Communication and Decision-Making in Corporate Boards

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Time constraints, managerial power, and reputational concerns can impede board communication. This paper develops a model where board decisions depend on directors' effort in communicating their information to others. I show that directors communicate more effectively when pressure for conformity is stronger—that is, when directors are more reluctant to disagree with each other. Hence, open ballot voting can be optimal, even though it induces directors to disregard their information and conform their votes to others. I also show that communication can be more efficient when directors' preferences are more diverse. The analysis has implications for executive sessions, transparency, and committees. (*JEL* D71, D72, D82, D83, G34)

Introduction

The board of directors is a collective body, whose members have diverse expertise in various aspects of the company's business. Therefore, communication between directors is critical to successful board functioning. In recent years, regulators, shareholders, and directors themselves have been paying increased attention to decision-making policies that could increase the quality of board discussions. Executive sessions that exclude the management, separation of the CEO and chairman positions, board retreats, and separate committees on specific topics have been put in place to promote more effective communication. As governance experts Carter and Lorsch (2004) emphasize, "If we could offer only one piece of advice, it would be to strive for open communication among board members."

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In practice, communication in boards is impeded by several factors. In many board meetings, time allocated for discussion of important issues is very limited, and managers use their power to prevent any contentious discussions.[1] Because of that, directors have been increasingly engaging in discussions outside board meetings (Hart 2003), which is difficult given directors' busy schedules. According to a former board chairman, "If you want to be influential on a board it takes time, so you have to make the commitment of time. Cause you're gonna have a lot of discussions outside of board meetings" (Stevenson and Radin 2009). Moreover, discussions outside board meetings can result in retaliation from the manager, who may want to prevent directors from communicating behind his back. Another obstacle to communication is that directors often refrain from openly expressing their views due to reputational concerns, such as the fear to appear incompetent by voicing a controversial opinion, or to be perceived as a troublemaker.[2] Finally, given directors' diverse preferences, backgrounds, and areas of expertise, conveying one's knowledge effectively and persuasively requires preparation and effort. All these factors make it personally costly for directors to communicate their position openly and effectively.[3]

The goal of this paper is to examine whether existing board policies mitigate or exacerbate the problem of ineffective communication, and to understand which policies are optimal. To study this question, I develop a theory of board decision-making whose key element is that the quality of discussion is endogenous and determined by the efforts directors put into communicating their position to others. The model yields novel implications for the choice between open and secret ballot voting, the role of board diversity, executive sessions, transparency, and board committees. These implications follow from two main results, which show that when communication is personally costly, certain biases in directors' preferences can improve the quality of board discussions. In particular, both directors' concerns about conformity and diversity in directors' private interests can give directors stronger incentives to incur the costs and communicate their position to others.

Anecdotal and survey evidence suggests that conflicts of interest and pressure for conformity play an important role in directors' decisions. Conflicts of interest arise due to private benefits directors receive from certain board

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[1] According to Lipton and Lorsch (1992), "Too much of this limited time is occupied with reports from managements and various formalities. In essence, the limited time outside directors have together is not used in a meaningful exchange of ideas." The manager's ability to prevent debate is especially high if the CEO and chairman roles are combined. For example, Michael Eisner, the former CEO and chairman of Disney, was known to allow very little discussion and no heated disagreement during board meetings. See "Are Disney's Directors Only Eisner's Puppets?" *Los Angeles Times*, February 16, 2004.

[2] Sonnenfeld (2002) describes a story of a CEO who was invited to join the board of a well-known company. He was told that new directors were expected to say nothing for the first 12 months. The candidate answered "Fine, I'll see you in a year," and never got the appointment.

[3] The fact that communication can be privately costly for the sender is well recognized in the literature. Dewatripont (2006) provides a review of the relevant literature. See Section 2.1 for a more detailed discussion.

decisions. For example, such conflicts are likely to arise in corporate control transactions due to directors' ownership, affiliation, or relation with the CEO. Desire for conformity, which makes directors reluctant to deviate from other board members, is perceived by many as equally important.[4] This reluctance to take a minority stand is due to several reasons, including the influence of the CEO and directors' reputational concerns. For example, anecdotal evidence suggests that directors who oppose the CEO without support from other board members face retaliation and pressure to resign.[5]

The paper develops a model that incorporates the key features of board decision-making described above—costly communication, conflicts of interest, and pressure for conformity. In the model, the board contemplates a decision whose value is uncertain—for example, an acquisition. Each director has private information relevant to the decision. The board's decision process takes place in two stages—communication, followed by decision-making. At the communication stage, each director decides whether to incur a cost to communicate his information to others. At the decision-making stage, all directors take actions (e.g., vote) based on their private information and the information inferred from the discussion, and the board's collective decision is made. Directors can have conflicts of interest and thus prefer a decision that is not optimal for shareholders. Directors can also have a preference for conformity and thus incur a loss if their action deviates from other directors' actions—for example, if they vote differently from the majority.

As a benchmark, I show that if decisions are made without prior communication—that is, if directors vote just on the basis of their private signals, then both conflicts of interest and conformity are detrimental for board decisions. However, the conclusions are different when prior to making the decision, directors can choose to communicate their information to others at a cost.

The first result shows that pressure for conformity at the decision-making (voting) stage gives directors stronger incentives to incur the costs and communicate their information to others prior to the vote. By encouraging better communication, conformity at the decision-making stage can have an overall positive effect on board decisions. As an illustration of this result, consider the

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[4] According to one director, "Groupthink is one of the greatest problems boards face" (Leblanc and Gillies 2005). Schwartz-Ziv and Weisbach (2013) examine board minutes of Israeli companies and find that dissension is very rare: in 97.5% of the 1,422 votes they observe, the vote was unanimous. Survey evidence in Lorsch and MacIver (1989) suggests that 49% of directors feel inhibited in taking a minority stand. See also Sonnenfeld (2002) and "What boards should know about groupthink" (*Compliance Week*, May 19, 2009) for case studies of conformity in the boardroom.

[5] Mace (1986) describes a case study in which an outside director was excluded from the company's proxy statement after openly criticizing the manager's press releases during a board meeting. "Don't raise questions with the president unless you can, for sure, count on the support of others on the board," commented the director afterward. The first section in the Appendix discusses several microfoundations for conformity and explains why the results are robust to different microfoundations.

difference between open and secret ballot voting. Anecdotal evidence suggests that in the majority of cases, directors vote by open ballot.[6] At first glance, this seems puzzling: pressure for conformity is stronger when voting is by open rather than secret ballot because the vote of each director is observable to other directors and the CEO. Thus, the open ballot system is likely to prevent directors from using their information and honestly voting their opinions. However, my first result implies that open ballot voting can nevertheless be optimal because it improves communication prior to the vote.

To see the intuition, suppose that the board contemplates a merger supported by the manager. If voting is by secret ballot, a director with negative information about the prospects of the merger will vote against it. Even if he is the only one to vote negatively, he will not be identified by the manager and hence will not be penalized. However, given potential costs of sharing his concerns with others, the director may be reluctant to speak up during the discussion and will simply vote against. Conversely, suppose that voting is by open ballot. Unless the director shares his negative information prior to the vote, he faces the risk that he will be the only one to vote against and hence will be penalized by the manager. Realizing this, the director has strong incentives to share his concerns with others, for example, outside the board meeting. By communicating his information, he ensures that other directors also become pessimistic about the merger and will support him in his opposition to the CEO. Thus, board communication is more effective under open ballot voting.

In general, the choice between open and secret ballot (stronger and weaker pressure for conformity) depends on several factors, including the decision under consideration, the nature of directors' information, and their private interests. Section 4 presents the implications of the model for voting procedures, transparency, and executive sessions, and discusses anecdotal evidence consistent with these implications. Pressure for conformity may exist at the communication stage as well. In particular, it may be costly for directors to voice a dissenting opinion, not only to vote in dissent. However, such decision-making policies as the use of open versus secret ballot voting affect pressure for conformity at the voting stage without affecting conformity at the communication stage. Thus, the first result shows that various inefficiencies during the discussion (due to conformity, fear of the CEO, or direct communication costs) can be overcome by increasing conformity at the voting stage, for example, by using open ballot voting. Section 5.2 discusses these issues in more detail.

The second result of the paper shows that a stronger conflict of interest relative to other board members gives a director stronger incentives to communicate his information to them. Thus, board discussions can be more

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[6] For example, in the sample of Schwartz-Ziv and Weisbach (2013), all board votes were taken by open ballot. See also the discussion in Rock (2004). Swartz (2007) documents that while open ballot voting is most common, some firms adopt secret ballot voting due to shareholder pressure or by management initiative.

effective when directors' private interests are more diverse. For example, this implies that in the context of a takeover, a board that includes both insiders, who are biased against the takeover, and bidder representatives, who are biased in its favor, can be more effective than a fully independent board.

The intuition is the following. Consider a firm that receives a takeover bid and an inside director who is biased against being taken over because of private benefits of control. Other board members expect the director to actively participate in the discussion and present evidence that the bid undervalues the target whenever he has such evidence. Hence, if the director does not speak up, other directors infer that he privately knows that the target's value is low. This negative inference increases the probability that the board will accept the bidder's offer. The more biased is the director relative to other board members, the more harmful for him is their negative inference when he does not speak up. At the margin, this gives a more biased director stronger incentives to incur the costs of communication and try to credibly convey his information.

Finally, the paper has implications for the allocation of decision-making rights among directors. I show that even if directors are identical, it can be optimal to allocate full decision-making power to one director, as opposed to giving voting rights to all directors. In the presence of communication costs, such allocation of control leads to the most efficient use of directors' diverse information, with the director in control serving as a communication link. Directors without decision-making power communicate their information to the director in control, who makes the decision by incorporating all available information. Section 4 discusses the implications of this result for the advisory role of the board and board committees. I also show that when directors are heterogeneous, it is optimal to allocate control to directors who care the least about conforming to others because such directors distort their decisions the least. This is consistent with the observed practices, where more experienced directors (who are likely to have lower costs of disagreeing with others) are more likely to be appointed to the chairman or lead director positions.

The paper proceeds as follows. The remainder of this section reviews the related literature. Section 1 presents the benchmark case without communication, and Section 2 analyzes the general setup. Section 3 considers an extension of the model to differential decision-making rights. Section 4 presents the policy and empirical implications. Section 5 discusses the robustness of the results, and Section 6 concludes. All proofs are given in the Appendix.

Related literature

The paper contributes to the theoretical literature on corporate boards. Most papers in this literature focus on the board-CEO interaction and consider the

board as a single agent.[7] In contrast, this paper considers the board as a collective decision-making body and focuses on the interaction between directors.[8] In this respect, it is most closely related to Warther (1998) and Chemmanur and Fedaseyeu (2011), who analyze directors' decisions whether to fire the CEO in the presence of costs of dissent: directors who vote against the CEO incur a loss, but only if their vote deviates from the majority. Hence, costs of dissent are similar to pressure for conformity. Warther (1998) and Chemmanur and Fedaseyeu (2011) show that costs of dissent introduce a coordination problem: directors may not vote against the CEO even if each of them has negative private information about him. My paper contributes to these papers by allowing for communication prior to voting. It emphasizes that communication can alleviate the coordination problem and also shows that when communication is costly, higher costs of dissent improve communication. Communication within the board is also studied in Harris and Raviv (2008), who compare insider- and outsider-controlled boards when the party without control can communicate its information to the party in control by sending a costless message. My paper is different from Harris and Raviv (2008) in that it studies collective decision-making by directors and focuses on costly communication.[9]

The theoretical contribution of this paper is to extend the literature on voluntary information disclosure, started by Verrecchia (1983), to the case of multiple senders and multiple receivers of information. The framework allows directors to be different in their preferences, information quality, and other characteristics, but remains very tractable.

