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A Theory of Friendly Boards

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ABSTRACT

We analyze the consequences of the board's dual role as advisor as well as monitor of management. Given this dual role, the CEO faces a trade-off in disclosing information to the board: If he reveals his information, he receives better advice; however, an informed board will also monitor him more intensively. Since an independent board is a tougher monitor, the CEO may be reluctant to share information with it. Thus, management-friendly boards can be optimal. Using the insights from the model, we analyze the differences between sole and dual board systems. We highlight several policy implications of our analysis.

> Too much emphasis on monitoring tends to create a rift between non-executive and executive directors, whereas the more traditional job of forming strategy requires close collaboration. In both activities, though, independent directors face the same problem: they depend largely on the chief executive and the company's management for information. (*The Economist* [February 10, 2001, p. 68], describing a survey by PriceWaterhouseCoopers of British boards.)

BOTH THE BUSINESS ROUNDTABLE and the American Law Institute list the provision of advice to management among the top five functions of boards of directors in the United States (Monks and Minnow (1996)). The advisory role of boards is important not only in the sole board system in the United States, but also in the dual board system in, for example, several European countries, in which boards are formally separated into a management board and a supervisory board. While there is a large literature that studies the monitoring role

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of boards, the advisory role has received little attention.[1] This paper examines the implications of combining the board's two roles in the sole board system, and then turns to a discussion of the dual board system.

The board is the ultimate legal authority with respect to decision making in the firm. According to the American Bar Association's Committee on Corporate Laws (1994), this means, among other things, that the board must review and approve fundamental operating and financial decisions, and other corporate plans and strategies. Because managers' preferred projects are not always those that maximize shareholder value, directors must be willing to withhold approval and insist on change. This active participation in the firm's decision making characterizes the monitoring role of the board.

In its advisory role, the board takes a more hands-off approach. The board draws upon the expertise of its members to counsel management on the firm's strategic direction. As one director puts it, "Directors are sounding boards for management. They contribute their opinions as to general policy, and their judgement whenever a problem comes up" (Lorsch and MacIver (1989), p. 64). However, since many board members have full-time jobs in other corporations, they rely on the CEO to provide them with relevant firm-specific information. The better the information the CEO provides, the better is the board's advice.

To analyze the implications of combining the board's two roles, we first present a model of the interaction between a sole board and a CEO. In this model, moral hazard problems arise because the CEO's preferred projects differ from those of the shareholders. When monitoring by the board is successful, the board effectively controls project selection, and the CEO, unable to implement his preferred projects, loses valuable control benefits. When the board does not control project selection, the board advises the CEO. The crucial assumption is that the quality of the board's advice improves as the CEO provides it with better information about the firm's investment opportunities.

In our model, independent boards monitor management more intensively. Thus, the CEO faces a trade-off in sharing information. On the one hand, the board will give better advice if the CEO shares his information. On the other hand, information revealed by the CEO helps the board determine the range of options available to the firm. The more precise the board's information about these options, the greater the risk to the CEO that the board will interfere in decision making. As a result, we show that the CEO will not communicate firm-specific information to a board that is too independent.

At first glance, the advisory and monitoring roles of a sole board complement each other, because the board uses any information the CEO provides both to make better recommendations and to implement better decisions. However, consistent with the quote above, the two roles of the board may also conflict. We show that in selecting their boards, shareholders may choose to play off one role against the other. Specifically, to encourage the CEO to share information,

[1] See the survey by Hermalin and Weisbach (2003). For a recent paper that also analyzes the advisory role of boards, see Song and Thakor (2006).

shareholders may optimally elect a less independent or friendlier board that does not monitor the CEO too intensively.

Several theoretical papers in the finance literature examine why boards may not monitor too intensively. Warther (1998) shows how the management's power to eject board members may result in a passive board. Similarly, Hermalin and Weisbach (1998) use a manager's power over the board selection process to show how board composition is a function of the board's monitoring intensity. These authors also describe how a passive board may arise. Almazan and Suarez (2003) argue that passive (or weak) boards may be optimal because, in their framework, severance pay and weak boards are substitutes for costly incentive compensation. Our paper is similar to Almazan and Suarez (2003) in that we also show that it might be optimal to have a passive (or, in our terminology, management-friendly) board. However, in our paper the driving forces behind this result are the potential conflicts between the different roles of the board.

After analyzing the sole board system, we reinterpret our model to discuss the separation of the board's advisory and monitoring functions in a dual board system. When the two roles are separated, the CEO does not face a trade-off in providing information. The model therefore shows that under certain conditions, shareholders prefer a dual board system to a sole board system. Thus, the model has implications for cross-country variation in governance systems. While the dual board structure allows for the cleanest separation of the board's two roles, it is possible to replicate this structure by separating the roles through the use of board committees. For example, one can view the audit committee in the sole board systems of the United States and the United Kingdom as fulfilling some of the functions of a supervisory board. Under this interpretation, our model may also shed some light on the policy debate concerning audit committees.

In the final part of the paper, we relax the assumption that the board's preferences are aligned with those of the shareholders. In the United States, boards' preferences may diverge from those of shareholders because nonshareholder constituency statutes allow directors to consider the effects of their decisions on nonshareholder stakeholders. Similarly, the preferences of management and supervisory boards may differ from each other in a dual board system because, in some countries, such as Germany, workers are given explicit representation on the supervisory board. We show that when the board's preferences are more closely aligned with those of the CEO, the quality of the advice that the board provides is higher. This is an additional reason why shareholders may benefit from a CEO-friendly board in the sole board system. In the dual board system, shareholders prefer boards whose preferences are adapted to their role.

Our analysis has several policy implications that are particularly relevant given the emphasis on governance reform in both the United States and Europe in the wake of recent corporate scandals. Because boards have been criticized for being too friendly to managers (e.g., U.S. House (2002)), Congress (through the Sarbanes-Oxley Act of 2002), the NYSE, and NASDAQ now require that independent directors play a more important role in firm governance. Others have asked whether a two-tier board structure might enhance board oversight

in countries, such as Britain, that currently have a sole board structure (see the discussion by O'Hare (2003) in *The Financial Times*).

In the context of our model, we find first that policies that enhance board independence may be detrimental for shareholders in a sole board system, but not for shareholders in a dual board system. Second, while the sole board structure can achieve the first–best outcome for shareholders more often than the dual board structure can, the latter is sometimes the second–best option for shareholders. Thus, where possible, shareholders should be allowed to choose between board structures. Finally, our model illustrates that shareholders are always at least weakly better off if the board has an advisory role.

This paper is structured as follows. Section I presents the model of the CEO's trade-off in consulting a sole board in an advisory capacity and discusses its empirical implications. Section II discusses the model's extension to the dual board system and to boards whose preferences may not be aligned with those of the shareholders. In Section III, we highlight the policy implications of our analysis and conclude. We present proofs in the Appendix.

I. The Model

The theory in this paper builds upon four basic ideas. First, the CEO dislikes monitoring by the board because he values control. Second, the CEO likes advising by the board because advice increases firm value without interfering with his choices. Third, both monitoring and advising by the board are more effective when the board is better informed. Finally, in both roles, the board depends crucially on the CEO for firm-specific information.[2]

Similar to the monitoring technology used in previous papers (e.g., Burkart, Gromb, and Panunzi (1997)), in our model the board monitors by interfering with the CEO's project choice. The CEO dislikes board interference both because his interests are not always aligned with the those of the board and because he enjoys private benefits of controlling project choice. Private benefits of control may arise for two reasons. First, as much of the corporate governance literature assumes (see, e.g., the discussion in Dyck and Zingales (2004)), the CEO may attribute a psychic value to being in control, in which case he dislikes board interference per se. Second, he may dislike board interference because it may weaken his authority, which may cause him to lose the respect of his subordinates, making it more difficult for him to manage, and may also diminish his value in the market for CEOs.[3]

Board advising increases firm value because the expertise of the board is complementary to that of the CEO. Moreover, if the CEO provides firm-specific

[2] Raheja (2005) examines the optimal board structure when insiders other than the CEO are an additional source of information to the board.

[3] Consistent with the idea that the CEO may incur significant costs due to board interference, Joseph L. Bower argues in an article in Corporate Board Member (2002) that "Overruling a CEO is very complex. If done formally as a vote—as opposed to effective argument that the CEO sees has persuaded a significant part of the board—it is tantamount to firing the CEO . . . But actual overruling is tough. They did it at Coke, and Douglas Daft remains, but he's been a much less powerful CEO after that."

information to the board, the board's advice is even better. While it is intuitive that the quality of advice is higher when the advisee reveals his private information to his advisor, to our knowledge this link between information revelation and the quality of advice has not been modeled before. We view the modeling of such a relationship as an additional contribution of our paper.

Formally, we model the communication game between the CEO and the board as a standard strategic information transmission game in which the board may distort its advice to influence the CEO's choice.[4] We choose this approach because, as long as the board's preferences are not fully aligned with those of the CEO, the board will have a strategic motive to manipulate its advice. This approach also generates several implications that are unique to it. In particular, as the interests of the CEO and the board converge, the noise in communication decreases, which leads to interesting comparative statics exercises that we explore in Section II.[5]

A. *Setup*

In this section, we describe the setup of our model of a sole board, whose time line we provide in Figure 1.

A.1. Timing

Period 0—Shareholders set up the firm

In period 0, the firm is established and the shareholders hire a CEO. They also elect a board whose degree of independence is given by $I \in [0, 1]$.[6] The board is responsible for both advising and monitoring the CEO.

Because inside directors' careers are dependent on the CEO, they have incentives to cooperate with the CEO. As a result, outsiders are generally considered to be more effective monitors than insiders. However, insiders may also play an important monitoring role because they have access to better information or they have a better understanding of the business environment and the actions taken by the CEO (e.g., Ocasio (1994), Morck (2004), Boumosleh and Reeb (2005)). If insiders are more effective at monitoring than outsiders, then

[4] For classic references, see Milgrom (1981) for sender-receiver games with verifiable information and Crawford and Sobel (1982) for cheap talk games.

[5] Our main results do not depend on the existence of strategic communication. Even if the board always truthfully reveals its information, most of our results in this section still hold. As noted by the referee, truth-telling can sometimes be sustained as an equilibrium outcome even in cheap talk games (e.g., Krishna and Morgan (2001), Battaglini (2002)). In addition, noisy communication can arise even without strategic considerations, as in models of information processing in organizations (Radner (1993), Vayanos (2003)). Thus, in many aspects our model is equivalent to one in which boards report truthfully, but messages are read with error.

