

# Corporate Governance in a Competitive Environment

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## **Abstract**

We examine a firm's corporate governance choices within a competitive environment. A firm can choose an active board that retains decision rights over the firm's resources or a passive board that delegates them to the manager. We characterize the equilibrium governance choices and find that there generally is no systematic relation between governance systems and firm performance. We discuss how the governance choice is affected by the rate of technological innovation, board expertise, the discount rate, the benefit of using new technology, and the cost of operating an internal control system. Finally, we analyze consequences of the Sarbanes-Oxley Act.

# Corporate Governance in a Competitive Environment

## 1. Introduction

The separation of ownership from control is one of the most significant features of the modern corporation. Shareholders do not participate in the day to day management of a firm; rather they appoint a board of directors. The board selects managers to execute the firm's business strategy and it installs a system of corporate governance—a set of mechanisms that affects the managers' resource allocation decisions—to comply with its fiduciary responsibility to the firm (Reiling, Thompson, Brady, and Macchiarola, 1981).

In response to the recent wave of governance scandals, the U.S. Congress passed the Sarbanes-Oxley Act of 2002 that established new corporate governance requirements. As a consequence, firms have been reevaluating their systems of corporate governance. If a firm's governance mechanisms are too weak, then it cannot adequately safeguard its resources; if its governance mechanisms are too restrictive, then in a competitive environment the firm might not be able to compete effectively as new opportunities arise. This paper examines the optimal choice of a firm's corporate governance within a competitive environment.

To analyze a firm's choice of governance and how it allocates control rights, we consider an industry with two firms and analyze a game that contains four stages. First, the shareholders of each firm choose a board of directors with a governance style that we label as being either *active* or *passive*. Each board selects a manager to pursue an opportunity that only one of the firms in the industry can exploit. Second, a firm manager learns the cost of exploiting the opportunity and develops a plan. Third, upon developing the plan, the manager proposes the plan to the board. An active board investigates the plan and it decides whether to implement it. A passive board offers the manager a capital budget, and the manager then decides whether to implement the plan; because the board does not know the cost of the project, it installs an internal control system to limit the manager's ability

to misappropriate the surplus that the project generates. Fourth, one of the firms exploits the opportunity or the firms turn it down, and the shareholders' payoffs are realized.

The key trade-off in the model is between an active board that retains control rights over the firm's resources but can less rapidly respond to transient business opportunities, and a passive board that delegates control rights to the manager and hence can more quickly pursue these opportunities. We characterize the equilibria to the game. Depending on the parameters of the game, there is an equilibrium where both firms choose active boards, an equilibrium where both firms choose passive boards, and equilibria where one firm chooses an active board and its rival chooses a passive board and vice versa. An important consequence of the presence of these alternative equilibria is that there generally is no systematic relation between measures of corporate governance and firm performance. We also examine how the choice of governance style is affected by the rate of technological innovation in an industry, board expertise at evaluating plans to implement new technology, the risk of the business environment, the benefit of using new technology, and the cost of installing an internal control system to monitor the manager. Finally, we analyze the consequences of implementing the Sarbanes-Oxley Act on firm governance behavior and competitiveness. This analysis allows us to reconcile claims from opponents of the Act that it has been burdensome to firms and it has reduced firms' competitiveness, and proponents that have claimed it has enhanced firm efficiency and competitiveness.

Several papers have considered the effect of board monitoring on firm performance. Burkart, Gromb, and Panunzi (1997) consider a setting where shareholders trade-off the gains from monitoring a manager to the gains from managerial initiative. They suggest that the manager's incentive to become informed about projects that the firm can pursue depends on the likelihood of that the manager will have effective control. Consequently, to maximize firm value, they establish that it is optimal for shareholders to commit to leave some control with the manager by having a fraction of the firm allocated to a large shareholder with

strong incentives to monitor the manager and the remaining fraction allocated to dispersed small shareholders with weak incentives to monitor. In related work examining why boards might not monitor too intensively, Hermalin and Weisbach (1998) model the board selection process—and thereby board monitoring intensity—as a bargaining game between the manager and board. They establish that board monitoring intensity declines following strong firm performance. Almazan and Suarez (2003) show that shareholders find it optimal to relinquish control to the manager to save on incentive and severance pay. In more recent work recognizing that boards monitor by influencing managers’ project choices, Adams and Ferreira (2006) examine a board that serves the dual role of monitoring and advising management. By sharing information, management can improve its ability to offer advice. Management, however, face a trade-off because the board can use this information to more closely monitor management that, in turn, discourages the manager from sharing information with the board. Accordingly, they find conditions under which shareholders might prefer a board that does not monitor the manager too intensively. While our paper is similar to this antecedent work in that we emphasize that it is might not be optimal to have intensive board monitoring, the fundamental distinction between the prior work and ours is that we examine the allocation of control rights within a competitive market setting where heightened board monitoring might reduce a firm’s nimbleness to capture a business opportunity and thereby preempt competitors from doing so.<sup>1</sup>

There is much empirical work examining the relation between corporate governance mechanisms and firm performance. In recent work, Gompers, Ishii, and Metrick (2003), Cremers and Nair (2004) and Brown and Caylor (2004) find that firms with higher governance scores appear to have superior performance, although they are unable to infer casualty. In contrast, Larcker, Richardson, and Tuna

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<sup>1</sup>Our focus on alternative corporate governance styles is reminiscent of work examining centralized versus decentralized organizational structures (e.g., Aghion and Bolton, 1992; Aghion and Tirole, 1994, 1997; Bolton and Farrell, 1990). We, however, emphasize the relation between the board and management while holding the organizational structure constant.

(2004) are unable to show that governance has a significant effect on a number of performance indicators. Hence, consistent findings regarding the importance of corporate governance for understanding firm performance is yet to emerge. Our analysis emphasizes that in some industries it is optimal for firms to install an active board that retains decision-making rights and in other industries it is optimal for firms to install a passive board with delegates these rights to executive management. In a cross-section of firms from a variety of industries, therefore, a systematic relation between firm performance and governance mechanisms might not be observed. We consequently suggest ways of partitioning a sample of firms so as to increase the likelihood of finding the hypothesized relation.

The paper proceeds as follows: Section 2 describes the model. Section 3 considers a firm's corporate governance choice in a non-strategic setting. Section 4 determines a firm's payoffs given its corporate governance choice and that of its competitor and it characterizes the equilibria to the game. Section 5 analyzes the equilibria and discusses their implications. Section 6 concludes. All proofs are relegated to the Appendix.

## 2. Model

We consider shareholders' governance choices within an industry containing two firms. Each firm has shareholders who are risk-neutral and have perfectly congruent interests, a board of directors appointed by the firm's shareholders, and an executive manager who seeks to exploit a business opportunity for the firm. If a firm exploits the opportunity, then it will generate a benefit to the firm equal to the opportunity's discounted future cash flows. This benefit can be exploited by one and only one firm in the industry. At date zero it is common knowledge that the opportunity with benefit  $B \in [0, 1]$  exists. The firm managers, however, do not know how to exploit the opportunity. As an example of this setting, consider the existence of a start-up venture that controls a patented technology. Because the technology is innovative, firms in the industry do not know whether or

not they can commercialize the patented technology, and consequently, are wary about acquiring the venture that controls the technology. Nevertheless, the firms are aware of the benefit and contemplate ways of introducing the technology into their products and services. A firm manager's discovery of a way to commercialize the technology follows a Poisson process. The probability that any one of the firm managers discovers the means to commercialize the technology during the next short interval of time  $dt$ , given that the technology has not been exploited up to that point, is  $\theta dt$ . At date zero, the probability of this discovery before time  $t$  is  $1 - e^{-\theta t}$ , and the corresponding probability density function is  $\theta e^{-\theta t}$ . On discovering the way to exploit the technology, the manager privately observes the cost realization, denoted  $c$ , of pursuing the opportunity, where random variable  $\tilde{c}$  is uniformly distributed on the  $[0, 1]$  interval. The manager's signal is non-verifiable and therefore cannot be credibly revealed to the firm's board. Further, the firms' cost realizations are independent draws.