The literature on costly communication acknowledges that communication between team members is costly and studies the effects of specialization and decentralization (see Dewatripont 2006 for a review). The closest paper in this literature is Dewatripont and Tirole (2005), where both the sender and the receiver need to incur costly effort to improve communication between them. The focus of their paper is on the "moral hazard in teams" problem in communication.

The paper is also related to the literature on voting in committees, and specifically, to several papers in this literature that allow for pre-vote communication.[10] Unlike my paper, these papers study a cheap talk setting. My paper is also different in the way it models the decision-making stage.

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[7] See, e.g., Hirshleifer and Thakor (1994), Hermalin and Weisbach (1998), Almazan and Suarez (2003), Song and Thakor (2006), Adams and Ferreira (2007), Kumar and Sivaramakrishnan (2008), Burkart and Raff (2012), Chakraborty and Yilmaz (2011), and Levit (2012). Adams, Hermalin, and Weisbach (2010) provide a comprehensive review of the literature.

[8] Baranchuk and Dybvig (2009) also study individual directors' preferences and information, but use a cooperative solution concept, while my paper models directors' behavior explicitly.

[9] Communication between directors is also considered in Raheja (2005), where informed insiders, who compete with each other to become the CEO's successor, can reveal their information to uninformed outsiders.

[10] E.g., Coughlan (2000), Gillette, Noe, and Rebello (2003), and Austen-Smith and Feddersen (2005). Gerling et al. (2005) provide a review of the literature on decision-making in committees.

Because the analysis of voting with communication is technically involved and gives rise to multiple equilibria, the above papers focus on two- or three-member committees or assume a degenerate information structure. My paper abstracts from voting, which allows a closed-form solution for any board size and a general information structure.

Finally, the paper is related to the literature on agents' concerns about conformity. Scharfstein and Stein (1990), Banerjee (1992), Bikhchandani, Hirshleifer, and Welch (1992), and Zwiebel (1995) show how incentives to conform arise endogenously, when agents have reputational concerns or infer information from other agents' actions. Morris and Shin (2002) take concerns about conformity as given and compare the effects of public versus private information on social welfare. In their paper, the separation of information into public and private is exogenous, while in my paper it arises endogenously through directors' communication decisions. Alonso, Dessein, and Matouschek (2008) study communication between agents who benefit from coordinating their actions but focus on costless communication.

1. Benchmark Case: No Communication

The analysis starts with the benchmark case without communication. I show that in this case, conflicts of interest and pressure for conformity reduce board effectiveness. Section 2 shows that these biases can have the opposite effect when costly communication is allowed.

1.1 Setup
1.1.1 Information structure. The board, which consists of N directors, is contemplating a decision. I adopt the information structure and firm value specification of Harris and Raviv (2005, 2008) and assume that the value of the firm is equal to

$$V(a,\theta) = V_0 - (a-\theta)^2, \qquad (1)$$

where a is the decision made by the board, and θ is the unknown state of the world, which is equal to the sum of N independent signals x_i and an independent noise term ε:

$$\theta = \sum_{i=1}^{N} x_i + \varepsilon. \qquad (2)$$

Signal x_i is distributed on $[-k_i, k_i]$, where k_i can be infinite, with a density function $f_i(\cdot)$, which is symmetric around zero. A director with a higher signal variance can be interpreted as having more expertise. Director i perfectly observes x_i but has no information about other signals. The term ε is distributed with a density function $f_\varepsilon(\cdot)$ with $\mathbb{E}[\varepsilon] = 0$ and corresponds to the information that is not known to any director. As discussed in Sections 2 and 5.4, the results would remain unchanged if directors' signals were correlated or if directors observed their signals only with some probability. Expressions (1) and (2)

imply that a social planner who has access to all directors' private signals will choose decision $a = \sum_{i=1}^{N} x_i$ to maximize the value of the firm.

To illustrate this setup, suppose that the firm is a potential target, and its board decides on the minimum price a it is willing to accept (other examples include choosing the scale of investment or the maximum price to pay in an acquisition). For example, in the well-known Air Products' takeover fight for Airgas, directors of Airgas strongly disagreed with each other over the minimum price they would accept.[11] While the minimum price set by the board should not be too low, it should also not be too high since it can deter the bidder completely. Hence, there exists some optimal minimum price $a^* = \theta$. This price is determined by several factors, including the value of the target as a stand-alone firm, the number and quality of potential bidders, and operational and financial synergies. These factors are represented by signals x_i and ε. Directors have different areas of expertise and thus have information that is relevant to different aspects of the decision.

1.1.2 Decision-making stage. Since the board is a collective body, its final decision is the result of collective decision-making by directors. Any modeling of one-shot collective decision-making implies that the board's decision is some, potentially probabilistic, function of individual directors' actions: $a = h(a_1, ..., a_N)$.

In the main part of the paper, I focus on the "random dictator" rule, which has been discussed in the political economy literature as an alternative to majority voting.[12] According to the "random dictator" rule, if directors' actions are $a_1, ..., a_N$, then the board's decision equals a_i with probability $\frac{1}{N}$. For example, in the context of a target's board deciding on the minimum takeover price, each director proposes the price a_i that he thinks should be set. If K out of N directors propose price p_1 and $N - K$ directors propose price p_2, then p_1 is chosen with probability $\frac{K}{N}$. The advantage of this specification is that unlike most models of collective decision-making with communication, it allows a tractable solution. In particular, regardless of signal distributions, there is a unique linear equilibrium at the decision-making stage and closed-form expressions for communication strategies and firm value. Combined with (1), this decision rule implies that firm value is equal to:

$$V(a_1, ..., a_N, \theta) = V_0 - \frac{1}{N} \sum_{i=1}^{N} (a_i - \theta)^2. \tag{3}$$

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[11] The Airgas chairman claimed that the board had unanimously agreed on the minimum acceptable price of $78 a share. However, 3 out of 10 Airgas directors disputed that they agreed with this price. See "Airgas directors disagree over minimum price while fending off hostile bid," *Bloomberg*, December 13, 2010.

[12] See, e.g., Zeckhauser (1973). Zhang and Casari (2012) present experimental evidence that the actual decision-making process in groups lies between the "random dictator" and the majority rule processes.

The results of the paper hold for a wider set of decision rules. Section 3 generalizes the model to the case in which some directors have more decision-making power than others, while the online Appendix analyzes a general linear specification of $h(a_1,...,a_N)$, as well as a model with voting.[13] More generally, the intuition behind the results holds for decision rules such that in the absence of communication, the decision-making stage alone does not allow efficient aggregation of directors' signals (i.e., it does not result in the social planner's choice), and hence communication has value. Majority voting is the simplest example of an inefficient decision rule because directors are restricted to binary actions, which cannot convey continuous and multidimensional information.[14] The "random dictator" rule, analyzed in the basic setup, does not efficiently aggregate directors' information either. The formal definition of efficient decision rules is as follows.

Definition 1. Let $a_i^*(x_i)$ be the equilibrium action of director i in the absence of communication given decision rule $h(a_1,...,a_N)$ when the director has information x_i. This decision rule is said to efficiently aggregate information if for any realization of $x_1,...,x_N$, $h\left(a_1^*(x_1),...,a_N^*(x_N)\right)$ equals the social planner's choice $\sum_{i=1}^{N} x_i$ with probability 1.

The motivation for the assumption of an inefficient decision rule is that efficient rules are difficult to implement in practice. First, directors' information is complex and multidimensional, and its distribution is unknown. Thus, to be efficient, the decision rule would need to be tailored to the specific company (based on its board structure and directors' expertise) and to the specific decision under consideration. Even if the information structure is known, an ex post efficient decision rule may not exist[15] or may be costly to implement. For example, a large literature studies how communicational constraints make implementation of mechanisms prohibitively costly (see Segal 2006 for a review). For these reasons, many papers on decision-making in organizations restrict attention to specific decision rules, which are easy to implement but are not efficient. The delegation literature focuses on delegating authority to a single agent (Dessein 2002; Harris and Raviv 2008; Chakraborty and Yilmaz 2011), and the literature on committees focuses on voting (see Gerling et al. 2005 for a

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[13] The general linear specification of $h(a_1,...,a_N)$ is characterized by m vectors $(\gamma_{1(j)},...,\gamma_{N(j)})$, $\gamma_{i(j)} \geq 0$, $\sum_{i=1}^{N} \gamma_{i(j)} = 1$, and probabilities $q_j > 0$, $\sum_{j=1}^{m} q_j = 1$, such that the board's decision equals the linear combination $\sum_{i=1}^{N} \gamma_{i(j)} a_i$ with probability q_j.

[14] For example, if all but one director have moderately positive signals but the remaining director has an extremely negative signal about the value of a proposal, the proposal is detrimental to firm value. Nevertheless, in the absence of communication, such a proposal will be approved by a majority of the votes.

[15] Committing to an ex post inefficient decision rule can be optimal to give agents incentives to report truthfully. For example, Li, Rosen, and Suen (2001) show that when committee members have conflicting preferences, there is no mechanism that efficiently pools members' private information, and that decisions have to be made through voting (or other procedures that partition continuous information into ranks).

review). I adopt the approach in these literatures and consider decision rules that inefficiently aggregate information. This assumption makes communication valuable.

1.1.3 Preferences. To capture conflicts of interest and conformity, I assume that the utility of director i is:

$$U_i(a, a_1, ..., a_N, \theta) = -(a - (b_i + \theta))^2 - \frac{r_i}{N-1} \sum_{k \neq i} (a_i - a_k)^2, \qquad (4)$$

where a is the board's decision. These preferences are common knowledge. As discussed in Section 5.4, the results would continue to hold if preferences were unknown.

The director's utility has two components. The first component reflects conflicts of interest: the director's preferred decision is $b_i + \theta$, rather than θ. For example, due to private benefits, an inside director may prefer the target to remain independent and would like to set a higher minimum price than is optimal for shareholders. I will refer to b_i as a "directional bias" in the rest of the paper, capturing the idea that directors may be biased in one or the other direction. The second component reflects pressure for conformity: the director suffers a loss if his action deviates from the actions of other directors. Since the board's decision equals a_k with probability $\frac{1}{N}$, the director effectively minimizes the expected squared distance of his action from the final board's decision. I will refer to r_i as the director's "conformity bias" in the rest of the paper. This specification is similar to Morris and Shin (2002) and captures, in a reduced-form way, different reasons for conformity, such as directors' reputational concerns and desire to avoid confrontation. The first part of the Appendix discusses several explanations for the conformity bias and explains why the results of the paper are robust to different explanations.

