vartheta_j(q_{new}^{cut}, q_{new}^{\min}) \right)^2} \right\} \\
&\quad + \gamma(1+\gamma) \left\{ \frac{(\frac{1}{\gamma}) \vartheta_j(q_{new}^{cut}, q_{new}^{\min}) \left( \frac{dE[\pi(q_c^k, q_{new}^{\min})]}{dS} \right) \left( \gamma + \vartheta_j(q_{new}^{cut}, q_{new}^{\min}) \right)}{\left( \gamma + \vartheta_j(q_{new}^{cut}, q_{new}^{\min}) \right)^2} \right\} = 0
\end{aligned}$$

Rearranging above equation (and simplifying notations),

$$\begin{aligned}
\frac{dC}{dS} - \frac{dB}{dS} &= \frac{\frac{dE[\pi(q_{new}^{\min})]}{dS}(\gamma+\vartheta_j)^2 - \gamma(1+\gamma)\frac{\partial E[\pi(\overline{q_s})]}{\partial S}(\gamma+\vartheta_j)}{(\gamma+\vartheta_j)^2} \\
&\quad \frac{-\gamma(1+\gamma)\frac{\partial \vartheta_j}{\partial S}\left(E[\pi(q_{new}^{\min})] - E[\pi(\overline{q_s})]\right)}{(\gamma+\vartheta_j)^2} \\
&\quad + \frac{(1+\gamma)\vartheta_j\left(\frac{dE[\pi(q_{new}^{\min})]}{dS}\right)(\gamma+\vartheta_j)}{(\gamma+\vartheta_j)^2} \\
&= \frac{\left\{(\gamma+(2+\gamma)\vartheta_j)\frac{dE[\pi(q_{new}^{\min})]}{dS} - \gamma(1+\gamma)\frac{\partial E[\pi(\overline{q_s})]}{\partial S}\right\}(\gamma+\vartheta_j)}{(\gamma+\vartheta_j)^2} \\
&\quad \frac{-\gamma(1+\gamma)\left[\frac{\partial \vartheta_j}{\partial S}\left(E[\pi(q_{new}^{\min})] - E[\pi(\overline{q_s})]\right)\right]}{(\gamma+\vartheta_j)^2} = 0
\end{aligned}$$

Since

$$\frac{dE[\pi(q_{new}^{\min})]}{dS} = \left(\frac{\partial E[\pi(q_{new}^{\min})]}{\partial q_{new}^{\min}}\right)\left(\frac{dq_{new}^{\min}}{dS}\right) + \frac{\partial E[\pi(q_{new}^{\min})]}{\partial S}$$

and

$$\frac{d\vartheta_j}{dS} = \frac{d\int_{q_{new}^{\min}}^{q_{new}^{cut}} \chi\psi_i h(q_{new}^i) dq_{new}^i}{dS} = \frac{dq_{new}^{cut}}{dS}\chi\psi_i h(q_{new}^i) - \frac{dq_{new}^{\min}}{dS}\chi\psi_i h(q_{new}^i)$$

then,

$$\begin{aligned}
&\frac{dC}{dS} - \frac{dB}{dS} \\
&= \frac{\left\{(\gamma+(2+\gamma)\vartheta_j)\left[\left(\frac{\partial E[\pi(q_{new}^{\min})]}{\partial q_{new}^{\min}}\right)\left(\frac{dq_{new}^{\min}}{dS}\right) + \frac{\partial E[\pi(q_{new}^{\min})]}{\partial S}\right] - \gamma(1+\gamma)\frac{\partial E[\pi(\overline{q_s})]}{\partial S}\right\}(\gamma+\vartheta_j)}{(\gamma+\vartheta_j)^2} \\
&\quad \frac{-\gamma(1+\gamma)\left[\left(\frac{dq_{new}^{cut}}{dS}\chi\psi_i h(q_{new}^i) - \frac{dq_{new}^{\min}}{dS}\chi\psi_i h(q_{new}^i)\right)\left(E[\pi(q_{new}^{\min})] - E[\pi(\overline{q_s})]\right)\right]}{(\gamma+\vartheta_j)^2}
\end{aligned}$$