At date zero, shareholders choose their firms' corporate governance style. The shareholders can choose an active board or a passive board.<sup>2</sup> An *active board* has the feature that after the manager informs it about a plan to implement the technology, it investigates the implications of the technology for the firm, the manager's plan to introduce the technology, and the cost of pursuing the opportunity. New technology can range from being fairly simple to being highly complex and requiring considerable expertise and effort on the part of the board to understand its implications for the firm. Accordingly, the time the board takes to complete its investigation of the technology and commit to the manager's plan varies from opportunity to opportunity. The board's investigation follows a Poisson process, which is independent of the Poisson process describing the

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<sup>2</sup>While in principle shareholders choose the governance structure when they appoint directors, in practice they might have little effective control. However, the market for corporate control, directors' concern for their reputations, and the guidance that corporate governance consultants offer might cause firms' governance systems to approximate the systems shareholders find optimal (see Hermalin and Weisbach, 1998). In related work, Adams and Ferreira (2006) also assume the shareholders choose the board's governance style.

manager's discovery of a way to commercialize the technology. The probability that the board completes its investigation during the next short interval of time  $dt$ , given that the manager has provided a plan to implement the technology, is  $\lambda dt$ . If the manager discovers how to commercialize the technology on date  $n$ , the probability that the board discovers the cost of the project before date  $n + t$  is  $1 - e^{-\lambda t}$ , and the corresponding probability density function is  $\lambda e^{-\lambda t}$ . On completion of its investigation, the board observes the same cost realization  $c$  that the manager had privately observed earlier. The board proceeds with the manager's business plan if  $c \leq B$ ; alternatively, if  $c > B$ , the firm leaves the opportunity for a competitor who might enjoy lower costs of implementing the technology. Because the board knows both  $B$  and  $c$ , it is able to ensure all the net benefits of the project,  $B - c$ , go to the shareholders.

A *passive board* has the feature that after the manager informs it about the plan to implement the technology, it authorizes a budget, denoted  $b$ , which the manager can use to implement the project. Because the passive board does not learn the cost  $c$ , the manager has the opportunity to spend some of the surplus  $(B - c)$  from the project on perquisites that do not benefit the shareholders. To limit the manager's information rent, the passive board installs an information and control system, denoted  $a$ , which ensures that the firm retains a fraction  $a$  of the surplus from the project; the remaining  $1 - a$  of the surplus goes to the manager in the form of perquisite consumption. When setting the budget, the board assumes that the manager will not accept the budget if it is less than the cost realization that the manager privately observes. When choosing the control system, the board recognizes that the control system's installation and maintenance costs are increasing in its capacity to reduce the manager's misappropriation of firm resources. Formally, a passive board chooses a budget  $b$  and information and control system  $a$  to maximize the firm's expected profits after deducting the costs

of the information and control system; that is,

$$\max_{b,a} \int_0^b (a(B - \tilde{c}) - ka^2) d\tilde{c}, \quad (2.1)$$

where  $k > 0$  is the cost per unit of the control system's capacity to monitor the manager. Notice that as  $a$  increases, where  $a \in [0, 1]$ , the control system monitors the manager's opportunism more closely and thereby allows shareholders to retain more of the profits from the business opportunity.<sup>3</sup> To determine the board's optimal budget and control system choices, we differentiate the objective function in (2.1) with respect to  $b$  and  $a$ , express the first-order conditions in terms of  $b$  and  $a$ , and then solve these two expressions simultaneously to yield the optimal choices

$$b^* = \frac{2B}{3} \text{ and } a^* = \frac{B}{3k}. \quad (2.2)$$

To focus on a control system choice that does not always completely eliminate the manager's misappropriation of firm assets or consumption of perquisites, that is  $a^* \in (0, 1)$ , we assume that  $k > B/3$ . Such a control system comports more closely with the institutional environment where agency problems do in fact occur than does a control system that eliminates them.<sup>4</sup>

Finally, once the firms have exploited the opportunity or turned it down, the

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<sup>3</sup>Antle and Eppen (1985) examine the use of a capital budget in a setting where the firm's owner and manager are asymmetrically informed about a proposed project's rate of return. To reduce the expected slack that the manager can consume, they find that it is optimal to set a budget that rations resources in some states. Our analysis extends their work by recognizing that a firm's information and internal control system can complement its budgeting and planning system to mitigate the agency problem and enhance organizational efficiency.

<sup>4</sup>Witness, for instance, the fact that the founder of Adelphia Communications Corporation, John Rigas and members of his family were found guilty of fraudulently excluding billions of dollars in liabilities from Adelphia's consolidated financial statements; falsifying operating statistics and inflating earnings; and concealing rampant self-dealing, including the use of Adelphia's funds to finance open market stock purchases and purchase luxury condominiums in New York and elsewhere for the Rigas Family. For further details of the charge, see Securities and Exchange Commission; Litigation Release No. 17627 / July 24, 2002 and Accounting and Auditing Enforcement Release No. 1599 / July 24, 2002.

game ends and their payoffs are realized. The discount rate is  $r > 0$ . The time line of events and the model's notation is summarized in Figure 1.

We focus on Nash equilibria in pure strategies where at date zero the shareholders of each firm  $i$ , where  $i = 1, 2$ , choose from a set  $G_i = \{\text{active board, passive board}\}$ . The set  $G = G_1 \times G_2$  is the set of all possible combinations of firm governance choices. The Nash equilibrium is a profile of governance choices  $g^* \in G$  with the property that there is no firm  $i$  that has a governance system that yields an outcome that the firm's shareholders prefer to that generated when the firm's shareholders choose  $g_i^*$  given that the other firm chooses the equilibrium governance system  $g_{-i}^*$ . When multiple Nash equilibria exist, we focus on the Pareto-dominant equilibrium. In this game, the Pareto-dominant equilibrium is the unique Aumann strong equilibrium; a *strong* equilibrium requires that no subset of firms, taking the choices of the others as given, can jointly deviate in a fashion that increases the payoffs of all its members (see Fudenberg and Tirole, 1991). Further, the Pareto-dominant equilibrium should be more focal in the institutional setting examined here because corporate governance consultants, such as Institutional Shareholder Services, Inc., recommend corporate governance provisions that they expect will increase shareholder value.

Before proceeding, we discuss several features of the model. First, the fundamental distinction between the two governance styles in this model is the allocation of control rights or discretion over how to invest shareholders' funds. An active board learns the costs and the board decides whether to implement the manager's plan. A passive board, in contrast, authorizes a budget and it allows the manager to decide whether to pursue the opportunity; the manager chooses not to proceed if the budget is less than the manager's privately observed cost realization. An empirical construct for an active board is the extent to which the board is composed of executive directors and directors with extensive experience in the firm's industry and who hold few other directorships. A proxy for a passive board might be the extent to which the board is composed of directors who do not have extensive experience in the firm's industry but rather have business experience

in other industries and hold directorships in firms in these other industries.<sup>5</sup> In addition, the presence of a shareholder with a large block holding, the presence of debt holders, or the presence of a lead director who can call meetings of all outside directors might further distinguish an active board from a passive board (see Shleifer and Vishny, 1997).

Second, to illustrate how an active board and a passive board can serve as governance substitutes, note the information equivalence of a board that authorizes during a fiscal period all of the firm's checks and deposits and, alternatively, a board that examines at the end of the fiscal period the cash account in the firm's ledger reporting the manager's activities and relies on the presence of an internal control to insure the integrity of the cash account in the ledger.<sup>6</sup> It is important to observe that even though the two tacks provide identical information, they differ in the assignment of control rights—the key feature distinguishing governance structures in this paper.

Third, we assume that the active board perfectly observes the cost realization  $c$ . The paper's insights are not qualitatively altered if we suppose, instead, that an active board seeks to acquire an informative, but not necessarily perfect signal about the cost realization  $c$  and installs an information and internal control system to reduce the manager's misappropriation of firm resources. Furthermore, we assume that any monetary cost to an active board of evaluating the manager's plan before it is implemented (i.e., learning  $c$ ) is equal to the monetary cost to a passive board of scrutinizing the firm's financial accounts after the manager's plan has been implemented. Therefore, the choice between having an active or

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<sup>5</sup>Core, Hotlhausen, and Larcker (1999) argue that old directors and directors who serve on multiple boards are less active monitors of management than young directors and directors who serve on fewer boards. Larcker, et al. (2004) document that on average 20 percent of a firm's board members are executive directors; they also find that approximately nine percent of a firm's non-executive directors serve on four or more boards and 27 percent of a firm's executive directors serve on two or more boards.