Specification (4) does not explicitly incorporate the fear of the CEO as one of the reasons for the conformity bias. The online Appendix presents two extensions of the model that capture directors' desire to support the CEO and shows the robustness of the results. Section 5.1 contains a discussion of these extensions.

This setup is sufficiently flexible to describe different board structures. For example, the presence of the CEO on the board could be captured by assuming that one of the directors has a large directional bias, has a small conformity bias, is particularly informed ($\mathbb{E}x_i^2$ is high relative to $\mathbb{E}x_j^2$), and is more influential than other directors (p_i is high in the extension of Section 3).[16]

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[16] When $r_i < 0$, this framework captures a preference for disagreeing, when a director derives utility from taking a contrarian position. The effect of such preferences is discussed in note 24. In addition, in Section 5.6, I analyze a generalized specification with weight $w(r_i)$ on the firm value term. Finally, the online Appendix analyzes more general preferences, where directors have reputational concerns and derive utility from taking the correct action even if the ultimate decision of the board is different. I show that such reputational concerns make directors' actions more efficient but reduce their incentives to share information.

Combined with the above specification for h, (4) implies that the director's utility is

$$U_i(a_1,...,a_N,\theta) = -\frac{1}{N}\sum_{k=1}^{N}(a_k-(b_i+\theta))^2 - \frac{r_i}{N-1}\sum_{k\neq i}(a_i-a_k)^2. \qquad (5)$$

1.2 Analysis of the benchmark case

Throughout the paper, the solution concept is perfect Bayesian equilibrium (PBE).

Let $a_i(I_i)$ be the action of director i given his information set I_i at the beginning of the decision-making stage. By (5), this action is determined by the first-order condition

$$a_i(I_i) = \frac{1}{1+Nr_i}\left(\mathbb{E}[\theta|I_i]+b_i\right) + \left(1 - \frac{1}{1+Nr_i}\right)\mathbb{E}[\bar{a}_{-i}|I_i], \qquad (6)$$

where $\bar{a}_{-i} = \frac{1}{N-1}\sum_{j\neq i}a_j$. If there are no biases in the director's preferences ($r_i = 0$ and $b_i = 0$), his action is $a_i(I_i) = \mathbb{E}[\theta|I_i]$, which is his best estimate of the state of the world. The presence of biases introduces distortions into the director's behavior. A conformity bias gives him an incentive to mimic the actions of other directors. In particular, when $r_i > 0$ and $b_i = 0$, the director tries to balance his desire to maximize firm value and his desire to conform to other directors. The weight $\frac{1}{1+Nr_i}$, attached to his best estimate of the state, decreases as the director's conformity bias becomes larger. The presence of a directional bias introduces an additional distortion, inducing the director to pursue the decision $\mathbb{E}[\theta|I_i]+b_i$ instead of $\mathbb{E}[\theta|I_i]$.

Because there is no communication in the benchmark case, director i only knows his own signal x_i. Hence, $\mathbb{E}[x_j|I_i] = 0$ for $j \neq i$ by the independence assumption, and $\mathbb{E}[\theta|I_i] = x_i$.

I now show that there is a unique linear equilibrium of the game. Suppose that a linear equilibrium exists—that is, a_i is linear in the director's signal: $a_i = \gamma_i x_i + g_i$. Plugging in the conjectured strategies of other directors in the first-order condition (6), we get:

$$a_i = \frac{1}{1+Nr_i}x_i + \frac{1}{1+Nr_i}b_i + \left(1 - \frac{1}{1+Nr_i}\right)\bar{g}_{-i}, \qquad (7)$$

where $\bar{g}_{-i} = \frac{1}{N-1}\sum_{j\neq i}g_j$. Thus, the best response strategy of director i is indeed linear in his signal. Comparing the coefficients, we see that γ_i is equal to $\frac{1}{1+Nr_i}$, and g_i is defined by a system of linear equations:

$$g_i = \frac{1}{1+Nr_i}b_i + \left(1 - \frac{1}{1+Nr_i}\right)\bar{g}_{-i}. \qquad (8)$$

Lemma A.2 in the Appendix shows that (8) has a unique solution given by (15) below. In particular, $g_i = b_i$ if $r_i = 0$, and $g_i = 0$ if $b_i = 0$ for all i. We conclude

that there is a unique linear equilibrium:

$$a_i^* = g_i + \frac{1}{1 + Nr_i} x_i. \tag{9}$$

If there are no biases in directors' preferences ($r_i = b_i = 0$ for all i), then $a_i^* = x_i$. However, even if information about the state is known to the board as a whole ($\varepsilon \equiv 0$), the board does not make the first-best decision $\sum x_i$ because each director only knows his own signal x_i. This inefficiency captures the assumption that the decision-making stage alone does not efficiently aggregate directors' signals and hence communication improves board decisions. In particular, (3) implies that for $\varepsilon \equiv 0$, the first-best is achieved if and only if each director takes action $\sum x_i$, a necessary condition for which is that all directors have shared their information with others.[17]

The presence of biases introduces additional inefficiencies:

1. Only conformity biases. If directors have conformity biases but no directional biases ($r_i > 0, b_i = 0$), then $a_i^* = \frac{1}{1 + Nr_i} x_i$. Thus, a conformity bias induces a director to put less than optimal weight on his private signal. In the extreme case, when r_i is infinitely large, the director does not care about the correct decision being made and wishes only to deviate as little as possible from other directors. Because the expected value of other directors' signals is zero, the director takes action $a_i^* = 0$. Hence, in this case, his private information never affects the board's decision.

2. Only directional biases. If directors have directional biases but no conformity biases ($b_i \neq 0, r_i = 0$), then $a_i^* = b_i + x_i$. The presence of a directional bias induces the director to push the board's decision in the direction of his bias, moving it farther away from the optimal decision from shareholders' perspective.

To summarize, in the absence of communication, both conformity and directional biases impede decision-making by distorting directors' actions at the decision-making stage.

2. Communication Prior to Decision-Making

This section introduces a communication stage prior to the decision-making stage. It starts with the setup of the communication stage and then presents the analysis. To illustrate the results more clearly, I first analyze the setting where directors have only conformity biases (Section 2.2), and then generalize the results to the setting where both types of biases are present (Section 2.3).

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[17] Note that directors' actions reveal information about their signals. However, the decision-making rule h is interpreted as a binding rule that matches directors' actions to the final decision, i.e., as an analog to majority voting. Since the rule is binding, I do not allow the social planner to use the information revealed through directors' actions to change the board's decision after the decision-making stage.

2.1 Communication stage

Factors such as CEO power, time constraints, and reputational concerns make it personally costly for directors to communicate their position openly and effectively. In addition, communication may require time and effort due to directors' diverse preferences and backgrounds. If a director's preferences are not aligned with those of other board members, he has incentives to misrepresent information. This inhibits communication (Crawford and Sobel 1982) and requires the director to expend effort to make his report more credible (see Section 5.3 for an additional discussion). Even if preferences are aligned, directors' diverse backgrounds and expertise, together with their complex and multidimensional information, may require additional effort to make communication effective. For example, it can be difficult for a director with a marketing background to convey his knowledge of the product market to directors with financial expertise. Dewatripont and Tirole (2005), who also study costly communication, point out that the sender needs to address receiver-specific knowledge and make his report both detailed enough to convey all relevant information and concise enough so as not to distract attention. They illustrate communication costs in the context of academic presentations and journal submissions and interpret them as the costs of transforming soft information into hard.

I model these different types of communication costs in the simplest possible way. Specifically, I assume that at the communication stage, each director simultaneously decides whether to incur a cost c_i to convey his signal to others. If the director incurs the cost, other directors learn x_i with certainty.[18] Directors can withhold their information but cannot lie—that is, information is verifiable. Generally, the literature uses two approaches to model communication. One approach, started by Grossman (1981) and Milgrom (1981), assumes that agents cannot lie. The other, started by Crawford and Sobel (1982), assumes that agents can lie without incurring any penalties. Actual board communication lies somewhere in between these two extremes: some misrepresentation is possible, but significant misrepresentation is likely to result in reputational penalties or other costs.[19] I adopt the first approach because it is more tractable and allows me to demonstrate the intuition in the simplest way, and discuss the robustness of the results to allowing for information manipulation in Section 5.3.

A fixed cost c_i is a reasonable way to capture direct costs of communication—that is, the time and effort needed to present information effectively. Other communication costs, coming from the director's reputational concerns and his reluctance to alienate the CEO, are likely to depend on the director's signal: these costs are likely to be higher if the signal is extreme and deviates

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[18] The benchmark case corresponds to $c_i = \infty$ for all i. The assumption that directors communicate simultaneously and disclose their signals to the whole board is made for simplicity. This assumption is standard in models of committee decision-making (Coughlan 2000; Austen-Smith and Feddersen 2005).

[19] Cornelli, Kominek, and Ljungqvist (2013) discuss the use of hard vs. soft information in board decisions.

significantly from the position of the CEO. For simplicity, the basic model captures these costs in a reduced-form way, together with direct costs of communication. Section 5.2 discusses a more general modeling of these costs and why the results are robust to this assumption.[20]

As will become clear below, the main results of the paper rely on the assumption that directors' communication costs are strictly positive. Only in this case can conformity and directional biases have a positive effect on board decisions by encouraging communication. In contrast, as the following lemma shows, when $c_i \leq 0$, directors always disclose their information, and hence the quality of board discussions is not affected by these biases.

Lemma 1. If $c_i \leq 0$, director i always reveals his signal.

From now on, I assume $c_i > 0$ and discuss the case $c_i \leq 0$ at the end of Sections 2.2 and 2.3.

2.2 Conformity biases
The analysis begins with the case in which directors have only conformity biases: $r_i \geq 0$, $b_i = 0$. To find the PBE, the model is solved by backwards induction. Let $J_C \subseteq \{1,...,N\}$ be the set of signals that were communicated at the first stage and $J_{NC} = \{1,...,N\} \setminus J_C$ be the set of signals that were not communicated. Either of the sets could be empty. Suppose also that given the equilibrium strategies at the communication stage, the expected value of director i's signal conditional on it not being communicated is y_i.

2.2.1 Equilibrium at the decision-making stage. Let us search for linear equilibria at the decision-making stage. In a linear equilibrium, the action of director i is some linear function of signals x_j, $j \in J_C$ that were communicated, and his private signal x_i. Similarly to the benchmark case, using (6), it can be shown that there is a unique linear equilibrium, characterized by the following proposition.

Proposition 1. Suppose that at the communication stage signals $x_i, i \in J_C$ were communicated, signals $x_i, i \in J_{NC}$ were not communicated, and y_i is the expected value of x_i conditional on no communication. Then there is the following linear equilibrium at the decision-making stage:

1. If director i communicated his signal, $i \in J_C$, his action is given by

$$a_i^* = \sum_{j \in J_C} x_j + \sum_{j \in J_{NC}} y_j. \tag{10}$$

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[20] When a director takes the time to explain his position to others, he not only incurs a cost himself, but may also impose a cost on other directors. Introducing the costs of receiving information would affect directors' equilibrium utility, but would not change the equilibrium strategies and firm value. This is because communication decisions are made simultaneously and directors care only about other directors' actions, not about other directors' utility.