Finally, we can get

$$\frac{dq_{new}^{\min}}{dS}$$

$$= \frac{\gamma(1+\gamma)\left(\gamma+\vartheta_j\right)\frac{\partial E[\pi(\overline{q_s})]}{\partial S}+\gamma(1+\gamma)\left[\left(\frac{dq_{new}^{cut}}{dS}\chi\psi_i h(q_{new}^i)\right)\left(E[\pi(q_{new}^{\min})]-E[\pi(\overline{q_s})]\right)\right]}{\left[\left(\gamma+(2+\gamma)\vartheta_j\right)\left(\frac{\partial E[\pi(q_{new}^{\min})]}{\partial q_{new}^{\min}}\right)\left(\gamma+\vartheta_j\right)+\gamma(1+\gamma)\chi\psi_i h(q_{new}^i)\left(E[\pi(q_{new}^{\min})]-E[\pi(\overline{q_s})]\right)\right]}$$

$$-\frac{\left(\gamma+\vartheta_j\right)\left(\gamma+(2+\gamma)\vartheta_j\right)\frac{\partial E[\pi(q_{new}^{\min})]}{\partial S}}{\left[\left(\gamma+(2+\gamma)\vartheta_j\right)\left(\frac{\partial E[\pi(q_{new}^{\min})]}{\partial q_{new}^{\min}}\right)\left(\gamma+\vartheta_j\right)+\gamma(1+\gamma)\chi\psi_i h(q_{new}^i)\left(E[\pi(q_{new}^{\min})]-E[\pi(\overline{q_s})]\right)\right]}$$

So, if

$$\frac{dq_{new}^{cut}}{dS} > \frac{\left(\gamma+\vartheta_j\right)\left(\gamma+(2+\gamma)\vartheta_j\right)\frac{\partial E[\pi(q_{new}^{\min})]}{\partial S}-\gamma(1+\gamma)\left(\gamma+\vartheta_j\right)\frac{\partial E[\pi(\overline{q_s})]}{\partial S}}{\gamma(1+\gamma)\left[\chi\psi_i h(q_{new}^i)\left(E[\pi(q_{new}^{\min})]-E[\pi(\overline{q_s})]\right)\right]},$$

then $\frac{dq_{new}^{\min}}{dS} > 0$. In this model, I assume that the above condition is satisfied. When the value/size of firm increases, the increase in the benefit outweighs the increase in the cost of benefit. Conclusively, the minimum quality level increases in the size/value of firms. By similar method, we can conclude that the minimum quality level increases in the prior expectation for the quality of incumbent CEOs in the "complement" case if

$$\overline{q_i} < \frac{(n-2)+\sqrt{n^2+4}}{2n}$$

and the minimum quality level increases in the prior expectation for the quality of incumbent CEOs in the "substitute" case if

$$\overline{q_i} < \frac{n-2}{n}$$

■

**Proof.** of Proposition 5: Since (1) $\frac{\partial q_{new}^{cut}(\mu,S)}{\partial S} > 0$ and (2) $\frac{\partial q_{new}^{\min}(\mu,S)}{\partial S} > 0$, then

$$\frac{\partial q_{new}^{*}(\mu,S)}{\partial S} = \frac{\left\{\frac{\partial q_{new}^{cut}(\mu,S)}{\partial S}+\frac{\partial q_{new}^{\min}(\mu,S)}{\partial S}\right\}}{2} > 0$$

Similarly, Since (1) $\frac{\partial q_{new}^{cut}(\mu,S)}{\partial \mu} > 0$ and (2) $\frac{\partial q_{new}^{\min}(\mu,S)}{\partial \mu} > 0$ under the condition that

$$\overline{q_i} < \frac{(n-2)+\sqrt{n^2+4}}{2n},$$

in the "complement case" and

$$\overline{q_i} < \frac{n-2}{n}$$

in the "substitute" case, then

$$\frac{\partial q^*_{new}(\mu, S)}{\partial \mu} = \frac{\left\{ \frac{\partial q^{cut}_{new}(\mu,S)}{\partial \mu} + \frac{\partial q^{\min}_{new}(\mu,S)}{\partial \mu} \right\}}{2} > 0$$

Overally, the equalibrium quality of board member increases in the firm value and the expectation for the talent of incumbent CEOs. ■