<sup>6</sup>The principal tool for determining the integrity of the cash account in the ledger is an independently prepared reconciliation of the entries in the cash account to the firm's bank statement (Wallace, 1995).

passive board features a trade-off between the costs of delaying the project while the active board investigates the project and the costs of  $ka^2$  incurred to operate the internal control system when the decision rights are delegated to the manager by the passive board.

Fourth, we suppose a firm's shareholders install the corporate governance system at date zero rather than choosing it after the manager decides to pursue the business opportunity. We view the choice as occurring at date zero because board members are elected at the annual shareholders meeting to serve for at least a year. Consequently, the composition of the board typically cannot change in response to the business opportunities which present themselves through the year even though these opportunities might call for different systems of governance.

Finally, to emphasize the effect of competition on shareholders' corporate governance choices, we abstract from the problem of motivating the manager. Of course, the rate of discovery  $\theta$  and the cost  $c$  of exploiting a new technology are typically a function of a manager's incentive scheme, which might depend on the firm's governance structure and the assignment of control rights. However, we should note in our defense that several empirical studies have questioned the effectiveness of monetary incentives. Jensen and Murphy (1990), for instance, find that executive compensation is fairly insensitive to firm performance suggesting that compensation arrangements provide managers with only weak incentives (also see Shleifer and Vishny (1997)).

### **3. Benchmark Setting**

This section considers a firm's governance choice when it is the sole participant in its industry. Within this non-strategic setting, we first determine the firm's expected payoff when it chooses an active board and then the firm's expected payoff when it chooses a passive board. We compare the expected payoffs and suggest circumstances where a monopolist is more likely to choose an active than a passive board.

When a monopolist installs an *active board*, its expected payoff at date zero is given by the expression

$$E [V_{act,mon}] = \int_0^{\infty} V_{act} \times h_a(t) \times e^{-rt} dt, \quad (3.1)$$

where:  $V_{act}$  denotes the firm's expected payoff at date  $t$  when the board proceeds with the manager's business plan and is given by

$$V_{act} \equiv \int_0^B (B - \tilde{c}) \times \frac{1}{B} d\tilde{c} = \frac{B}{2}, \quad (3.2)$$

$h_a(t)$  is the probability density that the board will proceed with the manager's plan at date  $t$ , and  $e^{-rt}$  is the appropriate discount factor given the board proceeds with the manager's plan at date  $t$ . To obtain  $h_a(t)$ , observe that a firm will proceed with the manager's plan at date  $t$  if and only if the firm's board has learned the cost of exploiting the opportunity at date  $t$  *and* the firm's cost of exploiting the opportunity is less than  $B$ . The probability that the firm's board has learned the cost of pursuing the opportunity by date  $t$  is given by the cumulative distribution function

$$F(t) = \int_0^t \left( \int_n^t \lambda e^{-\lambda(m-n)} dm \right) (\theta e^{-\theta n}) dn = 1 - \frac{e^{-\theta t} \lambda - e^{-\lambda t} \theta}{\lambda - \theta}. \quad (3.3)$$

To construct this expression, we recognize that the board's investigation follows a Poisson process that is independent of the Poisson process describing the manager's discovery of a plan to commercialize the technology. Therefore, we can express the probability that the board learns  $c$  at date  $t$  as a convolution of  $\int_n^t \lambda e^{-\lambda(m-n)} dm$ , which reflects the probability that the board discovers  $c$  by date  $t$  given that the manager has presented the plan to the board at date  $n$ , and  $\theta e^{-\theta n}$ , which is the probability that at date  $n$  the manager develops a plan to pursue the opportunity. It then follows that the probability that the board learns the cost

of pursuing the opportunity at date  $t$  is given by the probability density function

$$f(t) = \frac{\partial F(t)}{\partial t} = \frac{\theta\lambda(e^{-\theta t} - e^{-\lambda t})}{\lambda - \theta}. \quad (3.4)$$

Given (3.4) and recognizing that the firm will only proceed with the manager's plan if  $c$  is less than  $B$  yields

$$h_a(t) = \frac{\theta\lambda e^{-\theta t} - \theta\lambda e^{-\lambda t}}{\lambda - \theta} \times B. \quad (3.5)$$

Finally, substituting (3.2) and (3.5) into (3.1) yields the monopolist's expected payoff at date zero when it has an active board:

$$E[V_{act,mon}] = \frac{B^2}{2} \frac{\lambda\theta}{(\lambda + r)(\theta + r)}. \quad (3.6)$$

When a monopolist installs a *passive board*, its expected payoff at date zero is given by the expression

$$E[V_{pas,mon}] = \int_0^\infty V_{pas} \times h_p(t) \times e^{-rt} dt, \quad (3.7)$$

where:  $V_{pas}$  denotes the firm's expected payoff at date  $t$  when the manager proceeds with the business plan after the board has chosen the optimal budget  $b^*$  and control system  $a^*$  at date zero, and is given by

$$V_{pas} \equiv \int_0^{b^*} (a^*(B - \tilde{c}) - k(a^*)^2) \times \frac{1}{b^*} d\tilde{c} = \frac{B^2}{9k}, \quad (3.8)$$

and  $h_p(t)$  is the probability density that the board will proceed with the manager's plan at date  $t$ . To obtain  $h_p(t)$ , observe that a firm will proceed with the manager's plan at date  $t$  if and only if the manager has informed the board of the business

plan at date  $t$  and the manager accepts the budget that the board authorizes to exploit the opportunity. The probability density that the manager informs the board of the business plan at date  $t$  is  $\theta e^{-\theta t}$ , and the probability that the manager accepts the budget that the board authorizes equals  $b^* = 2B/3$ . Combining these factors yields

$$h_p(t) = \theta e^{-\theta t} \times \frac{2B}{3}. \quad (3.9)$$

Now, substituting (3.8) and (3.9) into (3.7) yields the monopolist's expected payoff at date zero when it has a passive board

$$E[V_{pas,mon}] = \frac{2B^3}{27k} \frac{\theta}{(\theta + r)}. \quad (3.10)$$

Comparing the expected payoffs in (3.6) to (3.10) yields

$$E[V_{act,mon}] - E[V_{pas,mon}] \propto \frac{\lambda}{\lambda + r} - \frac{4B}{27k},$$

where  $\propto$  indicates that the two expressions are proportional to each other (i.e., are of the same sign.) Hence, we expected that in a monopolistic setting, shareholders are more likely to install an active board rather than a passive board when, all else equal, the technology the firm seeks to exploit is such that the rate  $\lambda$  at which an active board can discover the cost of the manager's business plan is high, the discount rate  $r$  is low, the benefit of exploiting the opportunity  $B$  is low, and finally, the cost of the control system  $k$  for monitoring the manager is high; in particular, for all monitoring costs

$$k > k_{mon}^* \equiv \frac{4B(\lambda + r)}{27\lambda}, \quad (3.11)$$

shareholders prefer an active to a passive board.

## 4. Equilibrium

This section considers the firms' governance choices when the firms recognize that they are participating in a competitive environment. Within this strategic setting, we first determine the firms' expected payoffs for each profile of governance choices  $g \in G$  and then characterize the Nash equilibria to the game. There are both *symmetric* equilibria (i.e., both firms choose the same governance system) and *asymmetric* equilibria (i.e., one firm chooses an active board while the other chooses a passive board).

