Governance Mechanisms and Corporate Transparency*

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Abstract

By promoting greater corporate transparency firms can foster external scrutiny. However, the resulting actions are likely to reduce the incentives for internal accountability. Hence, a firm's reliance on external versus internal oversight is itself an aspect of its governance policies. Moreover, these competing mechanisms interact with technological progress and regulatory reform in determining the overall quality of oversight. In equilibrium, firms equalize the marginal benefits of internal and external governance through their degree of transparency. However, agency problems between the board and shareholders may lead to inefficient levels of both transparency and internal oversight. We show that new technology, as emphasized by recent regulation, can mitigate such inefficiencies. Improvements in information dissemination enhance transparency so that greater external scrutiny allows the board to monitor less. Advances in information processing shift the governance balance toward more internal oversight. Our results hold implications for competition in the market for corporate control and for regulation.

1 Introduction

At the heart of proper corporate governance is the identification and correction of inefficiencies in the running of a firm. In pursuing this objective, firms rely not only on their own internal mechanisms but also on external instruments. Since firms can take steps to further one mechanism over another, the extent to which a firm relies on internal versus external oversight must itself be an aspect of its governance arrangements in equilibrium. For example, directors can dedicate resources to the promotion of internal accountability through monitoring. Such action, however, is likely to discourage external scrutiny by reducing the expected return to a variety of actions such as takeovers, shareholder pressure on management or the board, and proxy fights. Likewise, directors can facilitate the acquisition of information by outsiders by increasing transparency through the firm's disclosure policy, thus providing an alternative channel for governance through outside action but in turn reducing the need for internal monitoring.

Understanding the interplay of these mechanisms has taken on greater importance following a wave of well-publicized corporate scandals such as Enron, Tyco, Worldcomm, and Global Crossing. Firms have taken steps to strengthen their governance by making boards more independent, by explicitly charging directors to enhance corporate transparency through higher disclosure standards, and by adopting new technologies for generating and disseminating financial information. From a regulatory perspective, the response to these governance failures - the Sarbanes-Oxley Act (Section 404 on internal controls and related rules) and the SEC's interactive-reporting project (SEC Press Release No. 2007-253, December 5, 2007) - has emphasized technological solutions to possible conflicts of interests within the firm which may hinder proper oversight. Technological advances such as financial information systems (FIS), XBRL-enabled interactive reporting,[1] or open conference-call technology (see Bushee et al., 2003), have greatly facilitated governance reforms by ensuring the timely generation and cost-effective dissemination of corporate information. But technological progress changes the relative efficacy of competing forms of governance so that any improvement along one dimension is likely to also affect other aspects of corporate oversight.

To study these issues we present a model in which both a corporate board and an external party

[1]XBRL (Extensible Business Reporting Language) is a newly developed financial-reporting markup language which allows firms to move to real-time financial reporting, facilitates directed searches of financial statements, and promises to vastly improve users' acquisition and processing of financial information (see Hodge *et al.*, 2004 and the references therein).

can improve firm value by identifying and replacing ineffective management. A large shareholder, private-equity firm, hedge fund, or other outside bidder ("acquirer") may screen potential targets to take over and restructure poorly-run firms. The acquirer's ability to identify inefficiencies at a particular firm depends not only on her screening effort but also on the firm's degree of transparency, with greater transparency reducing the cost of acquiring information. Directors decide what resources to dedicate to the monitoring of incumbent management. They also choose the degree of transparency through the firm's disclosure policy. However, board and shareholder interests can diverge because directors pursue the maximization of firm value together with their own interests by, for instance, taking actions which reduce the probability that they or management will be replaced.

In equilibrium, the board chooses the firm's transparency to equalize the marginal benefits of internal and external governance actions. However, the more board and shareholder interests diverge, the less incentive the board has to either disclose information or monitor management. We show that, although the information-gathering activities of the board and the acquirer are substitute instruments for increasing firm value, the firm's disclosure policy is complementary to the acquirer's screening activity. Greater transparency encourages more external scrutiny and, hence, a more active takeover market whereas more internal monitoring reduces the incentives for an acquirer to screen.[2]

Our framework allows us to easily study a number of issues related to the alignment of board-shareholder interests, the importance of technology for governance, and the effect of competition in the market for corporate control. In particular, we argue that technological progress, by increasing the return to information acquisition or reducing the cost of disclosure, mitigates the underlying agency problem between shareholders and their boards. Indeed, we show that the board increases its monitoring when its ability to process company-specific information improves. Surprisingly, this improvement in internal oversight also leads to increased transparency to counteract the acquirer's tendency to reduce her activism in response to the board's increased monitoring. By contrast, advances in the technology for disseminating information, by reducing the cost of corporate disclosure, encourage greater transparency and lead to more activism by the acquirer. More external

[2]These results are consistent with Berger and Hann (2002) who report that increased disclosure, defined as disaggregated, segment-level reporting, facilitates the market for corporate control.

scrutiny then allows the board to reduce its own monitoring. Hence, technological progress, while increasing shareholder value through better governance, also shifts the firm's reliance on one form of governance relative to another.

We extend the analysis to the case of multiple outside bidders and show that the board reduces transparency when there is greater competition among acquirers because there are more players potentially providing external governance. Initially, competition benefits the firm since it provides for better governance at lower costs. However, further competition actually has a negative effect on the market for corporate control because it becomes harder for each player to appropriate the gains from gathering private information. Competition now erodes the acquirers' incentives to screen a possible target to a point where overall information production and, hence, the effectiveness of governance decrease when the number of potential bidders is large.

The paper has a number of empirical and policy implications. For instance, we show that greater transparency fosters outsider activism but induces firms to dedicate less resources to internal monitoring. As a result, more transparent firms should exhibit less internally initiated executive turnover and more external restructuring, which is consistent with evidence in Leuz et al. (2008) that companies cease SEC reporting to reduce outside scrutiny and protect control benefits when governance arrangements are weak. Our model also predicts that reforms which reduce the relative private costs of board replacements, such as better director pay and qualifications or professional nonexecutive directors, work to improve transparency. Increasing the alignment between boards and shareholders also leads to more internally initiated governance actions, a result which is consistent with the evidence in Weisbach (1988) that boards with a greater fraction of outside directors are more willing to replace management. In the same vein, Shivdasani (1993) reports that a hostile takeover is less likely when outsiders represent a larger fraction of the directors. On the technology front, we predict that advances which improve the ability of firms to process internal company-specific information also improve transparency by, for instance, increasing the frequency and timeliness of disclosures. Nevertheless, the net effect of greater board-shareholder alignment is that a greater proportion of internally generated executive turnover. Our results also suggest that the adoption of new technology, as promoted by recent regulation (e.g., Section 404 of the Sarbanes-Oxley Act), induces firms to increase the use of some governance instruments at the cost of decreasing their reliance on others. Although the overall effect may be positive, firms' response

is likely to diminish the hoped for regulatory benefits of technology.

Our main contribution is to analyze how control mechanisms and corporate transparency are jointly determined as part of firms' optimal governance arrangements, an issue that, to the best of our knowledge, has not been studied before. At the same time, our analysis clarifies the role that technology can play in enhancing corporate transparency and the effectiveness of governance. This aspect is crucial for understanding the likely effects of recent regulations, such as the Sarbanes-Oxley Act or the SEC's Interactive-Reporting Initiative, which rely on modern information technology for compliance.

There has been little work to date on understanding how firms can influence the effectiveness of competing corporate-governance mechanisms.[3] In fact, the survey by Bushman and Smith (2001) points out the need for a more comprehensive investigation of the interactions across governance mechanisms and the role of financial-accounting information in this process. For instance, Hope (2003) reports that firm-level disclosures are positively related to forecast accuracy, suggesting that better disclosures fosters more accurate external analysis. Similarly, Rogers (2008) finds that the quality of disclosure is related to the ease with which insiders can trade shares. These findings provide further evidence on the link between firms' ability to adjust the external availability of information and the functioning of the market for corporate control.

Hirshleifer and Thakor (1998) consider the role of internal vs. external governance mechanisms but do not analyze the role of corporate disclosure or technological progress in influencing these different instruments. The notion that the takeover market can be a substitute for internal governance has been analyzed in Scharfstein (1988), who focuses on the disciplinary effect of takeovers on management. Hermalin (2005) investigates how recent trends in corporate governance, including legal and regulatory changes, influence the effectiveness of boards. Graziano and Luporini (2003) study board incentives in the face of external pressures. Boot and Thakor (2001) focus on selective disclosure of information, and Admati and Pfleiderer (2000) study the social value of disclosure when firm values are correlated (see also Diamond, 1985, for an early model of the benefits of disclosure to investors). By contrast, our work focuses on how disclosure and corporate transparency can aid external parties to gather information and use it for governance purposes.[4]

[3] See the surveys by Shleifer and Vishny (1997) on corporate governance, Holmström and Kaplan (2001, 2003) on the evolution of corporate governance and takeover activity, and Hermalin and Weisbach (2003) on corporate boards.

[4] In our approach, "disclosure policy" refers to the firm's choice concerning the level of detail it provides (e.g.,

Of particular relevance for our work is the literature on the disciplinary role of internal and external oversight. Kini et al. (2004) report that the corporate takeover market can play a disciplinary role but only when internal control mechanisms prove ineffective, consistent with our argument that a firm's overall governance decisions determine the degree to which external oversight can be effective. Mikkelson and Partch (1997) find that greater activity in the takeover market induces a greater correlation between management turnover and firm performance for nonacquired firms. To the extent that such turnover reflects internal governance and board monitoring, it is in line with our finding that the threat of board replacement following a successful takeover provides incentives for directors to restructure internally, thereby allowing them to retain their positions. More recently, Cremers and Nair (2005) find that internal governance is particularly value-enhancing for firms with low takeover defenses. Since acquirers in those instances are in a stronger position vis-à-vis incumbent boards, their findings are consistent with our result that boards with less bargaining power monitor more diligently. The cross sectional implications of our model are also in line with the findings in Adams (2003) that boards in larger, older, and more mature companies, i.e., firms with a lot of available information about management, devote less resources to monitoring activities.

The paper is organized as follows. In the next section we describe our model. The equilibrium is derived in Section 3. In Section 4, we study the incidence of advances in information technology. Section 5 analyzes the role of regulation and examines how competition in the market for corporate control affects overall governance. Section 6 summarizes empirical implications and concludes. Proofs are mostly relegated to the Appendix.

2 Model Description

Suppose that a firm's current operations generate an observable and contractible terminal cash flow X with probability p_θ and 0 with probability $1 - p_\theta$, where $\theta \in \{l, h\}$ denotes the type of the firm's management (high or low quality), which is unknown ex ante. We assume that $p_h > p_l$. The probability that management is of high quality is q, which is common knowledge, and we let

disaggregation across lines of business), the frequency of updates, etc., so that greater disclosure implies greater transparency. We do not address the strategic disclosure of information by management. For surveys of work on what managers strategically decide to disclose and what to keep private see Healy and Palepu (2001) and Verrecchia (2001).

$\overline{p} \equiv qp_h + (1-q)p_l$ denote the average success probability of managers.

The firm's shareholders charge a board of directors with its day-to-day governance. This board has two functions: to monitor incumbent management and to determine the firm's transparency. In particular, the board exerts monitoring effort $x_b \geq 0$ that with probability $\phi_b = 1 - e^{-Ix_b}$ yields a perfectly informative signal about management's quality and with complementary probability yields no information. For simplicity, the cost of this effort is linear: x_b. The state variable $I \geq 1$ captures the quality of technology dedicated to generating information and to aiding firms in the analysis of corporate data. Examples consist of internal IT systems for performance measurement such as Financial Information Systems.

