Monitoring Levels under Alternative Corporate Governance Systems*

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Abstract

This paper provides a theory on monitoring levels under alternative corporate governance systems. Corporate governance systems vary across nations. However, in the wake of recent corporate scandals, questions have been raised as whether there exists a unique corporate governance system that produces more monitoring than any other system. We attempt to provide an answer to this problem by considering a model that allows us to compare monitoring levels under alternative governance systems. We define alternative systems by board characteristics. Boards are characterized by two types of directors, one that are qualified to become CEO and the other that are forbidden to become CEO. Changing the ratio of these two types of directors allows us to obtain monitoring levels related to each governance system. We find that the level of monitoring depends on the parameters of the model such as the private benefit of the CEO rather than a formation of governance system.

Keywords: Monitoring; Board of Directors; Internally Promoted CEO; Externally Recruited CEO; Leak

JEL Codes: G30, P51, K22

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1 Introduction

This paper provides a theory on monitoring levels under alternative corporate governance systems. Corporate governance systems vary across nations.[1] However, in the wake of recent corporate scandals, doubts have been raised in many countries about their corporate governance systems. In particular, many academics, policy makers, and investors felt that there were too little monitoring performed by the boards of directors.[2] Since Berle and Means [1932], the boards of directors have been expected to be the primary monitoring devices of the managers but recent scandals have led many to feel that boards under their systems have weak monitoring. Therefore, in some countries such as in the U.S. and Japan, the laws were changed to remedy what was perceived by many that their governance systems let unwatched CEOs do whatever they wanted to do. However, investigating into these governance systems, the changes that have been made to them come across to us as merely formal, i.e., changing the composition of the board by increasing independent directors. This motivates us to seek into whether such changes in the boards literally change monitoring levels. And, if they do, is there an unique corporate governance system with an ideal board composition that can produce more monitoring than any other system? And, if they do not, what factors do affect monitoring levels? This paper attempts to answer these questions by providing a model that allows us to compare monitoring levels under alternative corporate governance systems. We find that the level of monitoring depends on the parameters of the model such as the whole board size or the private benefit of the CEO, rather than a formation of the corporate governance system.

Despite all the arguments on monitoring performed by the board of directors, there has not been a general model that relates monitoring levels to governance systems. Hermalin and Weibach [1998] provide a model in which all the directors on the board and the CEO interact to determine the monitoring level, but in their model, the board members are not expected to become CEO themselves.[3] Harris and Raviv [2005] provide model in which the board has two types of directors, outsiders and insiders whose information are different, and show that the board consists of many outsiders is not necessarily optimal in a different context from

[1] Interested readers are referred to Tirole [2006] and Shleifer and Vishny [1997].

[2] Papers that analyze some topics on the board in theoretical contexts with some illustrations of recent law changes are for example, Raheja [2005] and Harris and Raviv [2005] for the U.S., and Sato [2006] for Japan. Sarra and Nakahigashi [2002] discuss the recent changes in Japanese laws in detail.

[3] What is determined between the board and the CEO is the board composition, but in their model, the monitoring level and the board composition are one to one correspondence.

us. Raheja [2005] discusses the issue that is similar to ours in some respects, but our model can analyze what is not analyzed in his model; that is, in our model outsiders can perform monitoring absent insiders' information, which is more closer to the practice in the real world. We follow Hermalin and Weibach [1998] model and extend it to a general model that allows us to compare monitoring levels under alternative governance systems. Alternative governance systems are defined by differences in the board composition. We assume that there are two types of directors on the board; one is those who are qualified to become CEO, and the other is those who are forbidden to become CEO, but both types of directors are responsible for monitoring the CEO. By continuously changing the ratio of these two types of directors of the board, we can compare monitoring levels produced by boards of different composition. In our model, the differences in the board composition affect not only board characteristics, but the whole system of corporate governance. To be more specific, as a general model we consider a system in which a CEO is recruited not only from outside of the board, but a certain fraction of the board members are also qualified to become CEO. We refer to this system as a "hybrid" system, because the board under this system consists of two types of directors, one that is qualified to become a CEO, the other that is forbidden to become a CEO. The significance of this model is that we can obtain monitoring levels for each change of the ratio of the two types of directors on the board. Then it allows us to compare monitoring levels related to each corporate governance system. For example, we can consider two extreme cases of the "hybrid" systems and each system produces different level of monitoring. One is the case which the board consists entirely of directors who are forbidden to become CEO, where none of the directors become CEO and the CEO is always recruited from outside of the board. The other is the case which all the board members are given equal chances of becoming CEO. Then it is obvious that differences of the board characteristics affect CEO candidates and therefore the whole governance system.

We show that monitoring levels do not depend on such structural differences, but instead on some parameters common across all kinds of governance systems, such as the size of the board and the private benefit of the CEO. In the model, we assume that the board objective is aligned with those of shareholders so the higher is the profit of the firm, the higher is the board utility, and the monitoring is performed by the board of directors to update the ability of the initial

CEO that stochastically affects the firm's profit.[4] If a bad signal is observed, the initial CEO is fired a new CEO is hired; depending on the system, he is either recruited outside of the board or promoted from the board. Monitoring may induce an exchange of the initial players. When a new player is hired in place of the initial player, the new player receives his share on behalf of the initial player and this is a loss of the expected payoff for the initial players. We refer to this expected loss as "leak." We find that when the board monitors, it surely raises the expected profit of the firm, but at the same time increases the possibility of "leak" under any governance system. Hence, monitoring induces the trade-off between the positive effect of the expected profit and the negative effect of the expected loss of the initial players as well as the monitoring cost. "Leak" is inevitable to avoid under any corporate governance system where at least one of the initial players are expected to be changed. Thus, the governance system with less "leak" produces the intense monitoring and increases the profit of the firm.

The rest of the paper is organized as follows. In Section 2, we provide a simple model that is intended to capture the essential result of the main model. Section 3 provides the main model that allows us to compare monitoring levels under alternative corporate governance systems. Section 4 concludes.

2 Simple Model

This section is provided to capture the essential results and intuition of the main model laid out in the following sections. In the main model we analyze the monitoring levels under alternative corporate governance systems. To be more specific, the main model allows us to analyze the monitoring level (continuous) generated by the board of directors when the ratio of the directors who can become a CEO varies from 0% to 100% of the board members. Thus the main model is rather complicated so we provide a simplified model in this section before discussing the main model and consider two extreme cases: 0% (we refer to it as "separate" system) or 100% (we refer to it as "related" system). In both cases, the level of monitoring is discrete; all or nothing.

The "separate" system always recruits CEOs from outside of the board, and 0% of the incumbent directors are qualified to become CEO, while the "related" system always recruits

[4]We later show that the more the board monitors, the higher is the profit of the firm. Since shareholders do not incur cost in monitoring, but receives a share from the profit of the firm, more monitoring meets shareholders needs and is assumed to be good in this paper. However, it is beyond the scope of this paper to analyze the socially optimum level of monitoring.

CEOs from the board of directors, and 100% of the incumbent directors are equally qualified to become CEO.[5] In the former setup, if the initial CEO is fired, a new CEO externally recruited takes over his post and thus a change of a CEO does not affect the initial board composition and its expected profit. In the latter setup, if the initial CEO is fired, one of the directors is internally promoted to take over his post. Then the initial board lacks one director and to fill in the vacancy a new director is hired and thus a change of a CEO affects the initial board composition and its expected profit.

Definition : *"Leak" is defined as an expected loss of the final profit for the initial players.*

The simple model we consider to compare the two alternative systems is as follows. There are $n+1$ executives; specifically, one initial CEO and n directors which compose one board and acts as one player. The board objective is to maximize the profit of the firm subtracted by monitoring cost and the wage it must pay to the initial CEO. The outcome of the firm is dependent on the ability of the CEO. The ability of the CEO is either high (H) or low (L) determined by nature and neither the board nor the CEO knows the true ability. On the other hand, the initial CEO's objective is to receive both the wage and the private benefit. Wage is surely paid to the initial CEO, but the private benefit exogenously determined is given to the CEO who is serving at the end of the game, thus if the initial CEO is fired prior to the last stage he cannot obtain it.

In the 1st stage, an executive meeting takes place between the initial CEO and the initial board. We assume that the board posts an offer that the CEO must either accept or reject. Thus, the 1st stage practically starts with the board's move of offering (ζ, w), where $\zeta \in \{0,1\}$: 0 means no monitoring, 1 means the board does monitor, and w is the wage paid to the CEO when the board offers. To be more specific, the board offers the initial CEO $(\zeta, w) = (1, w_1)$ or $(\zeta, w) = (0, w_0)$. In the 2nd stage, the CEO accepts or rejects the offer. Then, the profit of the firm is realized.[6] Also, the CEO who is serving at the last stage of the game gains the private benefit b.

If the board monitors the CEO, it updates his ability based on the Bayse' rule. The priors for

[5] We may refer to the former as the system in which the board consists entirely of independent directors, and the latter as the system in which the board consists of no independent directors.