2. If director i did not communicate his signal, $i \in J_{NC}$, his action is given by

$$a_i^* = \sum_{j \in J_C} x_j + \sum_{j \in J_{NC}, j \neq i} y_j + \frac{1}{1+Nr_i} x_i + \left(1 - \frac{1}{1+Nr_i}\right) y_i. \quad (11)$$

The intuition is the following. First, if director i did not communicate his signal ($i \in J_{NC}$), other directors' actions will be based on the expectation of his signal, y_i. Indeed, according to (10) and (11), all directors except i put weight 1 on y_i. As in the benchmark case, a conformity bias then induces the director to put less than optimal weight on his private signal to move his action closer to other directors' actions. This is captured by the last two terms in (11): instead of using x_i with weight 1, as would be optimal from shareholders' perspective, the director uses a weighted average of his signal, x_i, and the expectation of his signal by others, y_i. Second, consider a director who communicated his signal ($i \in J_C$). By communicating, the director made other board members fully internalize his information and use it in their decisions. Indeed, as (10) and (11) show, all other directors now put weight 1 on x_i. As a result, even though director i still has a conformity bias, conformity no longer induces him to underreact to his information. By using his signal x_i with optimal weight 1, the director minimizes the expected difference of his action from other directors' actions. Thus, signals that were communicated are used efficiently by all directors.

2.2.2 Equilibrium at the communication stage. At the communication stage, each director takes into account the equilibrium strategies at the decision-making stage and compares his expected payoff from paying the cost c_i to communicate his signal to others and the expected payoff from not communicating. The following proposition characterizes the equilibrium communication strategies.

Proposition 2. There exists an equilibrium in which director i communicates his signal x_i if and only if $|x_i| > d_i$, where

$$d_i = \left(\frac{c_i}{1 - \frac{1}{N}\frac{1}{1+Nr_i}}\right)^{1/2}. \quad (12)$$

Due to the symmetry of density functions $f_i(\cdot)$ around zero and because directors do not have directional biases, the noncommunication intervals $[-d_i, d_i]$ are symmetric around zero, and hence $y_i = 0$. In the Appendix, I prove that if the distribution of signals is single-peaked at zero (e.g., normal), the equilibrium of Proposition 2 is unique.[21]

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[21] For a general distribution, there may be multiple equilibria. Importantly, the result that conformity at the decision-making stage encourages communication holds in any chosen equilibrium. Multiple equilibria can arise if the

The intuition behind the threshold strategies is the following. A director does not have incentives to incur communication costs if his signal is close to its expected value ($|x_i| < d_i$) because such disclosure is not valuable for decisions. In contrast, because the director cares about firm value, he wants others to take his signal into account if the signal is sufficiently extreme, and hence incurs the costs of communication. This argument is valid regardless of whether or not directors have conformity biases.

Importantly, conformity biases give directors additional incentives to share their signals: d_i decreases in r_i. To see the intuition, let us interpret directors' actions as votes. Absent pressure for conformity during the vote (e.g., if voting is by closed ballot), a director who does not share his information with others will still vote based on this information and hence will affect the outcome with his vote. However, when the director faces pressure to conform his vote to others' (e.g., if voting is by open ballot), he is reluctant to vote based on his information unless he communicated it to others and convinced them of his position (see (10) and (11)). Hence, unless the director communicates his information to others, this information will not be incorporated into the board's decision. Because the director wants the correct decision to be made, he now has stronger incentives to incur the costs of communication.[22]

Put less formally, when there is no pressure for conformity, the only benefit to the director of communicating his information is that he makes other directors' votes, and hence the ultimate decision, more informed. Pressure for conformity creates an additional benefit of communication. By convincing others of his position, the director ensures that his vote will be similar to other directors' votes and hence avoids the costs of dissent.

Using the equilibrium strategies, one can calculate the expected value of the firm:

Lemma 2. Expected firm value is equal to

$$\mathbb{E}(V) = V_0 - \mathbb{E}\varepsilon^2 - \sum_{i=1}^{N}\left[1 - \frac{1}{N} + \frac{1}{N}\left(\frac{Nr_i}{1+Nr_i}\right)^2\right]\left[\int_{-d_i}^{d_i} x^2 f_i(x)dx\right]. \quad (13)$$

Recall that V_0 is the maximum possible firm value, which would be achieved if the board made the fully informed decision $\theta = \sum_{i=1}^{N} x_i + \varepsilon$. The negative

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distribution has several points of symmetry. For example, for a uniform distribution, which is symmetric around any point, there is a continuum of equilibria characterized by $y_i \in [-k_i + d_i, k_i - d_i]$. The intuition behind the multiplicity of equilibria is similar to why there exist multiple self-fulfilling equilibria in rational expectations models. The director does not have incentives to reveal his signal if it is close to others' expectations conditional on no communication (rather than their unconditional expectation, which is zero). Thus, if other directors believe that conditional on no communication the expected value of x_i is y_i, these expectations become self-fulfilling.

[22] This result does not rely on the assumption that signals are independent. As long as the correlation between signals is not perfect, conformity induces a director to put less than optimal weight on his signal unless it is communicated to others. Hence, by the same argument, conformity gives directors more incentives to convince others of their position. The main difference between models with independent and correlated signals is that correlation would give rise to a free-rider problem in communication: directors would have weaker incentives to incur the costs, hoping that other directors with similar information would disclose it.

terms in (13) reflect the fact that the board's decision is not fully informed. The term $\mathbb{E}\varepsilon^2$ captures the fact that part of θ is not known to any director. Subsequent terms capture the fact that directors' private signals are not used efficiently, either due to lack of communication or due to conformity. Specifically, (13) emphasizes that there are two counteracting effects of the director's conformity bias r_i on firm value. The negative effect is reflected in the term $1 - \frac{1}{N} + \frac{1}{N}(\frac{Nr_i}{1+Nr_i})^2$: if the director did not communicate his signal, conformity decreases the weight he puts on this signal at the decision-making stage. The positive effect is reflected in the term $\int_{-d_i}^{d_i} x^2 f_i(x)dx$: a stronger conformity bias encourages communication and shrinks the noncommunication region $[-d_i, d_i]$. The next result shows that in the current setting, the positive effect dominates for a sufficiently small conformity bias.

Proposition 3. Suppose $0 < c_i < k_i^2(1 - \frac{1}{N})$, where $[-k_i, k_i]$ is the support of $x_i, k_i \in (0, +\infty]$. Then firm value is maximized at $(r_1^*, ..., r_N^*)$, where r_i^* is strictly positive.[23]

Intuitively, since directors disclose the most important information ($|x_i| > d_i$), the tradeoff of a higher r_i is between more efficient use of more important information by all directors and less efficient use of less important information by only one director, which explains why the positive effect can dominate.[24]

The assumption of positive communication costs is crucial for Proposition 3. As shown in Lemma 1, if $c_i \leq 0$, director i always reveals his signal, and hence r_i does not affect the communication and decision-making stages. As a result, conformity biases have no effect on firm value.

The assumption that the decision rule inefficiently aggregates directors' information is not needed for the result that conformity biases improve communication (see the online Appendix, which analyzes all linear decision rules, including efficient ones). It is important only for the result of Proposition 3 that the optimal conformity biases are positive. This is because communication, which is encouraged by conformity biases, is helpful only when the decision rule is inefficient.

2.3 Conformity and directional biases
This section studies the joint effect of directors' conformity and directional biases.

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[23] The assumption $c_i < k_i^2(1 - \frac{1}{N})$ ensures that the communication cost is not too high relative to the support of the distribution $[-k_i, k_i]$ and is satisfied for any distribution with infinite support. If this condition is not satisfied, the director does not communicate any information when $r_i = 0$.

[24] The analysis also illustrates the effect of preferences for disagreeing with others, which can be captured by $r_i < 0$. By (11), if $r_i < 0$, the director overweighs his private signal in his decisions. Moreover, unlike the case of conformity, there is no counteracting positive effect of contrarian preferences on communication. In fact, (12) shows that contrarian preferences induce a director to withhold his signal, so that his actions are more likely to be different from those of the rest of the board.

Let $a_i^*(b_1, ..., b_N)$ be the equilibrium action of director i at the decision-making stage. Lemma A.1 in the Appendix shows that for any distribution of signals,

$$a_i^*(b_1, ..., b_N) = g_i + a_i^*(0, ..., 0), \qquad (14)$$

where $a_i^*(0, ..., 0)$ are the equilibrium strategies in the absence of directional biases, given by (10) and (11), and the constants g_i solve the system of linear equations (8). Lemma A.2 in the Appendix shows that this system has a unique solution given by

$$g_i = \sum_{j=1}^{N} \lambda_{ij} b_j, \qquad (15)$$

where $\lambda_{ii}, \lambda_{ij} \in (0, 1)$ if $r_i > 0$, and $\lambda_{ii} = 1, \lambda_{ij} = 0$ if $r_i = 0$. For example, if $r_i = r$ for all i, the solution is given by $g_i = \omega b_i + (1 - \omega) \bar{b}_{-i}$, where $\omega = \frac{N - 1 + Nr}{N - 1 + N^2 r}$.

Directional biases introduce distortions g_i in directors' actions. According to (15), g_i is a weighted average of the director's own directional bias b_i and the biases of other directors b_j, $j \neq i$. First, g_i strictly increases in b_i: the director biases his actions in the direction of his preferred outcome. In the special case when $r_i = 0$, g_i coincides with b_i. If, in addition, the director has a conformity bias ($r_i > 0$), g_i also strictly increases in other directors' biases b_j, $j \neq i$. Intuitively, if other directors are known to favor a certain decision, a director who cares about conformity is more reluctant to oppose this decision.

This suggests that when directors' private interests are diverse, there is an additional benefit from pressure for conformity at the voting stage: it helps constrain opportunistic behavior. Absent pressure for conformity ($r_i = 0$), directors vote in a way that maximizes their own interests ($g_i = b_i$). Hence, the final decision, which is the preferred decision of the strongest group, is far from the optimal decision from shareholders' perspective. Conformity induces directors to be more cautious in pursuing their individual interests, moving the board's decision closer to the optimal decision. For example, in the case of two directors, if $r_1 = r_2 = r$ and $b_1 = -b_2$, distortions (g_1, g_2) are the highest for $r = 0$ and converge to zero as r increases.

In contrast, pressure for conformity can be detrimental when directors' private interests are not diverse. In particular, conformity can induce independent directors, who would otherwise make unbiased decisions, to favor the policies preferred by their opportunistic colleagues: if $r_i > 0$ and other directors have positive directional biases, then $g_i > 0$ even if $b_i = 0$.

I next analyze the communication stage. Because the model with directional biases is less tractable, I assume for the rest of the paper that the distribution of signals is uniform and discuss the general distribution at the end of the section. Lemma A.3 in the Appendix analyzes a general distribution.

Assumption 1. Signal x_i is uniformly distributed on $[-k_i, k_i]$.