[6] While in theory shareholders choose board structure because they elect directors, in practice, they may have little effective control. Nevertheless, different forces, such as activism by institutional investors or the market for corporate control, may lead a firm's board structure to approximate the optimal structure for shareholders.

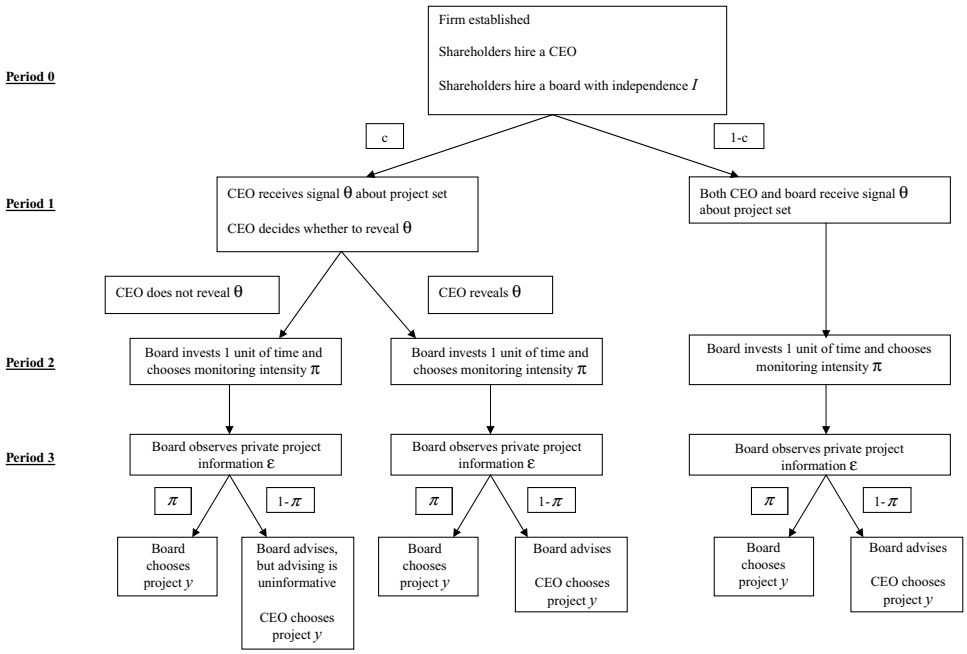

Figure 1. Timeline before the firm is liquidated at the end of Period 3.

we would expect that the first–best board would be packed with insiders. However, because this is the opposite of what most governance advocates argue should be true, we assume that insiders' career concerns inside the firm are sufficiently important that less independent boards face higher costs of monitoring the CEO.

Because board composition changes only infrequently, the initial choice of I functions as a credible commitment to monitor the CEO with the intended intensity. When renegotiation between the CEO and the board is possible, shareholders may commit to monitor the CEO with low intensity by choosing a "friendly board." However, in our model the actual monitoring intensity π will be endogenously chosen by the board. Thus, although it is not possible for shareholders to formally commit to a given monitoring intensity π, the choice of I will affect the board's decision to monitor.[7]

Period 1—The CEO gathers information and communicates with the board

In Period 1, the CEO and the board face a nonroutine project choice decision. We assume that this decision is nonroutine because the board is unlikely to have much of an advisory role on routine issues. There is an infinite number of feasible projects, but the firm can undertake only one of them. We denote each project by a real number $y \in \Re$. At this stage, the CEO and the board may

[7] In Period 0, the shareholders may also decide how much equity-based compensation to award the CEO. To simplify the analysis, we assume that all possibilities of aligning interests by means of incentive pay have already been exhausted.

acquire some firm-specific information that is useful for the project decision. We assume that the CEO is generally in a better position to acquire this information. Formally, we assume that with probability $c \in (0, 1)$, only the CEO acquires this information, while with probability $1 - c$, both the board and the CEO are equally informed. Thus, c is a measure of the degree of information asymmetry between the CEO and the board. The signal θ represents the information about the state of nature. When only the CEO is informed, he may choose to reveal his information to the board.[8]

We assume that the CEO's cost of acquiring information is zero to abstract from potential hold-up problems that may arise when ex post monitoring reduces the value of making ex ante investments in information acquisition, an effect that Burkart et al. (1997) emphasize in the context of monitoring by large shareholders. While introducing information acquisition costs should not change the implications of our analysis substantially, we wish to highlight that monitoring is costly in our model because it has detrimental effects on the incentives of the CEO to communicate openly with the board.

Period 2—The board gathers information and monitors the CEO

After receiving the CEO's report, the board invests one unit of its time to gather its own private signal ε about the profitability of the project. We assume that θ and ε are complements, that is, both pieces of information are relevant for the project choice decision. The board also chooses its monitoring intensity π. Because the board generally prefers a different project from the one the CEO prefers, we consider monitoring as successful if the board can impose its preferred project.

Period 3—Control is allocated and the project is chosen

At the beginning of Period 3, the board observes its private signal ε. With probability π, monitoring is successful and the board has effective control over the project decision. With probability $1 - \pi$, the CEO retains his right to choose his preferred project. In this latter case, the board may send a message a, that is, the board advises the CEO. Because the board may have information that the CEO does not have, its advice is generally informative, even though the board may choose to strategically distort it to influence the CEO's choice. At the end of Period 3, the firm is liquidated.

A.2. Technology, Information, and Preferences

The project y must be chosen from a continuum of sets of projects indexed by a real number $\theta \in \Re$. Our main assumption is that if the board is informed

[8] Since the CEO is always informed, the board could induce the CEO to reveal his signal by offering him a contract in which the board commits to punish the CEO if he does not reveal. However, due to the limited time they spend in the firm, directors may not know what information they need, which makes it difficult for them to implement such contracts. One way to formalize this idea is to assume that there is a probability that both the board and the CEO are uninformed about θ, that is, the arrival of the signal is stochastic. If the probability that the CEO does not obtain a signal is sufficiently high, it will not be optimal for the board to punish the CEO for not revealing information. For the sake of simplicity, we make this assumption only implicitly, that is, we assume that revelation-inducing contracts are not optimal.

about the relevant set of projects, denoted by the state variable θ, then the board obtains its private information ε. If the board remains uniformed about θ, then it cannot learn ε.

Formally, we assume that both the CEO and the board believe that the prior distribution of project sets θ is diffuse with zero mean,

$$\theta \sim U[-\infty, \infty], \tag{1}$$

and both the CEO and the board believe that the prior distribution of ε is uniform on the unit interval,

$$\varepsilon \sim U[0, 1]. \tag{2}$$

Conditional on knowing the realization of the state variable θ, the CEO's posterior belief is that $\varepsilon(\theta)$ is uniformly distributed on the unit interval [0, 1]. If $\theta \neq \theta'$, then $\varepsilon(\theta)$ is independent from $\varepsilon(\theta')$, that is, the $\varepsilon(\theta)$s are independently and identically distributed random variables. Conditional on knowing the realization of the state variable θ, the board learns the true realization of ε with probability one.

One way to motivate our distributional assumptions is to assume that directors have limited time to devote to the firm, and thus the board only has time to investigate one set of projects θ. This assumption makes the information that the CEO provides concerning the relevant project set θ crucial for the quality of the information acquired by the board. When the board invests one unit of time to investigate the project set θ, it learns the true value of $\varepsilon(\theta)$ with probability one. If the board does not learn which project set θ is the relevant one to investigate, board advice becomes uninformative.

We assume that shareholders' preferences can be represented by the following utility function:

$$U_s = -(y - \varepsilon)^2, \tag{3}$$

where y is the chosen project and ε is the random variable defined above. One way to interpret (1) is to think of it as firm value, where the quadratic term represents the technological relationship between inputs (i.e., the chosen project y) and firm profits. For simplicity, we normalize the maximum profit to zero. It is evident from (3) that shareholders would like to choose project $y_s = \varepsilon$, which is the project that maximizes firm value ex post. The problem is that ε is unknown at the start of the game; full knowledge of ε is only possible when the CEO's and the board's expertise are combined.

The CEO's preferences are given by

$$U_c = -(y - \varepsilon + g)^2 + \chi b, \tag{4}$$

where $g > 0$ is a measure of the CEO's bias in project choice, $b > 0$ is a parameter that measures the CEO's private benefits of retaining control over project choice, and χ is an indicator function such that

$$\chi = \begin{cases} 1, & \text{if the CEO retains control} \\ 0, & \text{otherwise} \end{cases}. \tag{5}$$

This utility function formalizes our assumptions that the CEO's preferred project, $y_c = \varepsilon - g$, is different from the shareholders' preferred project and that the CEO values the ability to control project choice. We assume $b > 0$ because the CEO may gain from maintaining his authority both directly, because he values power per se, and indirectly, because his reputation may be damaged when he is not in control.

Finally, shareholders can hire a board with the utility function

$$U_b = -(y - \varepsilon)^2 - C(\pi; I), \tag{6}$$

where $C(\pi; I)$ is the board's cost of monitoring the CEO with intensity π, given the degree of board independence I. These monitoring costs arise because directors may be reluctant to implement projects that are not favored by the CEO. For example, because insiders' careers are tied to the CEO, they may be unwilling to act counter to the CEO's wishes. We assume that $I \in [0, 1]$ is a choice variable from the perspective of the shareholders. The crucial assumption is that more independent boards are more willing to monitor:

$$\frac{\partial^2 C}{\partial \pi \, \partial I} < 0. \tag{7}$$

The board's preferences differ from those of the shareholders only in their disutility in monitoring. This is natural, since shareholders in many countries, such as the United States and the United Kingdom, are dispersed and do not monitor the CEO directly.

To make the board's preferences more realistic, we could also assume that directors have preferences over projects that are coincident neither with the shareholders' preferences nor with the CEO's. In Section II we analyze this case as an extension of the basic model and we show that in this situation, shareholders may have an additional incentive to choose a CEO-friendly board.

B. Analysis of the Model for a Fixed Degree of Board Independence, I

This section analyzes the model when the degree of board independence I is fixed. In Section I.C, we relax this assumption.

B.1. Solving the Game

We solve the game by working backwards. In Period 3, if monitoring is successful the board will have full control over project choice. Minimizing the mean squared error of y from ε, the board will choose

$$y_b = \begin{cases} \varepsilon, & \text{if the board knows } \varepsilon \text{ and } \theta \\ E(\varepsilon) = \dfrac{1}{2}, & \text{if the board does not know } \theta \end{cases}. \tag{8}$$

If monitoring is not successful, the CEO will retain control over project choice. Let $\Im$ be the CEO's information set when he retains control in Period 3. His choice of project will be

$$y_c = \arg\min_{y \in \Re} E[(y - \varepsilon + g)^2 \mid \Im]. \tag{9}$$

If the CEO does not receive any information from the board, which happens when the board is uninformed or chooses to send an uninformative message to the CEO, the project that minimizes the mean squared error of y from $\varepsilon - g$ is $y_c = \frac{1}{2} - g$. Otherwise, the CEO's choice depends on the informativeness of the message that the board sends.