There are four combinations of firm governance choices in the set  $G$ . First, we determine a firm's expected payoff for the governance choice profile  $g = \{\text{active board, active board}\}$ . The firm's expected payoff at date zero when it has an active board and its competitor also has installed an active board is given by the expression

$$E[V_{act,act}] = \int_0^{\infty} V_{act} \times h_{a,a}(t) \times e^{-rt} dt, \quad (4.1)$$

where:  $V_{act}$  is the firm's expected payoff at date  $t$  when the board proceeds with the manager's business plan given in expression (3.2),  $h_{a,a}(t)$  is the probability density that the board will proceed with the manager's plan at date  $t$ , and  $e^{-rt}$  is the appropriate discount factor given the board proceeds with the manager's plan at date  $t$ . To obtain  $h_{a,a}(t)$ , observe that a firm will proceed with the manager's plan at date  $t$  if and only if the firm's board has learned the cost of exploiting the opportunity at date  $t$ , the firm's competitor has not exploited the opportunity by date  $t$  thereby preempting the firm from doing so, *and* the firm's cost of exploiting the opportunity is less than  $B$ . To determine  $h_{a,a}(t)$  note that:

- The probability that the board learns the cost of pursuing the opportunity at date  $t$  is given by the probability density function  $f(t)$  in (3.4).
- The cumulative probability that the firm's competitor with an active board

has not exploited the opportunity by date  $t$  equals

$$1 - \left(1 - \frac{e^{-\theta t}\lambda - e^{-\lambda t}\theta}{\lambda - \theta}\right) B; \quad (4.2)$$

that is, the complement of the probability that the competitor has exploited the opportunity by date  $t$ . The probability that the competitor exploits the opportunity by date  $t$  equals the product of the probability that the competitor's board has discovered its cost by date  $t$ ,  $F(t)$ , and this cost is less than the opportunity's benefit,  $B$ .

Combining (3.4) and (4.2) and recognizing that the firm will only proceed with the manager's plan if  $c$  is less than  $B$  yields

$$h_{a,a}(t) = \left(\frac{\theta\lambda e^{-\theta t} - \theta\lambda e^{-\lambda t}}{\lambda - \theta}\right) \times \left(1 - \left(1 - \frac{e^{-\theta t}\lambda - e^{-\lambda t}\theta}{\lambda - \theta}\right) B\right) \times B. \quad (4.3)$$

Finally, substituting (3.2) and (4.3) into (4.1) yields the firm's expected payoff at date zero when it has an active board and its competitor has an active board

$$E[V_{act,act}] = \frac{B^2}{2} \frac{\theta\lambda}{(\theta + r)(\lambda + r)} \left(1 - \frac{\lambda\theta(2\lambda + 2\theta + 3r)}{(2\lambda + r)(2\theta + r)(\lambda + \theta + r)} B\right). \quad (4.4)$$

Second, we determine a firm's expected payoff for the governance choice profile  $g = \{\text{passive board, passive board}\}$ . The firm's expected payoff at date zero when it has a passive board and its competitor also has installed a passive board is given by the expression

$$E[V_{pas,pas}] = \int_0^\infty V_{pas} \times h_{p,p}(t) \times e^{-rt} dt, \quad (4.5)$$

where:  $V_{pas}$  is the firm's expected payoff at date  $t$  when the manager proceeds with the business plan after the board has chosen the optimal budget  $b^*$  and

control system  $a^*$  at date zero, given in (3.8), and  $h_{p,p}(t)$  is the probability density that the firm will proceed with the manager's plan at date  $t$ . To obtain  $h_{p,p}(t)$ , observe that a firm will proceed with the manager's plan at date  $t$  if and only if the manager has informed the board of the business plan at date  $t$ , the firm's competitor has not exploited the opportunity by date  $t$  and thereby preempted the firm from doing so, *and* the manager accepts the budget that the board authorizes to exploit the opportunity. The probability density that the manager informs the board of the business plan at date  $t$  is  $\theta e^{-\theta t}$ ; the cumulative probability that firm's competitor with a passive board has not exploited the opportunity by date  $t$  equals the complement of the probability that the competitor has exploited the opportunity by date  $t$ , which equals  $(1 - b^*(1 - e^{-\theta t}))$ ; and the probability that the manager accepts the budget that the board authorizes equals  $b^* = 2B/3$ . Combining these factors yields

$$h_{p,p}(t) = \theta e^{-\theta t} \times \left(1 - \frac{2B}{3}(1 - e^{-\theta t})\right) \times \frac{2B}{3}. \quad (4.6)$$

Substituting (3.8) and (4.6) into (4.5) yields the firm's expected payoff at date zero when it has a passive board and its competitor also has a passive board

$$E[V_{pas,pas}] = \frac{2B^3}{27k} \frac{\theta}{(\theta + r)} \left(1 - \frac{2B}{3} \frac{\theta}{(2\theta + r)}\right). \quad (4.7)$$

Third, we determine a firm's expected payoff for the governance choice profile  $g = \{\text{active board, passive board}\}$ . The firm's expected payoff at date zero when it has an active board and its competitor has installed a passive board is given by

$$E[V_{act,pas}] = \int_0^{\infty} V_{act} \times h_{a,p}(t) \times e^{-rt} dt, \quad (4.8)$$

where:  $V_{act}$  denotes the firm's expected payoff at date  $t$  when the board proceeds with the manager's business plan and  $h_{a,p}(t)$  is the probability density that the

firm will proceed with the manager's plan at date  $t$ ; therefore,  $h_{a,p}(t)$  is given by the product of the probability density that the firm's board has learned the cost of exploiting the opportunity at date  $t$ ,  $\frac{\theta e^{-\theta t} \lambda - \theta \lambda e^{-\lambda t}}{\lambda - \theta}$  (see (3.4)), the cumulative probability that the firm's competitor with a passive board has not exploited the opportunity by date  $t$ ,  $(1 - b^*(1 - e^{-\theta t}))$ , and the firm's cost of exploiting the opportunity is less than the benefit,  $B$ ; that is,

$$h_{a,p}(t) = \frac{\theta e^{-\theta t} \lambda - \theta \lambda e^{-\lambda t}}{\lambda - \theta} \times \left(1 - \frac{2B}{3}(1 - e^{-\theta t})\right) \times B. \quad (4.9)$$

Substituting these factors into (4.8) yields

$$E[V_{act,pas}] = \frac{B^2}{2} \frac{\lambda \theta}{(\lambda + r)(\theta + r)} \left(1 - \frac{2}{3} B \left(1 - \frac{(\lambda + r)(\theta + r)}{(2\theta + r)(\theta + \lambda + r)}\right)\right). \quad (4.10)$$

Fourth, we determine a firm's expected payoff for the governance choice profile  $g = \{\text{passive board, active board}\}$ . The firm's expected payoff at date zero when it has a passive board and its competitor has installed an active board is given by the expression

$$E[V_{pas,act}] = \int_0^{\infty} V_{pas} \times h_{p,a}(t) \times e^{-rt} dt, \quad (4.11)$$

where:  $V_{pas}$  denotes the firm's expected payoff at date  $t$  when the manager proceeds with the business plan, and  $h_{p,a}(t)$  is the probability density that the firm will proceed with the manager's plan at date  $t$ , which is given by the product of the probability density that the manager has informed the board of a business plan at date  $t$ ,  $\theta e^{-\theta t}$ , the cumulative probability that the firm's competitor with an active board has not exploited the opportunity by date  $t$ ,  $\left(1 - \left(1 - \frac{e^{-\theta t} \lambda - e^{-\lambda t} \theta}{\lambda - \theta}\right) B\right)$  (see (4.2)), and the probability that the manager accepts the budget that the board authorizes,  $2B/3$ ; that is,

$$h_{p,a}(t) = \theta e^{-\theta t} \times \left(1 - \left(1 - \frac{e^{-\theta t} \lambda - e^{-\lambda t} \theta}{\lambda - \theta}\right) B\right) \times \frac{2B}{3}. \quad (4.12)$$

Then substituting (3.8) and  $h_{p,a}(t)$  into (4.11) yields

$$E[V_{pas,act}] = \frac{2B^3}{27k} \frac{\theta}{(\theta+r)} \left( 1 - B \frac{\theta\lambda}{(2\theta+r)(\theta+\lambda+r)} \right). \quad (4.13)$$

Having determined the firm's expected payoff for the combinations of firm governance choices in the set  $G$ , we now compare payoffs for each profile  $g \in G$ . A firm's expected payoff  $E[V_{act,act}]$  when both firms choose active boards, see (4.4), is at least as large as its expected payoff  $E[V_{pas,act}]$  when the firm chooses a passive board and its competitor chooses an active board, see (4.13), if and only if

$$k \geq \frac{4B(\lambda+r)(2\lambda+r)((2\theta+r)(\theta+r) + \lambda(\theta(2-B)+r))}{27\lambda(r(2\lambda+r)(\lambda+r) + \theta(2\lambda+2\theta+3r)(\lambda(2-B)+r))} \equiv k_{act}^*. \quad (4.14)$$

Analogously, a firm's expected payoff  $E[V_{pas,pas}]$  when both firms choose passive boards, see (4.7), is at least as large as its expected payoff  $E[V_{act,pas}]$  when the firm chooses an active board and its competitor chooses a passive board, see (4.10), if and only if

$$k \leq \frac{4B(\lambda+r)(\lambda+\theta+r)(3r+2\theta(3-B))}{27\lambda(3r(\lambda+r) + 2\lambda\theta(3-B) + r\theta(9-4B) + 2\theta^2(3-2B))} \equiv k_{pas}^*. \quad (4.15)$$

Comparing (4.14) and (4.15), we observe that when the cost of the control system  $k$  to monitor the manager's performance is high, shareholders prefer an active board; when the cost of the control system  $k$  is low, shareholders prefer a passive board. A passive board does not delay the implementation of the manager's business plan, and accordingly, choosing a passive board reduces the likelihood that a competitor will preempt the investment opportunity. However, to mitigate the agency problem that arises from the board authorizing a plan that they have not fully vetted, they rely on the control system to limit the manager's information rents. Of course, shareholders will only choose a passive board and rely on the

control system if it is not too costly to install.