The following lemma summarizes the equilibrium at the communication stage.

Lemma 3. The equilibrium communication strategies are the following:

  (i) if $b_i > \bar{g}_{-i}$, director i reveals his signal if and only if $x_i > -k_i + 2\delta_i^+$,
  (ii) if $b_i < \bar{g}_{-i}$, director i reveals his signal if and only if $x_i < k_i + 2\delta_i^-$,

where $\bar{g}_{-i} = \frac{1}{N-1}\sum_{j\neq i} g_j$ and $\delta_i^- < 0 < \delta_i^+$ are the roots of the quadratic equation

$$\delta^2 + 2\delta(b_i - \bar{g}_{-i}) - \frac{c_i}{1 - \frac{1}{N}\frac{1}{1+Nr_i}} = 0. \tag{16}$$

Thus, in the presence of directional biases, communication strategies are no longer symmetric around zero. A director who is biased relative to the rest of the board ($b_i > \bar{g}_{-i}$) reveals information that supports his bias ($x_i > -k_i + 2\delta_i^+$) and withholds information that does not support his bias.[25] The next result shows that when communication is costly, directional biases can have a positive effect on communication:

Proposition 4. If director i is more biased than other directors, $b_i > \bar{g}_{-i}$, then he reveals more information as his bias b_i increases further. Similarly, if the director is less biased than other directors, $b_i < \bar{g}_{-i}$, then he reveals more information as his bias b_i decreases further.

To illustrate the intuition, I will refer to the example of a target's board deciding on the minimum acceptable price. In this example, a director with bias $b_i > 0$ gets private benefits from keeping the firm independent and hence prefers to set a higher minimum price than is optimal for shareholders. Suppose a director is more biased than other board members toward keeping the target independent ($b_i > \bar{g}_{-i}$). Then he discloses positive information about the target's value whenever he has it (whenever $x_i > T_i \equiv -k_i + 2\delta_i^+$). Thus, if the director does not speak up, other directors infer that his information is negative, $x_i < T_i$. When $x_i = T_i$, the director is indifferent between incurring the costs of communication and convincing others that $x_i = T_i$ and letting them make the more negative inference $\mathbb{E}[x_i | x_i < T_i]$. The more biased is the director relative to other board members, the more he wants them to believe that the target's value

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[25] This property would continue to hold if a director received multiple signals and could selectively disclose part of them. The director would disclose signals that support his bias and withhold signals that do not support his bias. In addition, he would be more likely to disclose two signals together if these signals reinforce, rather than contradict, each other. Disclosure in the presence of multiple signals has been examined by Fishman and Hagerty (1990) and Pae (2005) in the context of disclosure by a single agent to investors.

Note also that if the cost of communication is large relative to k_i, then $-k_i + 2\delta_i^+ > k_i$ and $k_i + 2\delta_i^- < -k_i$, and hence the director does not communicate any information in equilibrium. In what follows, I assume that c_i is sufficiently small relative to k_i, so that at least some information is communicated by each director.

is high. Hence, if b_i increases further, the director is no longer indifferent: the inference $\mathbb{E}[x_i|x_i < T_i]$ becomes relatively more harmful for him. At the margin, this induces the director to disclose more information, decreasing the threshold T_i. Importantly, an increase in a director's bias improves communication only if it further increases the conflict of interest between him and the rest of the board. This shows the importance of diversity in directors' private interests, discussed in more detail below.[26]

Proposition 4 contrasts the result of the cheap talk literature that conflicts of interest between the sender and receiver impede communication (e.g., Crawford and Sobel 1982). While the current setup differs from cheap talk models in two respects, communication costs and verifiable information, communication costs are key to the result that conflicts of interest improve communication. Section 5.3 discusses how introducing cheap talk communication would affect the equilibrium.

Lemma A.4 in the Appendix shows that expected firm value is given by

$$\mathbb{E}(V) = V_0 - \mathbb{E}\varepsilon^2 - \frac{1}{N}\sum_{i=1}^{N} g_i^2 - \sum_{i=1}^{N}\left[1 - \frac{1}{N} + \frac{1}{N}\left(\frac{Nr_i}{1+Nr_i}\right)^2\right]\int_{t_i}^{T_i}(x_i - y_i)^2 f_i(x_i)dx_i, \quad (17)$$

where $[t_i, T_i]$ is the interval of signals that are not communicated, and y_i is the expected value of the signal conditional on no communication, $y_i = \mathbb{E}[x_i|x_i \in [t_i, T_i]]$. By Lemma 3,

$$[t_i, T_i] = \begin{cases} \left[-k_i, -k_i + 2\delta_i^+\right] & \text{, for } i \text{ such that } b_i > \bar{g}_{-i}, \\ \left[k_i + 2\delta_i^-, k_i\right] & \text{, for } i \text{ such that } b_i < \bar{g}_{-i}. \end{cases} \quad (18)$$

Expression (17) illustrates the twofold effect of directional biases on firm value. At the decision-making stage, directional biases distort directors' actions, moving the board's decision away from the optimal decision from shareholders' perspective. This effect is represented by the term $-\frac{1}{N}\sum_{i=1}^{N} g_i^2$. In addition, directional biases affect the incentives to reveal information. This is reflected by the term $\int_{t_i}^{T_i}(x_i - y_i)^2 f_i(x_i)dx_i$, which measures the variance of signal x_i over the noncommunication interval $[t_i, T_i]$. As Proposition 4 shows, a stronger directional bias relative to other members encourages the director to communicate his signal, shrinking $[t_i, T_i]$ and increasing firm value. The next result shows that this positive effect can dominate:

Proposition 5. Consider any $(r_1, ..., r_N)$.

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[26] Although the results were derived for a uniform distribution of signals, the intuition is valid for a general distribution. Consider any distribution that is symmetric and single-peaked around zero. Lemma A.3 in the Appendix shows that there exist thresholds t_i, T_i, such that signal x_i is disclosed if and only if $x_i \notin [t_i, T_i]$. As previously, positively biased directors are more likely to disclose positive signals and vice versa. In particular, if $b_i > \bar{g}_{-i}, [t_i, T_i]$ is shifted to the left of zero, so that $\Pr(x_i \text{ is disclosed } | x_i > 0) > \Pr(x_i \text{ is disclosed } | x_i < 0)$. As b_i increases further, both t_i and T_i decrease. However, if the support of the distribution is finite and communication costs are sufficiently small, the communication strategy is boundary: $t_i = -k_i$. Hence, a further increase in the director's bias b_i improves communication, as for a uniform distribution.

(i) Suppose that $b_2 = ... = b_N = 0$. Then firm value is maximized at $b_1 = \pm b$, where $b > 0$.

(ii) Suppose $b_i = b$ for $i \leq i_0$ and $b_i = -b$ for $i > i_0$, where $1 \leq i_0 \leq N - 1$. Then firm value is higher for $b > 0$ than for $b = 0$ if b is sufficiently small.

Part (i) shows that even if $N - 1$ directors are unbiased, firm value is higher if the remaining director is biased than if he is unbiased. Part (ii) shows that a board that consists of directors whose directional biases are in opposite directions can be more effective than an unbiased board. For example, consider the board of a target. Part (ii) suggests that a fully independent board, in which all directors maximize shareholder value, may be less efficient than a board that includes both insiders, who are biased against the takeover, and bidder representatives, who are biased in its favor. The reason is that the two groups with conflicting interests have strong incentives to reveal information and convince others of their position, allowing the board as a whole to make more informed decisions.[27]

Proposition 5 relies on the assumption of positive communication costs. As shown in Lemma 1, if $c_i \leq 0$, director i always reveals his signal, and hence the only effect of his directional bias is to distort his decision-making behavior. Thus, if $c_i \leq 0$, directional biases negatively affect firm value.

3. Extension: Optimal Allocation of Control

In practice, some directors have more control over decisions than others. Examples include members of board committees, the board chairman, and the lead director. This section shows that the presence of communication costs has implications for the allocation of control among directors. The key factors determining the optimal allocation of control will be the amount of communication and effective use of directors' information. Hence, this section is related to the literature on optimal allocation of control among insiders and outsiders given the tradeoff between communication and independence (Adams and Ferreira 2007; Harris and Raviv 2008; Chakraborty and Yilmaz 2011). However, the tradeoff in my paper is different from the tradeoff in this literature since it is based on costly communication and no conflicts of interest.

To capture differential decision-making power, suppose that the board's decision equals a_i with probability p_i, where $\sum_{i=1}^{N} p_i = 1$, $p_i \geq 0$. Higher p_i corresponds to greater decision-making power. For example, if $p_i = 1$, director i is the sole decision-maker. To focus on the allocation of control, I assume

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[27] It is plausible that biased directors may discourage others from revealing information that does not support their bias. This possibility would amplify the result that diversity in preferences improves communication. Indeed, if insiders discourage others from revealing positive information about firm value, this can be counteracted by including bidder representatives, who encourage communication of positive information and discourage communication of negative information. In contrast, if all directors except insiders are unbiased, there is no counteracting effect, and communication is reduced.

that directors have only conformity biases. It is likely that when a director is very influential, other directors are particularly reluctant to deviate from him. To capture this, suppose that director i's utility is

$$U_i(a, a_1, ..., a_N, \theta) = -(a - \theta)^2 - r_i \sum_{k \neq i} \tilde{p}_k^i (a_i - a_k)^2, \qquad (19)$$

where $\tilde{p}_k^i = \frac{p_k}{1 - p_i}$ reflects the relative weight of director k among the remaining directors.

Lemma A.1 in the Appendix shows that the equilibrium action of director i at the decision-making stage is given by (10) for directors who communicated their signals, and by

$$a_i^* = \sum_{j \in J_C} x_j + \sum_{j \in J_{NC}, j \neq i} y_j + \frac{p_i}{p_i + r_i} x_i + \left(1 - \frac{p_i}{p_i + r_i}\right) y_i \qquad (20)$$

for directors who did not communicate their signals. At the communication stage (see Lemma A.3 in the Appendix), director i reveals his signal if and only if it satisfies

$$|x_i| > d_i = \left(\frac{c_i}{1 - \frac{p_i^2}{p_i + r_i}}\right)^{1/2}, \qquad (21)$$

and hence $y_i = 0$. The greater the director's control over the decision, the less effort he makes to communicate his information (d_i increases with p_i). For example, if $r_i = 0$, the director who has full control ($p_i = 1$) does not share any information. To see the intuition, suppose that the decision is binary (whether to accept or reject a proposal) and the director has a majority of the votes. Such a director has no need to communicate his information to the rest of the board: by voting according to his information, he ensures that it is fully incorporated into the final decision. In contrast, if a director does not participate in the vote ($p_i = 0$), his information will affect the board's decision only if he manages to convince the voting directors of his position.

I next study the optimal allocation of control between directors. In particular, I ask which vector $(p_1, ..., p_N)$ maximizes firm value among all vectors such that $\sum_{i=1}^N p_i = 1$, $p_i \geq 0$. For simplicity, consider the uniform distribution of signals. The following result shows that even if directors are identical, allocating full control to one director can be optimal.