B.2. Information and the Quality of Advice

This section describes the advice that the board gives to the CEO and the CEO's optimal choice of project given the board's advice. If the board is uninformed and the CEO does not reveal his information, the board's advice is uninformative. Thus, we focus on the situation in which the board learns θ, either directly or from the CEO.

We model the communication game between the board and the CEO assuming that the board has already invested one unit of time in investigating the set of relevant projects θ and has learned ε. First, we introduce some notation. Let $a \in [0, 1]$ denote a message (advice) the board sends to the CEO. Let $q(a \mid \varepsilon)$ denote the probability (density) function that the board sends the message a when it has observed ε. This is an "advising rule," which is chosen by the board. A Perfect Bayesian Nash Equilibrium for this game is defined as follows:

DEFINITION 1: *A Perfect Bayesian Nash Equilibrium for the advising game consists of a family of advising rules* $q(a \mid \varepsilon)$, *such that* $\int_0^1 q(a \mid \varepsilon) da = 1$ *for all* $\varepsilon \in [0, 1]$, *and a project choice function for the CEO, denoted* $y(a)$, *such that:*

(a) for each $\varepsilon \in [0, 1]$, *if* $q(a' \mid \varepsilon) > 0$ *then*

$$a' \in \arg\min_{a \in [0,1]} [y(a) - \varepsilon]^2;$$

(b) for each $a \in [0, 1]$,

$$y(a) \in \arg\min_{a \in [0,1]} \int_0^1 (y - \varepsilon + g)^2 p(\varepsilon \mid a)\, d\varepsilon,$$

where $p(\varepsilon \mid a) \equiv \frac{q(a \mid \varepsilon)}{\int_0^1 q(a \mid t)\, dt}$.

The first part of this definition says that, given the rule $y(a)$, any message a' that the board sends when it observes ε must imply a choice of project $y(a')$ by the CEO that is no worse than any other $y(a'')$ from the board's standpoint. The second part imposes a similar requirement on the equilibrium project choice function: Given the family of advising rules $q(a \mid \varepsilon)$, the project $y(a)$ must be a solution to the CEO's expected utility maximization problem when he observes the message a. The definition also requires that all probabilities be updated according to Bayes's rule.

Our first proposition characterizes the relevant equilibrium for the advising game.

PROPOSITION 1 (Advising Equilibria): *If $g > 0$, then there exists at least one equilibrium with the following properties: There is a positive integer N such that one can define a set of $N + 1$ real numbers, with generic element denoted by a_i, such that $0 = a_0 < a_1 < \cdots < a_{N-1} < a_N = 1$, and*

(a) $y(a) = \frac{a_{i+1}+a_i}{2} - g$ *for all* $a \in (a_i, a_{i+1})$, *and*
(b) $q(a \mid \varepsilon)$ *is uniform, supported on* $[a_i, a_{i+1}]$, *if* $\varepsilon \in (a_i, a_{i+1})$.

This proposition, which follows from Theorem 1 in Crawford and Sobel (1982), states that there is a "partition" equilibrium in which the board intentionally distorts its advice by adding noise to it, that is, the CEO only learns in which interval (a_i, a_{i+1}) the realization of ε lies. The CEO understands the board's strategy and, in equilibrium, chooses the average project in the interval (a_i, a_{i+1}) minus his bias g. It is important to note that there might be many partition equilibria of this sort, and further that there might be other types of equilibria. In their Theorem 1, Crawford and Sobel also show that any other equilibria will be payoff-equivalent to some partition equilibrium, implying that they will be economically identical. Furthermore, there always exists a *most informative equilibrium*, that is, a partition equilibrium in which the number of intervals N is maximal. As is standard in the cheap talk literature, we choose the most informative equilibrium as the focal one. Thus, in what follows we assume that N is the maximal number of intervals that is supported in equilibrium.[9]

Let σ_ε^2 be the residual variance of ε that the CEO expects to have, ex ante, after hearing the board's advice a in equilibrium. Crawford and Sobel (1982, part 4) show that

$$\sigma_\varepsilon^2 = \frac{1}{12N^2} + \frac{g^2(N^2-1)}{3}, \tag{10}$$

where N is the smallest integer greater or equal to $\tilde{N}$ and

$$\tilde{N} = -\frac{1}{2} + \frac{1}{2}\sqrt{1 + \frac{2}{g}}. \tag{11}$$

[9] For a critique of this equilibrium selection procedure in cheap talk games, see Farrell and Rabin (1996).

The board's advice is more informative when the size of the partition intervals decreases, that is, as N increases. Thus, the residual variance is maximized when $N = 1$; we denote it by $\sigma_M^2 = \frac{1}{12}$.

Intuitively, an informed board can better advise the CEO than an uninformed one. Thus, everything else constant, shareholders must be (weakly) better off when they expect the board to be informed. In order to formalize this idea, we compute the shareholders' expected utility when the board advises as a function of the board's information.

Let i denote the information the board has concerning θ. If $i = \theta$, the board knows the CEO's signal; if $i = \emptyset$, it does not. Conditional on the game arriving at the advising stage, we denote shareholders' ex ante expected utilities in these two scenarios by $E_A U_s(i = \theta)$ and $E_A U_s(i = \emptyset)$, respectively. The following result is straightforward.

PROPOSITION 2 (Information Sharing Implies Better Advice): *In equilibrium, the following holds:*

$$E_A U_s(i = \theta) = -\left(\sigma_\varepsilon^2 + g^2\right) \geq E_A U_s(i = \emptyset) = -\left(\sigma_M^2 + g^2\right). \tag{12}$$

We define the *advisory benefits from information sharing* to be $E_A U_s(i = \theta) - E_A U_s(i = \emptyset) = \sigma_M^2 - \sigma_\varepsilon^2$, which is always nonnegative given that σ_M^2 is the maximal residual variance.

Although our analysis is well defined for any value of the advisory benefits from information sharing, the model is uninteresting when $\sigma_M^2 - \sigma_\varepsilon^2 = 0$. In such cases, the board does not really have a dual role, because only monitoring can add value. For advising and monitoring to interact, it is necessary that $\sigma_M^2 - \sigma_\varepsilon^2 > 0$, which we assume.[10]

B.3. Information and Monitoring Intensity

In this section, we analyze the incentives for the board to monitor in Period 2. A board that knows θ will choose the monitoring intensity that solves

$$\begin{aligned} &\max_{\pi \in [0,1]} \pi E_\varepsilon\left[-(y_b - \varepsilon)^2 \mid i = \theta \right] + (1 - \pi) E_A U_s(i = \theta) - C(\pi; I) \\ &\quad = \max_{\pi \in [0,1]} -(1 - \pi)\left(\sigma_\varepsilon^2 + g^2\right) - C(\pi; I). \end{aligned} \tag{13}$$

We simplify the problem by assuming that the monitoring cost function is quadratic:

$$C(\pi; I) = \frac{\pi^2}{2I}, \tag{14}$$

for $I \in (0, 1]$.

[10] Since the residual variance decreases as N increases, the largest σ_ε^2 that is strictly less than σ_M^2 occurs for $N = 2$. Given the expression for $\tilde{N}$, it follows that the assumption that $\sigma_M^2 > \sigma_\varepsilon^2$ is equivalent to $g \leq \sigma_M^2 = 1/12$.

Thus, the optimal level of monitoring is uniquely determined by the first-order condition

$$\pi(i=\theta;I)=I\left(\sigma_\varepsilon^2+g^2\right) \tag{15}$$

and is always less than one, given our previous assumption that $\sigma_\varepsilon^2<\sigma_M^2=\frac{1}{12}$.

If the board does not know θ, its maximization problem becomes

$$\begin{aligned}&\max_{\pi\in[0,1]}\pi E_\varepsilon\left[-(y_b-\varepsilon)^2\,\middle|\,i=\emptyset\right]+(1-\pi)E_A U_s(i=\emptyset)-\frac{\pi^2}{2I}\\&=\max_{\pi\in[0,1]}-\pi\sigma_M^2-(1-\pi)\left(\sigma_M^2+g^2\right)-\frac{\pi^2}{2I},\end{aligned} \tag{16}$$

which implies that the optimal level of monitoring in this case is given by

$$\pi(i=\emptyset;I)=Ig^2. \tag{17}$$

The following two results follow directly from inspecting conditions (15) and (17).

PROPOSITION 3 (Determinants of the Board's Monitoring Intensity):

(a) $\pi(i=\theta;I)$ *and* $\pi(i=\emptyset;I)$ *are nondecreasing in the degree of board independence* I;
(b) for a given I, $\pi(i=\theta;I)\geq\pi(i=\emptyset;I)$.

The first result simply states that more independent boards will choose to monitor more intensively. This result is straightforward given that we have defined board independence as a variable that reduces the marginal cost of monitoring. The second result is more interesting. It states that better informed boards will choose to monitor more intensively, all else equal.

B.4. The Decision to Share Information

Now we address the information revelation problem, or the first-period decision problem for the CEO. To determine his strategy, the CEO compares his expected utilities from revealing and not revealing his information. When a board with degree of independence I learns his information, the expected utility for the CEO is given by

$$\begin{aligned}EU_c(i=\theta;I)&=\pi(i=\theta;I)E_\varepsilon\left[-(y_b-\varepsilon-g)^2\,\middle|\,i=\theta\right]\\&\quad+[1-\pi(i=\theta;I)]\left\{E_\varepsilon\left[-(y(a)-\varepsilon-g)^2\,\middle|\,i=\theta\right]+b\right\}\\&=-\pi(i=\theta;I)g^2-[1-\pi(i=\theta;I)](\sigma_\varepsilon^2-b)\\&=-\sigma_\varepsilon^2+b+\pi(i=\theta;I)\left(\sigma_\varepsilon^2-g^2-b\right).\end{aligned} \tag{18}$$

If the CEO chooses not to reveal his signal, his expected utility is given by

$$\begin{aligned} EU_c(i=\emptyset;I) &= -\pi(i=\emptyset;I)\left(\sigma_M^2+g^2\right)-[1-\pi(i=\emptyset;I)]\left(\sigma_M^2-b\right) \\ &= -\sigma_M^2+b+\pi(i=\emptyset;I)(-g^2-b). \end{aligned} \tag{19}$$

For a given degree of board independence I, the CEO will choose to reveal his information to the board if and only if[11]

$$EU_c(i=\theta;I)-EU_c(i=\emptyset;I)=\sigma_M^2-\sigma_\varepsilon^2+p(I)(\sigma_\varepsilon^2-b)\geq 0, \tag{20}$$

where we define $p(I)\equiv\pi(i=\theta;I)-\pi(i=\emptyset;I)=I\sigma_\varepsilon^2$. This variable can be interpreted as the *increase in the intensity of monitoring due to information sharing*.