The board establishes the firm's transparency[5] D by setting the extent, quality, and frequency of its financial reports, SEC filings beyond minimal statutory requirements, analyst meetings and conference calls, investor presentations, etc. Higher values of D represent a greater degree of transparency through, for instance, greater disclosure,[6] and come at cost $\frac{1}{t}D$.[7] The state variable t captures the quality of technology available to enhance transparency through, for instance, real-time filing systems, open conference-call technology via webcasts, XBRL-enabled reporting, etc.

External governance is provided by an outside party such as a corporate raider, private-equity firm, industry competitor, etc., which we refer to as an "acquirer" for simplicity. This acquirer can exert effort $x_a \geq 0$ to discover with probability $\phi_a = 1 - e^{-Ix_a}$ the quality of the firm's management; with complementary probability she learns nothing. We relax the assumption that boards and acquirers have the same information-processing capability I in Section 4.3. Since greater transparency facilitates external analysis (see Hope, 2003 on this point), we assume that effort by the acquirer incurs a cost $ke^{-D}x_a$ which is decreasing in the firm's transparency as well as in the acquirer's screening efficiency k. The acquirer specializes in identifying promising

[5]Bushman et al. (2004) define corporate transparency "as the availability of firm-specific information to those outside publicly traded firms" and, in particular, financial transparency in terms of "the intensity and timeliness of financial disclosures."

[6]In recent years, many boards have appointed a Disclosure Committee or explicitly charged their Audit Committee with determining the extent of financial and other disclosure. Several prominent companies such as Reynolds American, Sun Microsystems, Lazard, etc., now have disclosure committees; Cisco is an example where the Audit Committee also sets disclosure policy. This idea goes back to the Wallman Report (SEC Concept Report 33-7314, July 1996) and gained momentum in the wake of the Sarbanes-Oxley Act.

[7]The cost of disclosure, or transparency, can also represent any loss in competitive position resulting from inadvertently providing vital information to rival firms, as in Bhattacharya and Chiesa (1995) or Yosha (1995). More recently, Singh and Yerramilli (2007) argue that more market scrutiny stemming from increases in transparency is not always value-enhancing for the firm.

restructuring targets and, therefore, needs access to firm-specific data (see Bushman et al., 2004). Although the board and outside parties might analyze similar information they may nevertheless arrive at different inferences about the firm's prospect. Consequently, our framework allows for the possibility that information useful to the acquirer is not necessarily helpful in internal oversight. In the appendix, we also analyze the case in which a large shareholder provides external governance and show that our results go through virtually unchanged.

If management is found to be of low quality by either party, the board or the acquirer bring in a new team from the outside pool. Hence, replacing low-quality management improves the firm's prospects in expected value by $\overline{p}X - p_l X = q\left(p_h - p_l\right)X$. If neither party learns anything, there is no value in changing incumbent management. The total expected surplus conditional on discovering management's type is therefore $\Pi = (1-q)\,q\left(p_h - p_l\right)X$.

Board monitoring and screening by a potential acquirer occur simultaneously. We assume throughout that the acquirer will submit a bid for the firm only if her information identifies inefficiencies in the running of the firm and if the board's monitoring activities have been inconclusive.[8] If the board is successful at uncovering negative information the firm's shareholders capture all the governance surplus Π. Conversely, when the board is uninformed but receives a bid from the acquirer it cannot simply fire management as a way of preempting the takeover. One justification for this assumption are statutory limitations on board actions during takeover bids, such as management's role in advising the board on any offer or the requirement that the board respond to the bid before taking other actions. Alternatively, we can think of the acquirer's information as identifying individual members of the firm's management team that are ineffective so that observing an outside bid would not provide directors with sufficient information about which managers to replace. In this instance, the parties share the surplus, with the acquirer obtaining a fraction $1-\alpha$ of the surplus Π. We can think of α as the board's bargaining power given by, for instance, the degree of board entrenchment. Conversely, $1-\alpha$ could represent the acquirer's toehold. We can also interpret α as a measure of the board's legal or statutory position vis-à-vis outside bidders so that higher values of α correspond to a more target-friendly environment. Figure 1 summarizes

[8]This assumption is consistent with the finding in Kini *et al.* (2004) that the corporate takeover market can play a disciplinary role but only when internal control mechanisms prove ineffective. It also corresponds to business practices in the private-equity industry that typically proposes restructuring plans in conjunction with takeover bids to distinguish serious offers from frivolous ones that merely try to extort money from the firm ("greenmail").

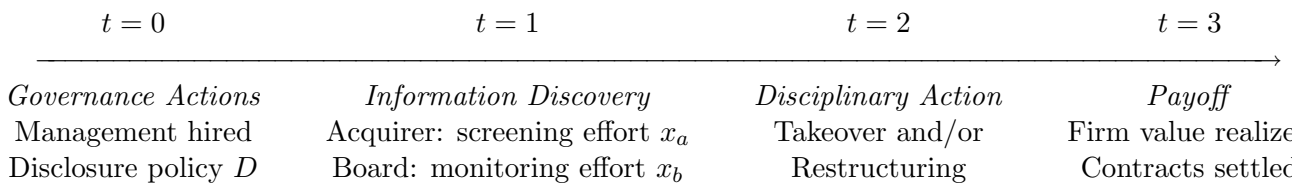

Figure 1: Time Structure of the Model

the time structure of our model.

Finally, we also allow for an agency problem between the board and shareholders by letting $\gamma \in [0, 1]$ represent the relative importance the board places on the maximization of shareholder value.[9] For high values of γ, board and shareholder interests agree, whereas low values of γ represent situations in which the board pursues its own interests or is possibly aligned with managers and would not perceive much value in replacing an ill-performing management team. A successful takeover may also impose a possibly non-pecuniary cost $c \geq 0$ on the board. This cost captures, for instance, any expected loss of reputation, career prospects, or perquisites if the directors are replaced as part of the restructuring and is consistent with the findings in Harford (2003), who reports that outside directors of target firms are often removed after a takeover, hold fewer directorships in the future, and suffer a direct negative financial impact following a takeover.

3 Internal and External Governance

We solve the model by backward induction. Starting at time 1, we first characterize the board's and the acquirer's monitoring and screening effort decisions for a given disclosure policy D. Let the board's and acquirer's *ex ante* expected payoffs be denoted by π_b and π_a, respectively. The board's payoff is given by[10]

$$\pi_b = \phi_b \gamma \Pi + (1 - \phi_b)\, \phi_a\, (\gamma \alpha \Pi - c) - x_b - \frac{1}{t} D \tag{1}$$

[9] Recent corporate governance scandals illustrate that significant agency conflicts may exist between shareholders and boards because the former delegate the monitoring and replacement of management to the company's directors. We note that such conflicts may persist even in the presence of optimal contracting arrangements between shareholders and directors. The parameter γ captures such residual agency problems.

[10] In Equation (1) we assume that the board internalizes the full cost associated with disclosure, which can comprise losses in competitive position. Similar results hold if the board only internalizes a fraction γ of these costs, so that its objective function is

$$\pi_b = \phi_b \gamma \Pi + (1 - \phi_b)\, \phi_a\, (\gamma \alpha \Pi - c) - x_b - \gamma \frac{1}{t} D.$$

The board maximizes Equation (1) with respect to monitoring effort x_b. A similar expression holds for the acquirer, which she maximizes by choosing screening effort x_a:

$$\pi_a = (1-\phi_b)\,\phi_a\,(1-\alpha)\,\Pi - ke^{-D}x_a \tag{2}$$

The following preliminary result summarizes the optimal levels of monitoring and screening for a given disclosure policy D:

Lemma 1 *For $D > \widetilde{D} \equiv \ln\left(\frac{k\gamma}{1-\alpha}\right)$, the optimal monitoring and screening success probabilities for the board and acquirer, respectively, are given by $\phi_b^*(D) = 1 - \frac{\Pi(1-\alpha)-ke^{-D}(\gamma\alpha\Pi-c)}{I\Pi(1-\alpha)(\gamma(1-\alpha)\Pi+c)}$ and $\phi_a^*(D) = 1 - \frac{(\gamma(1-\alpha)\Pi+c)k}{(1-\alpha)\Pi e^{D}-(\gamma\alpha\Pi-c)k}$, where $\phi_i^*(D) = 1 - e^{-Ix_i^*}$, $i = b, a$.*

For $D \leq \widetilde{D}$ and $k \geq 1$, board monitoring and acquirer screening are given instead by $\phi_b^*(D) = 1 - \frac{1}{\gamma I\Pi}$ and $\phi_a^*(D) = 0$, respectively.

Proof. See Appendix. ■

For a sufficiently transparent firm, i.e., $D > \widetilde{D}$, both the board and the acquirer find it optimal to exert effort to ascertain the quality of the firm's management and use that information to increase their returns. However, if the firm is very opaque (i.e., for D sufficiently low), the acquirer may find it too costly to obtain useful information and will therefore exert no effort in screening. Anticipating this outcome, the board adjusts its own monitoring activities accordingly because it will not be able to benefit from the external governance provided by the takeover market. Although we assume that greater disclosure always reduces the acquirer's cost of generating information, the return to acquiring a highly transparent firm could, in principle, be lower in the presence of other parties who can benefit from more disclosure. We later consider the case in which greater transparency erodes an acquirer's returns to generating information by explicitly introducing competition into the market for corporate control (Section 5.2).

Consistent with recent empirical findings (see, e.g., Gillan et al., 2006, Kini et al., 2004 or Cremers and Nair, 2005) internal (i.e., board monitoring) and external (i.e., market for corporate control) governance mechanisms are substitutes for each other from the perspective of maximizing firm value since $\frac{\partial\phi_b^*}{\partial D} < 0$ and $\frac{\partial\phi_a^*}{\partial D} > 0$. Furthermore, Huson et al. (2001) provide supporting evidence for this result by finding that the decline in takeover activity starting in the late 1980s

was accompanied by an increase in the frequency of forced CEO turnover, which implies that internal monitoring compensates for reduced external scrutiny.

It is worth noting, however, that firm transparency is complementary to external scrutiny. When the quality of disclosure rises, outside screening increases and a bid for the company becomes more likely. Since the board appropriates at least a fraction α of the resulting value gains, they can reduce their own monitoring effort, which lowers their probability of discovering management's type. Hence, we identify a new role for disclosure policy as an instrument that enables a board to adjust the mix of internal oversight and external governance. The finding in Berger and Hann (2002) that firms providing more disaggregated information under the new SFAS 131 segment-reporting standard face a higher takeover likelihood provides empirical support for this prediction.

We can now substitute the optimal monitoring and screening probabilities into (1) and maximize firm value with respect to the disclosure policy D at time 0.

Proposition 1 *For $\alpha \in (\underline{\alpha}, \bar{\alpha})$, there exists a value $\underline{t} > 0$ such that, for $t \geq \underline{t}$, the board's optimal disclosure policy is given by*

$$D^* = \ln\left(\frac{k\,(t+I)\,(\gamma\alpha\Pi - c)}{I\Pi\,(1-\alpha)}\right), \tag{3}$$

where $\frac{c}{\gamma\Pi} < \underline{\alpha} < \bar{\alpha} < 1$. This D^* implies well-defined monitoring and screening probabilities $\phi_b^*(D^*) = 1 - \frac{t}{(t+I)I(\gamma(1-\alpha)\Pi+c)}$ and $\phi_a^*(D^*) = 1 - \frac{I(\gamma(1-\alpha)\Pi+c)}{(\gamma\alpha\Pi-c)t}$.