[6] Since the intention of the simple model is to convey the intuition of the main model, we focus on the on-the-path of the game("accept" case), but the outcome of the players in the "reject" case are r for a CEO, and φ_N for the board which is specified later in this section.

both the initial CEO and any new CEO (who is hired to replace the initial CEO) are assumed to be $\frac{1}{2}$ for being H and L. The expected profit conditional on good signal y_H is denoted φ_H, and the expected profit conditional on bad signal y_L is denoted φ_L. It is denoted φ_N when the board does not monitor and no signal is observed, or when the board hires a new CEO after it has fired the initial CEO. We assume $\varphi_H > \varphi_N > \varphi_L$.[7] To be more specific, with probability Z the board obtains a good signal y_H from the CEO, and with probability $(1 - Z)$ it obtains a bad signal y_L. When y_H is observed, the board updates the priors of the initial CEO by the Bayse' rule and his posterior ability becomes higher than $\frac{1}{2}$ for being H. Thus he is retained and serves to the end of the game. When y_L is observed, the initial CEO's posterior becomes more than $\frac{1}{2}$ for being L so he is fired and a new CEO is hired and the new CEO serves to the end of the game. On the other hand, if the board offers not to monitor, the initial CEO serves to the end of the game without his priors being updated.

We now derive the expected payoffs of each player when the board posts a take-it-or-leave-it offer of (ζ, w). We start with the case in which the board offers $(\zeta, w) = (0, w_0)$. When there is no monitoring, there is no risk of the initial CEO being fired in both "separate" and "related" case. In either case, all the initial players remain the same throughout the game, and hence no "leak" occurs. Then the payoffs of the players are the same in both cases when $\zeta = 0$, and they are as follows. The initial CEO's expected payoff is

$$b + w_0, \tag{1}$$

and the board's expected payoff is

$$\varphi_N - w_0, \tag{2}$$

Next we derive the expected payoffs of the case in which the board offers $(\zeta, w) = (1, w_1)$. When the board monitors the CEO, it updates the priors; with probability Z the board observes a good signal, and with probability $(1-Z)$ the board observes a bad signal. Under the "separate" system, observing a bad signal is synonymous to saying that the initial CEO is fired and a new CEO is externally hired with probability $(1 - Z)$ and hence a share is "leaked" to a new CEO. Under the "related" system, it is synonymous to saying that the initial CEO is fired and a new CEO is internally hired with probability $(1-Z)$ and hence a share is "leaked" to a new director. (In the "related" system any share or profit the new CEO receives is not considered as a "leak"

[7] The board fires the initial CEO who is believed to be a bad match and replaces him with a new CEO, so φ_L is not realized.

since he is one of the initial players.) The cost of monitoring is $c > 0$ and we assume that it is a fairly small equal amount in both systems.[8] Thus the initial CEO's expected payoff in the "separate" case is

$$Zb + w_1^s, \tag{3}$$

and the board's expected payoff in the "separate" case is

$$Z\varphi_H + (1 - Z)\varphi_N - w_1^s - c, \tag{4}$$

where $Z\varphi_H$ is an expected profit of the firm when the board observes $y_{H,}$ and $(1 - Z)\varphi_N$ is an expected profit of the firm when the board observes y_L and replaces the initial CEO with a new CEO. w_1^s is a wage the board pays to the CEO under the "separate" system.

On the other hand, the initial CEO's expected payoff in the "related" case is

$$Zb + w_{1,}^r \tag{5}$$

and the board's expected payoff in the "related" case is

$$Z\varphi_H + (1 - Z)\left(b + \frac{n-1}{n}\varphi_N\right) - w_1^r - c, \tag{6}$$

where $(1 - Z)\left(b + \frac{n-1}{n}\varphi_N\right)$ is an expected profit of the firm when the board observes y_L and hence replaces the initial CEO with a new CEO; that is, under the "related" system when the signal is bad, one of the board members becomes a new CEO, and a new director is hired to keep the board size n. Thus, one of the board members surely gets b, and each of the remaining $(n - 1)$ board members receives $\frac{\varphi_N}{n}$. The total payoff is hence $b + \frac{n-1}{n}\varphi_N$. w_1^r is a wage the board pays to the CEO under the "related" system.

Given these expected payoffs, we can now consider the board's offer : (ζ, w), where $\zeta \in \{0, 1\}$. We assume that the CEO's reservation price from the outside opportunity is r. Then, the board offers CEO either of the following alternatives both with the guarantee that CEO will accept its offer.

In the "separate" case, if the board posts $(0, w_0)$, the board determines the wage level as to satisfy $b + w_0 = r$, but if the board posts $(1, w_1^s)$, the board determines the wage level as to

[8] $Z(\varphi_H - \varphi_N) - (1 - Z)\left(\frac{1}{n}\varphi_N\right) > c.$

satisfy $Zb + w_1^s = r$. Then, the board makes the optimal choice between the two alternatives; $(0, w_0) = (0, r - b)$ and $(1, w_1^s) = (1, r - Zb)$. Plugging $w_0 = r - b$ into (2) we obtain

$$\varphi_N + b - r. \tag{7}$$

Plugging $w_1^s = r - Zb$ into (4) we obtain

$$Z\varphi_H + (1 - Z)\varphi_N + Zb - r - c. \tag{8}$$

The board decision to monitor or not is determined by comparing (7) and (8). (8) > (7) holds when b is sufficiently small and hence the board takes the action $(1, w_1^s)$. (8) < (7) holds when b is sufficiently large and hence the board takes the action $(0, w_0)$. Notice that b is the "leak." When the board monitors, the expected profit of the firm increases, but at the same time, the "leak" is generated.

On the other hand, in the "related" case, if the board posts $(0, w_0)$, the board determines the wage level as to satisfy $b + w_0 = r$, and if the board posts $(1, w_1^r)$ the board determines the wage level as to satisfy $Zb + w_1^r = r$. Then, the board makes the optimal choice between the two alternatives; $(0, w_0) = (0, r - b)$ and $(1, w_1^r) = (1, r - Zb)$. Plugging $w_0 = r - b$ into (2) we obtain

$$\varphi_N + b - r. \tag{9}$$

Plugging $w_1^r = r - Zb$ into (6) we obtain

$$Z\varphi_H + (1 - Z)\left(b + \frac{n-1}{n}\varphi_N\right) + Zb - c - r. \tag{10}$$

The board decision to monitor or not is determined by comparing (9) and (10). (10) > (9) holds when $\frac{1}{n}\varphi_N$ is sufficiently small, and the board takes the action $(1, w_1^r)$. (10) < (9) holds when $\frac{1}{n}\varphi_N$ is sufficiently large, and the board takes the action $(0, w_0)$. Notice that $\frac{1}{n}\varphi_N$ is the "leak," and again, it is obvious that the monitoring increases the expected profit of the firm, but generates "leak."

The results and the implication of the simple model: Comparison of the alternative systems.

We compare the two alternative systems: "separate" and "related" systems. "Leak" occurs when there is a change in the initial members. Thus, under the "separate" system, benefit b

given to the new CEO "leak," whereas under the "related" system the pay to the new director $\frac{\varphi_N}{n}$ is "leak." However, if none of the initial member is changed, there is no "leak" in either system. From (8) and (10) where $w_1^s = w_1^r = r - Zb$, it is straightforward to show that when $b > \frac{1}{n}\varphi_N$, the board of the "related" system is more likely to monitor, but when $b < \frac{1}{n}\varphi_N$, the board of the "separate" system is more likely to monitor. This result implies two important effects. First, both types of governance system cannot avoid "leak" when monitoring is performed. In other words, either system cannot avoid the loss from the expected profit for the initial players as long as there is a possibility of the player being changed. Second, the monitoring introduces the trade-off between the positive effect of expected profit and the negative effect of the "leak." That is, if the board monitors, it surely increases the profit of the firm, but at the same time increases the amount of "leak." This means the board incurs two types of cost when it performs monitoring; that is, a monitoring cost and "leak."

However, in the main model, we consider the level of monitoring to be continuous rather than discrete, and treat the board disutility as a function of monitoring level. Note also that in the main model offered in the following section, Nash bargaining is used instead of take-it-or-leave-it offer as a bargaining procedure. This is because the latter gives all bargaining power to the board and this is not realistic. We also note that in the simple model, the board commits to monitor, but since this model is simplified version of the general model, this assumption is innocuous. We show that in the general model laid out in the following section, the board and the CEO determine the board composition and the wage in Nash bargaining and the former determines the monitoring level in the stage following negotiation. Thus, determining the board composition is a commitment device to the monitoring level.

3 Main Model

In this section, we describe and analyze the main model. As in the simple model, we consider a strategic interaction between the board and the CEO in the main model, but we introduce continuous monitoring level and Nash bargaining following Hermalin and Weisbach [1998], and extend their work to a general model that allows us to compare monitoring levels under alternative systems. We assume that the board consists of directors whose measure of monitoring cost varies over individuals. That is, some directors may incur high monitoring cost while the other directors do not incur much cost in monitoring, where each director's monitoring cost is exogenously given. The cost of monitoring incurred to each director is determined irrelevant to his status. (An independent director and an inside director may have the same monitoring cost.) For concreteness we may refer to a director who does not exert much cost in monitoring as an experienced director, but it could be given other interpretation. However, all the directors act as one player as a "board," thus the measure of monitoring cost of the board as a whole is what matters henceforth in determining the monitoring level.[9] We describe each director's measure of monitoring cost as $k_{i,}$ where $i = 1, ..., n$. Then, the total measure of monitoring cost of the board is expressed as $\overline{k}_l = \sum k_{i,}$ where $l = 0, 1$, and 0 represents the initial board, 1 represents the new board determined by Nash bargaining.