Proposition 6. Suppose that all directors are identical: x_i is uniform on $[-k, k]$, $c_i = c$, and $r_i = 0$ for all i. Then firm value is maximized when one director has full decision-making power—that is, when $p_{i_0} = 1$ for some i_0 and $p_i = 0$ for $i \neq i_0$.

Intuitively, when control is allocated to one director, the final decision aggregates directors' signals most efficiently. By (21), directors without voting

power (with $p_i = 0$) have stronger incentives to communicate their signal to the director in control than if they had voting power. The director in control then efficiently aggregates all disclosed information to make the decision. Thus, since the board's decision-making rule is inefficient (see Definition 1), signals that are disclosed to the decision-maker are used more efficiently than if all directors participated in the vote but did not share their signals with others. The downside of allocating control to one director is that signals that are not disclosed to the decision-maker have no effect on the final decision. However, because directors reveal the most valuable signals ($|x_i| > d_i$), the tradeoff is between more efficient use of more valuable information and less efficient use of less valuable information, and the positive effect dominates. Numerical analysis shows that Proposition 6 also holds when $r_i = r > 0$.

Another interesting question is which director should be given control when directors are heterogeneous. One important factor is directors' expertise. To abstract from the effect of expertise, I assume that directors' signals have the same distribution and instead focus on heterogeneity in directors' conformity biases.

Proposition 7. Suppose that directors are identical in all respects except their conformity biases: x_i is uniform on $[-k, k]$, $c_i = c$. If control is allocated to one director—that is, $p_i = 1$ for some i—then firm value is maximized when control is given to the director with the smallest conformity bias: $i \in \arg\min_j \{r_j\}$.

Intuitively, a director who cares the least about conformity makes the most unbiased decisions without worrying about others' opinions of his actions.

4. Implications

This section presents the implications of the analysis. It starts with policy implications and then describes empirical predictions and relevant evidence.

4.1 Policy implications
4.1.1 Open versus secret ballot voting and other policies that affect conformity. Directors' conformity biases can be strengthened or weakened by the adoption of certain decision-making policies. One such policy is the choice between open and secret ballot voting. The open ballot system intensifies pressure for conformity because the dissenting director's vote is observed by other directors and the CEO. In particular, suppose that the firm adopts director voting by open ballot but does not change any other policies or directors' compensation contracts. It will then become more costly for a director not to conform to the vote of the majority for two reasons. First, voting in dissent is now more likely to worsen the director's position inside the firm due to retaliation from the manager and fellow board members and, as a consequence, smaller perks and lower chances of retaining the board seat. Second, it may affect the director's career outside the firm. In particular, having a reputation

of a trouble-maker may jeopardize the director's chances of being invited to other boards (for example, Marshall 2010 finds that the labor market does not reward directors for showing dissent). At the same time, a director's concern about firm value will not change: concern for firm value is mostly determined by the director's contract (e.g., amount of performance-based compensation), which is unaffected by the change in the voting policy.

Hence, in the context of the model, adoption of open ballot voting is likely to increase parameter r_i without affecting other parameters. Section 2.2 shows that stronger conformity biases have two counteracting effects on board decisions and firm value. On the one hand, they encourage pre-vote communication. On the other hand, if a director does not communicate his position to others, a conformity bias induces him to vote less honestly and rely on his information less. The tradeoff between these two effects suggests that the adoption of open ballot is more likely to have a positive effect on firm value in situations where communication between directors is more valuable.

One consideration is the nature of directors' information: whether information is objective and can be convincingly communicated, or whether it is subjective and reflects differences of opinion. When information reflects a director's opinion rather than objective evidence, the director is less likely to change other directors' actions by sharing his information with them. Thus, communication has less value, and the use of secret ballot could be preferred because it would allow more efficient aggregation of directors' diverse opinions in the vote.

Another consideration is the type of decision on the agenda. Schwartz-Ziv and Weisbach (2013) classify board decisions into "managerial" and "supervisory." When the board is making a managerial decision, such as choosing the scale of investment or setting the acquisition price, it usually needs to choose the best alternative among many. In contrast, in supervisory decisions, the board mostly needs to approve or reject a given proposal presented by the management. To the extent that information sharing between directors is more important when the board chooses among many alternatives, open (secret) ballot voting may be preferred for managerial (supervisory) decisions.

Finally, another relevant factor is board structure, and in particular how diverse directors' private interests are. As Section 2.3 demonstrates, pressure for conformity (due to open ballot) is beneficial when directors' interests are diverse—for example, when there are two groups of directors with conflicting interests, such as insiders and bidder representatives on the target's board. In contrast, secret ballot would be preferred when interests are not diverse—for example, when the board consists of biased insiders and independent directors maximizing shareholder value.

In addition to the choice between open and secret ballot, there are other policies that affect conformity at the voting stage. One such policy is whether the CEO is present at the vote. Indeed, an important reason for conformity is directors' reluctance to oppose the CEO without support from other board

members. Thus, not allowing the CEO to be present at the vote (which is feasible if the CEO is not on the board or committee) is likely to weaken pressure for conformity.

Finally, transparency of board decision-making can also affect how strong conformity biases are. To increase pressure for conformity, a firm could publicly disclose the votes of its directors: knowing that their dissenting vote will be disclosed, directors who do not want to be perceived as trouble-makers may be more reluctant to oppose the majority. In China, for example, the law requires all listed firms to follow such a disclosure policy (see Section 4.2 for details about this law).

4.1.2 Executive sessions of outside directors. While open ballot voting encourages communication prior to the vote, a more direct way to improve discussions would be to reduce the costs of communication. One regulatory measure that could have reduced directors' costs of communicating outside board meetings is the requirement for regular executive sessions of outside directors without any management present, imposed on NYSE-, Amex-, and Nasdaq-listed companies in 2003. To see the effect of this requirement, note that in addition to the costs of time, discussions outside board meetings can impose another important cost—retaliation from the manager. Indeed, directors are likely to initiate such discussions if they have serious concerns about the manager, and thus, if information about such discussions is leaked, directors may strain their relationship with him. By making the meetings of outside directors mandatory, the 2003 requirement has eliminated the negative signaling role that such meetings had in the past. Consistent with this, NYSE corporate governance rules state that "regular scheduling of such meetings is important not only to foster better communication among non-management directors, but also to prevent any negative inference from attaching to the calling of executive sessions."

This argument has implications for the optimal frequency of executive sessions. Similarly to making these sessions mandatory, increasing their scheduled frequency is likely to reduce directors' communication costs. If executive sessions are scheduled frequently, a director can wait until the next session to voice his concerns and hence avoid initiating a meeting behind the manager's back. However, a higher frequency of executive sessions also involves a cost because it requires time commitment from outside directors. The tradeoff between these costs and benefits suggests that frequent executive sessions would be more valuable in firms where outside directors find it difficult to communicate outside executive sessions. First, these are firms where outside directors cannot openly communicate during the full board meeting, which is more likely when the outside directors are dependent on the CEO—for example, due to the presence of a board interlock or directors' business and social connections with the CEO. Second, these are firms where outside directors do not have other opportunities to communicate without raising suspicion from

the CEO—that is, firms with weak social and professional connections between their outside directors.

4.1.3 Delegation of decision-making power.
Section 3 shows that allocating decision-making power to a subset of directors can be optimal because it leads to more efficient use of directors' information. This result provides a rationale for the board to delegate decision-making authority over certain decisions to the manager and retain only an advisory role. When the board delegates decision-making authority, each director has strong incentives to communicate his position to the manager. The manager then incorporates the views of all directors and his own information in his final decision. As Proposition 6 shows, this can be more effective than if all directors had voting power.

This result also provides a rationale for the use of board committees. The standard rationale is that committees allow directors with relevant expertise to hold more detailed discussions. The above logic suggests that committees can be beneficial even if all directors have the same expertise.

Finally, Section 3 shows that if directors have similar expertise, it is efficient to allocate control to directors who care the least about conforming to others because such directors distort their actions the least. These considerations may be important for issues where pressure for conformity is particularly likely. Hence, this result is consistent with the listing requirement that the compensation, nominating, and audit committees, which are responsible for many controversial decisions, are composed entirely of independent directors. It is also consistent with the observed practices, where directors occupying leading positions, such as the chairman or lead director, are among the most experienced board members. Due to their stronger reputation, such directors are likely to have smaller conformity biases.

4.2 Empirical implications
This section discusses empirical predictions of the model and relevant anecdotal evidence.

As discussed in Section 4.1, a switch from secret to open ballot voting is likely to increase directors' conformity biases r_i without affecting other parameters of the model. According to Proposition 1, a higher r_i induces a director to put less than optimal weight on his private information if it was not revealed and to conform his actions to the expected actions of other directors. According to Proposition 2, a higher r_i also leads to more information being shared at the communication stage, which can be interpreted as communication prior to the vote and/or outside board meetings. Hence, the first prediction is as follows:

Prediction 1. All else equal, the open ballot system (compared to the secret ballot system) leads to: (i) more communication and dissent prior to the vote and outside board meetings; (ii) a higher likelihood of unanimous votes.

The evidence from board minutes in Schwartz-Ziv and Weisbach (2013) is consistent with this prediction. In their sample, all votes were conducted by open ballot. While active disagreement was common in pre-vote discussions, 97.5% of the votes were unanimous (see Section 6.5 of their paper). The interview evidence in Sapienza, Korsgaard, and Hoogendam (1997) also shows that split votes in board meetings are relatively rare. In contrast, consistent with the prediction, the discussion of most decisions in their sample took place outside board meetings. Similar evidence is presented in Stevenson and Radin (2009) and Rock (2004). The case illustrating the opposite dynamics for secret ballot voting occurred during a judge's election in Alaska (Vermeule 2010). All seven members of the election committee spoke in favor of a candidate during the discussion. However, during the subsequent secret ballot vote, the candidate was defeated by a vote of 4–3.

While previously the extent of disagreement between directors was hard to measure since the workings of the board were not observed, recent disclosure regulations have provided more access to these data. In 2004, the Chinese Securities Regulatory Commission required increased boardroom transparency in listed firms. Under the new law, if some independent directors vote in dissent, the firm must disclose the names of these directors in its annual report (Jiang, Wan, and Zhao 2012). In the United States, a somewhat similar 2004 SEC law requires firms to disclose if one of the directors leaves the board due to a disagreement (Marshall 2010; Agrawal and Chen 2011).

These disclosure laws are likely to have affected boardroom dynamics. Anecdotal evidence suggests that boards are very reluctant to expose any internal disagreements to the public. Since the laws required public disclosure of disagreements, they likely have strengthened pressure for conformity among directors—that is, in the context of the model, increased conformity biases r_i. Thus, similar to Prediction 1, Propositions 1 and 2 predict the following effects of disclosure laws:

Prediction 2. If votes of dissenting directors are publicly disclosed, then, all else equal: (i) there is more communication and dissent prior to the vote and outside board meetings; (ii) the vote is more likely to be unanimous.