For $t < \underline{t}$ or for $\alpha < \frac{c}{\gamma\Pi}$, the optimal disclosure policy is $D^* = 0$.

Proof. See Appendix. ■

Proposition 1 characterizes the unique equilibrium in which a board first sets the firm's disclosure policy D^* and then monitors incumbent management. The proposition implies that the division of governance surplus determines which of the two different governance regimes applies. For very high values of the surplus-sharing parameter α, the acquirer's return to screening is so low that the board cannot cost-effectively induce external governance and, instead, implements a policy of low transparency. In this instance, the board relies exclusively on internal governance. At the other extreme, for very low values of α the benefit to the board of having the acquirer screen the potential target is extremely low because shareholders do not capture much of the surplus from

the acquirer's activities. Since improving transparency is costly, the board will optimally choose to disseminate little or no information.

However, for intermediate values of α, the board finds it optimal to rely on two different tools to provide corporate governance. In addition to its own internal monitoring, the board uses its disclosure policy to foster external scrutiny. While internal monitoring has the direct consequence of aiding directors in the discovery of mismanagement (or lack of talent) within the firm, increases in the firm's transparency work indirectly by stimulating external takeover activity, and thus provide a second channel for governance. In equilibrium, the board chooses disclosure D^* so as to equalize the marginal benefits of both governance mechanisms. The restriction on the technology for dissemination t merely says that the disclosure of corporate information must be sufficiently inexpensive for the firm. We restrict the subsequent analysis to this latter case so that $t \geq \underline{t}$ and $\alpha \geq \frac{c}{\gamma\Pi}$.

Proposition 1 also establishes that in equilibrium disclosure, internal oversight, and outside activism are jointly determined. Any changes to a particular aspect of the governance environment will affect all three dimensions of corporate oversight through its effect on transparency. Our framework therefore allows us to study the net effect of changes in the corporate or technological environment on firm governance. Hence, singling out a specific governance instrument in isolation, such as disclosure policy or board monitoring, may be misleading for it neglects the interaction between different policy variables under the board's control. We discuss this issue further at the end of the next section.

3.1 The Cost of Board-Shareholder Misalignment

Consider the effect of an increase in γ, which brings directors' interests into greater alignment with those of shareholders, on the firm's disclosure policy. Simple differentiation of the expressions in Proposition 1 imply the following:

Corollary 1 *The firm's optimal disclosure policy is increasing in the level of board-shareholder congruence:* $\frac{dD^*}{d\gamma} = \frac{\alpha\Pi}{\gamma\alpha\Pi - c} > 0$. *Increased congruence also increases internal monitoring,* $\frac{d\phi_b^*}{d\gamma} = \Pi \frac{1-\alpha}{(\gamma\alpha\Pi - c - \gamma\Pi)^2} \frac{t}{I(t+I)} > 0$, *as well as screening by the acquirer,* $\frac{d\phi_a^*}{d\gamma} = I\frac{\Pi}{t}\frac{c}{(\gamma\alpha\Pi - c)^2} > 0$.

Corollary 1 highlights the inefficiency that arises from poor congruence between the objectives of shareholders and the board. As a result, the firm discloses too little information and remains opaque because the board does not benefit sufficiently from any value increase that would result from improved transparency and governance.

A similar result obtains for the information gathering activities of both the board and the acquirer. The more the board's interests are aligned with those of shareholders (higher γ), the more the board gains from an internal restructuring, and the more diligently it will scrutinize managerial actions. For instance, when the board is largely composed of outsiders, directors' interests are likely to be more aligned with those of shareholders than with management. Hence, our prediction parallels the results in Hermalin and Weisbach (1998) that more independent directors monitor more diligently. It is also consistent with the empirical evidence in Weisbach (1988) that boards with a greater fraction of outside directors are more willing to fire and replace management. Similarly, Perry (1999) reports that incentive compensation that aligns the board's interests with those of shareholders influences directors' monitoring of management. He also finds that boards receiving incentive-based compensation are more likely to replace poorly performing management.

Since greater shareholder-board alignment implies more disclosure and, hence, greater transparency, the acquirer's screening effort rises. However, the concurrent increase in board monitoring nevertheless reduces the opportunity for a successful outside bid, consistent with Shivdasani (1993), who reports that a hostile takeover is less likely when outsiders represent a larger fraction of the directors.

We also analyze the effect of a reduction in the cost to the board of being dismissed.

Corollary 2 *A higher dismissal cost following a takeover decreases transparency,* $\frac{dD^*}{dc} = -\frac{1}{\alpha}\frac{dD^*}{d\gamma} < 0$*, which leads to less screening by the acquirer,* $\frac{d\phi_a^*}{dc} = -\frac{I}{t}\frac{\gamma\Pi}{(\gamma\alpha\Pi - c)^2} < 0$*. Board monitoring, however, increases in the dismissal cost:* $\frac{d\phi_b^*}{dc} = \frac{1}{(\gamma\alpha\Pi - c - \gamma\Pi)^2}\frac{t}{I(t+I)} > 0$.

When the board's private loss from a takeover increases, the board reduces firm transparency in order to protect itself against replacement. The converse, of course, is that a reduction in the board's concern about dismissal should lead to an increase in the level of disclosure and, hence, improved transparency and greater openness to external scrutiny.

The incidence of dismissal costs on the board's monitoring effort is especially revealing: the greater the cost of takeover activity to the board by, the more diligent directors will be in monitoring and disciplining management. This result is reminiscent of the "kick-in-the-pants" effect in Hirshleifer and Thakor (1998), who find that the threat of dismissal makes boards act more in shareholders' interests. It is also in line with the empirical findings of Mikkelson and Partch (1997), who report that greater activity in the takeover market induces a greater correlation between management turnover and firm performance for nonacquired firms. To the extent that such turnover represents better internal governance and greater board monitoring, it is consistent with our explanation based on directors' desires to restructure internally and to thus retain their board seats by avoiding a takeover.

Despite leading to more internal monitoring, an increase in dismissal costs c comes at the cost of a decreased reliance on the takeover market as a mechanism for discipline, and thus leads to a reduction in value overall. The diminished role of external governance follows for two reasons. First, the board's increase in governance effort decreases the acquirer's return to takeover activity and, second, the reduction in transparency increases her cost of information acquisition.

To better understand the role of board-shareholder conflicts on governance arrangements we now contrast the preceding results with the case in which there is no conflict of interest and directors act in the best interests of shareholders. Full board-shareholder congruence corresponds to the limiting case where $\gamma \to 1$ and $c \to 0$, for which we obtain the following optimal disclosure policy:

$$D^* = \ln\left(\frac{k\alpha\,(t+I)}{I\,(1-\alpha)}\right), \tag{4}$$

yielding equilibrium board monitoring $\phi_b^* = 1 - \frac{t}{(t+I)I(1-\alpha)\Pi}$ and acquirer screening $\phi_a^* = 1 - \frac{I(1-\alpha)}{\alpha t}$. In this limiting case, the board's optimal disclosure policy becomes independent of the degree of asymmetric information about management quality and the degree of underperformance (i.e., the benefit of replacing management). These two aspects, however, have been identified in the literature as potentially important determinants of a firm's disclosure policy (see, e.g., Healy and Palepu, 2001, and the references therein). The preceding result illustrates that one needs to analyze the net impact on the various policy variables under the board's control to determine the ultimate effect.

To see this, consider optimal disclosure for a given level of monitoring effort, i.e., holding the board's monitoring success fixed at $\overline{\phi}_b$. Maximization of the board's payoff in Equation (1) with respect to disclosure now yields the following condition:

$$\left(1-\overline{\phi}_b\right)\alpha\Pi\frac{\partial\phi_a^*}{\partial D}-\frac{1}{t}=0 \tag{5}$$

Define $\widetilde{D}$ as the solution to Equation (5), which is clearly a function of the expected restructuring gains Π: $\widetilde{D}=D\left(I,t,\Pi,\overline{\phi}_b\right)$. These gains, given by $\Pi=(1-q)\,q\,(p_h-p_l)\,X$, incorporate both the degree of asymmetric information in terms of the variance of management quality, $(1-q)q$, as well as the return to restructuring $(p_h-p_l)\,X$. However, our analysis reveals that, once we allow the board to choose both its level of monitoring and the disclosure policy, the board internalizes the expected benefits of restructuring through its internal monitoring rather than through its disclosure policy. Intuitively, while the promise of restructuring gains clearly encourages directors to enhance corporate governance, the firm's disclosure policy need not reflect this value as other variables adjust to account for these gains.

3.2 Firm Characteristics

Proposition 1 establishes that the firm's optimal governance policies are a function not only of the underlying agency problem described by the parameters γ and c but also of firm-specific characteristics that determine the expected surplus from restructuring, $\Pi=(1-q)\,q\,(p_h-p_l)\,X$. The expression reveals that the benefit of replacing a low quality manager with one of higher quality, i.e., $\Delta_p\equiv p_h-p_l$, as well as the variability in management quality - captured by $Q\equiv(1-q)q$ - are of particular importance. While the former measures the expected improvement in managerial efficiency, the latter describes both the likelihood that the firm is inefficiently run in the first place and the probability that randomly hiring from the pool of managers improves the firm's prospects. Taken together Q and Δ_p reflect the ex ante severity of informational asymmetry between management and shareholders. An increase in efficiency gains Δ_p clearly raises $\Pi=Q\Delta_pX$. A higher variance of management quality, Q, does so as well because the usefulness of information collection for governance purposes increases in both parameters.

We summarize the effect of changes in firm characteristics on its transparency and governance

structure in the following corollary:

Corollary 3 *Increases in the variance of management quality, Q, and in the dispersion of management types, Δ_p*

1. *increase the optimal degree of firm transparency: $\frac{dD^*}{dQ}, \frac{dD^*}{d\Delta_p} > 0$;*
2. *increase the level of board monitoring: $\frac{d\phi_b^*}{dQ}, \frac{d\phi_b^*}{d\Delta_p} > 0$;*
3. *increase the amount of screening performed by the acquirer: $\frac{d\phi_a^*}{dQ}, \frac{d\phi_a^*}{d\Delta_p} > 0$.*

Proof. See Appendix. ■

The more severe the informational asymmetries between management and shareholders are (higher Q and Δ_p), the higher the payoff Π to all of the board's governance actions becomes. The higher restructuring gains in turn provide incentives both for more transparency and for increased board monitoring. From the acquirer's perspective, there are now two effects at work, both of which provide greater incentives for external scrutiny. First, an increase in restructuring gains Π raises the acquirer's return to screening. Second, greater transparency reduces the cost of screening.

To the extent that managerial inefficiencies, management quality, and restructuring gains vary across firms, this result provides a set of cross-sectional implications for governance activities. In particular, Corollary 3 establishes a monotonic relation between restructuring gains and the likelihood that governance actions take place. Hence, firms that benefit more from internal or external interventions should also exhibit improved governance. These predictions are consistent with Adams (2003) who finds that boards in smaller, younger, and less mature companies, i.e., firms for which little information about management is likely to be available, devote more resources to monitoring activities.