The condition in (20) captures the trade-off that the CEO faces. Intuitively, it can be decomposed into three distinct parts. The first one, $\sigma_M^2-\sigma_\varepsilon^2$, is a measure of the CEO's *advisory benefits from information sharing*. Without the board's advice, the variance of the payoff distribution from the CEO's standpoint is at its maximum, which is σ_M^2. When the CEO shares his information, board advising reduces this variance to σ_ε^2. Thus, $\sigma_M^2-\sigma_\varepsilon^2$ can be regarded as the CEO's gains from obtaining better advice after sharing information with the board.

The second term, $p(I)\sigma_\varepsilon^2$, is a measure of the CEO's *monitoring benefits from information sharing*. Even though the CEO dislikes monitoring by the board, he still prefers a board that is more informed in making decisions to an uninformed board that interferes with his project choice. When monitoring is successful, an informed board will reduce the variance of the payoff distribution from σ_ε^2 to zero, while an uninformed board will have no effect on this variance. Thus, $p(I)\sigma_\varepsilon^2$ can be interpreted as the CEO's marginal expected gain from improved monitoring by the board after sharing his information.

Finally, the last term, $-p(I)b$, is a measure of the CEO's *costs from information sharing*. Better informed boards will interfere with the CEO's choice more frequently. Thus, $-p(I)b$ can be interpreted as the CEO's expected loss in control benefits due to information sharing.

We now characterize the equilibrium when the degree of board independence I is fixed. Define I' to be

$$I'\equiv\begin{cases}\dfrac{\sigma_M^2-\sigma_\varepsilon^2}{\sigma_\varepsilon^2\left(b-\sigma_\varepsilon^2\right)}, & if\, b-\sigma_\varepsilon^2>0,\\ 1, & \text{if } b-\sigma_\varepsilon^2\leq 0.\end{cases} \tag{21}$$

We have the following result:

PROPOSITION 4 (Board Independence and Information Sharing): *The equilibrium is such that:*

(a) if $I\leq I'$, the CEO always reveals θ;
(b) if $I>I'$, the CEO never reveals θ .

[11] We assume that in equilibrium, when the CEO is indifferent between revealing or not revealing his signal to the board, he will choose to reveal.

According to this proposition, there exist equilibria in which the CEO will not share information with the board. Since firm value is higher when the CEO shares his information, this proposition explains why shareholders may prefer a board with which the CEO will communicate.

C. Endogenizing Board Independence

In the previous section, we argue that when the board's preference for monitoring is fixed, the CEO may not share his information with a board that has a dual role in equilibrium, depending on whether $I > I'$ or not. Here we discuss the equilibria that arise when shareholders choose the degree of board independence that maximizes shareholder value.

Let $m(I)$ be an indicator variable concerning the message the CEO sends to the board when his private information is θ and board independence is I. With the convention that $m = 1$ if the CEO communicates openly with the board and $m = 0$ otherwise, it follows from Proposition 4 that

$$m(I) = \begin{cases} 1, & \text{if } I \leq I' \\ 0, & \text{if } I > I' \end{cases}. \tag{22}$$

To characterize the optimal choice of I from the standpoint of the shareholders, for simplicity we assume that shareholders do not internalize the board's cost of monitoring $C(\pi; I)$.[12]

We can write the shareholders' problem as

$$\begin{aligned} \max_{I \in [0,1]} & -c\{m(I)[1 - \pi(i = \theta; I)](\sigma_\varepsilon^2 + g^2) \\ & + [1 - m(I)](\pi(i = \emptyset; I)\sigma_M^2 + [1 - \pi(i = \emptyset; I)](\sigma_M^2 + g^2))\} \\ & - (1 - c)\{[1 - \pi(i = \theta; I)](\sigma_\varepsilon^2 + g^2)\}. \end{aligned} \tag{23}$$

The next proposition characterizes the solution to this problem.

PROPOSITION 5 (Optimal Choice of Board Independence): *The equilibrium is always unique (with respect to the choice of I) and of one of the following three types:*

(a) *the optimal degree of board independence, I^*, is equal to* 1 *and the CEO shares his information $m(1) = 1$;*
(b) *the optimal degree of board independence, I^*, is equal to $I' < 1$ and the CEO shares his information $m(I') = 1$;*

[12] Nothing essential is lost with this assumption, it merely simplifies the algebra. The same qualitative results hold if shareholders compensate the board for its expected costs of monitoring ex ante. Shareholders cannot compensate the board ex post, because we assume that π is nonverifiable effort exerted by the board.

(c) *the optimal degree of board independence, I^*, is equal to* 1 *and the CEO does not share his information* $m(1) = 0$.

The first equilibrium arises whenever the CEO's revelation constraint is not binding when $I' \geq 1$. Because the CEO shares his information, monitoring by the board is more informed, thus the first–best solution obtains. In the second equilibrium, the CEO's revelation constraint is binding, while in the third equilibrium the revelation constraint is not met. In these latter two cases, shareholders compare their expected utilities from inducing or not inducing revelation. In the second equilibrium, the value of the CEO's information is so high that shareholders optimally commit to choose a board whose independence is less than the first–best level to induce the CEO to reveal it. In the third equilibrium, it is too costly to induce the CEO to reveal.

D. Comparative Statics

In this section, we briefly discuss the empirical content of our model. Because empirical proxies are most readily available for the manager's private benefits, we discuss here only the most straightforward results linking cross-sectional differences in the board's monitoring intensity π and independence I to the CEO's control benefits b.

The equilibrium described in Proposition 5 allows for the possibility that shareholders may find it optimal not to induce revelation by the CEO (case (c)). It can be shown that this case can only occur if the information asymmetry between the board and the CEO, as measured by the probability c that only the CEO is informed about θ, is not too high. If c is too high, the board can do nothing but rely on the CEO's information.

The following lemma holds:

LEMMA 1: *There always exists* $c' \in (0, 1)$*, such that if* $c > c'$*, there is no equilibrium in which the CEO does not share information with the board.*

Thus, we initially analyze the more interesting case in which the information asymmetry is not too extreme, $c \leq c'$. If this holds, all three cases in Proposition 5 are possible, depending on the other parameters, of course.

First, we define the expected level of monitoring intensity to be

$$\Pr(i = \theta)\pi(i = \theta; I) + \Pr(i = \emptyset)\pi(i = \emptyset; I). \tag{24}$$

We denote the expected level of monitoring in cases (a), (b), and (c) of Proposition 5 by π^f, π^r, and π^n, respectively, where f refers to the first–best, r refers to revelation, and n refers to no revelation. Proposition 5 implies that the expected level of monitoring intensity chosen by the board will be as follows. If the equilibrium is of type (a), then

$$\pi^f = \sigma_\varepsilon^2 + g^2, \tag{25}$$

which is the first–best level of expected monitoring. Note that π^f does not depend on b.

If the equilibrium is of type (b), then the level of monitoring intensity that makes the CEO just indifferent between revealing and not revealing his information is

$$\pi^r(b) = \frac{\left(\sigma_M^2 - \sigma_\varepsilon^2\right)\left(\sigma_\varepsilon^2 + g^2\right)}{\sigma_\varepsilon^2\left(b - \sigma_\varepsilon^2\right)}. \tag{26}$$

Finally, since $\Pr(i = \theta) = 1 - c$, in the equilibrium of type (c), we have

$$\pi^n = (1-c)\left(\sigma_\varepsilon^2 + g^2\right) + cg^2 = (1-c)\sigma_\varepsilon^2 + g^2, \tag{27}$$

which also does not depend on b.

As the CEO's cost of losing control increases, he is less likely to reveal his information. Thus, as b increases it becomes more costly to induce him to reveal. As a function of his private benefits, optimal monitoring varies nonmonotonically as follows:

PROPOSITION 6 (Relation between Expected Monitoring in Equilibrium and Private Benefits): *Assume that $c \leq c'$. Then, there exist levels of private control benefits b^f and b^n, where $0 < b^f < b^n$, such that:*

- *(a) the expected monitoring intensity of the board is at the first–best level, π^f, if private benefits are less than b^f;*
- *(b) the expected monitoring intensity of the board is $\pi^r(b)$ if private benefits are between b^f and b^n;*
- *(c) the expected monitoring intensity of the board is π^n if private benefits are above b^n.*

The optimal monitoring intensity is a nonmonotonic function of b. As we illustrate in Figure 2, when b is low, the board monitors with the first–best intensity π^f. Beyond b^f, monitoring decreases continuously and then jumps up again to π^n.[13]

In summary, the model implies a (roughly) "U"-shaped relation between board monitoring and private benefits, that is, monitoring decreases then increases with private benefits. As we illustrate in Figure 3, a similar relationship holds between board independence and the CEO's private benefits: When b is low, the board is fully independent, when $b^f < b < b^n$, board independence decreases linearly in b, and when $b > b^n$, the board is fully independent again. Figures 2 and 3 highlight that even when the board is fully independent, the board may not monitor at the first–best level because monitoring is less effective when the board has too little information. While it would be difficult to test the model's implications concerning the extent to which managers share information with their boards, the implied cross-sectional relationships between both board monitoring and independence and CEO private benefits can be examined empirically. Of course, care must be taken in interpreting the results in situations in which b is not exogenous, as we assume in our model.

[13] As Figure 2 illustrates, $\pi^r(b)$ is a convex function of b.