The next prediction concerns the effects of communication costs. The analysis shows that when communication costs are lower, directors are more likely to agree with each other at the decision-making stage. Indeed, a lower c_i in the context of the model leads to more information being shared (Proposition 2) and, as a result, directors' actions being closer to each other (Proposition 1). In addition, since lower communication costs improve board discussions, the board's decisions incorporate directors' information more effectively and hence are more likely to increase shareholder value (according to Proposition 3, firm value decreases in d_i and hence in c_i).

Since communication outside board meetings has become increasingly common (Hart 2003), a good measure of communication costs are directors'

costs of communicating outside meetings. These costs are likely to be lower if directors are geographically closer to each other and if their social and professional ties are stronger. In contrast, busy directors—for example, those who hold several directorships—are less likely to find the time to communicate outside meetings. Hence:

Prediction 3. When outside directors are less busy, are geographically closer to each other, and their social and professional connections are stronger, then, all else equal: (i) outside directors are more likely to vote in unison with each other; (ii) the board's decisions are more informed and are better for firm value.

The evidence in Fich and Shivdasani (2006), which suggests that board effectiveness is lower when outside directors sit on many boards, is consistent with prediction (ii).

In addition to communicating outside board meetings, outside directors also communicate during executive sessions without the presence of any insiders. There is considerable variation in the frequency of executive sessions across firms. Some firms set a minimum annual number of executive sessions, ranging from one to four, while others include an executive session as part of every board meeting.[28] The implications about the optimal frequency of executive sessions discussed in Section 4.1 can help explain this variation. Assuming that firms set the frequency of executive sessions optimally, we would expect the following:

Prediction 4. Executive sessions of outside directors are, all else equal, more frequent in firms where: (i) there are stronger social and business ties between outside directors and the CEO; (ii) there are weaker social and business ties between outside directors.

Section 4.1 also discusses the choice between open and secret ballot voting. Although most boards use open ballot, some variation exists. For example, Swartz (2007) documents that 47 U.S. firms have passed a charter amendment that requires voting by secret ballot on certain issues. Assuming that voting rules are chosen optimally, the discussion in Section 4.1 predicts the following:

Prediction 5. Secret ballot voting is, all else equal, more likely to be used: (i) for decisions involving more subjective judgments and less objective arguments; (ii) for supervisory rather than managerial decisions; (iii) when directors' private interests are less diverse.

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[28] See Shearman & Sterling LLP, "2007 trends in corporate governance of the largest U.S. public companies: General governance practices," p. 25.

For example, secret ballot voting is sometimes used in the elections of the chairman and lead director.[29] Since information involved in these decisions is more subjective than objective, the use of secret ballot in these cases is consistent with prediction (i).

To test the above predictions, it is important to account for all potential confounding factors. First, one needs to control for relevant elements of the model that may affect the dependent variable. They include: (i) pressure for conformity in predictions 1–3 (for example, measured by the influence of the CEO); (ii) directors' costs of communicating outside board meetings in predictions 1–2 (for example, measured by directors' geographical proximity and social connections); (iii) directors' conflicts of interest in prediction 3; (iv) quality of directors' information in predictions 3–5. Some of these factors may be hard to measure. In addition, confounding variables can also include factors outside the model. For example, in the context of prediction 3, the company's industry, strategy, and director ability could affect both the effectiveness of the board and directors' busyness, location, and connections with each other. Ideally, the identification strategy would rely on exogenous variation in the variable of interest. For example, to establish the causal effect of outside directors' connections on board performance, one could use exogenous variation in directors' connections due to random assignment of HBS students to sections (Shue 2013).

5. Robustness and Discussion

5.1 Retaliation from the manager

An important reason for conformity in the boardroom is fear of CEO retaliation. Directors' preferences in the basic model do not incorporate this motive explicitly: a director is reluctant to deviate from others regardless of whether or not his vote goes against the CEO's position. In the online Appendix, I analyze two extensions of the model that capture directors' fear of the CEO and show the robustness of the results. In the first extension, a director suffers a loss if he is less supportive of the CEO relative to other directors, but does not suffer any loss if he is more supportive of the CEO than others. In other words, the conformity bias is "asymmetric": it arises only if the director votes against the CEO because it is costly to oppose the CEO without support from other board members. In the second extension, the CEO is one of the directors, and conformity biases are modeled as a reluctance to deviate from the CEO's position.

In both extensions, similarly to Proposition 3, some degree of conformity is beneficial for firm value due to its positive effect on pre-vote communication.

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[29] See, e.g., the 2007–2011 DEF 14A filings of The Travelers Companies, Inc., and the 2009 10-K filing of Activision Blizzard, Inc., Exhibit 99-1. See also "Mixed feelings on secret ballot v. consensus decisions," *Australian Financial Review*, August 8, 2009.

The intuition is the same as in the basic model. When pressure for conformity is strong (e.g., because voting is by open ballot), a director with negative information about the CEO or his preferred decision will not vote against the CEO unless he knows that other directors share his concerns. Thus, to be able to vote against the CEO without suffering retaliation, the director has strong incentives to convince others of his position by sharing his information prior to the vote. Because directors share their negative information with each other, they can be more effective in jointly opposing the CEO than if each of them acted individually based on his private information (as is more likely under secret ballot voting).

5.2 Fear of the CEO and conformity at the communication stage

In the current setup, communication costs are fixed and do not depend on the value of the signal. While such specification captures direct costs of communication, such as the costs of time and effort, other types of costs may depend on the information the director has. For example, it may be more costly to reveal information that conflicts with the CEO's view. Alternatively, if pressure for conformity exists at the communication stage as well, it may be more costly to reveal a signal that deviates from other directors' expected signals.[30]

Importantly, the intuition is robust to this assumption. In particular, for any given structure of communication costs $c_i(\cdot)$, stronger conformity *at the decision-making stage* improves communication. To see this, suppose that for a given signal x_i, a director is indifferent between communicating it at a cost $c_i(x_i)$ and not communicating. Suppose now that the costs of voting differently from other directors increase (e.g., if secret ballot voting is replaced by open ballot). As in the basic model, the director now has an additional benefit of revealing his signal because it allows him to avoid the costs of dissent during the vote. Hence, the director is no longer indifferent and strictly prefers to incur the costs of communication. Put differently, certain changes in decision-making procedures, such as those discussed in Section 4.1, allow to increase pressure for conformity at the voting stage without affecting the costs of communication and pressure for conformity at the communication stage, and thus allow to overcome inefficiencies during the discussion.

5.3 Information manipulation

The model assumes that directors' information is verifiable and cannot be manipulated. As the next discussion shows, the intuition is robust to this assumption.

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[30] Since the expected signal of each director is zero, conformity at the communication stage could be modeled by a function $c_i(\cdot)$ such that $c_i(x)$ increases with $|x|$. Similarly, if the CEO is biased toward higher actions (e.g., due to empire-building preferences if a corresponds to the amount of investment), communication costs coming from the fear of the CEO could be modeled by a decreasing function $c_i(\cdot)$.

First, allowing information manipulation would not affect the result that conformity biases encourage communication. To see this, note that the equilibrium of Section 2.2 would not change even if directors could misrepresent signals. Indeed, when directors do not have directional biases, they have incentives to report information truthfully since all board members share the objective of maximizing firm value.

Second, even if information is nonverifiable, a stronger conflict of interest with other board members will still increase a director's incentives to incur the costs of communication for the same reason as before: the inference upon no communication becomes more harmful for him as the conflict of interest increases. In addition, once information manipulation is allowed, this effect will be augmented by the standard result of the cheap talk literature that conflicts of interest prevent full communication. Either of these two effects can potentially dominate.

To see this in the simplest way, suppose that an additional, cheap talk, stage is added prior to the costly communication stage. At this initial stage, each director can convey his information at no cost, but not credibly. If such communication is not fully successful, the director can incur costly effort and credibly convey his information at the next stage. According to the cheap talk literature, a stronger directional bias increases the director's incentives to manipulate his report and thus inhibits communication during the cheap talk stage. In contrast, according to the results of this paper, a stronger bias increases the amount of information conveyed at the costly communication stage. The net effect can be either positive or negative. To see this, consider three cases. If directors' interests are perfectly aligned, there is full information revelation at the cheap talk stage. If conflicts of interest are very strong, no information is revealed at the cheap talk stage, but there is full information revelation at the costly communication stage (δ_i^+ in Lemma 3 converges to zero as $b_i - \bar{g}_{-i}$ increases). Finally, if conflicts of interest are in the intermediate range, only part of the information is revealed after the two stages.[31]

5.4 Uncertainty about preferences or information endowment

The results are robust to the assumption that directors' preferences are known. Suppose, for example, that directional biases are directors' private information. For simplicity, let a director's bias be $-b$ or b with equal probability, $b > 0$. Then, there exists a threshold $T_b > 0$ such that a director with bias b ($-b$) discloses his signal if it is above (below) T_b ($-T_b$). Hence, conditional on the director not revealing his signal, others infer that his signal is on average zero. A director with bias b and signal T_b is indifferent between letting others

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[31] I have also analyzed a setup in which at the communication stage, a director chooses whether to send a "cheap talk" message at no cost or incur a cost c_i to convey his signal credibly. Conflicts of interest can encourage communication in this setup as well: a small increase in conflicts of interest both increases the set of signals that are conveyed credibly and increases the informativeness of cheap talk messages.

make this less favorable inference of zero and incurring the cost and credibly conveying to them that his signal is $T_b > 0$. If b increases, the director is no longer indifferent between these two options and strictly prefers to reveal T_b. Hence, more information is revealed when the distribution of biases is more extreme.

The results are also robust to the assumption that directors are always informed and other directors know about it. Suppose, for example, that director 1 observes his signal with probability α and remains uninformed with probability $1 - \alpha$. Suppose also that other directors do not know whether the director is informed. Repeating the analysis, it can first be shown that if the director has no directional bias, his communication strategy does not depend on α, and hence the effect of conformity remains unchanged. Second, if $r_i = 0$ and the director has a relatively high directional bias ($b_1 > \bar{b}_{-1}$), he discloses his signal if and only if $x_1 > T_1 = \frac{2\delta_1^+ - \alpha k_1}{2 - \alpha}$, where δ_1^+ is the positive root of (16). The threshold T_1 decreases in b_1 for any α, confirming the result that conflicts of interest encourage communication. In addition, the fact that other members do not know whether the director is informed allows the director to withhold more information (T_1 decreases in α).

5.5 Costly information acquisition

The focus of the paper is on costly communication. Another potentially important friction in board decision-making is costly information acquisition. Which friction is more important varies across firms. In firms where management is willing to supply directors with firm-specific information, directors' expertise and industry experience allow them to process this information in a way that gives them relevant private knowledge. In this case, effective sharing of individual directors' knowledge is key to efficient decision-making. In other firms, management withholds or manipulates information it provides to the board. In this case, it may be more important to elicit information from management or to encourage directors to obtain information from other sources.