We also obtain the following relation between the acquirer's characteristics and the firm's disclosure policy:

Corollary 4 *Reductions in the efficiency of the acquirer's ability to generate information (i.e., increases in k) increase the degree of transparency for the firm: $\frac{dD^*}{dk} > 0$.*

Proof. Differentiation of $D^* = \ln\left(\frac{k(t+I)(\gamma\alpha\Pi - c)}{I\Pi(1-\alpha)}\right)$ establishes the result. ■

The corollary shows that the board responds to a reduction in the acquirer's screening efficiency by increasing the firm's transparency to offset the lower level of external scrutiny that would otherwise take place. Empirically, this finding suggests that in markets with more specialized acquirers we should expect to see lower levels of disclosure and reduced transparency.

3.3 Sensitivity to Bargaining Power

Governance arrangements also depend on institutional factors stemming from the legal, regulatory, and market environment. For instance, new legal devices such as staggered boards and poison pills have made hostile takeovers more expensive in the 1990s (Holmström and Kaplan, 2001). At the same time, hostile takeovers to restructure underperforming companies have given way to amicable mergers to exploit growth opportunities in new technologies and markets (Holmström and Kaplan, 2003). Rising takeover costs suggest a strengthening of the board's bargaining position over the last decade. Similarly, more board entrenchment would also correspond to an increase in the board's bargaining power α.[11]

Changes in bargaining power affect the tradeoff between the two governance mechanisms and, hence, the equilibrium level of transparency. An increase in α induces the board to disclose more information and to reduce monitoring, thereby enticing more external scrutiny and shifting governance policies toward a greater reliance on the market for corporate control.

Proposition 2 *An increase in the board's bargaining power α increases transparency: $\frac{dD^*}{d\alpha} = \frac{\gamma\Pi - c}{(1-\alpha)(\gamma\alpha\Pi - c)} > 0$. At the same time, the board monitors less while external scrutiny increases:*

$$\frac{d\phi_b^*}{d\alpha} = \frac{-\gamma\Pi}{(\gamma\Pi(\alpha-1)-c)^2}\frac{t}{I(t+I)} < 0 \tag{6}$$

$$\frac{d\phi_a^*}{d\alpha} = \frac{I\Pi^2\gamma^2}{t(\gamma\alpha\Pi - c)^2} > 0 \tag{7}$$

A rise in α raises the board's return from outside bids, thus providing directors with a greater incentive to disclose information, increase corporate transparency, and facilitate an external takeover market. Taken together, these results imply that as bargaining power α increases the board makes less heavy use of internal mechanisms for governance and instead relies more intensely on external

[11] In Section 5.2 we disentangle the effects of competition in the market for corporate control from those related to institutional factors that can change the degree of board entrenchment.

mechanisms. Although allocating more surplus to the board directly reduces the acquirer's return to takeovers, the increase in the level of disclosure more than compensates for this reduction. As a result, the acquirer increases her screening effort, allowing the board to reduce its monitoring. The net effect is a shift away from internal mechanisms and toward external ones. Empirically, Cremers and Nair (2005) find that internal governance is particularly value-enhancing for firms with low takeover defenses, which in our model corresponds to reductions in the bargaining parameter α.

4 Technological Progress

The preceding results highlight how imperfect alignment between the interests of the board and those of shareholders lead to inefficient governance policies. In this section we study how technology, which determines the costs of generating and disseminating company-specific information, can influence a firm's governance policies by mitigating the negative consequences of agency problems within the firm and acting as a substitute instrument for improving governance.

Recent regulation to address shortcomings in corporate governance place heavy emphasis on new information technology. Specific examples of technological progress with governance implications are the development of the *Actuate Financial Performance System* designed to collect, aggregate and measure financial data with a view to help firms comply with Section 404 of the Sarbanes-Oxley Act, and of the *Rivet Dragon Tag XBRL* system for the dissemination and extraction of financial data over the internet (*e-week*, February 20, 2005).[12] The regulatory efforts to promote the use of such new technologies is most evident in the SEC's interactive-reporting initiative. The SEC's new Office of Interactive Disclosure, which was created in October 2007 "to lead the transformation to interactive financial reporting by public companies," has argued that the advent of XBRL-enabled "interactive data is on the brink of transforming the review and analysis of financial information for the benefit of investors and public companies alike" because it represents "a superior way of doing business and making faster, cheaper, and more informed investment decisions."[13]

[12]The two articles in *e-week* describe the systems as follows: "[Rivet Dragon Tag] should give [firms] a way to create and distribute their financial information in XBRL, which is becoming a financial reporting standard for investor and regulatory communities around the world. [It] is a platform-independent standard ... that permits the automatic exchange and extraction of financial data across the Internet." "[T]he Actuate Financial Performance Management (FPM) system ... integrates data from disparate systems to provide on-demand reports to every employee with financial accountability. Companies using Actuate FPM can distribute fiscal responsibility throughout the enterprise, help drive financial performance and assist in compliance with federal regulations such as the Sarbanes-Oxley Act."

[13]*SEC's Office of Interactive Disclosure Urges Public Comment as Interactive Data Moves Closer to Reality for*

Understanding the role of technology in corporate governance has taken on increased importance given that many countries (UK, Belgium, Denmark, Germany, Italy, the Netherlands, Spain, Canada, Israel, Australia, China, Japan, and Korea) are aiming for mandatory interactive reporting by 2010. In the US, the SEC shares similar aims according to preliminary implementation schedules. Although interactive disclosure filings are not currently mandatory, some companies - such as Microsoft and NYSE-Euronext - have nevertheless started to voluntarily comply with the expected disclosure requirements. By contrast, over 8,400 financial institutions supervised by the Federal Deposit Insurance Corporation, the Federal Reserve Board, and the Office of the Comptroller of the Currency have had to submit their quarterly Call Reports in XBRL-enabled form since October 2005 to facilitate data collection and to automate its processing. Information technology is thus becoming an increasingly important tool for governance.

4.1 The Cost of Dissemination

In this section we consider advances in the technology for information dissemination t that reduce the cost of corporate disclosure. Relevant examples are the development of webcast technology for open conference calls over the internet, interactive financial reporting based on XBRL, and new real-time filing systems for material events mandated under the Sarbanes-Oxley Act.

Proposition 3 *An improvement in information-dissemination technology t increases transparency* $\left(\frac{dD^*}{dt} = \frac{1}{t+I} > 0\right)$ *and acquirer screening* $\left(\frac{d\phi_a^*}{dt} = I\frac{\gamma(1-\alpha)\Pi+c}{(\gamma\alpha\Pi-c)t^2} > 0\right)$*, but decreases board monitoring* $\left(\frac{d\phi_b^*}{dt} = \frac{1}{(t+I)^2(\gamma(\alpha-1)\Pi-c)} < 0\right)$.

Not surprisingly, better or more cost-effective dissemination technology leads to greater transparency. When technology reduces the cost of making firm-specific information available to outsiders, the optimal action of the board is to disclose more information and make the firm more transparent.[14] This result is in line with the findings of Bushee *et al.* (2003) that firms in high-tech industries and, therefore, with a superior installed base of technology, are more likely to host open-access conference calls to communicate supplemental information on recent earnings reports

Investors (SEC Press Release No. 2007-253; December 5, 2007).

[14] Improvements in the dissemination technology might also allow firms to disclose corporate data while preventing the leakage of information that would worsen the competitive position of the firm. Hence, technology may reduce the cost of transparency for the firm by allowing it to secure its proprietary data.

to investors. Similarly, Premuroso and Bhattacharya (2007) find that early adopters of interactive reporting (e.g., XBRL) signal superior corporate governance and operating performance and significantly outperform their nonadopting peers.

More interesting is the fact that reductions in the cost of dissemination partially compensate for the existence of agency problems between the board and shareholders. While low congruence (γ) leads to low degrees of transparency, more cost-effective dissemination technology increases disclosure even in the face of significant agency problems within the firm. Hence, investing in such technological advances represents an instrument for improving governance even if the underlying conflict of interest persists. Improvements in the diffusion of information may be especially important if the takeover market is an important source of governance for the firm.

Similarly revealing is the response of both the board and the acquirer to improvements in information dissemination: in equilibrium, internal governance actions decrease $\left(\frac{d\phi_b^*}{dt} < 0\right)$ while external scrutiny and activity in the market for corporate control rises $\left(\frac{d\phi_a^*}{dt} > 0\right)$. As a consequence of an increase in t, the board relies more heavily on the external market to provide governance for the firm. Intuitively, such technological progress facilitates transparency which, in turn, increases the efficacy of external governance. Although these effects go in the opposite direction from those associated with increased congruence - at least for the case of board monitoring - it is straightforward to see that increases in t nevertheless unambiguously increase governance actions and, hence, firm value. Defining $\Phi^* \equiv 1 - (1 - \phi_b^*)(1 - \phi_a^*)$ as the aggregate amount of information produced in equilibrium, simple differentation establishes the following result:

Corollary 5 *Advances in information-dissemination technology t increase aggregate information production:* $\frac{d\Phi^*}{dt} = \frac{1}{(t+I)^2(\gamma\alpha\Pi - c)} > 0$.

4.2 Information Production

Technological advances can also enhance the ability to extract useful information from corporate data, which increases the return to monitoring and screening effort. Examples of such improvements in information-processing capabilities can be found in the development of financial information systems promoted by the new regulatory paradigm, data storage and retrieval technology, computational and financial-analysis tools, etc.

Proposition 4 *An improvement in information processing I decreases transparency and acquirer screening, i.e.,* $\frac{dD^*}{dI} = \frac{-t}{I(t+I)} < 0$ *and* $\frac{d\phi_a^*}{dI} = -\frac{\gamma(1-\alpha)\Pi+c}{t(\gamma\alpha\Pi-c)} < 0$*, but increases board monitoring, i.e.,* $\frac{d\phi_b^*}{dI} = \frac{t+2I}{I^2(t+I)^2}\frac{t}{(\gamma(1-\alpha)\Pi+c)} > 0$.

Section 404 of the Sarbanes-Oxley Act has obliged firms to invest in their financial-information processing capabilities. Such improvements (increases in I) have the opposite effect on the company's disclosure policy to that found for improvements in dissemination technology. Two forces lie at the root of this effect. From the perspective of shareholders and regulators, external and internal governance are substitutes so that an improved ability to process information increases the effectiveness of monitoring and reduces the need for takeovers. As a consequence, the importance of disclosure as a governance tool decreases, too. At the same time, such technological progress will also, *ceteris paribus*, increase the ability of an acquirer to screen. This latter effect attenuates the impact of the reduction in transparency. The net effect is an overall reduction in the level of disclosure when information-processing capabilities improve.

In equilibrium, advances in the ability to process information facilitate monitoring by the board, which then substitutes its own monitoring effort for disclosure. However, this improvement in internal governance comes at the expense of external mechanisms, an aspect which is often overlooked in the current policy debate: with the increase in the success of the board's monitoring, the acquirer is less likely to benefit from her own screening activities despite her improved screening ability. Hence, the acquirer has a reduced incentive to exert screening effort, and this effect is further exacerbated by the board's decision to reduce the level of disclosure. However, technological progress again improves governance and firm value because aggregate information production increases, i.e., $\frac{d\Phi^*}{dI} > 0$.