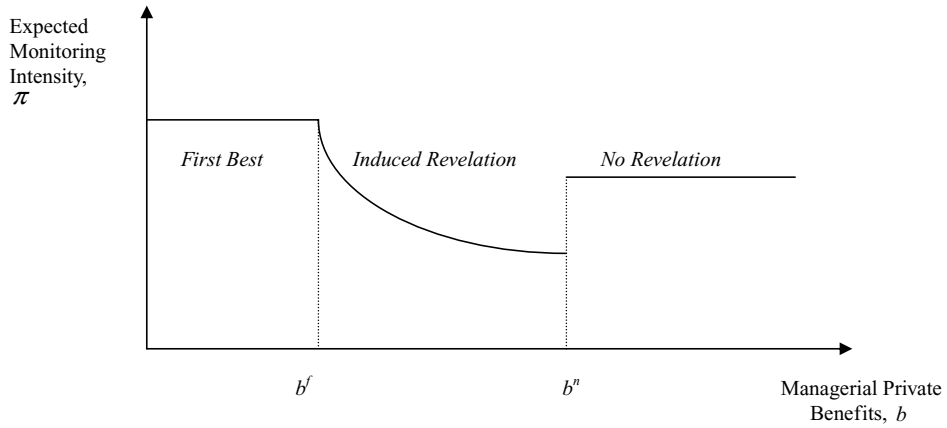

Figure 2. Expected Monitoring Intensity of the Board and Managerial Private Benefits. The figure shows the relationship between the expected monitoring intensity of the board in equilibrium and managerial private benefits when the information asymmetry between the manager and the board is not too extreme. The figure is not drawn to scale. b_f is the level of private benefits below which the manager always shares his information and the expected monitoring intensity of the board is at the first-best level in equilibrium. b_n is the level of private benefits above which the manager does not share his information.

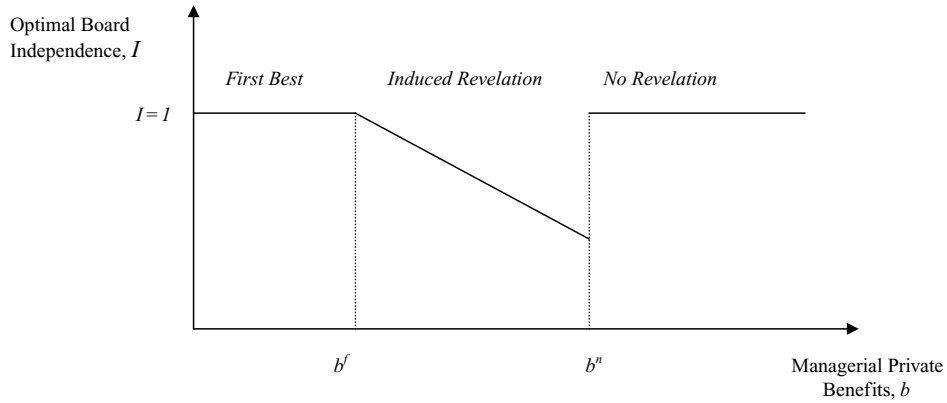

Figure 3. Optimal Board Independence and Managerial Private Benefits. The figure shows the relationship between optimal board independence and managerial private benefits when the information asymmetry between the manager and the board is not too extreme. The figure is not drawn to scale. b_f is the level of private benefits below which the manager always shares his information and board independence is equal to one. b_n is the level of private benefits above which the manager does not share his information.

The role of the CEO's informational advantage c is to determine the point at which it is no longer optimal for shareholders to induce information revelation. As c increases, the threshold b^n in Figures 2 and 3 increases, implying that revelation is the optimal choice for a larger set of values of the CEO's private

benefits of control. If $c > c'$, then it is always optimal to induce revelation, thus monitoring and board independence will be decreasing in b for all values of b larger than b^f. On the other hand, as c decreases, the threshold b^n decreases, which implies that friendlier boards are optimal for a smaller set of firms.

Following Enron, the role of internal control systems has become much more important. For example, a provision of Sarbanes-Oxley requires that CEOs and CFOs certify their financial statements. Such provisions are likely to reduce the information asymmetry between managers and directors, that is, to reduce c. Ceteris paribus, such provisions are also likely to increase the willingness of directors to intervene in decision making, that is, to increase π. With more hard information at their disposal, it will be harder for directors to rubber-stamp the CEO's decisions because of increased liability concerns. While both of these changes are unlikely to eliminate the role of board friendliness, they will make board friendliness less relevant. Thus, we should expect independent boards that monitor more intensively to play a more important role in the future. It is important to realize, however, that unless boards are given better access to information, simply increasing board independence is not sufficient to improve governance.

II. Extensions

A. Separating the Roles of Monitor and Advisor

In this section, we modify our model to discuss what happens when shareholders have an additional mechanism at their disposal, namely, the assignment of the right to monitor the CEO to a board that does not have a dual role. In practice, many governance mechanisms exist that have a pure monitoring function, for example, takeovers. Also, managers often rely on advisors (such as consultants) who play no role in evaluating them. It is instructive, therefore, to think about situations in which it is optimal to separate the two roles rather than combine them in one institution such as the board.

This idea is particularly relevant for the choice of board structure. While boards in the United States combine the two roles to varying degrees, this is not necessarily true in other countries. In Table I, we classify countries, for which we could obtain information, by their board structure types. As is evident from the table, the sole board is by no means the dominant type of board structure. Thus, an analysis of the choice between a board that combines monitoring and advising (a *sole* or *unitary* board) and one that separates the two roles (a *dual* or *two-tier* board) may help us understand cross-country variations in governance.

Because members of the two boards in a dual board system generally do not overlap, the dual board structure allows for the cleanest separation of the board's two roles. Of course, there may be other ways of separating the board's roles, for example, through the use of board committees. In particular, the role of the audit committee in the sole board systems of the United States and the United Kingdom may be similar to that of supervisory boards. As such, our analysis may also help us understand when boards should delegate decision-making to committees.

Table I
Cross-country Variation in Board Structure

The table classifies 40 countries according to whether they have a sole board system, a dual board system, or a mixed system. We classify a country as having a mixed system if different firms can have different types of board structures within that country. For example, in France and Bulgaria, firms are allowed to choose between the sole and the dual board structures, whereas in Switzerland, banks must have a dual board structure. Data sources are Brefort, Tenev, and Zhang (2002), the Institute of Directors in South Africa (1994), Korn/Ferry International (1998), OECD (2001), World Bank and IMF (2001–2002). The dates of the data are from 2001 to 2003 in 25 cases, from 1998 in 12 cases, from 1997 in one case (Thailand) and from 1994 in one case (South Africa). In the case of Ukraine, we are unable to verify the date of the data.

Board Structure Type	Country
Sole board system	Australia, Brazil, Canada, Egypt, India, Italy, Japan, Malaysia, Norway, Philippines, Singapore, South Africa, South Korea, Sweden, Thailand, Turkey, U.S., Ukraine, United Kingdom, Zimbabwe
Dual board system	Austria, Belgium, China, Croatia, Czech Republic, Denmark, Estonia, Georgia, Germany, Holland, Indonesia, Latvia, Mauritius, Poland, Spain, Taiwan
Mixed board structures	Bulgaria, Finland, France, Switzerland

Before discussing the trade-off that shareholders face in deciding between a sole and a dual board system, we first reinterpret our model in order to characterize the equilibrium in a dual board system. We assume that the management board has some expertise and is solely responsible for advising the CEO. The supervisory board has no specialized knowledge and has the sole authority to monitor the CEO. In addition, we assume that the management board does not communicate information it obtains from the CEO to the supervisory board. If both boards communicated perfectly, there would be no real difference between the dual and the sole board.

With this separation of tasks, we obtain the following equilibrium in our model:

PROPOSITION 7 (Dual Board Equilibrium): *In a dual board system:*

(a) the CEO always reveals his information to the management board;
(b) the CEO reveals his information to the supervisory board if and only if $\sigma_\varepsilon^2 \geq b$*;*
(c) the supervisory board monitors with intensity π^f *if* $\sigma_\varepsilon^2 \geq b$*, and with expected intensity* $(1-c)\pi^f$ *if* $\sigma_\varepsilon^2 < b$*;*
(d) the supervisory board is always fully independent, $I_S^* = 1$.

If $\sigma_\varepsilon^2 \geq b$, the monitoring benefits from information sharing exceed the costs from information sharing, thus the CEO is fully aligned with the supervisory board with respect to information disclosure. In such a case, because the CEO always reveals his information, the first–best obtains in both the sole and dual board structures. This case is uninteresting, since there is no trade-off between

the two board structures and board independence is actually favored by the CEO, whose interests are fully aligned with those of the shareholders.

Only when $\sigma_\varepsilon^2 < b$ does the CEO dislike monitoring by the board. In this case, since there is too little monitoring ($(1 - c)\ \pi^f$) in the dual board system, the sole board system is the first–best for all $b \leq b^f$ and is strictly better than the dual board system for all $b \in (\sigma_\varepsilon^2, b^f]$. Thus, the sole board structure may be better than the dual board structure because a sole board can take advantage of information it obtains from the CEO to improve the quality of both monitoring and advising. However, if b is sufficiently large, there will exist a set of firms for which managerial private benefits are such that shareholders prefer to separate the two roles of the board into a dual board structure instead of choosing a more management-friendly sole board. If the value of the CEO's information is high enough that a sole board would choose to monitor with intensity $\pi^r\ (b)$ to induce the manager to reveal it, but $\pi^r(b) < (1 - c)\pi^f$, shareholders prefer a dual board system. The following result holds:

PROPOSITION 8 (Choice of Dual vs. Sole Board System): *There exists a level of CEO private benefits b^D, where $b^f < b^D < b^n$ (provided that b^n exists), such that shareholders prefer a sole board system for all $b \leq b^D$ and a dual board system for all $b \geq b^D$.*

When making their decision about board structure, this proposition shows that shareholders must decide whether using information obtained as part of the advisory process to monitor the CEO is sufficiently important given the trade-off the manager faces. When the gain to using the CEO's information is sufficiently high and the value the CEO attaches to control is not too high, shareholders may prefer a management-friendly sole board to a dual board system. However, as the CEO's private benefits increase, shareholders prefer a dual board system.

In describing the German dual board system, Clarke and Bostock (1997, p. 244) note that "In many companies the flow of information from managers to supervisors is sparse." Although they criticize the dual board structure for this reason, Proposition 8 shows that there may be situations in which it is optimal to limit the flow of information between managers and supervisors.

If one views the audit committee as a variant of the supervisory board, part (d) of Proposition 7 suggests that audit committees should be fully independent. This is consistent with the requirements of the Sarbanes-Oxley Act. On the other hand, our results suggest that the Sarbanes-Oxley provision that companies disclose whether they have financial experts on the audit committee may not be effective. DeFond, Hann, and Hu (2005) examine the market reaction to the appointment of financial experts to the audit committee prior to Sarbanes-Oxley. They find that the market reacts positively only to the appointment of accounting financial experts, as opposed to nonaccounting financial experts or nonexperts. Thus, the market reacts positively only when new directors appear to strengthen the ability of the audit committee to carry out its role. Our results are consistent with theirs, because Proposition 8 states that shareholders may

be better off if the monitoring and the advisory roles of the board are completely separated. If some audit committee members are nonaccounting financial experts whom managers consult in other capacities, the audit committee may take on an advisory nature.