Against this background, we characterize the equilibria to the game. When characterizing the equilibria, we separately consider the setting where  $k_{act}^* \leq k_{pas}^*$ , which occurs if and only if

$$B - \frac{(\lambda - r)(\lambda + \theta + r)}{\lambda\theta} \geq 0, \quad (4.16)$$

and the converse setting where  $k_{act}^* > k_{pas}^*$ . We bifurcate the setting in this fashion because when  $k_{act}^* \leq k_{pas}^*$ , we find that all equilibria are symmetric, but when  $k_{act}^* > k_{pas}^*$ , we find that there are additional equilibria that are asymmetric. We formalize these observations in the next two propositions.

**Proposition 4.1.** *If  $B - (\lambda - r)(\lambda + \theta + r) / (\lambda\theta) \geq 0$ , then there is a unique Pareto-dominant Nash equilibrium characterized by the firms both choosing active boards when  $k \geq k_{act}^*$  and a unique Nash equilibrium characterized by the firms both choosing passive boards when  $k < k_{act}^*$ .*

**Proposition 4.2.** *If  $B - (\lambda - r)(\lambda + \theta + r) / (\lambda\theta) < 0$ , then there is a unique Nash equilibrium characterized by the firms both choosing active boards when  $k \geq k_{act}^*$ , a unique Nash equilibrium characterized by the firms both choosing passive boards when  $k \leq k_{pas}^*$ , and Nash equilibria characterized by one firm choosing an active board and the other firm choosing a passive board when  $k \in (k_{pas}^*, k_{act}^*)$ .*

Figures 2 and 3 illustrate the two propositions.

## 5. Analysis

This section analyzes the equilibria and discusses their implications. First, we describe when both firms choose passive boards, both choose active boards, and when firms choose different governance styles. Second, we discuss how the likelihood of observing the governance style changes with changes in the parameters

of the game. Third, we consider the implications of the Sarbanes-Oxley Act on firms' control system costs and missed business opportunities. For purposes of this analysis, we assume that  $k$  is the realization of a continuously distributed random variable on the unit interval.

### 5.1. Discussion of equilibria

When all equilibria are *symmetric*, the industry is said to be characterized by firms having *homogeneous* governance styles; alternatively, when there are equilibria that are *asymmetric*, the industry is said to be characterized by firms having *heterogeneous* governance styles. Propositions 4.1 and 4.2 therefore suggest circumstances when an industry is more likely to be characterized as having homogeneous or heterogeneous governance structures. When the discount rate is large relative to the rate at which an active board might complete its investigation of the manager's business plan, i.e.,  $r \geq \lambda$ , then (4.16) is always satisfied and we find symmetric equilibria only. We expect to observe homogeneous governance styles in industries populated by small firms that pursue new technologies. These firms are typically regarded as having higher expected returns (Fama and French, 1992)—they have high  $r$ —and their boards often lack the expertise needed to evaluate a business plan for pursuing a new technology—they have low  $\lambda$ .

Furthermore, (4.16) suggests that firms in an industry are more likely to be characterized as having homogeneous governance structures when: the relative size of the benefit  $B$  associated with implementing a new technology is high, when the rate  $\lambda$  at which boards can evaluate the implications of an innovative technology is low, and when the cost of capital or the discount rate  $r$  of firms in the industry is high. The effect of the rate  $\theta$  at which firms in an industry can implement new technologies on the homogeneity of industry governance structures, however, is ambiguous—the effect depends on the relative size of  $r$  and  $\lambda$ . When  $r$  exceeds  $\lambda$ , which is more likely the case for small firms than large firms, then an increase in the rate of technological innovation increases the likelihood of observing firms in an industry having homogeneous governance styles. In short, the vector of

parameters that satisfies (4.16) seems descriptive of industries populated by small firms applying innovative technologies.

Turning to Proposition 4.1, we find that when  $B \geq (\lambda - r)(\lambda + \theta + r) / (\lambda\theta)$  and thus the benefit from exploiting the opportunity is large, a firm is more inclined to choose a passive board than an active board because, all else equal, choosing a passive board reduces the likelihood that the firm's competitor will preempt it. When shareholders choose a passive board, however, they anticipate the costs of operating the control system to monitor the manager; indeed, when the benefits from exploiting the opportunity are at least greater than  $(\lambda - r)(\lambda + \theta + r) / \lambda\theta$ , the shareholders tolerate higher costs of the control system when the firm's competitor chooses a passive board rather than an active board (i.e., observe  $k_{act}^* \leq k_{pas}^*$ ). Nevertheless, given the benefits and costs associated with these two choices, Proposition 4.1 establishes that shareholders enjoy a higher expected payoff after choosing an active board than a passive board when the costs of operating the control system are relatively high, specifically when  $k \geq k_{act}^*$ .

In Proposition 4.2, we find that when  $B < (\lambda - r)(\lambda + \theta + r) / (\lambda\theta)$ , the benefit a firm obtains from exploiting the opportunity is not that great. In these circumstances, a firm's shareholders are less concerned that the firm might be preempted by its competitor and are less willing to incur the costs of the control system. Shareholders therefore will choose passive boards only when the costs of the control system are low; if the costs are high, they prefer an active board; alternatively, when the control system costs are moderate, the equilibrium is characterized by one firm choosing an active board and the other firm choosing a passive board. These findings are consistent with the institutional environment where firms in the same industry optimally choose different corporate governance styles.

## 5.2. Prevalence of Corporate Governance Styles

To offer predictions about the prevalence of alternative governance styles, we examine how the equilibrium thresholds  $k_{act}^*$  and  $k_{pas}^*$  in Propositions (4.1) and 4.2 change in response to changes in parameters of the firms' competitive environment. These predictions, which hold irrespective of the sign of  $B - (\lambda - r)(\lambda + \theta + r) / (\lambda\theta)$ , are highlighted in the next corollary.

**Corollary 5.1.** *An industry is more likely to feature a symmetric equilibrium where both firms choose passive boards and less likely to feature a symmetric equilibrium where both firms choose active boards when:*

1. *The technological innovation rate  $\theta$  increases;*
2. *The rate  $\lambda$  that a firm's board can evaluate a manager's business plan decreases;*
3. *The discount rate  $r$  increases;*
4. *The benefit of implementing the new technology  $B$  increases; and,*
5. *The cost  $k$  of a control system to monitor the manager's behavior decreases.*

The intuition for these relations is as follows. First, when the rate of technological innovation increases, a firm becomes more concerned that the competitor will discover the opportunity and invest before the firm acts. Consequently, the shareholders increasingly prefer a passive board that immediately commits to a budget and authorizes the manager to pursue the opportunity over an active board that takes time evaluating the manager's proposal before investing. Second, when a board's effectiveness at assessing a manager's business plan decreases, possibly because it does not immediately have the expertise to do so and has to seek advice from outside experts, then the firm's shareholders increasingly prefer a passive board over an active board. Shareholders prefer a passive board because

even though the passive board does not have the expertise to evaluate the manager's proposal *ex ante*, they recognize that the firm has a control system in place that will monitor the manager's performance *ex post*, and hence, mitigate the moral hazard problem that arises in this environment. Third, as the discount rate increases, the shareholders are more eager to implement the manager's plan and begin enjoying the benefits of the opportunity. Consequently, they prefer a passive board over an active board. Fourth, when the benefit of exploiting the opportunity increases, the shareholders become increasingly concerned that they might lose the opportunity to a competitor. To reduce the likelihood of this eventuality, they prefer a passive board to an active board. Fifth, as the costs of the control system decreases, the passive board optimally chooses a more effective control system. Shareholders then find a passive board increasingly desirable because they recognize that the board can grant the manager authority to take advantage of investment opportunities as they arise, knowing that there is a control system in place that will more effectively limit the manager's information rents.