The objectives of the players in the main model are the same as in the simple model except that the monitoring level is continuous and the board disutility is a function of monitoring level. We begin with some specifics on the timings. We assume there are $n + 1$ executives with one CEO, and n directors which compose one board and act as one player throughout the game.

3.1 Timing

Below we provide some specifics on timing.[10] The game has 4 stages. The three exogenous variables are, the number of directors n, and the initial board's measure of monitoring cost $\overline{k}_{0,}$ and the private benefit b the CEO receives at the end of the game.

1st stage. *Nash bargaining between the board and the initial CEO*: The initial CEO and the board that consists of initial n directors negotiate over the wage of the CEO and the new board composition.[11] The ability of the initial CEO is either H or L. We assume that the initial CEO's priors are more than $\frac{1}{2}$ for being H, so that he has some bargaining power over the board. If the board were to hire any new CEO, the priors would be precisely $\frac{1}{2}$ for both H and L.[12] When the bargaining succeeds, the wage of the CEO, and the new board composition whose measure of monitoring cost is $\overline{k}_1$, are endogenously determined. Wage w is paid to the CEO right after it is determined regardless of whether he will serve to the last stage of the game or not. Board disutility is a function of monitoring level. If the bargaining fails, we assume the CEO is fired

[9] See Wilson[1968] for a group of individual where its decision is made collectively.

[10] See Timeline in Figure One.

[11] All the initial directors participate in the negotiation, but after they determine who to hire as new director(s), the same number of the initial directors stochastically leave the board to keep its size n.

[12] This is different from the simple model in which we assumed that all new CEOs including the initial CEO had precisely the same priors of $\frac{1}{2}$ for H and L in the simple model.

and the board hires a new CEO. Since the prior beliefs on the ability of the entirely new CEO is $\frac{1}{2}$ for H and L, the new CEO does not have any bargaining power. Hence, we assume that if the negotiation fails, the initial board whose measure of monitoring cost is $\overline{k}_0$ determines the wage of the CEO so as to maximize its own expected payoff given that it guarantees at least the threat point of the newly hired CEO.

2nd stage. *Monitoring by the board*: After the negotiation, the new board whose measure of monitoring cost is $\overline{k}_1$ monitors the initial CEO and updates his ability by observing signal $y \in Y = \{y_H, y_L\}$. To be more specific, the new board chooses the monitoring level as to maximize its utility. We denote the monitoring level as $\zeta \in [0, 1]$, and this is interpreted as the probability of succeeding in monitoring and obtaining signal y. We assume that with probability ζ, the board observes either y_H or y_L, and with probability $1 - \zeta$, the board fails to monitor and obtains no signal. This means the board obtains signal y about the ability of the CEO only when it succeeds in monitoring. The board disutility of monitoring is expressed as $\overline{k}_1 \cdot d(\zeta)$.

We later show for a given $\overline{k}_1$, the optimum ζ is determined in the 2nd stage. Then, by backward induction, in the 1st stage equilibrium $\overline{k}_1^*$ is determined by Nash bargaining. We show in Proposition 1 that ζ is strictly monotone decreasing function of $\overline{k}_1$, and hence ζ and $\overline{k}_1$ are one to one correspondence. Therefore, the board and the initial CEO determine $\overline{k}_1$ in Nash bargaining, but we may regard as if they are determining ζ in the bargaining.

3rd stage. *The board decides to retain the initial CEO, or fire him and hire a new CEO*: The board decides to retain or fire the initial CEO depending on the signal. The CEO who is believed to be probable of being H is retained, and fired if he is probable of being L. When the initial CEO is fired, a new CEO is hired. With probability $1 - \zeta$, the board fails to get signal y on the initial CEO's ability and if so, it has no choice but to retain the incumbent CEO.

4th stage. *The profit of the firm is realized* : The profit is a random variable denoted by $\widetilde{X}$ dependent on the ability of the CEO and is realized at the 4th stage. We denote by X the realized profit which belongs to $\{X_H, X_L\}$ where $X_H > X_L$. The board obtains φ from X, specifically $\rho X = \varphi$ where $\rho \in (0, 1)$. $(1 - \rho)X$ will be distributed to shareholders, investments, and so forth. Thus, the larger is X, the more the board meets the shareholders' expectations. The CEO who is at the last stage of game obtains a private benefit of $b > 0$, which permits some interpretations, such as bonus, retirement allowances, and reputations.

3.2 The Players' Problems

3.2.1 The Initial CEO's Problem

The initial CEO's objective is to receive both the wage w and the private benefit b. Wage w is paid right after the negotiation, but CEO gains b at the last stage of the game. Thus, the CEO certainly wants to serve to the last stage of the game. If he is fired in the preceding stage, he does not obtain b, but he surely receives the wage w. Thus, the initial CEO's utility is $w + b$ if he serves to the end of the game, or just w if he is fired before the last stage. His job is to produce X , but this is a random variable dependent on the ability of the CEO. This means he has no active role other than negotiating in Nash bargaining. When the board monitoring succeeds, the initial CEO's ability is updated by the board by the Bayes' rule and the board decides to retain or remove the CEO; when the CEO is considered to be probable of having low ability, he is removed and a new CEO who is expected to produce higher X is hired and takes the initial CEO's position from the point he is replaced. We assume that the reservation utility of the CEO who's been removed is 0.[13] When the CEO's ability is believed to be probable of being H, he is retained and he remains to the end of the game.

3.2.2 The Board's Problem

All the directors on the board act as one player and hence we consider the utility of the board as a whole in this paper. The board problem is to maximize the profit of the firm subtracted by disutility of monitoring and the wage it must pay to the CEO. We assume the utility of the board is

$$\Omega_{Board} = \sum_{i} \pi_i, \tag{11}$$

where, π_i is the utility function for each director and is expressed as

$$\pi_i = \frac{\varphi}{n} - k_i \cdot d(\zeta) - \frac{w}{n}. \tag{12}$$

The first term $\frac{\varphi}{n}$ is the utility of each director on the board, where $\varphi = \rho X$ is a share from the final profit of the firm, and hence a random variable dependent on the ability of the CEO. There are n directors on the board. A parameter k_i is a measure of each director's cost of monitoring and $d(\cdot)$ expresses the disutility of monitoring and is a common, strictly increasing, strictly

[13]For simplicity we assume that the reservation of the CEO is 0, but this of course can be any other constant.

convex, twice-differentiable continuous function.[14] Monitoring level ζ is the level of monitoring which can be interpreted as the probability that the board obtains signal y about the CEO. $\overline{k}_l$ is the total of k_is, where k_i is a measure of each director i 's cost of monitoring. That is, $\overline{k}_l = \sum_{i=1}^{n} k_i$, where $l = 0, 1$. The initial composition of the board whose measure of monitoring cost is $\overline{k}_0$ remains the same until it is endogenously changed; i.e. by the negotiation between them and the CEO. We denote $\overline{k}_1$ for the new board level of monitoring cost whose composition is endogenously determined by negotiation. Whether they hire a director who has low cost in monitoring or high cost in monitoring affects the monitoring level of the whole board. The board strategy is to fire the CEO when the board observes a bad signal and retain the H type CEO. Therefore, according to the signal, the board either keeps the initial CEO or fires him and hire a new CEO.

3.3 Assumptions

The relations between the profit of the firm X_j, $j \in \{H, L\}$, where $X_H > X_L$, and the ability of the CEO a_i, $i \in \{H, L\}$ are assumed as follows. We start with $P_j^i = \Pr\{X_j | a_i\}$. For example, P_L^H is the probability that the CEO produces X_L conditional on his high ability a_H. We assume

$$P_H^H > P_H^L. \tag{13}$$

From (13), (14) is derived.

$$P_L^L > P_L^H. \tag{14}$$

We denote $E(\widetilde{X}|a_i) = P_H^i X_H + P_L^i X_L \equiv \overline{X}^i$, where $\widetilde{X}$ is a random variable dependent on the ability of the CEO. We assume that the board receives $\rho\overline{X}^i$ from this whole amount. Then it is obvious from (13) and (14) that $\rho\overline{X}^H \equiv A > B \equiv \rho\overline{X}^L$.

We denote the priors for the initial CEO's ability as γ and assume this is higher than $\frac{1}{2}$ for H; that is, $\gamma^H > \frac{1}{2}$. ($\gamma^L = 1 - \gamma^H < \frac{1}{2}$.) If the initial CEO produces a profit without being monitored, his ability would not be updated and hence the expected profit is expressed as $\gamma^H A + \gamma^L B \equiv \varphi_I$. The expected profit conditional on an entirely new CEO is denoted $\varphi_{N.}$ $\varphi_N \equiv \frac{1}{2}(A + B)$ for we assume everybody except for the initial CEO is believed to have priors of $\frac{1}{2}$ for both being H and L if he were to serve as a CEO.

[14] The smaller the k_i, the more experienced the director is, and hence less costly it is for him to monitor.