B. Boards with Different Preferences over Projects

So far, we have interpreted a management-friendly board as a board that puts little effort into monitoring the CEO, because it is not too independent. We have also assumed, however, that even a management-friendly board will choose the value-maximizing project, if in control. This assumption may be unrealistic if boards' interests are not the same as those of shareholders, which may be the case for several reasons. For example, in some instances CEOs are involved in the nomination of directors (see, e.g., Shivdasani and Yermack (1999)). Thus, CEOs may choose directors whose interests are more aligned with their interests than with the shareholders' interests. In addition, many states in the United States have enacted so-called nonshareholder constituency statutes, which allow directors to consider the effects of their decisions on nonshareholder stakeholders such as employees, the local community, and the environment. As a result, even though directors in the United States have a fiduciary duty to shareholders, they may still be legally entitled to consider interests other than those of shareholders in decision making.

In the context of the dual board system, the preferences of the management and the supervisory boards may differ from those of the shareholders because workers often have explicit representation on the board.[14] For example, under the German system of codetermination, employees are allocated seats on the supervisory board. Because the supervisory and the management boards have different roles, it is natural to assume that their objectives should differ. We formalize this intuition below by allowing boards to have interests that are coincident with neither the shareholders' nor the CEO's interests.

We first consider a sole board system. We assume that the board has its own bias in project choice, $g_b \in [0, g]$. Note that g_b can also be seen as a measure of board independence. If $g_b = 0$, the board would like to choose the shareholders' preferred project, thus in this sense it is fully independent from the CEO's interests. On the other hand, if $g_b = g$, the board will always choose the CEO's preferred project. Intuition suggests that for a given I, if one could freely choose g_b to maximize expected profits for shareholders, g_b would equal zero. After all, why would shareholders choose a board with bias $g_b > 0$ in project choice? To analyze whether this is the case, we study the effects of changing g_b on three determinants of board effectiveness: the *quality of board advising*, the *quality of board monitoring*, and the *intensity of board monitoring*. For the sake of

[14] Workers may also have representatives on the board in some European sole board systems, for example, in Sweden. This creates an additional wedge between the preferences of sole boards and those of shareholders.

simplicity, we consider the case in which I is fixed at a level at which the CEO's revelation constraint (20) is not binding, so the board always knows θ.

We define the quality of board advising to be $-\sigma_\varepsilon^2$, which is the residual variance of ε that the CEO expects to have after hearing the board's advice in equilibrium. The next proposition describes the effect of g_b on the quality of advice.

PROPOSITION 9 (Board Friendliness and the Quality of Advice): *The residual variance σ_ε^2 is decreasing in $g_b \in [0, g]$.*

Because the shareholders' ex ante expected utility is decreasing in σ_ε^2, shareholders may benefit from a CEO-friendly board due to an increase in the quality of the advice that the board provides. This is an additional reason for choosing a friendly board, a reason that was not present in the previous analysis, in which the board's preferences over projects conformed with the shareholders' preferences. This effect is a formal justification for the claim that "the more traditional job of forming strategy requires close collaboration" in the quote that starts this paper.

Although increasing the board's bias improves the board's advisory performance, it may worsen the board's monitoring performance. We define the quality of monitoring as minus the distance between the project the board picks when it is in control and the shareholders' preferred project: $-|y_b - y_s|$. This value is equal to $-g_b$, implying that the quality of monitoring is decreasing in g_b. Clearly, shareholder value is increasing in the quality of monitoring.

Finally, as before, the intensity of monitoring is given by π. With probability π, the board gains control over project selection and chooses the project $y_b = \varepsilon - g_b$. With probability $1 - \pi$, the CEO retains decision rights over project selection. Knowing θ, the board chooses the level of monitoring intensity that solves

$$\max_{\pi \in [0,1]} -(1-\pi)\left[\sigma_\varepsilon^2 + (g - g_b)^2\right] - \frac{\pi^2}{2I}. \tag{28}$$

The optimal level of monitoring is uniquely determined by the first-order condition

$$\pi(g_b) = I\left[\sigma_\varepsilon^2 + (g - g_b)^2\right]. \tag{29}$$

Since σ_ε^2 is decreasing in g_b, the intensity of monitoring is decreasing in the board's bias g_b. Boards whose preferences over projects are biased away from those of shareholders will not monitor managers as intensively as unbiased boards.

We have shown that, although the quality of advising improves with a biased board, both the *intensity* and the *quality* of monitoring are compromised if the board is too friendly to the CEO, in the sense that its bias g_b is large. We summarize these results in the next proposition.

PROPOSITION 10 (Board Friendliness and Shareholder Value): *Suppose that the CEO reveals his information to a board with bias g_b. Then, the following holds:*

(a) increasing the board's bias, g_b, improves the board's advising role and, holding the quality and intensity of monitoring constant, increases shareholder value;
(b) increasing the board's bias, g_b, worsens the board's monitoring role and, holding the quality of advising constant, decreases shareholder value.

The choice of an optimal g_b trades off these two conflicting forces. On the one hand, a large g_b improves advising because the board will communicate more openly with the CEO; on the other hand, a larger g_b reduces both the intensity and the quality of monitoring. Although solving for the optimal g_b in the shareholder's maximization problem involves no conceptual difficulties, explicitly solving for the optimal g_b is cumbersome because, while σ_ε^2 is a continuous function of g_b, it is not always differentiable.[15] Regardless, an explicit solution is not necessary for our purposes. It is sufficient to note that, due to the trade-off we describe above, for a given I the optimal g_b will not always be zero (nor equal to g). Intuitively, when π is not very sensitive to g_b, increasing the board's bias will have a small effect on the intensity of monitoring and a relatively larger effect on the quality of advising. In addition, some comparative statics are possible. For example, the optimal bias g_b^* should be inversely related to I because an increase in I makes the marginal effect of g_b on π even more negative, making it more costly to increase g_b:[16]

$$\frac{\partial^2 \pi}{\partial g_b \partial I} = \frac{d\sigma_\varepsilon^2}{dg_b} - 2(g - g_b) < 0. \tag{30}$$

In other words, boards that face high costs of monitoring the CEO (low I) should optimally have a high bias g_b^*. This implies that when boards are pressured to be independent, it might be optimal to also limit CEO participation on the nominating committee to help ensure that directors' preferences are not too aligned with those of the CEO. Of course, a complete analysis of the sole board system would allow for the simultaneous choice of I and g_b. Again, it is unnecessary to fully solve the problem to realize that to induce the CEO to reveal his information to the board, for many parameter constellations either board independence I must be less than one or the board's project preferences must be close to those of the CEO, that is, $g_b > 0$, or both. Thus, friendly boards arise optimally.

Our analysis in this section suggests that a unitary board with interests that are not fully aligned with those of shareholders may be optimal due to the effect of board friendliness on the quality of the advice it provides to the CEO. Bertrand and Mullainathan (2003) provide evidence consistent with the idea

[15] That a solution to the maximization problem exists follows immediately from the facts that [0, g] is a compact set and σ_ε^2 is a continuous function of g_b, as we show in the proof of Proposition 9.

[16] Assuming, for simplicity, that we are in a region in which $\frac{d\sigma_\varepsilon^2}{dg_b}$ is well defined.

that managers' interests are aligned with those of workers. If this is the case, our analysis suggests that nonshareholder constituency statutes may not be as detrimental to shareholder value as many argue, because they allow boards' preferences to be more aligned with those of managers.

Another interesting situation arises in the dual board system. In this case, boards' preferences with respect to projects will depend on their role. Intuition suggests that the supervisory board should be aligned with shareholders, while the management board should be aligned with the CEO. The next proposition shows that this intuition is indeed correct.

PROPOSITION 11 (Role-specific Preferences in the Dual Board System): *In the dual board system:*

(a) the optimal supervisory board has preferences that are always fully aligned with those of shareholders, that is, $g_{sb} = 0$ *;*
(b) the optimal management board has preferences that are always fully aligned with those of the CEO, that is, $g_{mb} = g$.

The main implication of this result is that, when a dual board's preferences over projects are optimally chosen, the distortion in the advice given by the management board is zero ($\sigma_\varepsilon^2 = 0$). Since advice provided by a sole board is generally distorted, this is another reason the dual board structure dominates the sole board structure with respect to the advisory role of boards.

We believe that part (a) of this proposition is particularly interesting in light of recent findings by Gorton and Schmid (2004). The authors find that companies with equal representation of employees and shareholders on supervisory boards in Germany trade at a 31% discount compared to companies with only one-third labor representation. They argue that this may be because labor maximizes a different objective function than do shareholders. Part (a) of Proposition 11 is consistent with their findings, since we show that to maximize shareholder value, the supervisory board should be fully aligned with shareholders.

Because the interests of the management board and the CEO are perfectly aligned, we can replace σ_ε^2 by zero for the management board in the dual board equilibrium. Since Proposition 7 continues to hold exactly if σ_ε^2 is replaced by zero, we can see that even when boards' preferences are not fully aligned with those of shareholders, the main trade-off between the sole and dual board structures remains the same.

III. Final Remarks

The question of when advisors should have the authority to evaluate their advisees or when monitors should have the authority to participate in decision making is an interesting question, and one that has, to our knowledge, not been raised before. It is particularly relevant for the study of corporate boards, because we observe both the combination of the two roles (i.e., advising and monitoring) in the sole board system, and the separation of the two roles in the

dual board system. Given the recent worldwide emphasis on governance reform, we believe that our analysis of the interaction between the board's advisory and monitoring roles is especially timely because it has several relevant policy implications.

The first implication of our model is that emphasizing director independence may have adverse consequences in the sole board system. The reason is that managers are less inclined to share information with a sole board as its monitoring intensity increases. With less information, even an independent board cannot monitor effectively. This implies that recent regulation aimed at increasing board independence may decrease shareholder value. However, shareholders may benefit if increases in independence are accompanied by improved disclosure practices. In contrast, enhancing the independence of supervisory boards in a dual board system will not affect the incentives of managers to share information. Thus, increasing the independence of supervisory boards unambiguously increases shareholder value.

When boards have an advisory role, we show that shareholders may be better off if the board's preferences are aligned with those of managers. This suggests that nonshareholder constituency statutes may not be as detrimental to shareholder value as many argue, because they allow boards' preferences to be more aligned with those of managers. On the other hand, our model questions whether workers' interests should be directly represented on the supervisory board in the system of codetermination as in Germany.