***Table 1 Sample distribution of board composition***

- *I collect board profiles of 266 firms among Fortune 500 U.S firms in 2005 from the Securities and Exchange Commission (SEC) filings to search each firm's proxy statement (filing form: DEF 14A)*
- *Number of observation: 266 firms*
- *All value is the average value*
- *Total: Total number of directors on boards*
- *Out: Total number of outside directors*
- *Ongoing: the total number of other firm's ongoing CEO on boards. These members are qualified as outside directors*
- *Retired: the total number of CEOs who retired from other firms on boards. These members are also classified as outside directors.*
- *Ongoing plus Retired/Out(%) denotes the proportion of ongoing plus retired CEOs in the total number of outside directors on boards*
- *% is the percentage on boards.*
- *All values are mean value*

| | *Total* | *Out* | *%* | *Ongoing plus Retired* | *%* | *Ongoing plus Retired/Out(%)* | *Ongoing* | *%* | *Retired* | ***%*** |
|---|---|---|---|---|---|---|---|---|---|---|
| *Mean* | *11.23* | *9.53* | *84.59* | *4.45* | *39.72* | *46.86* | *1.98* | *17.82* | *2.46* | *21.75* |
| *Standard deviation* | *2.14* | *2.24* | *9* | *2.08* | *17.42* | *20.2* | *1.52* | *13.34* | *1.48* | *12.61* |
| *Min* | *7* | *4* | *44.44* | *0* | *0* | *0* | *0* | *0* | *0* | *0* |
| *Max* | *20* | *17* | *100* | *11* | *88.89* | *100* | *10* | *71.43* | *8* | *72.73* |

***Table 2 The growth rate of CEO compensation, market capitalization, total assets, and sale***

- *I download the CEO compensations/ other financial information of firms which have total assets greater than $ 5,000 million in 2005 from Compustat data base*
- *All values are the median growth rate*
- *The CEO compensation includes the following item: Salary, Bonus, Other Annual, Total Value of Restricted Stock Granted, Total Value of Stock Options Granted (using Black-Scholes), Long-Term Incentive Payouts, and All Other Total.*
- *The market capitalization is the sum of market value of equity and book value of debt*

| | *CEO compensation* | *Market capitalization* | *Total assets* | *Sales* | *Return on assets* | *Board compensation (Annual director fee)* |
|---|---|---|---|---|---|---|
| *2003-2004* | *0.15* | *0.11* | *0.08* | *0.1* | *0.079* | *0* |
| *2002-2004* | *0.17* | *0.29* | *0.2* | *0.19* | *0.123* | *0.16* |
| *2001-2004* | *0.11* | *0.29* | *0.29* | *0.18* | *0.186* | *0.3* |
| *2000-2004* | *0.26* | *0.37* | *0.43* | *0.23* | *-0.001* | *0.39* |
| *1999-2004* | *0.39* | *0.55* | *0.61* | *0.44* | *-0.001* | *0.47* |
| *1998-2004* | *0.7* | *0.65* | *0.87* | *0.57* | *-0.007* | *0.55* |
| *1997-2004* | *0.86* | *0.89* | *1.21* | *0.84* | *-0.05* | *0.67* |
| *1996-2004* | *1.3* | *1.54* | *1.59* | *1.51* | *-0.117* | *0.71* |
| *1995-2004* | *1.93* | *2.02* | *1.93* | *1.51* | *-0.16* | *0.79* |
| | | | | | | |

***Table 3-A Descriptive statistics for the average board quality***

- *The average quality of boards of 266 firms among Fortune 500 U.S firms in 2005*
- *All values are in $ thousand*
- *Proxy for the average board quality: the compensations as CEOs, averaged over the retired CEOs plus ongoing CEOs on the same board*
- *For the ongoing CEOs: the compensation as CEOs in 2004 year*
- *For the retired CEOs: the converted level of compensations as CEOs one year before retirement. If A director retired in 2002, his quality is measured by (compensation as CEO in 2001)*(1+the median growth rate of CEO compensation between 2001 and 2004)*
- *The Wilcoxon rank-sum test shows that the mean of "The quality of boards: retired CEOs only" is significantly higher than the mean of "The quality of boards: ongoing CEOs only" at 1% level*
- *The last column shows the ranking difference between the highest director and lowest director on the same board. I rank 487 ongoing CEOs and former CEOs by the compensation levels as CEOs.*

| | *The quality of boards* | *The quality of boards: ongoing CEOs only* | *The quality of boards: retired CEOs only* | *The maximum quality-the minimum quality on the same boards* | ***The lowest ranking-the highest ranking on the same boards*** |
|---|---|---|---|---|---|
| *Mean* | *11891.87* | *9849.937* | *14006.65**** | *15330.36* | *226.88* |
| *Standard deviation* | *10274.73* | *7270.531* | *14087.53* | *17425.04* | *114.06* |
| *Max* | *86896.84* | *39227.35* | *86896.84* | *136897.3* | *463* |
| *Min* | *382.21* | *311* | *417* | *179.79* | *4* |
| *25%* | *6470.96* | *4743.48* | *6759.23* | *5801.35* | *139* |
| *50%* | *9289.67* | *8420.43* | *10690.15* | *10487.52* | *221.5* |
| *75%* | *14248.38* | *11590.36* | *15673.35* | *20235.35* | *318* |