An important consequence of the results in the last two sections is that advances in information technology have the potential to change the relative effectiveness of external and internal governance mechanisms. Although overall beneficial, the observed effects of such improvements depend on the exact nature of technological progress.[15] In equilibrium, the net effect of improvements in information dissemination is to shift the oversight toward external mechanisms, whereas advances

[15] Hauswald and Marquez (2003) study the incidence of technological progress on the competitiveness of financial markets. They also find that the exact nature of improvements determines whether markets become more or less competitive.

in information processing induce firms to rely more on internal governance.

4.3 Asymmetries in Information Processing

So far, we have assumed for the sake of simplicity that the state of technology characterizing the processing of information by both the board and the acquirer is the same. However, compliance with Section 404 of the Sarbanes-Oxley Act on Internal Control Over Financial Reporting has accelerated the development of financial information systems and other internal monitoring devices that are independent of any improvements in information-processing systems at large. Similarly, the need to comply with recent SEC rules such as Reg FD and interactive reporting encourage the development of adequate means to collect, aggregate, and disseminate corporate information. Hence, in this section we separate the effects of advances in information-processing technology for internal use from those which improve external scrutiny.

We extend our model to let the board's monitoring success probability be given by $\phi_b(x_b) = 1 - e^{-I_b x_b}$, where I_b now indicates the quality of internal IT systems. Similarly, the acquirer's screening success probability becomes $\phi_a(x_a) = 1 - e^{-I_a x_a}$, where I_a measures the information processing capabilities available to the acquirer. We assume, as before, that $I_b, I_a > 1$, and that t is sufficiently large that some amount of disclosure is optimal in equilibrium. We can now state the following result:

Proposition 5 *Given states of technology I_b and I_a, the optimal monitoring and screening success probabilities for the board and acquirer are given, respectively, by*

$$\begin{aligned}
\phi_b^*(D) &= \frac{kI_b e^{-D}(\alpha\gamma\Pi - c) - (1-\alpha)\Pi I_a(1 - I_b(\Pi\gamma(1-\alpha) + c))}{I_a I_b \Pi(1-\alpha)(\gamma\Pi(1-\alpha) + c)} \\
\phi_a^*(D) &= 1 - \frac{\Pi\left(e^D I_a(1-\alpha) - k\gamma I_b\right)}{\Pi e^D I_a(1-\alpha) - kI_b(\alpha\gamma\Pi - c)},
\end{aligned}$$

for D sufficiently large. For any $\frac{c}{\gamma\Pi} < \underline{\underline{\alpha}} < \bar{\bar{\alpha}} < 1$, there is a $\underline{\underline{t}} > 0$ such that the board's optimal disclosure policy is given by

$$D^* = \ln\left(\frac{k(t + I_b)(\gamma\alpha\Pi - c)}{I_a\Pi(1-\alpha)}\right),$$

for $t \geq \underline{\underline{t}}$. This D^* implies well-defined $\phi_b^*(D^*)$, $\phi_a^*(D^*) \in (0,1)$ in equilibrium.

Proof. See Appendix. ■

The proposition mirrors the results obtained in the previous sections, but highlights the role of differential changes in technology (I_b and I_a) on the firm's governance policies. Note that, as before, the bound $\underline{\underline{t}}$ merely ensures that, in equilibrium, the firm discloses enough that an outside bidder is willing to acquire information. We again focus on the case where $t > \underline{\underline{t}}$ so that the firm relies on both internal and external mechanisms of corporate governance in equilibrium. Simple differentiation establishes how changes in I_b and I_a affect the firm's monitoring and disclosure decisions.

Corollary 6 *Advances in internal information processing I_b increase transparency $\left(\frac{dD^*}{dI_b} = \frac{1}{t+I_b} > 0\right)$ whereas improvements in external information processing I_a decrease it $\left(\frac{dD^*}{dI_a} = -\frac{1}{I_a} < 0\right)$.*

Surprisingly, technological advances which improve internal monitoring also increase the firm's transparency through more disclosure. This result holds despite the fact that technological progress along this dimension increases the relative efficiency of internal monitoring. Conversely, innovations affecting the acquirer's ability to identify worthwhile takeover targets lead to a decrease in transparency. Again, this result obtains despite the fact that such improvements enhance the efficiency of the takeover market relative to internal evaluation mechanisms.

The intuition behind these findings derives from the respective roles played by the board's and the acquirer's activities in effective corporate governance. Consider the effect of an increase in the quality of internal information systems I_b. Given the increase in monitoring efficiency, the board's response should be to monitor more (an increase in x_b). The acquirer's response to such an increase in board effort would be to reduce her own screening effort x_a, since the two mechanisms are substitutes. To prevent such a reduction in acquirer activity the board increases the firm's transparency by devoting resources freed up by the increased monitoring efficiency to disclosure efforts which, in equilibrium, bolster the external takeover market.

A similar logic applies to improvements in the acquirer's ability to identify a likely target firm. When I_a increases, the acquirer increases her own effort in finding a takeover target (i.e., x_a increases). All things equal, the response of the board would be to reduce its own level of monitoring x_b. But such a reduction has a negative consequence for the firm because shareholders

capture a greater fraction of the restructuring surplus when the firm's own internal mechanisms identify mismanagement. In order to minimize the effect of this relative shift in board versus acquirer monitoring, the board *reduces* the amount of information it discloses, thereby reducing the overall cost to the firm and attenuating the reduction in the board's own monitoring effort.

Bushee *et al.* (2003) provide evidence that is consistent with the preceding results. They find that firms with larger institutional shareholdership and greater analyst following are less likely to rely on open-access conference calls to communicate with their presumably more sophisticated shareholders. In the context of our model, such firms are less transparent in their communication with shareholders and engage in less disclosure. But institutional shareholders and financial analysts represent those market participants that we would associate with better and more sophisticated information-processing capabilities for financial analysis, i.e., higher I_a. Their employers (mutual funds, investment advisors, investment banks) have been at the forefront in developing sophisticated IT systems for financial analysis.

Corollary 7 *Advances in internal information processing I_b increase the level of board monitoring* $\left(\frac{d\phi_b^*}{dI_b} = \frac{2I_b+t}{I_b^2(I_b+t)^2}\frac{t}{(\gamma(1-\alpha)\Pi+c)} > 0\right)$ *and decrease external scrutiny* $\left(\frac{d\phi_a^*}{dI_b} = -\frac{\gamma(1-\alpha)\Pi+c}{(\gamma\alpha\Pi-c)t} < 0\right)$.

Improvements in internal information systems I_b not only increase the aggregate amount of information produced, they also alter the relative importance of internal versus external mechanisms for governance. Specifically, we find that firms' investments in financial-information systems increase the amount of information generated by the board. Improved internal oversight, however, comes at the expense of a reduction in the amount of externally produced information. Since monitoring-related technology increases the productivity of board effort, improvements in such systems lead to a higher level of effort x_b and, hence, a better informed board. But this increase in the effectiveness of internal governance reduces the incentives for the acquirer to screen potential targets, thus reducing its own likelihood of acquiring information.

Nevertheless, the increase in board monitoring outweighs the decrease in screening by the acquirer, so that the aggregate amount of information being produced increases. These findings are consistent with the evidence in Krishnan and Lai (2003) and Sriram *et al.* (2004), who find a positive association between expenditures on financial information systems (a proxy for their quality) and firm value.

Corollary 8 *Advances in external information processing I_a do not affect internal or external oversight, i.e., $\frac{d\phi_b^*}{dI_a} = 0$ and $\frac{d\phi_a^*}{dI_a} = 0$.*

To understand why increases in I_a have no effect on information production, it is important to recall that ϕ_b and ϕ_a are both functions of the firm's degree of transparency. An increase in I_a makes the acquirer's screening more cost-effective, increasing the amount of screening she performs for any given level of transparency. The board is therefore able to benefit from the improved efficiency of the market for corporate control by reducing the level of transparency ($\frac{dD^*}{dI_a} < 0$, as shown above) and economizing on the associated costs of disclosure. Although shareholders are better off, in equilibrium the firm exactly offsets the acquirer's increased efficiency by adjusting its disclosure policy.

This last result suggests that firms' equilibrium response is likely to reduce the benefits obtained from the regulatory push for the adoption of new technology. Similarly, it provides a justification for the current regulatory focus on improving the efficiency of corporate disclosures through the SEC's interactive-reporting initiative (raising t) and financial-information systems stipulated in the Sarbanes-Oxley Act (increasing I). Hence, the incidence of technological improvements is reflected not just in increases in monitoring and screening, but also in terms of the firm's transparency.

5 Regulation and Competition

In this section we analyze two important issues related to the disclosure of corporate information. We first consider the role of regulation that imposes a minimum disclosure standard as a way of increasing social welfare. Second, we investigate how competition in the market for corporate control affects a firm's incentives to disclose information and increase its transparency.

5.1 Socially Optimal Disclosure

Recent regulatory proposals, most notably the Sarbanes-Oxley Act, have called for increased accountability of management and directors, as well as for more transparency and disclosure by firms. Specifically, its Section 404 stipulates that firms disclose larger amounts of pertinent and material information to the public in a more timely manner and that they certify both the accuracy of the information and the quality of the financial-reporting systems used.

In our framework, mandatory disclosure for firms is equivalent to imposing a requirement that $D \geq \underline{D}$, where $\underline{D}$ is the statutory minimum level of disclosure. It is straightforward to show that if $\underline{D} \geq D^*$ the board maximizes its payoff by choosing a disclosure policy equal to the mandatory level $\underline{D}$. Otherwise, the difference $D^* - \underline{D} > 0$ can be interpreted as the degree of voluntary disclosure for the firm.

Consider therefore social welfare given by

$$W(D) = \left[1 - \left(1 - \phi_b^*(D)\right)\left(1 - \phi_a^*(D)\right)\right]\Pi - x_b^*(D) - ke^{-D}x_a^*(D) - \frac{1}{t}D,$$

where we assume that a regulator can impose minimum disclosure standards but does not otherwise intervene in internal or external governance activities.[16] Maximization with respect to a minimum level of disclosure yields the first order condition

$$\frac{dW}{dD} = \left(\frac{\partial \phi_b^*}{\partial D}\left(1 - \phi_a^*\right) + \frac{\partial \phi_a^*}{\partial D}\left(1 - \phi_b^*\right)\right)\Pi - \frac{\partial x_b^*}{\partial D} - ke^{-D}\frac{\partial x_a^*}{\partial D} + ke^{-D}x_a^* - \frac{1}{t} = 0, \tag{8}$$

which defines the socially optimal level of disclosure $\underline{D}$. We can use this expression to compare the regulator's optimal choice of $\underline{D}$ to the firm's (profit-maximizing) disclosure policy D^*. Evaluating equation (8) at D^* shows that

$$\left.\frac{dW}{dD}\right|_{D^*} = \frac{\Pi}{(t+I)(\gamma\alpha\Pi - c)t}\left[t\alpha + (1-\alpha)\left(t\ln\frac{(\gamma\alpha\Pi - c)t}{(\gamma(1-\alpha)\Pi + c)I} - I\right)\right], \tag{9}$$

which is greater than zero given the assumptions on α and t, implying that the firm's equilibrium disclosure policy falls short of the disclosure standard preferred by a regulator attempting to maximize social welfare. This shortfall suggests a rationale for regulating and enforcing minimal disclosure standards because, left to their own devices, firms will choose to provide too little information to the external market and instead rely more heavily on internal governance mechanisms.