Since information generated during the advisory process enhances the monitoring process, as long as managerial control benefits are not too large, our model implies that the first–best outcome for shareholders is implemented by the sole board system. Otherwise, it is better to give shareholders the choice of board structure. In this case, firms that might otherwise be forced to choose a management-friendly sole board may prefer to move to a dual board structure in which monitoring is higher. If one views the audit committee as a variant of the supervisory board, our analysis suggests further that shareholders may benefit from measures that strengthen the audit committee's role as an independent monitor.

Because monitoring is more effective when a sole board also advises, it is important to also consider the board's advisory role when evaluating board effectiveness and composition. Investigating circumstances in which it is optimal to have a board that does not monitor too much has implications for the interaction between monitoring by boards and monitoring by other governance mechanisms. When a management-friendly board is optimal, one should expect other governance mechanisms to pick up the slack.

Appendix: Proofs

Proof of Proposition 1: The proof follows from Theorem 1 in Crawford and Sobel (1982). If one performs the following change of variables,

$$\tilde{y} \equiv y + g, \tag{A1}$$

one can express utilities as

$$\tilde{U}_b = -(\tilde{y} - \varepsilon - g)^2 \tag{A2a}$$

$$\tilde{U}_c = -(\tilde{y} - \varepsilon)^2. \tag{A2b}$$

Now all the conditions of Theorem 1 in Crawford and Sobel (1982) are satisfied, implying that there is a positive integer N such that for every n with $1 \leq n \leq N$, there exists at least one equilibrium in which $q(a \mid \varepsilon)$ is uniform, supported on $[a_i, a_{i+1}]$ if $\varepsilon \in (a_i, a_{i+1})$, where the following conditions hold:

(a) $0 = a_0 < a_1 < \cdots < a_{n-1} < a_n = 1$;
(b) $\tilde{y}(a) = \frac{a_{i+1}+a_i}{2}$ for all $a \in (a_i, a_{i+1})$; and
(c) $(\frac{a_{i+1}+a_i}{2} - a_i - g)^2 - (\frac{a_i+a_{i-1}}{2} - a_i - g)^2 = 0$ for all $i = 1, \ldots, n-1$.

The proof is complete if one notices that

$$y(a) \equiv \tilde{y}(a) - g = \frac{a_{i+1} + a_i}{2} - g. \quad \text{Q.E.D.} \tag{A3}$$

Proof of Proposition 2: If the CEO has control over project selection and the board is informed, that is, $i = \theta$, then from Proposition 1 the board will send a message $a \in [a_i, a_{i+1}]$ if $\varepsilon \in (a_i, a_{i+1})$, implying that the CEO will choose $y_c = \frac{a_{i+1}+a_i}{2} - g$. Using the Law of Iterated Expectations and the fact that $E_\varepsilon\{\varepsilon \mid \varepsilon \in (a_i, a_{i+1})\} = \frac{a_{i+1}+a_i}{2}$, the shareholders' ex ante expected utility when the game arrives at the advising stage in equilibrium is given by

$$\begin{aligned}
&E_A U_s(i = \theta) \\
&\quad = -E_\varepsilon[(y(a) - \varepsilon)^2 \mid i = \theta] \\
&\quad = -E_\varepsilon \left\{ E\left[\left(\frac{a_{i+1} + a_i}{2} - g - \varepsilon \right)^2 \middle| \varepsilon \in (a_i, a_{i+1}) \right] \right\} \\
&\quad = -E_\varepsilon \left\{ E\left[\left(\frac{a_{i+1} + a_i}{2} - \varepsilon \right)^2 - 2g\left(\frac{a_{i+1} + a_i}{2} - \varepsilon \right) + g^2 \mid \varepsilon \in (a_i, a_{i+1}) \right] \right\} \\
&\quad = -\left(\sigma_\varepsilon^2 + g^2\right).
\end{aligned} \tag{A4}$$

When the board is not informed, that is, $i = \emptyset$, it will send an uninformative message to the CEO (i.e., $N = 1$), implying that the residual variance of ε is maximized, which leads to $E_A U_s(i = \emptyset) = -(\sigma_M^2 + g^2)$, completing the proof. Q.E.D.

Proof of Proposition 4: Define the function

$$R(I) = \sigma_M^2 - \sigma_\varepsilon^2 + I\sigma_\varepsilon^2\left(\sigma_\varepsilon^2 - b\right), \tag{A5}$$

which is the left-hand side of the revelation constraint in (20).

If $\sigma_\varepsilon^2 - b < 0$, then for all $I \in (0, 1)$, $\frac{dR(I)}{dI} < 0$. Because $R(I') = 0$ and we assume that the CEO chooses to reveal when he is indifferent, it follows that he reveals if $I \leq I'$ and does not reveal if $I > I'$. If $I' > 1$, then the proposition holds trivially because $I < I'$ and the CEO always reveals.

If $\sigma_\varepsilon^2 - b \geq 0$, then by definition $I' = 1$. This implies that the CEO should always reveal his information if the proposition is valid. Since for all $I \in [0, 1]$, $R(I) \geq 0$, it is indeed true that the CEO always reveals. Q.E.D.

Proof of Proposition 5: First, suppose that the CEO's revelation constraint is not binding. That is, shareholders can choose whichever I they want without affecting the CEO's incentives to communicate with the board. Since in this case $m(I) = 1$, from (23) the shareholders' problem is

$$\max_{I \in [0,1]} -\left[1 - I\left(\sigma_\varepsilon^2 + g^2\right)\right]\left(\sigma_\varepsilon^2 + g^2\right). \tag{A6}$$

Because firm value is always strictly increasing in I in this case, the optimal I^* is equal to one. But this will be an equilibrium only if $I^* = 1$ does not violate the CEO's revelation constraint, that is, we require that $I' \geq 1$. Thus, if the set of parameters is such that $I' \geq 1$, the optimal degree of board independence I^* is equal to one and the manager shares his information, $m(1) = 1$. This is the equilibrium in item (a).

Now consider the case in which $I' < 1$. If shareholders choose to induce revelation in such a case, that is, $m(I) = 1$, the revelation constraint must be binding, that is, $I = I'$, implying that the monitoring intensity is given by

$$\pi(\theta; I') = I'\left(\sigma_\varepsilon^2 + g^2\right) = \frac{\left(\sigma_M^2 - \sigma_\varepsilon^2\right)\left(\sigma_\varepsilon^2 + g^2\right)}{\sigma_\varepsilon^2\left(b - \sigma_\varepsilon^2\right)} \tag{A7}$$

and the shareholders' expected utility is given by

$$EU_s(I = I') = -\left[1 - \frac{\left(\sigma_M^2 - \sigma_\varepsilon^2\right)\left(\sigma_\varepsilon^2 + g^2\right)}{\sigma_\varepsilon^2\left(b - \sigma_\varepsilon^2\right)}\right]\left(\sigma_\varepsilon^2 + g^2\right). \tag{A8}$$

On the other hand, if shareholders choose not to induce revelation, so $m(I) = 0$, the optimal I^* is again equal to one. From (23), shareholders' expected utility is given by

$$EU_s(I = 1) = -c\left[\sigma_M^2 + (1 - g^2)g^2\right] - (1 - c)\left(1 - \sigma_\varepsilon^2 - g^2\right)\left(\sigma_\varepsilon^2 + g^2\right). \tag{A9}$$

Thus, if $I' < 1$, the optimal level of board independence is given by

$$I^* = \begin{cases} I' \text{ if } EU_s(I = I') \geq EU_s(I = 1) \\ 1 \text{ if } EU_s(I = I') < EU_s(I = 1) \end{cases}. \tag{A10}$$

These are equilibria (b) and (c) above. It is straightforward to check that, depending on the parameters, either case is indeed possible (we show that this is so in the next lemma). Q.E.D.

Proof of Lemma 1: We need to establish the existence of at least one c', such that for all $c > c'$, $EU_s(I = I') \geq EU_s(I = 1)$. To do this we define the function

$$\varphi(c) \equiv \lim_{b \to \infty} EU_s(I = I') - EU_s(I = 1). \tag{A11}$$

Because $EU_s(I = I') - EU_s(I = 1)$ is strictly decreasing in b, if $\varphi(c) \geq 0$, then $EU_s(I = I') - EU_s(I = 1)$ is positive for *any* $b > 0$. Thus, it suffices to show that there is a c' such that $\varphi(c) \geq 0$ if $c > c'$.

We have

$$\varphi(c) = -\left(\sigma_\varepsilon^2 + g^2\right) + c\left[\sigma_M^2 + (1 - g^2)g^2\right] + (1 - c)(1 - \sigma_\varepsilon^2 - g^2)\left(\sigma_\varepsilon^2 + g^2\right). \tag{A12}$$

It is easy to verify that there is only one fixed point $c' \in (0, 1)$ such that $\varphi(c') = 0$. In order to see this, note that if $c = 0$,

$$\varphi(0) = -\left(\sigma_\varepsilon^2 + g^2\right) + \left(1 - \sigma_\varepsilon^2 - g^2\right)\left(\sigma_\varepsilon^2 + g^2\right) = -\left(\sigma_\varepsilon^2 + g^2\right)^2 < 0. \tag{A13}$$

Note further that because the assumption of informative advising $\sigma_M^2 > \sigma_\varepsilon^2$ implies that $N \geq 2$ and $g \leq \sigma_M^2 = 1/12$, from (10) the largest value for $\sigma_\varepsilon^2 + g^2$ is $\frac{1}{12 \cdot 4} + (\frac{1}{12})^2 + (\frac{1}{12})^2$, which is strictly less than $\frac{1}{12} = \sigma_M^2$. Thus, if $c = 1$, we have

$$\varphi(1) = -\left(\sigma_\varepsilon^2 + g^2\right) + \sigma_M^2 + (1 - g^2)g^2 > 0. \tag{A14}$$

Because $\varphi(c)$ is strictly increasing, there is only one $c' \in (0, 1)$ such that $\varphi(c') = 0$. If $c > c'$, the condition $EU_s(I = I') < EU_s(I = 1)$ in the proof of Proposition 5 can never occur. Thus, there is no constellation of parameters such that it is optimal for shareholders not to induce the CEO to reveal his information. Q.E.D.

Proof of Proposition 6: Let b^f be the level of private benefits such that

$$R(1) = \sigma_M^2 - \sigma_\varepsilon^2 + \sigma_\varepsilon^2\left(\sigma_\varepsilon^2 - b^f\right) = 0. \tag{A15}$$

For any $b < b^f$ we have that $R(1) > 0$, which implies that the equilibrium is that in case (a) of Proposition 5. In this case, the expected monitoring intensity is given by π^f, proving part (a).