It is worthwhile noting how the presence of a competing firm alters the choice of governance system relative to the case of a monopolist behaving non-strategically. Comparing (3.11) to (4.14) and (4.15), we observe  $k_{act}^* > k_{mon}^*$  and  $k_{pas}^* > k_{mon}^*$ . Hence, in a competitive environment where firms might be preempted by their competitors, we find firms are less likely to choose active boards than in a monopolistic setting where there is no preemption.

Relations between measures of corporate governance and firm performance vary depending on the firms' equilibrium governance choices. The expected payoff to a board in a symmetric active equilibrium is increasing in the rate at which a firm can evaluate the manager's plan to pursue the opportunity, i.e.,  $\partial E[V_{act,act}]/\partial\lambda > 0$ . Accordingly, strengthening governance mechanisms that allow a board to scrutinize a manager's business plan more closely, such as by increasing the proportion of unaffiliated directors with firm industry experience on the board, is anticipated to enhance the firm's value. The expected payoff to a board in a symmetric passive equilibrium, however, is unaffected by these

changes, i.e.,  $\partial E[V_{pas,pas}]/\partial\lambda = 0$ . A passive board relies on the information and control system to *ex post* report on the manager's actions; this monitoring serves as a substitute for the *ex ante* evaluation of the manager's business plan. The cost of the information and control system, therefore, more strongly affects the expected payoff of a firm with a passive board than a firm with an active board; i.e.,  $\partial E[V_{pas,pas}]/\partial k < 0$  whereas  $\partial E[V_{act,act}]/\partial k = 0$ . In this light, when empirically examining the relation between measures of firm performance and corporate governance in a cross-section of firms drawn from a variety of industries, it is important to partition firms according to whether they have active or passive boards before looking for these relations. Failure to make this partitioning provides an explanation for the failure to find the hypothesized relations in some of the empirical literature (e.g., Larcker, et al., 2004).

### 5.3. Implications of the Sarbanes-Oxley Act

When President Bush signed the Sarbanes-Oxley Act of 2002, he claimed it included "the most far-reaching reforms of American business practices since the time of Franklin Delano Roosevelt." (Fried, et al., 2002, 1). Perhaps the most controversial section of this Act is the requirement in Section 404 that firm management assess the effectiveness of the internal control structure and procedures for financial reporting and publicly report any material weaknesses. This section has been severely criticized because the cost of compliance is typically significant and falls disproportionately on smaller companies that are least able to afford it; further, many have argued that complying with this section has shifted management's focus from developing and implementing its business strategy and, as a consequence, has reduced firm competitiveness. To mitigate this cost, the Securities and Exchange Commission's (SEC) Advisory Committee on Smaller Public Companies has proposed an exemption or partial exemption from Section 404 for smaller companies. This proposal, however, has not received unanimous support: indeed, the former SEC Chairman, Arthur Levitt, former Federal Reserve Bank Chairman, Paul Volker, and former U.S. comptroller general and former

head of the Public Oversight Board, Charles Bowsher, among others, in a letter to the SEC argue that relaxing the provision of Section 404 would be misguided and would undermine the intent of the legislation to insure better reporting and better auditing (Rapoport, 2006).

Against this background, we examine the implication of Section 404 within the context of our model. Under Section 404, a firm’s internal controls are effective when no material weaknesses exist.<sup>7</sup> We interpret this Section as imposing the constraint that a firm must have a control system that eliminates the possibility of resource misappropriation, which in the context of our model implies that either a firm must have an active board or a passive board that implements a control system that prevents the manager from spending the surplus from the project on management perquisites. Implementing Section 404 in our model does not alter a firm’s payoff for the governance choice profile  $g = \{\text{active board, active board}\}$ , but almost always alters a firm’s payoff when it or its competitor chooses a passive board. Specifically, when a firm with a passive board must install a control system that satisfies Section 404, i.e.,  $a = 1$  in (2.1), the optimal capital budget is given by  $b_{SOX}^* = B - k$ . When  $B < k$ , operating a control system required under the Act is so costly that a firm would choose not to pursue the opportunity. To avoid this uninteresting case, we suppose for the remainder of this analysis that  $B - k > 0$ . We characterize the implications of Section 404 for the firms’ governance structures in the next proposition.

**Proposition 5.2.** *After implementing the Sarbanes-Oxley Act, an industry is more likely to feature a symmetric equilibrium where both firms choose active boards and less likely to feature a symmetric equilibrium where both firms choose passive boards.*

After implementing the Sarbanes-Oxley Act, we find that industries are more likely to be characterized by firms having active boards that retain their control rights

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<sup>7</sup>See the Public Company Accounting Oversight Board’s Auditing Standard No. 2 “An Audit of Internal Control Over Financial Reporting Performed in Conjunction with an Audit of Financial Statements” that provides guidance for implementing Section 404.

than passive boards that delegate control rights to management. The intuition for the heightened likelihood of active boards is that compliance with the Section 404 has made the choice of installing a passive board, which places greater reliance on an accounting internal control system to prevent the misallocation of the firm's resources, more costly. Hence, consistent with the commonly voiced criticism of the Sarbanes-Oxley Act, we expect boards to spend more time actively monitoring management after implementation of the Act than they would have spent before its implementation.

An implication of Proposition 5.2 is that compliance with the Act might decrease a firm's competitiveness by increasing the probability that a firm's competitor will preempt it from exploiting the opportunity. The attitudes of the business community to the provisions of the Act have been mixed: opponents have complained that it has weakened firm competitiveness (e.g., Greifeld, 2006); while proponents have contended that it has led to firms being better managed and more competitive (e.g., Donaldson, 2003). Indeed, we find the Act's effect on the probability that a firm will be preempted is ambiguous. The probabilities that a firm is preempted in the various equilibria are formalized in the next corollary.

**Corollary 5.3.** *The probability that a firm will be preempted in an industry characterized by a symmetric equilibrium where firms choose passive boards was  $\frac{1}{3}B$  before implementation of the Sarbanes-Oxley Act and is  $\frac{1}{2}(B - k)$  after its implementation. The probability that a firm will be preempted in an industry characterized by a symmetric equilibrium where firms choose active boards is  $\frac{1}{2}B$  both before and after implementation of the Act.*

If both firms switch from having passive boards before the Act to having active boards after the Act, then they are *more* likely to be preempted and therefore will perceive themselves as being less competitive. The reason for the decline in competitiveness is that active boards take time investigating the manager's business plan, which increases the probability that the firm's rival will preempt it. In contrast, if firms in an industry do not switch from having passive boards but

merely improve their internal control systems to comply with the provisions of Section 404, then they are *less* likely to be preempted, because  $B/3 > (B - k)/2$  when  $k \in [B/3, B]$ . Accordingly, these firms will perceive themselves as being more competitive. The intuition here is that Section 404 has had the effect of reducing a passive board's capital budget from  $b^* = 2B/3$  to  $b_{SOX}^* = B - k$ . In the post Sarbanes-Oxley environment, the firm's competitor is less likely to pursue the opportunity, leaving the firm's manager to decide whether to pursue the opportunity. Finally, the Act is expected to have no effect on those industries where firms have historically had active boards.<sup>8</sup>

## 6. Conclusion

We examine the choice of corporate governance structures in a competitive environment. In a setting where a firm can exploit an opportunity and thereby preempt its competitor from doing so, shareholders choose between an active board and a passive board of directors. An active board investigates its manager's business plan to exploit the opportunity before authorizing the manager to proceed, whereas a passive board provides the manager with a budget and allows the manager to decide whether to pursue the opportunity.