However, our results also suggest that enforcing minimal disclosure standards can come at the expense of reduced diligence in monitoring. Hence, regulators and policy makers should take into account not only the effect on external oversight but also the shift away from internal governance

[16] We note that, from a public policy perspective, disclosure may have additional benefits not captured by our model in which disclosure merely facilitates external governance. To the extent that such benefits are not internalized by the firm, we expect that including additional roles for disclosure should not affect the qualitative nature of our results.

that more corporate transparency implies when assessing the likely impact of regulatory changes. Moreover, this result continues to hold even in the absence of an agency conflict between shareholders and directors (i.e., for $\gamma = 1$ and $c = 0$). Instead, it is a consequence of the board's ability to appropriate the gains from its own governance actions and its failure to internalize the full social benefit that accrues when an outsider conducts the restructuring.

We note that the analysis in this section presupposes that one can calculate and implement the socially optimal disclosure standard on a firm-by-firm basis. For instance, in the UK companies can opt out from standard governance and disclosure requirements specified in The Combined Code and adopt firm-specific oversight arrangements provided they give detailed explanations for their choices. However, out of necessity many regulatory regimes might have to apply a "one size fits all" approach, i.e., a single disclosure standard for all firms. If so, it could easily be that firms whose restructuring value (Π) is particularly high would choose to voluntarily disclose more than the mandated minimum.

5.2 Competition in the Market for Corporate Control

So far, we have assumed that corporate disclosure benefits a single acquirer who devotes resources to discover inefficiencies within the firm and takes it over if any are found. In practice, however, it is likely that there are other parties who might also be able to make use of the information provided by the firm and who can thus provide some measure of external governance. Competition in the takeover market can have important consequences for social welfare because it affects not only the incentives for each party to devote resources to information discovery but also the firm's choice of transparency.[17] Moreover, explicitly modeling such competition allows us to disentangle the effect of changes in the competitiveness of takeover markets from other institutional factors that can increase the board's bargaining power α.

To study these issues, we extend the model to a setting with N potential symmetric acquirers. Specifically, assume that each acquirer i exerts effort x_i in screening the firm, discovering managerial inefficiencies with probability $\phi_i = 1 - e^{-Ix_i}$. We assume that if two or more acquirers are successful

[17] To the extent that the disclosure of corporate information serves also to enlighten small investors, disclosure may make it more difficult for an acquirer to benefit from a takeover of the target firm. While an analysis of this issue is beyond the scope of this paper, the effects should be similar to those of assuming that there are multiple parties that can make use of any information provided by the company, and whose effort may erode each other's return.

in discovering the quality of management, a bidding war for the firm ensues so that shareholders capture the entire restructuring gain Π. If only one acquirer is successful, however, she becomes the single bidder for the firm and splits the restructuring gain with shareholders, receiving as before $(1-\alpha)\,\Pi$. For tractability, we abstract here from any agency problem between the board and shareholders by assuming that $\gamma = 1$ and $c = 0$.

The payoff to the board can now be expressed as

$$\pi_b = \phi_b \Pi + (1-\phi_b) \sum_{k=1}^{N} \left(\binom{N}{k} \phi_i^k \left(1-\phi_i\right)^{N-k} \alpha_k \Pi \right) - x_b - \frac{1}{t} D, \tag{10}$$

where $\alpha_k = \alpha$ for $k = 1$, and is equal to 1 otherwise. Equation (10) reflects the fact that the board splits the benefit Π with a bidder only when exactly one acquirer has successfully identified the quality of management. For acquirer i, we have

$$\pi_i = (1-\phi_b)\,\phi_i \left(1-\phi_i\right)^{N-1} (1-\alpha)\,\Pi - k e^{-D} x_i \tag{11}$$

Recall our measure Φ^* of aggregate amount of information produced in equilibrium which now becomes $\Phi^* \equiv 1 - (1-\phi_b^*)\,(1-\phi_i^*)^N$. We can now establish the following result.

Proposition 6 *For N potential participants in the market for corporate control, there exists a well defined equilibrium in firm disclosure D^*, board monitoring ϕ_b^* and external screening ϕ_i^* by acquirer i. For N large enough, an increase in N decreases firm transparency $\left(\frac{dD^*}{dN} < 0\right)$ and leads to less aggregate information production in equilibrium, i.e., $\frac{d\Phi^*}{dN} < 0$.*

Proof. See Appendix. ■

Proposition 6 establishes that a more competitive takeover market leads to a decrease in the level of disclosure by the firm.[18] Greater competition among acquirers allows the board to reduce the firm's transparency because there are more potential bidders who are capable of providing external governance.

A second important effect concerns the aggregate amount of information produced in equilibrium Φ^*. This measure is decreasing in N (i.e., $\frac{d\Phi^*}{dN} < 0$) for the simple reason that, with more active

[18] This result holds for N sufficiently large. For small values of N, so that the market is not very competitive, a marginal increase in N can lead to greater disclosure. See the proof in the Appendix for details.

bidders, each acquirer is less likely to reap the benefit of its investment in screening the target firm, and hence reduces her screening effort ($\frac{dx_i^*}{dN} < 0$, which implies that $\frac{d\phi_i^*}{dN} < 0$). Moreover, each acquirer's reduction in screening is sufficiently large to outweigh the increase in the number of potential bidders so that in aggregate the total amount of information produced decreases. But less external scrutiny further reinforces the effect of competition on disclosure. Since acquirers reduce their information gathering activities as N increases, the board has less of an incentive to incur the cost of disseminating information.

6 Discussion

Recent regulation addressing perceived shortcomings in corporate governance has put a heavy emphasis on disclosure and technology to improve firm transparency and outsiders' access to information. In this paper, we argue that firms choose their level of transparency to affect the balance between internal and external mechanisms for corporate oversight. We show that the mix between internal monitoring and external takeover activity is therefore an integral part of the firm's governance choices. Many of the current regulatory initiatives rely heavily on the advent of new technologies for the dissemination and processing of corporate information. We find that technological progress improves the production of firm-specific information and aid overall governance. They can therefore be seen as partial resolutions to existing agency problems between the board and shareholders.

Our results hold important empirical implications. For instance, the move to interactive-reporting standards considered by the SEC should lead to a more active market for corporate control as the cost of information acquisition and processing falls for outside investors. Consistent with the findings in Bushee *et al.* (2003) that high-tech firms with presumably more advanced information technology disclose more information more widely, we find that better dissemination technology increases corporate disclosure. We would thus expect such firms to attract more scrutiny from potential acquirers and face more takeover activity whereas internal governance actions should be rarer. In fact, data reported by Lucier *et al.* (2003, 2004) indicate that internally induced CEO turnover has been lower in the information-technology sector than the national mean in recent years.

Furthermore, our analysis predicts that technological improvements affecting internal information production such as financial reporting and performance-measurement systems should strengthen voluntary disclosure standards. Hence, using data on firms' compliance with Section 404 of the Sarbanes-Oxley Act and, more importantly, the reported changes to their financial reporting systems, investments, upgrades, etc., one could test how the new regulation has affected disclosure policies. Similarly, we would expect monitoring and CEO turnover to increase in the quality of such systems, a prediction that could be tested by exploiting the structural break created by the recent regulatory changes. By the same token, takeover activity aimed at restructuring underperforming firms should decrease the more firms comply with the upgrading of internal performance measurement and reporting systems. From a regulatory perspective, our results point out that firms adjust the balance of their governance mix in response to regulatory changes so that the current push for reforms based on new technologies might not deliver all the desired benefits.

An interesting avenue for research would be to explicitly study how governance considerations provide incentives for firms to develop and adopt information technology. This extension would focus on the tradeoff between such development and other incentive mechanisms for achieving greater congruence of interests between those in charge of running the firm (i.e., directors, management) and those who own it (shareholders). We leave this issue for future research.

Appendix A: Proofs

Proof of Lemma 1. Given the disclosure policy D, maximization of the board's and acquirer's respective payoff functions with respect to monitoring and screening efforts yields the following FOCs:

$$\begin{aligned}\frac{\partial \pi_b}{\partial x_b} &= Ie^{-Ix_b}\gamma\Pi(1-\alpha) + Ie^{-I(x_b+x_a)}(\gamma\alpha\Pi - c) + Ie^{-Ix_b}c - 1 = 0\\ \frac{\partial \pi_a}{\partial x_a} &= I\Pi e^{-I(x_b+x_a)}(1-\alpha) - ke^{-D} = 0\end{aligned}$$

We can now solve the preceding system of equations for optimal efforts x_b^* and x_a^* and then substitute back into the monitoring and screening probabilities to obtain

$$\begin{aligned}x_b^* &= \frac{-\ln\left(-\frac{-\Pi e^D+\Pi\alpha e^D+\gamma\alpha\Pi k-ck}{I\Pi(\gamma\Pi+c-c\alpha-2\gamma\alpha\Pi+\gamma\alpha^2\Pi)}\right)+D}{I} \Rightarrow \phi_b^*(D) = 1 - \frac{\Pi(1-\alpha) - ke^{-D}(\gamma\alpha\Pi - c)}{I\Pi(1-\alpha)(\gamma(1-\alpha)\Pi + c)}\\ x_a^* &= \frac{\ln\frac{-\Pi e^D+\Pi\alpha e^D+\gamma\alpha\Pi k-ck}{k(\gamma\alpha\Pi-c-\gamma\Pi)}}{I} \Rightarrow \phi_a^*(D) = 1 - \frac{(\gamma(1-\alpha)\Pi + c)k}{(1-\alpha)\Pi e^D - (\gamma\alpha\Pi - c)k}\end{aligned}$$

For ϕ_a^* to be positive, we need

$$\Pi\left(e^D(1-\alpha) - k\gamma\right) > 0 \Leftrightarrow e^D > \frac{k\gamma}{(1-\alpha)} \Leftrightarrow D > \widetilde{D} \equiv \ln\left(\frac{k\gamma}{(1-\alpha)}\right)$$

If this condition is not satisfied, i.e. $D < \ln\left(\frac{k\gamma}{(1-\alpha)}\right)$ then $\phi_a^* \leq 0$ implying that the optimum must have the acquirer exerting zero effort. Given $x_a = 0$, maximization of the board's objective function $\pi_b = \phi_b\Pi - x_b - \frac{1}{t}D$ yields the solution $x_b = -\frac{1}{I}\ln\frac{1}{I\Pi}$, implying $\phi_b^* = 1 - \frac{1}{I\Pi}$, as desired. □

Proof of Proposition 1. We prove the proposition in a series of steps.