Recall that

$$\lim_{b \to \infty} EU_s(I = I'; b) = -\left(\sigma_\varepsilon^2 + g^2\right). \tag{A16}$$

From Lemma 1, the assumption that $c \leq c'$ implies

$$\lim_{b \to \infty} EU_s(I = I'; b) < EU_s(I = 1). \tag{A17}$$

Now, we also have

$$\begin{aligned} EU_s(I = I'; b^f) &= -\left(1 - \sigma_\varepsilon^2 - g^2\right)\left(\sigma_\varepsilon^2 + g^2\right) \\ &> -c\left[\sigma_M^2 + (1 - g^2)g^2\right] - (1 - c)\left(1 - \sigma_\varepsilon^2 - g^2\right)\left(\sigma_\varepsilon^2 + g^2\right) \\ &= EU_s(I = 1), \end{aligned} \tag{A18}$$

because $\sigma_M^2 > \sigma_\varepsilon^2 + g^2$.

Thus, since $EU_s(I = I'; b)$ is continuous and monotonic in the interval $[b^f, \infty)$, there exists $b^n > b^f$ such that

$$EU_s(I = I'; b^n) = EU_s(I = 1). \tag{A19}$$

If $b \in (b^f, b^n]$, we have that $I^* = I' < 1$, implying that we are in an equilibrium of the second type described in Proposition 5 and thus the monitoring intensity is given by

$$\pi^r(b) = \frac{\left(\sigma_\varepsilon^2 + g^2\right)\left(\sigma_M^2 - \sigma_\varepsilon^2\right)}{\sigma_\varepsilon^2\left(b - \sigma_\varepsilon^2\right)}. \tag{A20}$$

Finally, if $b > b^n$, it is optimal for shareholders not to induce revelation and thus we are in an equilibrium of the third type described in Proposition 5, implying that the expected monitoring intensity is π^n. Q.E.D.

Proof of Proposition 7: Because the management board does not monitor the CEO, the CEO's revelation constraint with respect to the management board is

$$\sigma_M^2 - \sigma_\varepsilon^2 \geq 0, \tag{A21}$$

which implies that the CEO always discloses his information to the management board.

The CEO's revelation constraint with respect to the supervisory board is

$$I\sigma_\varepsilon^2\left(\sigma_\varepsilon^2 - b\right) \geq 0, \tag{A22}$$

which holds if and only if $\sigma_\varepsilon^2 - b \geq 0$. If $\sigma_\varepsilon^2 \geq b$, the CEO will reveal his information to the supervisory board, independent of I. Thus, shareholders will optimally choose $I_S^* = 1$, implying that the supervisory board will monitor with the first–best intensity $\pi^f = \sigma_\varepsilon^2 + g^2$.

If $\sigma_\varepsilon^2 < b$, the CEO will never reveal his information to the supervisory board, independent of I. Thus, again shareholders will optimally choose $I_S^* = 1$. If the supervisory board is not informed, which happens with probability c, it will choose not to intervene ($\pi^* = 0$) because successful uninformed monitoring implies a payoff of $-\sigma_M^2$, which is less than the expected payoff when the CEO is in control $-(\sigma_\varepsilon^2 + g^2)$ (recall that the management board always advises the CEO, so the variance is σ_ε^2 when the CEO is in control). When informed, the

supervisory board will monitor with the first–best intensity, $\pi^f = \sigma_\varepsilon^2 + g^2$. Thus, the expected monitoring intensity is $(1-c)\,\pi^f$ in this case. Q.E.D.

Proof of Proposition 8: If $b > \sigma_\varepsilon^2$, the expected value for shareholders under a dual board structure is given by

$$\begin{aligned} EU_s^D &= -c\big(\sigma_\varepsilon^2 + g^2\big) - (1-c)\big(1-\sigma_\varepsilon^2 - g^2\big)\big(\sigma_\varepsilon^2 + g^2\big) \\ &= -\big[1-(1-c)\big(\sigma_\varepsilon^2 + g^2\big)\big]\big(\sigma_\varepsilon^2 + g^2\big). \end{aligned} \tag{A23}$$

If $b \in (\sigma_\varepsilon^2, b^f]$, the sole board structure's payoff is

$$EU_s^S = -\big(1-\sigma_\varepsilon^2 - g^2\big)\big(\sigma_\varepsilon^2 + g^2\big), \tag{A24}$$

which implies that the sole board dominates the dual board structure if $b \in (\sigma_\varepsilon^2, b^f]$.

If $b \in (b^f, b^n]$, the sole board structure's payoff is

$$EU_s^S(I = I'; b) = -\left[1 - \frac{\big(\sigma_\varepsilon^2 + g^2\big)\big(\sigma_M^2 - \sigma_\varepsilon^2\big)}{\sigma_\varepsilon^2\big(b - \sigma_\varepsilon^2\big)}\right]\big(\sigma_\varepsilon^2 + g^2\big). \tag{A25}$$

Thus, a dual board structure is preferred if and only if

$$1 - c \geq \frac{\sigma_M^2 - \sigma_\varepsilon^2}{\sigma_\varepsilon^2\big(b - \sigma_\varepsilon^2\big)}. \tag{A26}$$

At $b = b^f$, we have that

$$1 - c < \frac{\sigma_M^2 - \sigma_\varepsilon^2}{\sigma_\varepsilon^2(b_f - \sigma_\varepsilon^2)} = 1. \tag{A27}$$

This implies that the sole board structure is strictly better at b^f. Due to the continuity and monotonicity of $\frac{\sigma_M^2 - \sigma_\varepsilon^2}{\sigma_\varepsilon^2(b - \sigma_\varepsilon^2)}$, there exists a unique $b^D > b^f$ such that

$$1 - c = \frac{\sigma_M^2 - \sigma_\varepsilon^2}{\sigma_\varepsilon^2\big(b^D - \sigma_\varepsilon^2\big)}. \tag{A28}$$

Now, we only need to show that $b^D < b^n$. Suppose not; then $1 - c < \frac{\sigma_M^2 - \sigma_\varepsilon^2}{\sigma_\varepsilon^2(b^n - \sigma_\varepsilon^2)}$, which implies that a sole board structure in which revelation is induced strictly dominates the dual board structure at b^n. But by the definition of b^n a sole board structure that does not induce revelation yields the same expected payoffs as a sole structure with no revelation, that is,

$$\begin{aligned} EU_s(I = I'; b^n) = EU_s(I = 1) = -c\big[\sigma_M^2 + (1-g^2)g^2\big] \\ -(1-c)\big(1-\sigma_\varepsilon^2 - g^2\big)\big(\sigma_\varepsilon^2 + g^2\big), \end{aligned} \tag{A29}$$

which is strictly lower than EU_s^D because $\sigma_M^2 + (1-g^2)g^2 > \sigma_\varepsilon^2 + g^2 + (1-g^2)g^2 > \sigma_\varepsilon^2 + g^2$. But this contradicts the assumption that the sole board is better than the dual board at b^n, which implies that $b^D < b^n$ must hold. Q.E.D.

Proof of Proposition 9: Let σ_ε^2 be the residual variance of ε that the CEO expects to have after hearing the board's advice a in equilibrium. It can be shown that

$$\sigma_\varepsilon^2 = \frac{1}{12N^2} + \frac{(g-g_b)^2(N^2-1)}{3}, \tag{A30}$$

where N is the smallest integer greater or equal to $\tilde{N}$, where

$$\tilde{N} = -\frac{1}{2} + \frac{1}{2}\sqrt{1 + \frac{2}{g-g_b}}. \tag{A31}$$

(For calculations, see Crawford and Sobel (1982), part 4).

We want to show that σ_ε^2 is decreasing in g_b for $g_b \in [0, g]$. First, note that $\tilde{N}$ is increasing in g_b, which implies that N is nondecreasing in g_b. Second, suppose that a marginal increase in g_b does not change N (i.e., we are in a situation in which $N > \tilde{N} \geq 1$). Then it is straightforward to see from (A30) that σ_ε^2 decreases in g_b.

However, it is unclear whether σ_ε^2 is a continuous function of $g_b \in [0, g]$ because N jumps discontinuously when $\tilde{N}$ reaches a new integer value. We will show, however, that σ_ε^2 is indeed a continuous function of $g_b \in [0, g]$. First, suppose that g_b' is such that any infinitesimal increase in g_b induces a change from N' to $N'+1$. Then it follows that

$$N' = -\frac{1}{2} + \frac{1}{2}\sqrt{1 + \frac{2}{g-g_b'}}, \tag{A32}$$

which implies that

$$g - g_b' = \frac{1}{2N'(N'+1)}. \tag{A33}$$

The variance before the jump is given by

$$\sigma_\varepsilon^2(N') = \frac{1}{12N'^2} + \frac{(g-g_b')^2(N'^2-1)}{3} \tag{A34}$$

and that after the jump is given by

$$\sigma_\varepsilon^2(N'+1) = \frac{1}{12(N'+1)^2} + \frac{(g-g_b')^2(N'^2+2N')}{3}. \tag{A35}$$

Thus,

$$\sigma_\varepsilon^2(N') - \sigma_\varepsilon^2(N'+1) = \frac{1}{12}\left[\frac{1+2N'}{N'^2(N'+1)^2}\right] - \frac{(g-g_b')^2(1+2N')}{3}. \quad \text{(A36)}$$

We need to show that this difference is zero. From (A33), we get

$$\sigma_\varepsilon^2(N') - \sigma_\varepsilon^2(N'+1) = \frac{1}{12}\left[\frac{1+2N'}{N'^2(N'+1)^2}\right] - \frac{(1+2N')}{12N'^2(N'+1)^2} = 0. \quad \text{(A37)}$$

Thus, we conclude that σ_ε^2 is indeed a continuous function of $g_b \in [0, g]$. As a consequence, σ_ε^2 is decreasing in $g_b \in [0, g]$. Q.E.D.

Proof of Proposition 11: The supervisory board never advises the CEO, thus if $g_{sb} > 0$, both the quality and the intensity of monitoring are below their optimal levels, while the quality of the advice is not affected by g_{sb}. Hence, $g_{sb}^* = 0$. The management board never monitors the CEO, thus any $g_{mb} < g$ will lead to some distortion in the advice provided by the board, that is, $\sigma_\varepsilon^2 > 0$, without affecting monitoring. For that advice not to be distorted, that is, $\sigma_\varepsilon^2 = 0$, we must have $g_{mb}^* = g$. Q.E.D.

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