The signal is a random variable denoted by $\widetilde{y}$ and realized when the board succeeds in monitoring. We denote by y the realized signal which belongs to $\{y_H, y_L\}$. We denote by $\mu_j^i \equiv \Pr(a_i | y = y_j)$, the posterior probability that the CEO has ability a_i conditional on the observation of y by the Bayes' rule. We assume $\mu_L^H < \frac{1}{2}$ $(\mu_L^L > \frac{1}{2})$, and $\mu_H^H > \gamma^H > \frac{1}{2}$. $(\mu_H^L = 1 - \mu_H^H < \frac{1}{2}.)$ The expected profit at this point is expressed as $\mu_j^H A + \mu_j^L B$ which we denote by $\varphi_j \equiv E(\widetilde{X}|y = y_j)$. We denote by Z for the probability of the board observing y_H for an initial CEO whose prior ability is γ^H, and denote by $(1 - Z)$ for the probability of observing y_L for the same initial CEO.

From these assumptions, $\varphi_H > \varphi_I > \varphi_N > \varphi_L$. Then, when the board observes y_L, the initial CEO is fired because the expected profit conditional on his ability is lower than the expected profit conditional on the new CEO.[15] Therefore, if the board observes y_H, it retains the initial CEO but if it observes y_L, it fires the initial CEO and hires a new CEO.

Next, we note some off-the-path of equilibrium assumptions. That is, we assume the posteriors of the new CEO hired when the Nash bargaining has failed in the 1st stage. When the bargaining fails between the initial CEO and the initial board, the initial CEO is fired and the new CEO is hired. However, the new CEO's priors are $\frac{1}{2}$ for both being H and L, so he has no threat over the board. Therefore, in such a case we assume that there is no bargaining, but the initial board alone decides the wage and the new board composition. We then denote by η_j^i the posterior probability that the new CEO has ability i conditional on the observation of signal after the initial board monitors. The expected profit at this point is expressed as $\varphi_{N\text{ j}} \equiv \eta_j^H A + \eta_j^L B$, $j = H, L$. We assume $\frac{1}{2} < \eta_H^H < \mu_H^H$. We denote by Q for the probability of the board observing y_H for a new CEO whose prior ability is $\frac{1}{2}$ for both H and L, and denote by $(1 - Q)$ for the probability of the board observing y_L for the same new CEO. We assume

$$Z \geq Q \tag{15}$$

3.4 The Analysis

3.4.1 The Expected Payoff of The Board

Below we analyze the monitoring level generated by the board of directors when the ratio of the directors who can become CEO varies from 0% to 100% of the board. To be more specific,

[15] $\mu_L^H A + \mu_L^L B \equiv \varphi_L < \varphi_N \equiv \frac{1}{2}(A + B)$.

we consider a system in which a CEO is recruited not only from outside of the board, but a certain fraction of the board members are also qualified to become CEO. We refer to this system as a "hybrid" system, because the board under this system consists of two types of directors: directors who are forbidden to become CEO and directors who are qualified to become CEO. We assume there are always n directors on the board and $n = n_1 + n_2$ where n_1 and n_2 are the parameters, each indicating the number of directors who cannot become CEO and who can become CEO. Then, with probability $\frac{n_2}{n}$ one of the directors who are qualified to become CEO takes over the initial CEO's post when he is fired, but with probability of $1 - \frac{n_2}{n} = \frac{n_1}{n}$ a new CEO is hired from outside when the initial CEO is fired.[16] n_1 can be interpreted as a number of the independent directors, whereas n_2 can be interpreted as a number of the inside directors.

The extreme cases of the "hybrid" systems are the case which the board consists entirely of directors who are forbidden to become CEO, and the case which the board consists entirely of directors who are qualified to become CEO. We refer to the system with the former board as a "separate" system where $n = n_1$ and hence the CEO is always recruited from outside of the board. On the other hand, we refer to the system with the latter board as a "related" system where $n = n_2$. Under the "related" system, we assume that none board member never becomes a CEO.

We derive the expected payoffs of the directors under "hybrid" system. The expected payoff of the directors who cannot become CEO is expressed as

$$\frac{n_1}{n}\left\{\zeta[Z \cdot \varphi_H + (1-Z)\varphi_N] + (1-\zeta)\varphi_I\right\} - \frac{n_1}{n}\overline{k}_1 \cdot d(\zeta) - w_1, \tag{16}$$

where ζ is the level of monitoring which we interpret as the probability of obtaining signal y_i, $i = H, L$, and Z is the probability of obtaining $y_{H.}$ Then, $\frac{n_1}{n}\left\{\zeta[Z \cdot \varphi_H + (1-Z)\varphi_N] + (1-\zeta)\varphi_I\right\}$ is the expected profit of all the directors who are forbidden to become CEO. $[Z \cdot \varphi_H + (1-Z)\varphi_N]$ is the expected profit when the board succeeds in monitoring and obtains signal, and φ_I is the profit when the board fails to monitor and obtains no information. $\frac{n_1}{n}\ \overline{k}_1 \cdot d(\zeta)$ is the measure of collective monitoring cost for the directors who cannot become CEO. For simplicity, we assume that the average of all directors who cannot become CEO and all directors who can become CEO are the same, and thus the monitoring cost can be expressed as a fraction of $\overline{k}_1 \cdot d(\zeta)$, that is $\frac{n_1}{n}\ \overline{k}_1 \cdot d(\zeta)$. w is the wage the board pays to the initial CEO and $w = w_1 + w_2$, where w_1 is the amount attributed to the directors who cannot become CEO, and w_2 is the amount

[16] I am now in the progress of making a more general model.

attributed to the directors who can become CEO.

The expected payoff of the directors who can become CEO is expressed as

$$\frac{n_2}{n}\left\{\zeta\left[Z\varphi_H+(1-Z)\left(\frac{n-1}{n}\cdot\varphi_N+b\right)\right]+(1-\zeta)\varphi_I\right\}-\frac{n_2}{n}\overline{k}_1\cdot d(\zeta)-w_2, \qquad (17)$$

where $\frac{n_2}{n}\left\{\zeta\left[Z\varphi_H+(1-Z)\left(\frac{n-1}{n}\cdot\varphi_N+b\right)\right]+(1-\zeta)\varphi_I\right\}$ is the expected profit of all the directors who are qualified to become CEO. $\left[Z\varphi_H+(1-Z)\left(\frac{n-1}{n}\cdot\varphi_N+b\right)\right]$ is the expected profit when the board succeeds in monitoring, and φ_I is the profit when it fails to monitor and obtains no information. When the board succeeds in monitoring and observes bad signal y_L, the initial CEO is fired. Then, with probability $\frac{n_2}{n}$ one of the directors who are qualified to become CEO takes over the initial CEO's post, but with probability of $1-\frac{n_2}{n}=\frac{n_1}{n}$ a new CEO is hired from outside. In the former case, the director who became a CEO receives b, but the rest of the qualified directors whose number is (n_2-1) remain on the board and receive $\frac{\varphi_N}{n}$ each. Notice that the board always have n directors, so if one of the initial directors becomes a CEO, the board lacks one director but we assume this vacancy is filled in right away by hiring a new director. Therefore, the share each remaining directors receive is $\frac{\varphi_N}{n}$. In the latter case, all the initial directors who are qualified to become CEO remain on the board and receive $\frac{\varphi_{N.}}{n}$ each. Therefore, collective profit of the directors who are qualified to become CEO when the board observes y_L is expressed as $n_2\left[\frac{n_1}{n}\frac{\varphi_{N.}}{n}+\frac{n_2}{n}\left(\frac{1}{n_2}b+\frac{n_2-1}{n_2}\frac{\varphi_{N.}}{n}\right)\right]=\frac{n_2}{n}\left(\frac{n-1}{n}\cdot\varphi_N+b\right)$. As in (16), we can obtain the second and the third terms; that is, $\frac{n_2}{n}\,\overline{k}_1\cdot d(\zeta)$ is the monitoring cost for the directors who are qualified to become CEO and w_2 is the amount they pay to the CEO.

We denote

$$G_1=\{\zeta[Z\cdot\varphi_H+(1-Z)\cdot\varphi_N]+(1-\zeta)\varphi_I\}, \qquad (18)$$

and

$$G_2=\left\{\zeta\left[Z\varphi_H+(1-Z)\left(\frac{n-1}{n}\cdot\varphi_N+b\right)\right]+(1-\zeta)\varphi_I\right\}. \qquad (19)$$

Then, from (16), (17), (18), and (19), the expected payoff of the board as a whole is expressed as[17]

$$\Omega=\frac{n_1}{n}G_1+\frac{n_2}{n}G_2-\overline{k}_1\cdot d(\zeta)-(w_1+w_2). \qquad (20)$$

When all the directors in the board act collectively and maximize the whole board utility Ω with respect to ζ, the first order condition yields

[17] G_2 is not defined when $n_2=0$.

$$\begin{aligned}\frac{\partial \Omega}{\partial \zeta} &= Z\varphi_H + (1-Z)\left[n_1 + \frac{n_2(n-1)}{n}\right]\frac{\varphi_N}{n} + (1-Z)\frac{n_2}{n}b - \varphi_I - \overline{k}_1 \cdot d'(\zeta) \\ &= 0.\end{aligned} \tag{21}$$

Proposition 1 *Define $\zeta^*(\overline{k}_1)$ to be the solution to (21). The less cost it is for the board to monitor, the more it monitors the CEO with scrutiny.*

Proof. *From the implicit function theorem,* $-\overline{k}_1 \cdot d''(\zeta^*(\overline{k}_1))\zeta^{*\prime}(\overline{k}_1) - d'(\zeta^*(\overline{k}_1)) = 0$, *and hence* $\zeta^{*\prime}(\overline{k}_1) = -\frac{-d'(\zeta^*(\overline{k}_1))}{-\overline{k}_1 \cdot d''(\zeta^*(\overline{k}_1))} < 0$. *Therefore,* $\zeta^{*\prime}(\overline{k}_1) < 0$. ■

Proposition 1 implies that ζ is strictly monotone decreasing function of $\overline{k}_1$, and hence ζ and $\overline{k}_1$ are $1:1$ correspondence. Thus, if the board consists of directors who incur less monitoring cost, the board itself collectively incurs less monitoring cost and the intensity to which it monitors the CEO increases.