Lemma 2 *There exists a value of $\alpha < 1$, α', such that $x_a^* = 0$ for $\alpha \geq \alpha'$.*

Proof: We start by showing that the disclosure policy D must be bounded above in equilibrium. To this end, consider board payoffs, which in equilibrium must be non-negative:

$$\pi_b = \phi_b\gamma\Pi + (1-\phi_b)\phi_a(\gamma\alpha\Pi - c) - x_b - \frac{1}{t}D \geq 0$$

Since $\phi_b, \phi_a, \alpha \leq 1$, the maximum revenue the board can obtain is bounded above by Π. Therefore, a minimal constraint for profits to be positive is that $\gamma\Pi - \frac{1}{t}D \geq 0 \Leftrightarrow D \leq t\gamma\Pi$ providing an upper bound on D in equilibrium. Assume therefore that $D = t\gamma\Pi$, and consider now the acquirer's payoffs:

$$\pi_a = (1-\phi_b)\phi_a(1-\alpha)\Pi - ke^{-D}x_a = (1-\phi_b)\phi_a(1-\alpha)\Pi - ke^{-t\gamma\Pi}x_a$$

The FOC for profit maximization with respect to x_a is

$$\begin{aligned}\frac{\partial \pi_a}{\partial x_a} &= (1-\phi_b)\frac{\partial \phi_a}{\partial x_a}(1-\alpha)\Pi - ke^{-t\gamma\Pi}\\ &= (1-\phi_b)(1-\alpha)\Pi Ie^{-Ix_a} - ke^{-t\gamma\Pi} = 0\end{aligned}$$

Since $\phi_b \leq 1$ this derivative is bounded from above by $(1-\alpha)\,\Pi I e^{-Ix_a} - ke^{-t\gamma\Pi}$. However, the term $\frac{\partial \phi_a}{\partial x_a} = Ie^{-Ix_a}$ is itself bounded from above by I for $x_a \geq 0$. Therefore, for a large enough α, the FOC cannot be satisfied. The optimal solution is therefore for $x_a^* = 0$ for large enough α. □

Assuming that α is small enough so that the acquirer does indeed monitor, we can now find D^* by substituting the optimal monitoring and screening probabilities in Proposition 1 back into the board's objective function in Equation (1): $\pi_b\left(x_b^*, x_a^*\right)$. The FOC is then

$$\frac{\partial \pi_b\left(x_b^*, x_a^*\right)}{\partial D} = \frac{I\Pi\left(1-\alpha\right) - \left(I+t\right)e^{-D}k\left(\Pi\alpha\gamma - c\right)}{tI\left(ke^{-D}\left(\gamma\alpha\Pi - c\right) - \Pi\left(1-\alpha\right)\right)} = 0$$

Solving the FOC for D yields $D^* = \ln\left(\frac{k(t+I)(\gamma\alpha\Pi - c)}{I\Pi(1-\alpha)}\right)$. For the monitoring and screening probabilities to be well-defined, $\phi_b^*, \phi_a^* \in [0,1]$, we require that $D^* \geq \ln\left(\frac{k\gamma}{(1-\alpha)}\right)$, or $\ln\left(\frac{k(t+I)(\gamma\alpha\Pi-c)}{I\Pi(1-\alpha)}\right) - \ln\left(\frac{k\gamma}{(1-\alpha)}\right) = \ln\left(\frac{(t+I)(\gamma\alpha\Pi-c)}{I\Pi\gamma}\right) \geq 0$ which holds in equilibrium for t large enough. Similarly, the SOC for a maximum, $\frac{\partial^2 \pi_b\left(x_b^*, x_a^*\right)}{\partial D^2} = \frac{\Pi k\left(e^{-D}\right)(\alpha-1)(\alpha\gamma\Pi - c)}{tI(ke^{-D}(\gamma\alpha\Pi-c) - \Pi(1-\alpha))^2} < 0$, requires $\alpha\gamma\Pi - c > 0$, which holds by assumption.

This solution, however, assumes that x_b, x_a, and D are positive in equilibrium. To check whether this condition is satisfied we compare this solution to that obtained assuming the board chooses a disclosure policy of $D = 0$. As a preliminary step, we have the following result:

Lemma 3 *There is a value of $\alpha > 0$, α'', such that $x_a^* = 0$ for $\alpha \leq \alpha''$.*

Proof: From the solutions for optimal monitoring and screening, we have

$$\begin{aligned}
\phi_b^* &= 1 - \frac{\Pi\left(1-\alpha\right) - ke^{-D}\left(\gamma\alpha\Pi - c\right)}{I\Pi\left(1-\alpha\right)\left(\gamma\left(1-\alpha\right)\Pi + c\right)} \\
\phi_a^* &= 1 - \frac{\left(\gamma\left(1-\alpha\right)\Pi + c\right)k}{\left(1-\alpha\right)\Pi e^{D} - \left(\gamma\alpha\Pi - c\right)k}
\end{aligned}$$

As $\alpha \to 0$, these expressions converge to $\phi_b^* = 1 - \frac{\Pi + ke^{-D}c}{I\Pi(\gamma\Pi + c)}$ and $\phi_a^* = 1 - \frac{(\gamma\Pi + c)k}{\Pi e^D + ck}$. Now consider the optimal choice of D obtained above

$$D^* = \ln\left(\frac{k\left(t+I\right)\left(\gamma\alpha\Pi - c\right)}{I\Pi\left(1-\alpha\right)}\right)$$

As $\alpha \to 0$, the term inside the logarithm converges to $\frac{-k(t+I)c}{I\Pi}$, so that D^* is not well-defined, and consequently neither is x_a^*. Therefore, there is a minimum value of α, α', such that $x_a > 0$ only if $\alpha > \alpha'$.

Substituting D^* into the above expressions yields the equilibrium screening and monitoring probabilities

$$\begin{aligned}
\phi_b^*\left(D^*\right) &= 1 - \frac{t}{\left(t+I\right)I\left(\gamma\left(1-\alpha\right)\Pi + c\right)} \\
\phi_a^*\left(D^*\right) &= 1 - \frac{I\left(\gamma\left(1-\alpha\right)\Pi + c\right)}{\left(\gamma\alpha\Pi - c\right)t} \quad \square
\end{aligned}$$

We also need to ascertain that the board itself always finds it optimal to monitor, irrespective of whether the acquirer screens.

Lemma 4 *If $I > 1$, then in equilibrium $x_b > 0$.*

Proof: We proceed as in the proof of Lemma 2, by deriving an upper bound for D, but vary the approach slightly by considering only those choices that are consistent with profit maximization. Consider therefore the acquirer's problem,

$$\max_{x_a} \pi_a = (1-\phi_b)\,\phi_a\,(1-\alpha)\,\Pi - ke^{-D}x_a$$

The acquirer's incentives are maximized by imposing the out-of-equilibrium constraint that $\phi_b = \alpha = 0$. We can then solve to obtain

$$x_a^{\max} = \frac{1}{I}\ln\left(\frac{k}{I\Pi}\right)D \Rightarrow \phi_a^{\max} = 1 - \frac{k}{I\Pi}e^{-D}$$

Now consider the board's problem,

$$\pi_b(x_b, x_a^{\max}) = \phi_b\Pi + (1-\phi_b)\,\phi_a^{\max}\alpha\Pi - x_b - \frac{1}{t}D$$

and maximize this with respect to D:

$$\frac{\partial \pi_b}{\partial D} = (1-\phi_b)\,\frac{\partial \phi_a^{\max}}{\partial D}\alpha\Pi - \frac{1}{t} = 0$$

Using the definition of $\phi_a^{\max}$ and solving for D obtains

$$D^{\max}(\phi_b) = \ln\left(\frac{(1-\phi_b)\,k\alpha t}{I}\right)$$

Evaluated at $\phi_b = 0$, $D_0^{\max} = D^{\max}(0) = \ln\left(\frac{k\alpha t}{I}\right)$, this expression determines the maximum amount of disclosure the board would want to do, assuming that the incentives for effort provision of the acquirer are maximized.

Given this maximal level of effort provision by the acquirer (and hence a maximal incentive to free-ride on the acquirer's screening), we next establish when the board will find it optimal to monitor. Consider the problem of finding the optimal level of effort for the board assuming it will disclose as much as $D_0^{\max}$:

$$\max_{x_b} \pi_b(x_b, x_a^{\max}) = \phi_b\Pi + (1-\phi_b)\,\phi_a^{\max}\alpha\Pi - x_b - \frac{1}{t}D_0^{\max}$$

The FOC is

$$\frac{\partial \pi_b}{\partial x_b} = \frac{\partial \phi_b}{\partial x_b}\Pi\,(1-\phi_a^{\max}\alpha) - 1 = 0$$

Letting $\alpha \to 1$, and solving, we obtain $x_b = -\frac{1}{I}\ln\left(\frac{1}{I}\right)$,which will be positive as long as $I > 1$. □

The final step is to show that for $\alpha \in [\underline{\alpha}, \overline{\alpha}]$, with $\underline{\alpha} < \overline{\alpha}$, $x_b, x_a, D > 0$. For this, we compare the board's proposed equilibrium profits $\pi_b^* = \pi_b(x_b^*, x_a^*)$ with those obtained if instead $x_a = 0$, which we denote as $\widehat{\pi}_b = \pi_b(\widehat{x}_b, 0)$, where $\widehat{x}_b = \arg\max_{x_b}[\phi_b\Pi - x_b]$. This difference can be written as

$$\pi_b^* - \widehat{\pi}_b = \frac{1}{I}\ln\left(\frac{t\Pi}{(t+I)\,(\gamma\Pi\,(1-\alpha)+c)}\right) + \frac{1}{t}\ln\left(\frac{I\Pi\,(1-\alpha)}{k\,(t+I)\,(\gamma\alpha\Pi - c)}\right)$$

It is straightforward now to show that there is always a value $\underline{t} > 0$ such that $\pi_b(x_b^*, x_a^*) - \pi_b(\widehat{x}_b, 0) >$

0 for all $t > \underline{t}$ (for sufficiently small c, which is a necessary condition for the board to be willing to participate). Therefore, for t sufficiently large there is an open set $(\underline{\alpha}, \overline{\alpha})$ such that $x_b, x_a, D > 0$ in equilibrium, with the optimal values as described above, thus demonstrating the proposition. □

Proof of Corollary 3. All the results follow from simple differentiation of the equilibrium expressions obtained in Proposition 1:

$$\begin{aligned}
\frac{dD^*}{dQ} &= \frac{\partial D^*}{\partial \Pi}\frac{\partial \Pi}{\partial Q} = \Delta_p X \frac{c}{\Pi\left(\alpha\gamma\Pi - c\right)} > 0 \\
\frac{d\phi_b^*}{dQ} &= \frac{\partial \phi_b^*}{\partial \Pi}\frac{\partial \Pi}{\partial Q} = \Delta_p X \frac{\left(1-\alpha\right)t\gamma}{I\left(\gamma\Pi\left(1-\alpha\right)-c\right)^2\left(t+I\right)} > 0 \\
\frac{d\phi_a^*}{dQ} &= \frac{\partial \phi_a^*}{\partial \Pi}\frac{\partial \Pi}{\partial Q} = \Delta_p X \frac{\gamma I c}{\left(\alpha\gamma\Pi - c\right)^2 t} > 0
\end{aligned}$$

as desired. Since $\frac{d\Pi}{d\Delta_p} > 0$ as well, a similar calculation shows that $\frac{dD^*}{d\Delta_p}, \frac{d\phi_b^*}{d\Delta_p}, \frac{d\phi_a^*}{d\Delta_p} > 0$. □

Proof of Proposition 5. Substituting $\phi_b = 1 - e^{-I_b x_b}$ and $\phi_a = 1 - e^{I_a x_a}$ into the payoff equations (1) and (2) that we maximize with respect to monitoring and screening effort we obtain the following FOCs for a given disclosure policy D:

$$\begin{aligned}
\frac{\partial \pi_b}{\partial x_b} &= I_b e^{-I_b x_b}\Pi - I_b e^{-I_b x_b}\alpha\Pi + I_b e^{-I_b x_b - I_a x_a}\alpha\Pi - 1 = 0 \\
\frac{\partial \pi_a}{\partial x_a} &= I_a \Pi \exp\left(-I_b x_b - I_a x_a\right) - I_a \Pi \exp\left(-I_b x_b - I_a x_a\right)\alpha - k e^{-D} = 0
\end{aligned}$$