The key trade-off in the model is between an active board that retains control rights over the firm's resources but can less nimbly respond to transient business opportunities and a passive board that delegates control rights to the manager and hence can more quickly pursue these opportunities before its rival can preempt them. Firms therefore strategically choose their governance structures in response to their rivals' choices. Depending on parameters of the industry, there is an equilibrium where both firms choose active boards, an equilibrium where both firms choose passive boards, and equilibria where a firm chooses an active board

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<sup>8</sup>Critics of the Act contend that compliance with the Act reduces the competitiveness of U.S. companies relative to foreign companies that do not need to comply with it (Greifeld, 2006). Because we assume that all firms in an industry comply with the same regulatory provisions, we do not address this criticism but rather leave considering it for future research.

and its rival chooses a passive board and vice versa. An important consequence of the presence of alternative equilibria is that there generally is no systematic relation between measures of corporate governance, such as number of independent directors or monitoring by debt holders, and firm performance in sample of firms drawn from various industries. We offer suggestions, however, as to how a sample of firms might be partitioned to expose this relation.

We characterize how shareholder choice of governance structures is affected by the rate of technological innovation in an industry, board expertise at evaluating plans to implement new technology, the risk of the business environment, the benefit of using new technology, and the cost of installing an internal control system to monitor the manager. Our analysis also predicts some governance consequences of the Sarbanes-Oxley Act. After complying with the Act, we note that industries are more likely to be characterized by firms choosing active rather than passive boards, which is consistent with claims that boards are now spending more time monitoring management. We also find that the effect of the Act on firm competitiveness is ambiguous: for industries that experience a switch from having firms with passive boards to active boards, we note that a firm is more likely to be preempted by its rival, suggesting that the firm is less competitive; in contrast, for industries whose firms do not switch from having passive boards but merely improve their internal control systems to comply with the Act, we find that a firm is less likely to be preempted by its rival. These observations reconcile claims that complying with the Act is burdensome and has reduced firm competitiveness with claims that the Act has improved corporate management and enhanced firm competitiveness.

## A. Appendix

### Proof of Proposition 4.1:

If  $B \geq \frac{(\lambda-r)(\lambda+\theta+r)}{\lambda\theta}$ , then  $k_{act}^* \leq k_{pas}^*$ . If  $k \leq k_{pas}^*$ , then  $E[V_{pas,pas}] \geq E[V_{act,pas}]$ ; consequently, it is an equilibrium for both firms to choose passive boards. If  $k \geq k_{act}^*$ , then  $E[V_{act,act}] \geq E[V_{pas,act}]$  and therefore it is an equilibrium for both firms to choose active boards. On considering the relations in (4.14) and (4.15) it is clear that the equilibrium in each case is unique. When  $k \in [k_{act}^*, k_{pas}^*]$ , i.e.,  $k$  satisfies both (4.14) and (4.15), then there exist multiple equilibria: one where both firm's choose active boards and one where both firms choose passive boards.

Since we emphasize the Pareto-dominant Nash equilibrium and claim that this equilibrium is characterized by both firms choosing active boards rather than passive boards, it remains to show that if  $k \in [k_{act}^*, k_{pas}^*]$ , then  $E[V_{act,act}] \geq E[V_{pas,pas}]$ . Observe that an increase in  $k$  decreases  $E[V_{pas,pas}]$ , but has no effect on  $E[V_{act,act}]$ . Therefore, to establish that  $E[V_{act,act}] > E[V_{pas,pas}]$  for all  $k \in [k_{act}^*, k_{pas}^*]$ , it is sufficient to show that  $E[V_{act,act}] > E[V_{pas,pas}]$  for the lowest value of  $k$  that satisfies both (4.14) and (4.15). Hence, we set  $k$  equal to the right-hand side of the (4.14). Note that

$$E[V_{act,act}] - E[V_{pas,pas}] \propto (2\theta + 2r - \lambda).$$

If  $B > \frac{(\lambda-r)(\lambda+\theta+r)}{\lambda\theta}$ , then because  $B \in [0, 1]$  it must be the case that  $1 \geq B > \frac{(\lambda-r)(\lambda+\theta+r)}{\lambda\theta}$ . This expression implies  $\lambda < \sqrt{r^2 + r\theta}$ . But, if  $\lambda < \sqrt{r^2 + r\theta}$ , then  $(2\theta + 2r - \lambda) > 0$ . Thus, we conclude that both choosing active boards Pareto dominates both firms choosing passive boards. ■

### Proof of Proposition 4.2:

If  $B > \frac{(\lambda-r)(\lambda+\theta+r)}{\lambda\theta}$ , then  $k_{pas}^* < k_{act}^*$ . If  $k \leq k_{pas}^*$ , then  $E[V_{pas,pas}] \geq E[V_{act,pas}]$ ; consequently, it is an equilibrium for both firms to choose passive boards. If  $k \geq k_{act}^*$ , then  $E[V_{act,act}] \geq E[V_{pas,act}]$  and therefore it is an equilibrium for both firms to choose active boards. On considering the relations in (4.14) and (4.15),

we observe that the equilibrium in each case is unique. When  $k \in [k_{pas}^*, k_{act}^*]$ , then there exists an equilibrium where a firm chooses a passive board and the other firm chooses an active board, and another equilibrium where the firms' choices are reversed. ■

**Proof of Corollary 5.1:**

Consider the case when  $B - (\lambda - r)(\lambda + \theta + r)/\lambda\theta \geq 0$ . It is straightforward to show :  $\frac{\partial k_{act}^*}{\partial \theta} > 0$ ,  $\frac{\partial k_{act}^*}{\partial \lambda} < 0$ ,  $\frac{\partial k_{act}^*}{\partial r} > 0$ , and  $\frac{\partial k_{act}^*}{\partial B} > 0$ . Consider the case when  $B - (\lambda - r)(\lambda + \theta + r)/\lambda\theta < 0$ . In addition to using the above relations, it is again straightforward to show:  $\frac{\partial k_{pas}^*}{\partial \theta} > 0$ ,  $\frac{\partial k_{pas}^*}{\partial \lambda} < 0$ ,  $\frac{\partial k_{pas}^*}{\partial r} > 0$ , and  $\frac{\partial k_{pas}^*}{\partial B} > 0$ . Finally, lower (higher) values of  $k$  are associated with a symmetric passive (active) equilibrium. ■

**Proof of Proposition 5.2:**

To establish the proposition, we show that the restrictions imposed by the Sarbanes-Oxley Act (SOX) yield threshold values for  $k$ , denoted,  $k_{act}^{SOX}$  and  $k_{pas}^{SOX}$  such that  $k_{act}^{SOX} < k_{act}^*$  and  $k_{pas}^{SOX} < k_{pas}^*$ .

First, suppose the competitor chooses an active board in the absence of SOX. The firm chooses an active board if  $E[V_{act,act}]/E[V_{pas,act}] \geq 1$ . Using (4.4) and (4.13), this condition can be expressed as:

$$\frac{E[V_{act,act}]}{E[V_{pas,act}]} = \frac{\frac{B^2}{2} \frac{\theta\lambda}{(\theta+r)(\lambda+r)} \left(1 - \frac{\lambda\theta(2\lambda+2\theta+3r)}{(2\lambda+r)(2\theta+r)(\lambda+\theta+r)} B\right)}{\frac{2B^3}{27k} \frac{\theta}{(\theta+r)} \left(1 - B \frac{\theta\lambda}{(2\theta+r)(\theta+\lambda+r)}\right)} \geq 1. \quad (A.1)$$

In the presence of SOX (i.e., when  $a_{SOX}^* = 1$ ,  $b_{SOX}^* = B - k$ ,  $V_{pas}^{SOX} = (B - k)/2$ , and  $h_{p,a}(t) = \theta e^{-\theta t} \times \left(1 - \left(1 - \frac{e^{-\theta t} \lambda - e^{-\lambda t} \theta}{\lambda - \theta}\right) B\right) \times (B - k)$ ), the corresponding expression is:

$$\frac{E[V_{act,act}^{SOX}]}{E[V_{pas,act}^{SOX}]} = \frac{\frac{B^2}{2} \frac{\theta\lambda}{(\theta+r)(\lambda+r)} \left(1 - \frac{\lambda\theta(2\lambda+2\theta+3r)}{(2\lambda+r)(2\theta+r)(\lambda+\theta+r)} B\right)}{\frac{(B-k)^2}{2} \frac{\theta}{(\theta+r)} \left(1 - \frac{B\theta\lambda}{(2\theta+r)(\theta+\lambda+r)}\right)} \geq 1. \quad (A.2)$$