3.4.2 Nash Bargaining

We now turn to analyze the effect of Nash bargaining between the CEO and the board. The unique point of this negotiation is that the bargaining is theoretically held between 3 players; the CEO, the directors who cannot become CEO, and the directors who are qualified to become CEO.[18] We start with the threat points for each player. The reservation price for the CEO is 0. As for the board, each type of directors have different threat points. The threat point for the directors who may not become CEO is expressed as

$$\theta_0^S = \frac{n_1}{n}\left\{\zeta_0^*\left[Q \cdot \varphi_{NH} + (1-Q)\,\varphi_N\right] + (1-\zeta_0^*)\varphi_N - \overline{k}_0 \cdot d(\zeta_0^*)\right\}, \tag{22}$$

where ζ_0^* is the optimum level of monitoring chosen by the board if they hired a new CEO at the end of the 1st stage. On the other hand, the threat point for the directors who are qualified become CEO is

$$\begin{aligned}\theta_0^R &= \frac{n_2}{n}\left\{\zeta_0^* \cdot Q\left[(n-1)\frac{\varphi_{NH}}{n} + b\right] + \zeta_0^*(1-Q)\left[(n-2)\frac{\varphi_N}{n} + \left(\frac{n-1}{n}\right)b\right]\right. \\ &\quad \left. + (1-\zeta_0^*)\left[(n-1)\frac{\varphi_N}{n} + b\right] - \overline{k}_0 \cdot d(\zeta^*)\right\}.\end{aligned} \tag{23}$$

[18] See Alvin E. Roth [1979] for n-player Nash bargaining games.

where ζ_0^* is the optimum level of monitoring chosen by the board if they hired a new CEO at the end of the 1st stage. The threat point for the CEO is $\theta_0^C = 0$. The threat point is in the interior of the feasible set,[19] thus they enter into negotiation.

The directors and the CEO enter into negotiation and Nash product is expressed as below.

$$\begin{aligned} V &= \left\{\frac{n_1}{n}\left[G_1 - \overline{k}_0 \cdot d(\zeta^*\left(\overline{k}_1\right)) - \theta_0^S\right] - w_1\right\}^{\frac{n_1}{n}} \\ &\times\left\{\frac{n_2}{n}\left[G_2 - \overline{k}_0 \cdot d(\zeta^*\left(\overline{k}_1\right)) - \theta_0^R\right] - w_2\right\}^{\frac{n_2}{n}} \\ &\times\{\left[(\zeta^*\left(\overline{k}_1\right) \cdot Z + \left(1 - \zeta^*\left(\overline{k}_1\right)\right)\right] \cdot b + w_1 + w_2 - \theta_c\}, \end{aligned} \tag{24}$$

Define $\overline{k}_1^*$ and w^* to be the solution to Max V , then the equilibrium level of monitoring is expressed as $\zeta^*(\overline{k}_1^*)$. Solving for $d'\left(\zeta^*(\overline{k}_1^*)\right)$ yields:

Lemma 1

$$d'(\zeta^*(\overline{k}_1^*)) = \frac{1}{\overline{k}_0}\left\{Z\varphi_H + (1-Z)\,\varphi_N - \varphi_I - (1-Z)\left(\frac{n_1}{n}b + \frac{n_2}{n}\frac{\varphi_N}{n}\right)\right\}. \tag{25}$$

Proof of Lemma 1 is in the Appendix.

By plugging $n_1 = n$,and $n_2 = 0$ into (25), we obtain the equilibrium level of monitoring for the board under the "separate" system:

$$d'(\zeta_S^*(\overline{k}_1^*)) = \frac{1}{\overline{k}_0}\left\{Z\varphi_H + (1-Z)\,\varphi_N - \varphi_I - (1-Z)b\right\}. \tag{26}$$

By plugging $n_1 = 0$ and $n_2 = n$, into (25), we obtain the equilibrium level of monitoring for the board under the "related" system:

$$d'(\zeta_R^*(\overline{k}_1^*)) = \frac{1}{\overline{k}_0}\left\{Z\varphi_H + (1-Z)\,\varphi_N - \varphi_I - (1-Z)\frac{\varphi_N}{n}\right\}. \tag{27}$$

From (25), (26), and (27), we obtain:

Proposition 2 *"Leak" occurs under any type of corporate governance system. Moreover, the amount of "leak" under the "hybrid" system is always between that of the "separate" and "related" system, and in turn so is the level of monitoring.*

[19] Proof is in the Appendix.

Proof. Compare (25), (26), and (27). Since $d(\zeta)$ is convex function, we compare the right-hand sides where the only differences among them are the amount of "leaks." Then, it is straightforward that the equilibrium level of monitoring for the "hybrid" system is always between the "separate" system and the "related" system. ■

This Proposition implies the possibility of "leak" exists in every system where any of the initial players are expected to be changed. Thus, when the board monitors the CEO, the expected profit of the firm surely increases, but the possibility of "leak" increases as well irrelevant to the formation of the system of corporate governance. Therefore, the intensity to which the board monitors the CEO is affected by the amount of "leak." "Leak" in the "separate" system is b, whereas it is $\frac{\varphi_N}{n}$ in the "related" system. Since the "hybrid" system takes the formation of a combination of the "separate" and the "related" systems, the "leak" appears as a weighted average of the two; that is, with probability $\frac{n_1}{n}$, a new CEO is selected from outside of the board, and in turn b will be leaked to the newly hired CEO with according probability, and with probability $\frac{n_2}{n}$, a new CEO is selected from inside of the board and $\frac{\varphi_N}{n}$ will be leaked to the new director who is hired to fill in the vacancy of the board. Thus, the monitoring level generated under "hybrid" system is always between that of the "separate" and the "related" system. See Figure Two.

Proposition 3 *1. Suppose $b < \frac{1}{n}\varphi_N$, that is the private benefit b is sufficiently low, or the size of the board n is sufficiently small. Then for all levels of monitoring cost $\overline{k}_1$,the board under the "separate" system monitors the incumbent CEO most intensely followed by the board under the "hybrid" and the "related" systems; that is, $\zeta_S^*\left(\overline{k}_1\right) > \zeta\left(\overline{k}_1\right) > \zeta_R^*\left(\overline{k}_1\right)$. Suppose next $b > \frac{1}{n}\varphi_N$, then for all levels of monitoring cost $\overline{k}_1$, the opposite is true; $\zeta_R^*\left(\overline{k}_1\right) > \zeta\left(\overline{k}_1\right) > \zeta_S^*\left(\overline{k}_1\right)$.*

2. Moreover, the level of monitoring cost of the whole board differs across the three systems. When $b < \frac{\varphi_N}{n}$, monitoring cost is low in the order of the board under the "separate" system, the "hybrid" system, and the "related" system; that is, $\overline{k}_1^S < \overline{k}_1 < \overline{k}_1^R$. When $b > \frac{1}{n}\varphi_N$, the opposite is true; $\overline{k}_1^R < \overline{k}_1 < \overline{k}_1^S$.

3. Thus, when $b < \frac{\varphi_N}{n}$ holds, the "separate" system produces far intensive monitoring than the board of the "hybrid" system and the "related" system. When $b > \frac{\varphi_N}{n}$ holds, the board *under the "related" system produces far intensive monitoring followed by the board under the "hybrid" system and the "related" system.*

Proof. 1:

Compare (25), (26), and (27). The greater the right-hand side, the greater is the level of monitoring. Holding fix all three $\overline{k}_1$s at the same level, it is obvious that $\zeta_S^*\left(\overline{k}_1\right) > \zeta\left(\overline{k}_1\right) > \zeta_R^*\left(\overline{k}_1\right)$ holds when b is smaller than $\frac{\varphi_N}{n}$. With the same logic, $\zeta_S^*\left(\overline{k}_1\right) < \zeta\left(\overline{k}_1\right) < \zeta_R^*\left(\overline{k}_1\right)$ holds when b is larger than $\frac{\varphi_N}{n}$.

2:

From (21) and (25), $\overline{k}_1$ for the "hybrid" systems is expressed as

$$\overline{k}_1 = \overline{k}_0\left\{1 + \frac{(1-Z)b}{Z\varphi_H + (1-Z)\varphi_N - \varphi_I - (1-Z)\left[\frac{n_1}{n}b + \frac{n_2}{n}\frac{\varphi_N}{n}\right]}\right\}. \tag{28}$$

Then,

$$\overline{k}_1^S = \overline{k}_0\left\{1 + \frac{(1-Z)b}{Z\varphi_H + (1-Z)\varphi_N - \varphi_I - (1-Z)b}\right\}, \tag{29}$$

$$\overline{k}_1^R = \overline{k}_0\left\{1 + \frac{(1-Z)b}{Z\varphi_H + (1-Z)\varphi_N - \varphi_I - (1-Z)\frac{\varphi_N}{n}}\right\}. \tag{30}$$

From (28), (29), and (30) we can conclude (28) is always between (29) and (30).