As before, we solve the preceding system of equations for optimal efforts x_b^* and x_a^*:

$$\begin{aligned}
x_b^* &= \frac{-\ln\left(-\frac{-I_a\Pi e^D + I_a\Pi\alpha e^D + I_b\gamma\alpha\Pi k - I_b c k}{I_a\Pi I_b(\gamma\Pi + c - c\alpha - 2\gamma\alpha\Pi + \gamma\alpha^2\Pi)}\right) + D}{I_b} \\
x_a^* &= \frac{\ln\frac{-I_a\Pi e^D + I_a\Pi\alpha e^D + I_b\gamma\alpha\Pi k - I_b c k}{k(\gamma\alpha\Pi - c - \gamma\Pi)I_b}}{I_a}
\end{aligned}$$

We can now substitute these back into the monitoring and screening probabilities to get

$$\begin{aligned}
\phi_b^*(D) &= \frac{k I_b e^{-D}\left(\alpha\gamma\Pi - c\right) - \left(1-\alpha\right)\Pi I_a\left(1 - cI_b - \Pi I_b\gamma\left(1-\alpha\right)\right)}{I_a I_b \Pi\left(1-\alpha\right)\left(\gamma\Pi\left(1-\alpha\right) + c\right)} \\
\phi_a^*(D) &= \frac{\Pi\left(e^D I_a\left(1-\alpha\right) - k\gamma I_b\right)}{\Pi e^D I_a\left(1-\alpha\right) - k I_b\left(\alpha\gamma\Pi - c\right)}
\end{aligned}$$

To find D^*, substitute the optimal monitoring and screening probabilities above back into the board's objective function in Equation (1) to find $\pi_b\left(x_b^*, x_a^*\right)$. The FOC is then

$$\frac{\partial \pi_b\left(x_b^*, x_a^*\right)}{\partial D} = \frac{I_a\Pi\left(1-\alpha\right) - \left(I_b + t\right)k e^{-D}\left(\gamma\alpha\Pi - c\right)}{t\left(I_b k e^{-D}\left(\gamma\alpha\Pi - c\right) - I_a\Pi\left(1-\alpha\right)\right)} = 0$$

that we solve for $D^* = \ln\left(\frac{k(t+I_b)(\gamma\alpha\Pi - c)}{I_a\Pi(1-\alpha)}\right)$. For the monitoring and screening probabilities to be well-defined, i.e., $\phi_b^*, \phi_a^* \in [0,1]$, we require that $D^* \geq \ln\left(\frac{k\gamma I_b}{I_a(1-\alpha)}\right)$ so that $\ln\left(\frac{(t+I_b)(\gamma\alpha\Pi - c)}{\Pi\gamma I_b}\right) >$

$0 \Leftrightarrow (t+I_b)(\gamma\alpha\Pi - c) > \Pi\gamma I_b$, which holds in equilibrium for large t. Similarly, the SOC for a maximum $\frac{\partial^2 \pi_b\left(x_b^*, x_a^*\right)}{\partial D^2} = \frac{(\alpha\gamma\Pi - c)(\alpha-1)\left(e^{-D}\right)kt\Pi I_a}{\left(I_b k e^{-D}(\gamma\alpha\Pi - c) - I_a\Pi(1-\alpha)\right)^2} < 0$ since $\alpha < 1$. As before, this solution is only valid if both the board and the acquirer exert effort, which by similar arguments as used above will be true for $\alpha \in [\underline{\underline{\alpha}}, \overline{\overline{\alpha}}]$, where $0 < \underline{\underline{\alpha}} \leq \overline{\overline{\alpha}} < 1$, when t is sufficiently large. To show that there are value of t such that $\underline{\underline{\alpha}} < \overline{\overline{\alpha}}$, consider the case where $I_b = I + \epsilon_b$ and $I_a = I + \epsilon_a$. As $\epsilon_b, \epsilon_a \to 0$, we are in the exact setting as above, so that we know that there is always an open set of values α for which x_b, x_a, and $D > 0$. □

Proof of Proposition 6. Maximizing the board's and the acquirers' payoff functions, Equations (10) and (11), with respect to x_b and x_i, respectively, and imposing symmetry for all acquirers (i.e., that $x_i = x_j$, $i \neq j$), yields the following solutions:

$$\begin{aligned} x_b^*(D) &= \frac{\ln\frac{(1-\alpha)I\Pi}{k} + D - N\ln\frac{e^D(1-\alpha)+k(N(1-\alpha)-1)}{kN(1-\alpha)}}{I} \\ x_i^*(D) &= \frac{1}{I}\ln\frac{e^D(1-\alpha)+k(N(1-\alpha)-1)}{kN(1-\alpha)} \end{aligned}$$

These solutions yield monitoring and screening probabilities for a given disclosure policy D as:

$$\begin{aligned} \phi_b^*(D) &= 1 - \frac{ke^{D(N-1)}}{(1-\alpha)I\Pi}\left(\frac{(1-\alpha)+ke^{-D}(N(1-\alpha)-1)}{(1-\alpha)kN}\right)^N \\ \phi_i^*(D) &= 1 - \frac{kN(1-\alpha)}{(1-\alpha)(e^D+kN)-k}, \end{aligned}$$

for $D > \ln\left(\frac{k}{1-\alpha}\right)$. Otherwise, the acquirers exert no effort ($x_i^* = 0$), and ϕ_b^* is as defined in Lemma 1. Note that, as N increases, for $D > \ln\left(\frac{k}{1-\alpha}\right)$ we have

$$\frac{\partial\phi_i^*(D)}{\partial N} = \frac{k(1-\alpha)\left(k-(1-\alpha)e^D\right)}{\left(k(1-N(1-\alpha))-e^D(1-\alpha)\right)^2} < 0$$

As before, we calculate the optimal disclosure policy from the FOC for board profit maximization, $\frac{\partial\pi_b}{\partial D}(x_b^*, x_i^*, D) = \frac{\left(ke^{-D}(N\alpha-2N+1)+(1-\alpha)(N-1)\right)\alpha}{(1-\alpha)(ke^{-D}(1-N+N\alpha)-(1-\alpha))I} - \frac{1}{t} = 0$, as

$$D^* = \ln\left(\frac{k\left((t+I)\alpha\left((2-\alpha)N-1\right)-I(N-1)\right)}{(1-\alpha)\left(I(1-\alpha)+t\alpha(N-1)\right)}\right)$$

Note that we require again that t be sufficiently large for the equilibrium to be well defined. The equilibrium monitoring and screening probabilities now become

$$\begin{aligned} \phi_b^* &= 1 - \frac{(\alpha t(N-1)+(1-\alpha)I)^{1-N}}{\left((t+I)\alpha\left((2-\alpha)N-1\right)-I(N-1)\right)}\frac{N^N\alpha^N t^N}{I\Pi} \\ \phi_i^* &= 1 - \frac{t\alpha(N-1)+(1-\alpha)I}{N\alpha t} \end{aligned}$$

Comparative statics of D^* with respect to N yields

$$\frac{dD^*}{dN} = \frac{(1-\alpha)\left(\alpha\left(t+I\right)-I\right)^2}{\left(t\alpha\left(N-1\right)+\left(1-\alpha\right)I\right)\left(\alpha t\left(N\alpha-2N+1\right)-I\left(1-\alpha\right)\left(N\alpha+1-N\right)\right)},$$

which is negative when N is large, given t sufficiently large that disclosure is optimal. Similarly, we find that, in equilibrium, each acquirer screens less as competition in the market for corporate control increases:

$$\frac{d\phi_i^*}{dN} = -\frac{\left(\alpha\left(t+I\right)-I\right)}{N^2 t\alpha} < 0,$$

for $t > I\left(\frac{1-\alpha}{\alpha}\right)$.

For the aggregate amount of information produced in equilibrium, $\Phi^* = 1-(1-\phi_b^*)\left(1-\phi_i^*\right)^N = 1-\frac{1}{I\Pi}\frac{\alpha t(N-1)+(1-\alpha)I}{(t+I)\alpha((2-\alpha)N-1)-I(N-1)}$, we find

$$\frac{d\Phi^*}{dN} = \frac{-\left(1-\alpha\right)\left(\alpha\left(t+I\right)-I\right)^2}{\Pi I\left(\alpha t\left(N\left(\alpha-2\right)+1\right)+I\left(1-\alpha\right)\left(N\left(1-\alpha\right)-1\right)\right)^2} < 0,$$

as desired. □

Appendix B: Large Shareholders and Governance

Consider the case where, rather than relying on an external takeover specialist to identify inefficiencies within the firm, there is a large shareholder (ls) who owns a fraction β of the firm's shares. This large shareholder benefits from an internal board-induced restructuring since the value of his shares also increase. However, if the board fails to act, the large shareholder can investigate the firm itself and exert influence, either through a proxy fight or through an outright acquisition of the remaining shares. In this case, much as in the case with an external acquirer, we assume that the large shareholder manages to capture a fraction $1-\alpha$ of the expected value improvement net of the gain that accrues anyway to his pre-existing shares. We assume that screening by the large shareholder takes place in similar fashion as in the case with a acquirer. The extensive form of the game remains the same.

The payoff for this large shareholder is

$$\pi_{ls} = \phi_b\beta\Pi + \left(1-\phi_b\right)\phi_{ls}\left(\beta+\left(1-\alpha\right)\left(1-\beta\right)\right)\Pi - ke^{-D}x_{ls},$$

where the first term reflects the fact that if an internal restructuring occurs, the increase in the value of the large shareholder's stake is proportional to β. The second term reflects the fact that, if no internal restructuring takes place, the large shareholder can exert control and capture a fraction $(1-\alpha)$ of the gain $(1-\beta)\Pi$, which is net of the shares he already owns (and on which he captures the full expected value increase). The payoff to the board remains the same as in the text.

The solution to the maximization of π_b and π_{ls} is

$$\begin{aligned} x_b &= \frac{-\ln\frac{-\Pi e^D+\alpha\Pi e^D-\Pi\alpha\beta e^D-kc+k\alpha\gamma\Pi}{I\Pi(1-\alpha+\alpha\beta)(\alpha\gamma\Pi-c-\gamma\Pi)}+D}{I} \\ x_{ls} &= -\frac{\ln k\frac{\alpha\gamma\Pi-c-\gamma\Pi}{-\Pi e^D+\alpha\Pi e^D-\Pi\alpha\beta e^D-kc+k\alpha\gamma\Pi}}{I} \end{aligned}$$

so that, for given D, we have

$$\begin{aligned}
\phi_b^*(D) &= 1 - e^{-Ix_b} = 1 - \frac{\Pi(1-\alpha+\alpha\beta) - (\alpha\gamma\Pi - c)\,ke^{-D}}{I\Pi(1-\alpha+\alpha\beta)(\gamma\Pi(1-\alpha)+c)} \\
\phi_{ls}^*(D) &= 1 - e^{-Ix_{ls}} = 1 - k\frac{\gamma\Pi(1-\alpha)+c}{e^D\Pi(1-\alpha+\alpha\beta)+kc-k\alpha\gamma\Pi}
\end{aligned}$$

Note now that

$$\begin{aligned}
\frac{\partial}{\partial D}\phi_b^*(D) &< 0 \\
\frac{\partial}{\partial D}\phi_{ls}^*(D) &> 0,
\end{aligned}$$

so that the qualitative results of the model extend also to the case where governance is provided by a large shareholder.

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