Using (A.1) and (A.2), it follows that:

$$\frac{E[V_{act,act}]}{E[V_{pas,act}]} - \frac{E[V_{act,act}^{SOX}]}{E[V_{pas,act}^{SOX}]} = -\frac{\lambda(B - \frac{3}{4}k)(B - 3k)^2 \left(1 - \frac{\lambda\theta(2\lambda+2\theta+3r)B}{(2\lambda+r)(2\theta+r)(\lambda+\theta+r)}\right)}{B(\lambda+r)(B-k)^2 \left(1 - \frac{\lambda\theta B}{(2\theta+r)(\lambda+\theta+r)}\right)} < 0. \quad (\text{A.3})$$

At  $k_{act}^*$  given in (4.14),

$$E[V_{act,act}^{SOX}] / E[V_{pas,act}^{SOX}] > E[V_{act,act}] / E[V_{pas,act}] = 1.$$

Because (A.2) is increasing in  $k$ , the threshold for  $k$  in the presence of SOX for which  $E[V_{act,act}^{SOX}] / E[V_{pas,act}^{SOX}] = 1$ , denoted  $k_{act}^{SOX}$ , must be less than the threshold  $k_{act}^*$  in the absence of SOX.

Second, suppose the competitor chooses a passive board in the absence of SOX. The firm chooses a passive board if  $E[V_{pas,pas}] / E[V_{act,pas}] \geq 1$ . Using (4.7) and (4.10), this condition can be expressed as:

$$\frac{E[V_{pas,pas}]}{E[V_{act,pas}]} = \frac{\frac{2B^3}{27k} \frac{\theta}{(\theta+r)} \left(1 - \frac{2B}{3} \frac{\theta}{(2\theta+r)}\right)}{\frac{B^2}{2} \frac{\lambda\theta}{(\lambda+r)(\theta+r)} \left(1 - \frac{2}{3}B \left(1 - \frac{(\lambda+r)(\theta+r)}{(2\theta+r)(\theta+\lambda+r)}\right)\right)} \geq 1. \quad (\text{A.4})$$

In the presence of SOX (i.e., when  $a_{SOX}^* = 1$  and  $b_{SOX}^* = B - k$ ), the corresponding expression is:

$$\frac{E[V_{pas,pas}^{SOX}]}{E[V_{act,pas}^{SOX}]} = \frac{\frac{(B-k)^2}{2} \frac{\theta}{(\theta+r)} \left(1 - \frac{\theta(B-k)}{(2\theta+r)}\right)}{\frac{B^2}{2} \frac{\lambda\theta}{(\lambda+r)(\theta+r)} \left(1 - (B-k) \left(1 - \frac{(\lambda+r)(\theta+r)}{(2\theta+r)(\theta+\lambda+r)}\right)\right)} \geq 1. \quad (\text{A.5})$$

Using expressions (A.4) and (A.5), it follows that:

$$\begin{aligned}
& \frac{E[V_{pas,pas}]}{E[V_{act,pas}]} - \frac{E[V_{pas,pas}^{SOX}]}{E[V_{act,pas}^{SOX}]} \\
\propto & \left[ 3r^2(\lambda + r)(4B - 3k)(3k - B) + [\theta\lambda r(4B - 3k)(3k - B)(3k + 12 - 5B)] \right. \\
& + [\theta r^2(4B^2(-15 + 8B) + Bk(225 - 117B) - k^2(135 - 108B) - 27k^3)] \\
& + [2\lambda\theta^2(2 - B + k)(4B - 3k)(3k - B)(3 - B)] + [r\theta^2(-16B^2(6 - 6B + B^2) \\
& + kB(360 - 351B + 76B^2) - k^2(96B^2 - 324B + 216) - k^3(81 - 36B))] \\
& + [-2\theta^3(8B^2(3 - B)(1 - B) + 3k^2(3 - 2B)(6 - 8B + 3k) \\
& \left. - kB(3 - 2B)(30 - 19B)] \right]. \tag{A.6}
\end{aligned}$$

Each term in square brackets is positive when  $k \in [B/3, B]$ . This can be verified by inspection for the first, second, and fourth bracketed terms. The other bracketed terms are concave in  $k$ , and are positive at  $k = B/3$  and  $k = B$ , so

$$E[V_{pas,pas}] / E[V_{act,pas}] \geq E[V_{pas,pas}^{SOX}] / E[V_{act,pas}^{SOX}].$$

It then follows that at  $k_{pas}^*$ , which is given in (4.15),

$$E[V_{pas,pas}] / E[V_{act,pas}] = 1 > E[V_{pas,pas}^{SOX}] / E[V_{act,pas}^{SOX}].$$

Because (A.5) is decreasing in  $k$ , the threshold for  $k$  in the presence of SOX for which  $E[V_{pas,pas}^{SOX}] / E[V_{act,pas}^{SOX}] = 1$ , denoted  $k_{pas}^{SOX}$ , must be less than the threshold  $k_{pas}^*$  in the absence of SOX. ■

**Proof of Corollary 5.3:**

We calculate the probability that a firm's competitor will preempt the firm from exploiting the opportunity conditional on the firm being able to decide whether or not to pursue the opportunity depending on its cost realization. The firm is in a position to decide to pursue the opportunity if and only if its rival has

not preempted it.

To determine the probability before implementation of the Sarbanes-Oxley Act that a firm will be preempted in an industry characterized by a symmetric equilibrium where firms choose *passive* boards, take (4.6), adjust it for the probability of competitor preemption and eliminate  $2B/3$ , which is the probability that the firm's manager decides to pursue the opportunity, to obtain

$$\int_0^{\infty} \theta e^{-\theta t} \times \frac{2B}{3} (1 - e^{-\theta t}) dt = \frac{1}{3}B.$$

Similarly, the probability after implementation of the Sarbanes-Oxley Act that a firm will be preempted in an industry characterized by a symmetric equilibrium where firms choose *passive* boards is given by

$$\int_0^{\infty} \theta e^{-\theta t} \times (B - k) (1 - e^{-\theta t}) dt = \frac{1}{2}(B - k).$$

To determine the probability that a firm will be preempted in an industry characterized by a symmetric equilibrium where firms choose *active* boards, take (4.3), adjust it for the probability of competitor preemption and eliminate  $B$ , which is the probability that the firm's board decides to pursue the opportunity, to obtain

$$\int_0^{\infty} \frac{\theta \lambda e^{-\theta t} - \theta \lambda e^{-\lambda t}}{\lambda - \theta} \times \left( 1 - \frac{e^{-\theta t} \lambda - e^{-\lambda t} \theta}{\lambda - \theta} \right) B dt = \frac{1}{2}B. \blacksquare$$

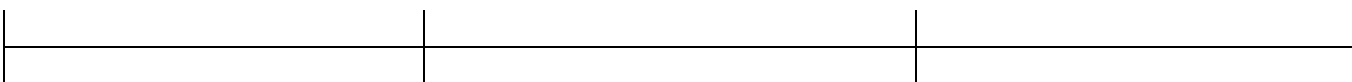
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**Figure 1: Time line of events**



At date  $t$  equal to zero, each firm's shareholders choose a board of directors that is active or passive. The board selects a manager. The players know the benefit  $B$  of exploiting a new technology but not how to do so.

The manager seeks a plan to commercialize the technology; the rate of discovery follows a Poisson process with parameter  $\theta$ . On discovery of the plan, the manager privately observes the project's cost  $c$ .

The manager proposes the plan to the board. An active board investigates the plan and decides whether to authorize it; the rate of completion of its investigation to learn the cost of the project  $c$  follows a Poisson process with parameter  $\lambda$ . A passive board chooses a control system of quality  $a$  (at a cost per unit of quality  $k$ ) and authorizes a budget  $b$ ; the manager decides whether to pursue the opportunity.

Once the firms have exploited the opportunity or turned it down, the game ends and the shareholders' payoffs are realized. The discount rate is  $r$ .