3:

From (25), (26), (27), (28), (29), and (30), it is clear that when $b < \frac{\varphi_N}{n}$, the level of monitoring is intense according to priority of the "separate" system, the "hybrid" system, and the "related" system. Next suppose $b > \frac{\varphi_N}{n}$, then the level of monitoring is intense according to priority of the "related"system, the "hybrid" system, and the "separate" system. ■

The above Proposition holds because the marginal expected loss for the initial players induced by marginal increase in monitoring level is higher in a system where "leak" is large. Thus, if "leak" is large, monitoring level becomes less intense since the marginal disutility of monitoring equals expected profit minus "leak." This implies when comparing the systems, the system with the smallest "leak" generates the strongest monitoring.

Next we consider the case in which the board composition of the "hybrid" system is changed. To be more specific, holding the whole board size fixed and changing the ratio of the directors who cannot become CEO and who can become CEO of the board, we obtain

Proposition 4 *1. Holding fix the whole board size and increasing the number of directors who cannot become CEO, the level of monitoring increases if the amount of "leak" related to the new CEO is small relative to the amount of "leak" related to the new board member.*

2. Holding fix the whole board size and increasing the number of directors who can become CEO, the level of monitoring increases if the amount of "leak" related to the new board member is small relative to the amount of "leak" related to the new CEO.

Proof. 1. Holding fix the other parameters and partially differentiating (25) with respect to n_1 we obtain

$$\frac{\partial \zeta^*\left(\overline{k}_1^*\right)}{\partial n_1} = \frac{1}{d''(\zeta^*\left(\overline{k}_1^*\right))} \frac{(1-Z)}{\overline{k}_0} \left[-b + \frac{\varphi_N}{n}\right].$$

Thus when $\frac{\varphi_N}{n} > b$ holds, the level of monitoring increases, but when $\frac{\varphi_N}{n} < b$ holds, the level of monitoring decreases.

2. Holding fix the other parameters and partially differentiating (25) with respect to n_2 we obtain

$$\frac{\partial \zeta^*\left(\overline{k}_1^*\right)}{\partial n_2} = \frac{1}{d''(\zeta^*\left(\overline{k}_1^*\right))} \frac{(1-Z)}{\overline{k}_0} \left[b - \frac{\varphi_N}{n}\right].$$

Thus when $\frac{\varphi_N}{n} < b$ holds, the level of monitoring increases, but when $\frac{\varphi_N}{n} > b$ holds, the level of monitoring decreases. ■

Proposition 4 implies that if the marginal increase of $\frac{n_1}{n}b$ (which is a "leak" to the new CEO) is larger than the marginal decrease of $\frac{n_2}{n}\frac{\varphi_N}{n}$ (which is a "leak" to the new board member), the board monitors with less intensity when its composition is changed by increasing the directors who cannot become CEO. Under the same condition, the board monitors with more intensity when its composition is changed by increasing the directors who can become CEO. The above Proposition has significance in that it gives an insight to a company that wishes to reform its board structure since it is not easy to increase or decrease the whole board size, but changing the composition can be attained without much objection. For example, consider the case of Company Q; we assume Q is paying a lot of retirement allowance to the CEO at the end of the fiscal year and the amount paid to the CEO is higher than the final profit each director receives. Then, if Q wishes to reform the board structure so that it would monitor the CEO with more scrutiny, it should raise the number of directors who can become CEO and decrease the number of directors who cannot become CEO of the existent board.

Then we consider the case in which the either of the number of directors who cannot become CEO or who can become CEO of the "hybrid" board is changed by holding fixed the other type. We obtain:

Proposition 5 *1. Increasing the number of directors who cannot become CEO holding fix the number of directors who can become CEO increases the amount of "leak" to the new CEO, but decreases the amount of "leak" to the new board member as well as the probability of the "leak" to the new board member. Thus the level of monitoring appears as the effect of all these effects.*

2. Increasing the number of directors who can become CEO holding fix the number of directors who cannot become CEO increases the amount of "leak" to the new CEO as well as the probability of the "leak" to the new board member , but decreases the amount of "leak" to the new board member. Thus the level of monitoring appears as the effect of all these effects.

3. Increasing both types of directors in the same proportion, the board monitors with more intensity.

Proof. 1. By partially differentiating (25) with respect to n_1 we obtain

$$\frac{\partial\varsigma^*\left(\overline{k}_1^*\right)}{\partial n_1} = \frac{1}{d''(\varsigma^*\left(\overline{k}_1^*\right))}\frac{(1-Z)}{\overline{k}_0}\left[-\frac{n_2}{n^2}b + \frac{n_2}{n^2}\frac{\varphi_N}{n} + \frac{n_2}{n^2}\frac{\varphi_N}{n}\right].$$

Thus when $\frac{n_2}{n^2}\frac{\varphi_N}{n} + \frac{n_2}{n^2}\frac{\varphi_N}{n} > \frac{n_2}{n^2}b$ holds, the level of monitoring increases, but when $\frac{n_2}{n^2}\frac{\varphi_N}{n} + \frac{n_2}{n^2}\frac{\varphi_N}{n} < \frac{n_2}{n^2}b$ holds, the level of monitoring decreases.

2. By partially differentiating (25) with respect to n_2 we obtain

$$\frac{\partial\varsigma^*\left(\overline{k}_1^*\right)}{\partial n_2} = \frac{1}{d''(\varsigma^*\left(\overline{k}_1^*\right))}\frac{(1-Z)}{\overline{k}_0}\left[\frac{n_1}{n^2}b + \frac{n_2}{n^2}\frac{\varphi_N}{n} - \frac{n_1}{n^2}\frac{\varphi_N}{n}\right].$$

Thus when $\frac{n_1}{n^2}b + \frac{n_2}{n^2}\frac{\varphi_N}{n} > \frac{n_1}{n^2}$ holds, the level of monitoring increases, but $\frac{n_1}{n^2}b + \frac{n_2}{n^2}\frac{\varphi_N}{n} < \frac{n_1}{n^2}\frac{\varphi_N}{n}$ holds, the level of monitoring decreases.

3. By multiplying both n_1 and n_2 of (25) with α, and then partially differentiating it with α we obtain

$$\frac{\partial\varsigma^*\left(\overline{k}_1^*\right)}{\partial \alpha} = \frac{1}{d''(\varsigma^*\left(\overline{k}_1^*\right))}\frac{(1-Z)}{\overline{k}_0}n_2 n^{-1}\alpha^{-2}\varphi_N,$$

where $\alpha > 0$ is the parameter indicating that n_1 and n_2 increase in the same proportion. From the above equation, $\frac{\partial\varsigma^*\left(\overline{k}_1^*\right)}{\partial \alpha} > 0$ and hence it is clear that the monitoring level always increases. ■

Proposition 5 implies that when the board composition is changed, its level of monitoring is determined as a result of the following effects; the marginal change in $\frac{n_1}{n}b$ (which is "leak" to the new CEO), and the marginal change in $\frac{n_2}{n}\frac{\varphi_N}{n}$ (which is "leak" to the new board member). Note that the marginal change in $\frac{n_2}{n}\frac{\varphi_N}{n}$ can be decomposed into the marginal change in $\frac{n_2}{n}$ multiplied by $\frac{\varphi_N}{n}$ and the marginal change in $\frac{\varphi_N}{n}$ multiplied by $\frac{n_2}{n}$. In the case of increasing the number of directors who cannot become CEO, $-\frac{n_2}{n^2}b$ is the marginal change of the amount to the new CEO, $\frac{\varphi_N}{n^2}$ is the marginal change in $\frac{\varphi_N}{n}$, and $\frac{n_2}{n^2}$ is the marginal change in the probability. Thus, the total effect is $-\frac{n_2}{n^2}b+\frac{n_2}{n}\frac{\varphi_N}{n^2}+\frac{n_2}{n^2}\frac{\varphi_N}{n}$. This Proposition has meaning to a new company whose board composition is yet to be determined. For example, consider the case of Company R; we assume that R is going to be registered very soon. Some members are already determined to serve as directors, but they want to increase the number of directors. In this kind of situation, the issue is to increase the number of independent directors or inside directors. Former can be regarded as the director who cannot become CEO, and the latter can be regarded as the director who can become CEO of our model. Then, the decision to increase which type of director can be determined by the possibility and the amount of "leak."

4 Conclusion

In this paper we considered the monitoring levels under alternative governance systems. We find that monitoring introduces the trade-off between the positive effect of the expected profit and the negative effect of the "leak" regardless of the formation of the corporate governance system. "Leak" is inevitable to avoid under any corporate governance system where at least one of the initial players are expected to be changed. Since "leak" is the expected loss for the initial players, players act in a way to avoid it. However, if the board monitors, it surely increases the profit of the firm, but at the same time increases the possibility of "leak." This simply means the board incurs not only the monitoring cost, but also "leak" when it monitors. Thus, despite the conventional wisdom, board characteristics does not affect monitoring levels. We conclude that the governance system with less "leak" produces the intense monitoring.