***Table 3-B Descriptive statistics for quality of directors***

| | *The ongoing CEOs on boards* | *The retired CEOs on boards* |
|---|---|---|
| *Number of observations* | *236* | *251* |
| *Mean* | *9683.26* | *13760.29*** |
| *Standard deviation* | *7689.18* | *16252.02* |
| | | |

***Table 4 How the average quality of boards depends on characteristics of firms***

- *Dependent variable: the quality of other firms' ongoing CEOs and retired CEOs as outside directors on board in 2005*
- *Proxy for quality: The natural log value of the CEO compensations, averaged over ongoing CEOs plus retired CEOs as outside directors on boards*
- *All independent variables are the natural log value in 2004*
- *The standard error is in parenthesis*

| | *OLS with logvalue/robust standard error* | *OLS with logvalue/robust standard error* | *OLS with logvalue/robust standard error* |
|---|---|---|---|
| *Ln(CEO compensation)* | | *.10* *( .067)* | *.116** *(.066)* |
| *Ln(Market capitalization)* | *-.03* *( .106)* | *-.051* *(.112)* | *.004* *( .131)* |
| *Ln(Total assets)* | *.051* *( .099)* | *.043* *( .10)* | *.003* *( .121)* |
| *Ln(Sale)* | *.258*** *( .082)* | *.253*** *( .083)* | *.225*** *( .084)* |
| *Ln(Anndir)* | *.156* *(.163)* | *.141* *( .164)* | *.17* *( .126)* |
| *Market to book ratio* | | | *.005* *( .009)* |
| *Long term debt/total assets* | | | *.469* *( .431)* |
| *Constant* | *5.811*** *( .697)* | *5.242*** *( .832)* | *4.994*** *( .84)* |
| *R-squared* | *0.1124* | *0.1187* | *0.1197* |
| *N* | *188* | *188* | *179* |

***Table 5 How the average quality of boards depends on characteristics of firms***

- *Dependent variable: the quality of other firms' ongoing CEOs and retired CEOs as outside directors on board in 2005*
- *Proxy for quality: The natural log value of the market capitalization, averaged over ongoing CEOs plus retired CEOs as outside directors on boards*
- *All independent variables are the natural log value in 2004*
- *The standard error is in parenthesis*

| | *OLS with logvalue/robust standard error* | *OLS with logvalue/robust standard error* | *OLS with logvalue/robust standard error* |
|---|---|---|---|
| *Ln(CEO compensation)* | | *.261*** *(.126)* | *.138* *(.137)* |
| *Ln(Market capitalization)* | *.531**** *( .227)* | *.538*** *( .225)* | *.66**** *( .243)* |
| *Ln(Total assets)* | *-.163* *(.219)* | *-.231* *( .205)* | *-.308* *( .231)* |
| *Ln(Sale)* | *.221* *( .165)* | *.193* *( .177)* | *.278* *( .17)* |
| *Ln(Anndir)* | *.226* *( .274)* | *.154* *( .233)* | *.168* *( .185)* |
| *Market to book ratio* | | | *.013* *( .012)* |
| *Long term debt/total assets* | | | *.703* *( .742)* |
| *Constant* | *3.454* *(1.347)* | *2.226* *(1.352)* | *1.696* *(1.528)* |
| *R-squared* | *0.1633* | *0.1798* | *0.1931* |
| *N* | *203* | *203* | *194* |