As for the future research, we will see the effects of the parameters which we treated exogenous in this paper; the initial board composition $\overline{k}_0$, the size of the board n, and the private benefit b of the CEO. Specifically we wish to treat some of these parameters endogenously by extending this model to the repeated game model.

References

1. Alvin, Roth E. "*Axiomatic models of bargaining.*" Lecture Notes in Economics and Mathematical Systems 170, Berlin ; New York: Springer-Verlag, 1979.

2. Berle, Adolf A. and Means, Gardiner C. "The Modern Corporation and Private Property." New York: Macmillan, 1932.

3. Harris, Milton and Raviv, Artur "A Theory of Board Control and Size." *mimeo.*

4. Hermalin, Benjamin E. and Weisbach, Michael S."Endogenously Chosen Board of Directors and Their Monitoring of the CEO." *American Economic Review, 1998,* 88, pp. 96-118.

5. Raheja, Charu G. "Determinants of Board Size and Composition: A Theory of Corporate Boards." *Journal of Financial and Quantitative Analysis*, 2005, 40(2), pp. 283-306.

6. Sarra, Janis and Nakahigashi, Masafumi [2002] "Balancing Social and Corporate Culture in The Global Economy: The Evolution of Japanese Corporate Structure and Norms," *Journal of Law and Policy,* 24(4), 299-354(56).

7. Sato, Meg A. "Corporate Structure and Monitoring: Comparison of Alternative Systems of Corporate Governance." COE-F-133, Facutly of Economics, University of Tokyo.

8. Shleifer, Andrei and Vishny, Robert W. "A Survey of Corporate Governance." *Journal of Finance*, 1997, 52(2), pp.737-783.

9. Tirole, Jean "The Theory of Corporate Finance." Princeton, N.J.: *Princeton University Press,* 2006.

10. Wilson, Robert "The Theory of Syndicates." *Econometrica*, 1968, 36(1), pp119-132.

Appendix

Proof that the threat point is an interior point in the "separate" system

The addition of the threat points for the board and the CEO is

$$\zeta_0^* \left[Q\varphi_{NH} + (1-Q)\,\varphi_N\right] + (1-\zeta_0^*)\,\varphi_N - \overline{k}_0 \cdot d(\zeta_0^*). \tag{31}$$

The addition of the utilities for both players are

$$\begin{aligned} &\zeta[Z \cdot \varphi_H + (1-Z) \cdot \varphi_N] + (1-\zeta)\varphi_I \\ &-\overline{k}_0 \cdot d(\zeta) + [\zeta Z + (1-\zeta)]\, b. \end{aligned} \tag{32}$$

From (15), it is clear that (32) > (31) when we plug ζ_0^* into (32). Hence, participation constraint is satisfied.

q.e.d.

Proof that the threat point is an interior point in the "related" system

The addition of the threat points for the board and the CEO is

$$\theta_0^R = \frac{n_2}{n}\Bigg\{\zeta_0^* \cdot Q\left[\left(\frac{n-1}{n}\right)\varphi_{NH} + b\right] \tag{33}$$
$$+\zeta_0^*(1-Q)\left[\left(\frac{n-2}{n}\right)\varphi_N + \left(\frac{n-1}{n}\right)b\right] + (1-\zeta_0^*)\left[\left(\frac{n-1}{n}\right)\varphi_N + b\right] - \overline{k}_0 \cdot d(\zeta^*)\Bigg\}.$$

The addition of the utilities for both players are

$$\left[\zeta^*\left(\overline{k}_1\right) \cdot Z + \left(1-\zeta^*\left(\overline{k}_1\right)\right)\right] b + \tag{34}$$
$$\zeta^*\left(\overline{k}_1\right)\left[Z\varphi_H + (1-Z)\left(\frac{n-1}{n}\varphi_N + b\right)\right]$$
$$+(1-\zeta^*\left(\overline{k}_1\right))\varphi_I - \overline{k}_0 \cdot d(\zeta^*\left(\overline{k}_1\right)).$$

From (15), it is clear that (34) > (33) when we plug ζ_0^* into (33). Hence, participation constraint is satisfied.

q.e.d.

Proof of (25)

$$V = \Bigg\{\frac{n_1}{n}\left[\zeta^*\left(\overline{k}_1\right) \cdot \left[Z\varphi_H + (1-Z)\varphi_N\right] + \left(1-\zeta^*\left(\overline{k}_1\right)\right)\varphi_I - \overline{k}_0 \cdot d(\zeta^*\left(\overline{k}_1\right)) - \theta_0^S\right]$$
$$-w_1\Bigg\}^{\frac{n_1}{n}} \times \Bigg\{\frac{n_2}{n}\left[\zeta^*\left(\overline{k}_1\right) \cdot \left[Z\varphi_H + (1-Z)\left(\frac{n-1}{n}\varphi_N + b\right)\right] + \left(1-\zeta^*\left(\overline{k}_1\right)\right)\varphi_I\right.$$
$$\left. -\overline{k}_0 \cdot d(\zeta^*\left(\overline{k}_1\right)) - \theta_0^R\right] - w_2\Bigg\}^{\frac{n_2}{n}} \times \Bigg\{\left[\zeta^*\left(\overline{k}_1\right) \cdot Z + \left(1-\zeta^*\left(\overline{k}_1\right)\right)\right]b + w_1 + w_2 - \theta_c\Bigg\}.$$

For simplicity, we denote the first bracket as A, the second bracket as B, and the third bracket as C.

The two first-order conditions $\frac{\partial V}{\partial w_1} = \frac{\partial\left(A^{\frac{n_1}{n}} B^{\frac{n_2}{n}} C\right)}{\partial w_1} = 0$, and $\frac{\partial V}{\partial w_2} = \frac{\partial\left(A^{\frac{n_1}{n}} B^{\frac{n_2}{n}} C\right)}{\partial w_2} = 0$ constitute 2 equations in the 2 unknown endogenously chosen wages, w_1 and w_2.

$$\begin{aligned} w_1 &= \frac{n_1}{2n}[\zeta^*\left(\overline{k}_1\right) Z\varphi_H + (1-\zeta^*\left(\overline{k}_1\right))\varphi_I - \overline{k}_0 d(\zeta^*\left(\overline{k}_1\right)) + \theta_c + b\left(\zeta^*\left(\overline{k}_1\right) - \zeta^*\left(\overline{k}_1\right) Z\right. \\ &\left. -1\right)] + \frac{n_1(n_1+2n_2)}{2n^2}\zeta^*\left(\overline{k}_1\right)(1-Z)\varphi_N - \frac{n_1(n_1+2n_2)}{2n^2}\theta_0^S + \frac{n_1 n_2}{2n^2}\theta_0^R \\ &-\frac{n_1 n_2}{2n^2}\zeta^*\left(\overline{k}_1\right)(1-Z)(b + \frac{n-1}{n}\varphi_N). \end{aligned}$$

$$\begin{aligned} w_2 &= \frac{n_2}{2n}[\zeta^*\left(\overline{k}_1\right) Z\varphi_H + (1-\zeta^*\left(\overline{k}_1\right))\varphi_I - \overline{k}_0 d(\zeta^*\left(\overline{k}_1\right)) + \theta_c + b\left(\zeta^*\left(\overline{k}_1\right) - \zeta^*\left(\overline{k}_1\right) Z\right. \\ &\left. -1\right)] - \frac{n_1 n_2}{2n^2}\zeta^*\left(\overline{k}_1\right)(1-Z)\varphi_N + \frac{n_1 n_2}{2n^2}\theta_0^S - \frac{(2n)n_2}{2n^2}\theta_0^R \\ &+\frac{2nn_2}{2n^2}\zeta^*\left(\overline{k}_1\right)(1-Z)(b + \frac{n-1}{n}\varphi_N). \end{aligned}$$

Plugging w_1 into A yields

$$\begin{aligned} &\frac{n_1}{2n}\zeta^*\left(\overline{k}_1\right) Z\varphi_H + \frac{n_1^2}{2n^2}\zeta^*\left(\overline{k}_1\right)(1-Z)\varphi_N \\ &+\frac{n_1 n_2}{2n^2}\zeta^*\left(\overline{k}_1\right)(1-Z)(b + \frac{n-1}{n}\varphi_N) \\ &+\frac{n_1}{2n}[\left(1-\zeta^*\left(\overline{k}_1\right)\right)\varphi_I - \overline{k}_0 \cdot d(\zeta^*\left(\overline{k}_1\right)) - \theta_c - b\left(\zeta^*\left(\overline{k}_1\right) - \zeta^*\left(\overline{k}_1\right) Z - 1\right)] \\ &-\frac{n_1^2}{2n^2}\theta_0^S - \frac{n_1 n_2}{2n^2}\theta_0^R. \end{aligned} \tag{35}$$

Plugging w_2 into B yields

$$\begin{aligned} &\frac{n_2}{2n}\zeta^*\left(\overline{k}_1\right) Z\varphi_H + \frac{n_1 n_2}{2n^2}\zeta^*\left(\overline{k}_1\right)(1-Z)\varphi_N + \frac{n_2^2}{2n^2}\zeta^*\left(\overline{k}_1\right)(1-Z)(b + \frac{n-1}{n}\varphi_N) \\ &+\frac{n_2}{2n}[\left(1-\zeta^*\left(\overline{k}_1\right)\right)\varphi_H - \overline{k}_0 \cdot d(\zeta^*\left(\overline{k}_1\right)) - \theta_c - b\left(\zeta^*\left(\overline{k}_1\right) - \zeta^*\left(\overline{k}_1\right) Z - 1\right)] \\ &-\frac{n_1 n_2}{2n^2}\theta_0^S - \frac{n_2^2}{2n^2}\theta_0^R. \end{aligned} \tag{36}$$

Plugging w_1 and w_2 into C yields

$$\begin{aligned} C &= \frac{1}{2}[\zeta^*\left(\overline{k}_1\right)Z\varphi_H + (1-\zeta^*\left(\overline{k}_1\right))\varphi_I - \overline{k}_0\cdot d(\zeta^*\left(\overline{k}_1\right)) - \theta_c - b\left(\zeta^*\left(\overline{k}_1\right) - \zeta^*\left(\overline{k}_1\right)Z\right. \\ &\left.-1\right)] + \frac{n_1}{2n}\zeta^*\left(\overline{k}_1\right)(1-Z)\varphi_N + \frac{n_2}{2n}\zeta^*\left(\overline{k}_1\right)(1-Z)(b+\frac{n_2-1}{n_2}\varphi_N) \\ &-\frac{n_1}{2n}\theta_0^S - \frac{n_2}{2n}\theta_0^R. \end{aligned} \tag{37}$$

Then, we multiply (36) with $\frac{n}{n_2}$. That is,

$$\begin{aligned} &\frac{n_2}{2n}\frac{n}{n_2}\zeta^*\left(\overline{k}_1\right)Z\varphi_H + \frac{n_1n_2}{2n^2}\frac{n}{n_2}\zeta^*\left(\overline{k}_1\right)(1-Z)\varphi_N \\ &+\frac{n_2^2}{2n^2}\frac{n}{n_2}\zeta^*\left(\overline{k}_1\right)(1-Z)(b+\frac{n-1}{n}\varphi_N) \\ &+\frac{n_2}{2n}\frac{n}{n_2}[\left(1-\zeta^*\left(\overline{k}_1\right)\right)\varphi_I - \overline{k}_0\cdot d(\zeta^*\left(\overline{k}_1\right)) - \theta_c - b\left(\zeta^*\left(\overline{k}_1\right) - \zeta^*\left(\overline{k}_1\right)Z - 1\right)] \\ &-\frac{n_1n_2}{2n^2}\frac{n}{n_2}\theta_0^S - \frac{n_2^2}{2n^2}\frac{n}{n_2}\theta_0^R. \end{aligned}$$

It is obvious that

$$\frac{n_2C}{n} = B. \tag{38}$$

Next, multiply (35) with $\frac{n}{n_1}$,

$$\begin{aligned} &\frac{n_1}{2n}\frac{n}{n_1}\zeta^*\left(\overline{k}_1\right)Z\varphi_H + \frac{n_1^2}{2n^2}\frac{n}{n_1}\zeta^*\left(\overline{k}_1\right)(1-Z)\varphi_N + \frac{n_1n_2}{2n^2}\frac{n}{n_1}\zeta^*\left(\overline{k}_1\right)(1-Z)(b+\frac{n-1}{n}\varphi_N) \\ &+\frac{n_1}{2n}\frac{n}{n_1}[\left(1-\zeta^*\left(\overline{k}_1\right)\right)\varphi_I - \overline{k}_0\cdot d(\zeta^*\left(\overline{k}_1\right)) - \theta_c - b\left(\zeta^*\left(\overline{k}_1\right) - \zeta^*\left(\overline{k}_1\right)Z - 1\right)] \\ &-\frac{n_1^2}{2n^2}\frac{n}{n_1}\theta_0^S - \frac{n_1n_2}{2n^2}\frac{n}{n_1}\theta_0^R. \end{aligned}$$

Again, it is clear that

$$\frac{n_1C}{n} = A. \tag{39}$$

Recall that

$$V = A^{\frac{n_1}{n}}B^{\frac{n_2}{n}}C,$$

and hence plugging (38) and (39) into the first order condition with respect to $\zeta^*\left(\overline{k}_1\right)$ yields

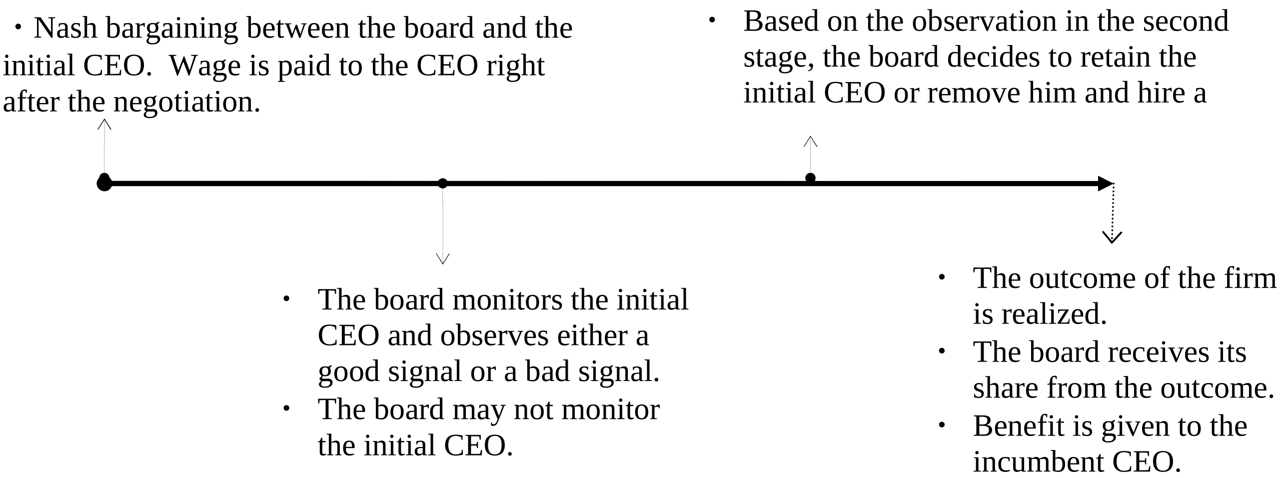
$$\begin{aligned}
&\frac{n_1}{n}\left[\left(Z\varphi_H + (1-Z)\,\varphi_N\right) - \varphi_I - \overline{k}_0 \cdot d'(\zeta^*\left(\overline{k}_1\right))\right] \\
&+\frac{n_2}{n}\left[\left(Z\varphi_H + (1-Z)\,(\frac{n-1}{n}\varphi_N + b)\right) - \varphi_I - \overline{k}_0 \cdot d'(\zeta^*\left(\overline{k}_1^*\right))\right] \\
&+(Z-1)\,b = 0.
\end{aligned}$$

Thus,

$$d'(\zeta^*\left(\overline{k}_1^*\right)) = \frac{1}{\overline{k}_0}\left\{Z\varphi_H + (1-Z)\,\varphi_N - \varphi_I - (1-Z)\left(\frac{n_1}{n}b + \frac{n_2}{n}\frac{\varphi_N}{n}\right)\right\}.$$

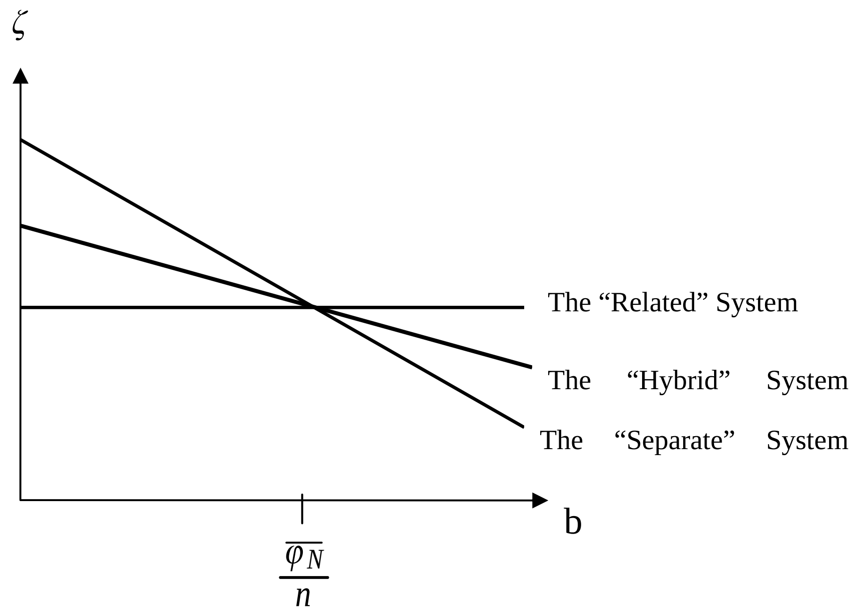
q.e.d.

Figure One



・Nash bargaining between the board and the initial CEO. Wage is paid to the CEO right after the negotiation.
・ Based on the observation in the second stage, the board decides to retain the initial CEO or remove him and hire a
・ The board monitors the initial CEO and observes either a good signal or a bad signal.
・ The board may not monitor the initial CEO.
・ The outcome of the firm is realized.
・ The board receives its share from the outcome.
・ Benefit is given to the incumbent CEO.

Figure Two


ζ
The "Related" System
The "Hybrid" System
The "Separate" System
b
$\frac{\overline{\varphi_N}}{n}$