***Table 6 Sample distribution of newly joined outside directors***

- *I download 2001-2005 board profiles of U.S firms which have total asset values greater than $ 1,000 million in 2004 from IRRC data base*
- *I select ongoing CEOs who newly join boards as outside directors during 2000-2005*
- *Proxy for quality: total compensation level as CEOs one year before joining boards*
- *The converted quality: I convert the quality measure into 2004 year value. For instance, if A ongoing CEO joins the boards in 2001, his quality is measured by (CEO compensation in 2000)*(1+the median growth rate of CEO compensation between 2000 and 2004)*
- *All values are mean values ($ thousand)*

| *Joining year* | *N* | *The converted quality: total compensations as CEOs* |
|---|---|---|
| *1995* | *15* | *9499.27* |
| *1996* | *28* | *8872.37* |
| *1997* | *31* | *9017.83* |
| *1998* | *24* | *10761.86* |
| *1999* | *41* | *11024.35* |
| *2000* | *35* | *12455.85* |
| *2001* | *61* | *9716.44* |
| *2002* | *35* | *7487.426* |
| *2003* | *83* | *7951.995* |
| *2004* | *67* | *7507.653* |
| *2005* | *27* | *5377.355* |
| ***Total*** | *339* | *8636.49* |

***Table 7-A How the quality of newly joined director i depends on characteristics of firm j: Ongoing CEO Directors only***

- *I download 2001-2005 board profiles of U.S firms which have total asset values greater than $ 1,000 million in 2004 from IRRC data base*
- *I select ongoing CEOs who newly join boards as outside directors during 2000-2005*
- *Dependent variable: the quality of other firms' ongoing CEOs*
- *Proxy for quality: The natural log value of total compensation level as CEOs one year before joining boards*

| | *OLS with logvalue* | *OLS with logvalue* | *OLS with logvalue* |
|---|---|---|---|
| *Ln(CEO compensation)* | | *.194*** *(.084)* | *.199*** *(.087)* |
| *Ln(Market capitalization)* | *.31*** *( .129)* | *.24** *( .131)* | *.271* *(.17)* |
| *Ln(Total assets)* | *-.131* *( .111)* | *-.099* *(.111)* | *-.117* *(.142)* |
| *Ln(Sale)* | *.1* *( .097)* | *.069* *( .097)* | *.05* *(.104)* |
| *Ln(Anndir)* | *.085* *( .164)* | *.033* *( .164)* | *.009* *(.173)* |
| *Market to book ratio* | | | *.0003* *( .03)* |
| *Long term debt/total assets* | | | *-.09* *( .423)* |
| *Constant* | *5.589**** *(.551)* | *4.706**** *(.666)* | *4.809**** *( .713)* |
| *R-squared* | *0.2032* | *0.2248* | *0.2176* |
| *N* | *197* | *197* | *191* |

***Table 7-B How the quality of newly joined director i depends on characteristics of firm j: Ongoing CEO Directors only***

- *I download 2001-2005 board profiles of U.S firms which have total asset values greater than $ 1,000 million in 2004 from IRRC data base*
- *I select ongoing CEOs who newly join boards as outside directors during 2000-2005*
- *Dependent variable: the quality of other firms' ongoing CEOs*
- *Proxy for quality: The natural log value of the market capitalization*

| | *OLS with logvalue* | *OLS with logvalue* | *OLS with logvalue* | *2SLS with logvalue* |
|---|---|---|---|---|
| *Ln(CEO compensation)* | | *.256*** | *.256*** | *.021* |
| | | *( .12)* | *(.122)* | *(.791)* |
| *Ln(Market capitalization)* | *.689**** | *.59**** | *.656**** | *.686*** |
| | *(.189)* | *( .193)* | *(.212)* | *(.299)* |
| *Ln(Total assets)* | *-.287** | *-.246* | *-.255* | *-.254* |
| | *( .16)* | *( .16)* | *(.173)* | *(.182)* |
| *Ln(Sale)* | *.259** | *.223* | *.169* | *.232* |
| | *( .141)* | *(.141)* | *(.148)* | *( .205)* |
| *Ln(Anndir)* | *-.237* | *-.306* | *-.343* | *-.283* |
| | *( .242)* | *( .243)* | *( .251)* | *( .33)* |
| *Market to book ratio* | | | *.018** | *.017** |
| | | | *( .009)* | *(.01)* |
| *Long term debt/total assets* | | | *.885* | *.841* |
| | | | *(.666)* | *( .686)* |
| *Constant* | *3.489**** | *2.386*** | *2.21*** | *3.22* |
| | *(.777)* | *(.928)* | *( .986)* | *( 3.528)* |
| *R-squared* | *0.2840* | *0.2962* | *0.3006* | *0.2928* |
| *N* | *270* | *270* | *262* | *262* |

***Table 8 Regression of the CEO compensations on board quality (OLS and 2SLS)***

- *The dependent variable: The CEO compensations (TDC1) in 2005*
- *All independent variables are the values in 2004 except tenure as CEOs and Board structure variables*
- *The board quality: the averaged quality of other firms' ongoing CEOs and retired CEOs as outside directors on boards in 2005*
- *The proxy for the board quality is the averaged compensation level as CEOs over ongoing and retired CEOs on boards in 2005, which is used in Table 4*
- *The instrument for the board quality is the board compensation (annual director fee)*

| | *OLS with logvalue* | *2SLS* |
|---|---|---|
| *Ln(Market capitalization)* | *-.364* | *-.286* |
| | *( .22)* | *( .215)* |
| *Ln(Asset)* | *.561*** | *.513*** |
| | *( .224)* | *( .22)* |
| *Ln(Sale)* | *.061* | *-.107* |
| | *( .099)* | *( .219)* |
| *ROA* | *.035** | *.056* |
| | *(.018)* | *( .018)* |
| *Debt/Asset* | *-1.11*** | *-1.103*** |
| | *(.523)* | *(.541)* |
| *Market to book ratio* | *.062*** | *.004* |
| | *( .026)* | *( .014)* |
| *Ln(Tenure as CEOs)* | *.207**** | *.274**** |
| | *(.075)* | *( .104)* |
| ***Board structures*** | | |
| *CEOCBO* | *.035* | *-.038* |
| | *( .152)* | *(.194)* |
| *The quality of boards* | *.164*** | *.604* |
| | *(.077)* | *( .753)* |
| *The size of boards* | *.061* | *.220* |
| | *( .363)* | *( .52)* |
| *The proportion of outside directors* | *.28* | *.192* |
| | *( .781)* | *( .944)* |
| *Constant* | *4.342**** | *1.351* |
| | *(1.266)* | *(5.42)* |
| *R-squared* | *0.3039* | *0.2147* |
| *N* | *161* | *161* |

***Table 9 Descriptive statistics for the board compensations***

- *I download the board compensations data of U.S firms which have total asset values greater than $ 5,000 million in 2005*
- *The board compensations: annual director fees in 2005*
- *All values are in $ thousand*

| | *The board compensations ($thousand)* |
|---|---|
| *N* | *466* |
| *Mean* | *46.6* |
| *Standard deviation* | *20.64* |
| *Max* | *200* |
| *Min* | *6* |
| *25%* | *30* |
| *50%* | *45* |
| *75%* | *60* |
| | |

***Table 10 The compensation for outside directors (Annual director fee): Cross-section data***

- *I download financial information of U.S firms which have total asset values greater than $ 5,000 million in 2005*
- *Dependent variable: the annual director fee in 2005 year*
- *Independent variables are the characteristics of firms*
- *All values are 2004 year values*

| | *OLS with logvalue/ robust standard error* | *Quantile regression (.25)* | *Median quantile regression* | *Quantile regression (.75)* |
|---|---|---|---|---|
| *Asset* | *-.01*<br>*(.05)* | *.007*<br>*(.104)* | *-.032*<br>*( .058)* | *-.108**<br>*( .06)* |
| *Sale* | *.66****<br>*(.14)* | *.926****<br>*( .24)* | *.704****<br>*( .132)* | *.399****<br>*(.139)* |
| *Sale*Sale* | *-.03****<br>*(.008)* | *-.044****<br>*( .013)* | *-.029****<br>*( .007)* | *-.013**<br>*( .008)* |
| *Market capitalization* | *.001*<br>*(.05)* | *.008*<br>*( .109)* | *.026*<br>*( .060)* | *.084*<br>*( .062)* |
| *CEO compensation (TDC1)* | *.13****<br>*(.03)* | *.129****<br>*( .045)* | *.099****<br>*( .025)* | *.12****<br>*( .027)* |
| *ROA* | *-.0003*<br>*(.004)* | *-.0002*<br>*( .007)* | *.004*<br>*( .004)* | *-.002*<br>*( .004)* |
| *Constant* | *-.88*<br>*(.67)* | *-2.42***<br>*( 1.122)* | *-.911*<br>*( .627)* | *.682*<br>*( .659)* |
| *R-squared* | *0.3999* | | | |
| *Pseudo R-squared* | | *0.2303* | *0.2305* | *0.2101* |
| *N* | *448* | *448* | *448* | *448* |