The effect of conformity and directional biases on directors' incentives to collect information is ambiguous. For example, the effect of conformity is likely to depend on how correlated directors' signals are. If signals are independent, as in the current setting, or weakly correlated, conformity can reduce the incentives to acquire information because information will be used less efficiently. If signals are highly correlated—for example, are identical—conformity can encourage information acquisition because knowing the signal is necessary to act similarly to others. Likewise, the effect of directional biases on information acquisition depends on whether information is hard or soft. If information is hard and can be credibly conveyed to others, then a more biased director is likely to have stronger incentives to acquire information, especially if he can focus his effort on searching for signals that support his bias. This is because a more biased director benefits more from changing other directors'

beliefs in the direction of his bias. In contrast, if information is soft and can be manipulated, then stronger directional biases preclude communication and thus discourage information acquisition.

5.6 Generalized utility specification

In the basic model, a stronger conformity bias does not change a director's concern about firm value. In this section, I generalize directors' preferences to the case in which a stronger conformity bias can also decrease a director's concern about firm value. In particular, extending the specification in Section 3, suppose that the utility of director i is now given by

$$U_i(a, a_1, ..., a_N, \theta) = -w(r_i)(a - \theta)^2 - r_i \sum_{k=1, k \neq i}^{N} \tilde{p}_k^i (a_i - a_k)^2, \quad (22)$$

where $w(r_i)$ is the weight put on firm value. The basic model corresponds to $w(r_i) \equiv 1$.

The proof of Lemma A.5 in the Appendix shows that director i communicates his signal if and only if $|x_i| > d_i$, where d_i decreases in r_i if and only if

$$\frac{w(r_i)^2 p_i^2}{(w(r_i) p_i + r_i)^2} + \left(1 - p_i + \frac{p_i r_i^2}{(w(r_i) p_i + r_i)^2}\right) w'(r_i) > 0. \quad (23)$$

This shows that conformity is helpful for communication only if directors care about firm value. Indeed, if $w(r_i) \equiv 0$, then $\frac{\partial d_i}{\partial r_i} = 0$, and hence conformity biases have no effect on communication.

In addition, (23) shows that if a stronger conformity bias r_i also decreases a director's concern about firm value $w(r_i)$, then r_i has two different effects on communication. The first effect, which is emphasized in the paper, is reflected in the first term of (23): if $w(r_i) = 1$, as in the basic setup, then $w'(r_i) = 0$ and hence communication always increases with r_i. However, when the director's concern about firm value decreases with r_i, there is also a second effect: if $w'(r_i) < 0$, the second term in (23) is negative. Intuitively, the only reason why a director incurs the costs of communication is because he cares about firm value. Hence, the lower the weight $w(r_i)$ on the firm value component, the lower are the director's incentives to communicate.[32]

Consider a special case of (22), in which $w(r_i) = 1 - r_i$, $r_i \in [0, 1]$; that is, a director's utility is the weighted average of firm value and conformity terms. The proof of Lemma A.5 in the Appendix shows that d_i decreases in r_i if and only if $r_i < \hat{r}_i$ for some $\hat{r}_i \in (0, 1)$; that is, the positive effect on

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[32] This discussion suggests that in addition to changing the board's decision-making procedures, the firm can encourage communication between directors through contracts—for example, through performance-based compensation. Higher pay-performance sensitivity (w) increases a director's incentives to share his information, but not fully: this is because the costs of communication are privately borne by the director, while the benefits are shared with all shareholders.

communication dominates for small r_i. Moreover, Lemma A.5 shows that firm value is maximized at a strictly positive r_i; that is, Proposition 3 continues to hold.

6. Concluding Remarks

Board communication is impeded by several factors, including time constraints, the dominance of the CEO, directors' reputational concerns, and diversity of directors' backgrounds. This paper develops a theory of board decision-making whose key element is that directors need to incur personal costs to communicate their information to others effectively. I show that directors' conformity biases—that is, their reluctance to disagree with other board members— encourage them to incur the costs and communicate more effectively. This suggests that the widely used open ballot system is not necessarily inefficient, even though it strengthens pressure for conformity during the vote and induces directors to disregard their private information and vote with the majority. I also show that board communication can be more efficient when directors' private interests are more diverse. Hence, fully independent boards can be less effective than boards where some directors' interests conflict with shareholders' interests. The analysis has novel implications for voting procedures, boardroom transparency, executive sessions, and the allocation of control between directors.

While the focus of the paper is on corporate boards, it can also be applied to other committees where communication costs are important. Notably, there is considerable diversity in the decision-making rules of different committees. Whereas corporate boards mostly use the open ballot system, there is variation in the use of open and secret ballot across university committees and nonprofit boards. Government agencies are different from most boards in that the votes of their members are publicly disclosed. It would be interesting to understand why board decision-making rules are different from those used in other committees. Is it because boards are inherently different in their structure and functions? Or is it because board policies are influenced by managers who want to retain control over decisions?

Appendix

Motivating pressure for conformity

Directors' conformity biases can be due to a number of reasons. First, they can be caused by psychological factors such as certain social norms and pressures. In addition, there are several rational explanations for conformity, coming from directors' reputational concerns. This section presents these explanations and discusses why the results of the paper are robust to different reasons behind conformity.

Reputation for being competent and informed. Directors may want to conform to others if their actions are used to infer the quality of their private information. In particular, suppose that the precision of directors' signals depends on their ability: smarter directors receive more precise

signals. If all directors except one take very similar actions, this implies that signals of all but one director are similar to each other, but the signal of the deviating director is sufficiently different. Because smart directors tend to receive correlated signals and less competent directors receive pure noise, this would imply that the deviating director is likely to be less competent. Hence, to signal his competence, each director has incentives to mimic the behavior of other directors.

Under this rationale, pressure for conformity will arise at the communication stage as well. Importantly, as discussed in Section 5.2, certain decision-making rules (e.g., the choice between open and secret ballot voting) affect directors' conformity biases at the voting stage without affecting the communication stage. Thus, the result that open ballot voting improves communication is robust to this rationale for conformity.

Reputation for having opportunistic motives.   Conformity can also arise because dissent can indicate the presence of opportunistic motives. If a director votes against a proposal that is supported by the rest of the board and does not back up his view with convincing arguments, other directors may question his impartiality. Thus, to appear unbiased, a director can choose to conform to the majority.

This argument can also explain managerial retaliation against dissenting directors. By criticizing the manager without supporting his criticism with convincing evidence, the director indicates a possible bias against the manager. Because this bias is likely to lead the director to oppose the manager's actions in the future, even without objective reasons, it is optimal for the manager (and the rest of the board) to remove the dissenting director. As discussed in Section 5.1, the results continue to hold if conformity biases are due to fear of managerial retaliation.

In the examples above, conformity biases come from directors' concerns about internal reputation and their position on the board. Conformity can also arise from concerns about external reputation. Directors may be reluctant to dissent because it could indicate to outsiders their incompetence or conflict of interest and hinder their reputation in the labor market.

For any type of reputational concerns, a director could partly alleviate the negative inference from dissent by explaining his reasons for dissent after the vote. However, the ability to communicate *after* the vote does not change the result that open ballot voting improves communication *before* the vote and hence makes the vote more informative. To see the intuition, note that the need to explain one's behavior after a dissenting vote is equivalent to the cost of nonconformity and arises only if voting is conducted by open ballot. Such explanations would not be needed if voting were conducted by secret ballot. Put differently, the cost of nonconformity can now be defined as the cost of voting differently from others plus the cost of having to explain one's vote afterward. Since these costs are higher under open ballot, directors have stronger incentives to communicate prior to the vote under open than under secret ballot.

Desire to avoid confrontation.   In addition to reputational concerns, a director may be reluctant to dissent because of a general desire to avoid confrontation. Even if other directors did not convince him during the discussion, the director may want to vote with them in order to show that he took their opinion seriously and is not a trouble-maker. These incentives to conform are stronger when the director's vote is observed by others, that is, when voting is by open ballot. Hence, under open ballot, directors have incentives to voice their opinions during the discussion, realizing that a desire to avoid confrontation will induce other directors to side with them. This shows that open ballot voting induces more pre-vote communication than secret ballot voting in this setting as well.

Proofs
To prove the main results, I first prove several auxiliary results for a more general model with preferences $(b_1, ..., b_N)$, $(r_1, ..., r_N)$ and weights $(p_1, ..., p_N)$, $\sum_{i=1}^{N} p_i = 1$, measuring the influence

of individual directors. I derive the equilibrium and expected firm value for this more general model. The proofs of the main results follow from these auxiliary results.

Auxiliary results: General model. Suppose that firm value is given by

$$V_0 - \sum_{i=1}^{N} p_i (a_i - \theta)^2, \tag{A1}$$

and the utility of director i is

$$U_i(a, \theta) = -\sum_{k=1}^{N} p_k (a_k - (b_i + \theta))^2 - r_i \sum_{k=1, k \neq i}^{N} \tilde{p}_k^i (a_i - a_k)^2, \tag{A2}$$

where $\sum_{i=1}^{N} p_i = 1$ and $\tilde{p}_k^i = \frac{p_k}{1 - p_i}$.

Lemma A.1 (equilibrium at the decision-making stage). Suppose that at the communication stage signals $x_i, i \in J_C$ were communicated, and that y_i is the expected value of x_i conditional on no communication. Denote $J_{NC} = \{1, ..., N\} \backslash J_C$. Then there is a linear equilibrium at the decision-making stage characterized by the following strategies:

1. If director i communicated his signal, $i \in J_C$, his action is given by

$$a_i = g_i + \sum_{j \in J_C} x_j + \sum_{j \in J_{NC}} y_j. \tag{A3}$$

2. If director i did not communicate his signal, $i \in J_{NC}$, his action is given by

$$a_i = g_i + \sum_{j \in J_C} x_j + \sum_{j \in J_{NC}} y_j + \frac{p_i}{p_i + r_i} (x_i - y_i), \tag{A4}$$

where g_i solves the system

$$g_i = \frac{p_i}{p_i + r_i} b_i + \left(1 - \frac{p_i}{p_i + r_i}\right) \sum_{k \neq i} \tilde{p}_k^i g_k. \tag{A5}$$

Proof of Lemma A.1. Let us verify that the strategies given by (A3)–(A5) constitute an equilibrium. Denote the sum of the signals that were communicated by X, and the expected sum of the signals that were not communicated by Y: $X = \sum_{j \in J_C} x_j$ and $Y = \sum_{j \in J_{NC}} y_j$. Also denote by I_i the information set of director i after the communication stage. Taking the first-order condition of (A2), the optimal action of director i is given by

$$a_i = \frac{p_i}{p_i + r_i} (b_i + \mathbb{E}[\theta | I_i]) + \frac{r_i}{p_i + r_i} \mathbb{E}\left[\sum_{k \neq i} \tilde{p}_k^i a_k | I_i\right].$$

First, consider the best response of director $i, i \in J_C$. For him, $\mathbb{E}[\theta | I_i] = X + Y$. Also, given the equilibrium strategies (A3) and (A4) of other players,

$$\mathbb{E}\left[\sum_{k \neq i} \tilde{p}_k^i a_k | I_i\right] = \sum_{k \neq i} \tilde{p}_k^i g_k + \left(\sum_{k \neq i} \tilde{p}_k^i\right)(X + Y) + \sum_{k \in J_{NC}} \tilde{p}_k^i \frac{p_k}{p_k + r_k} \mathbb{E}[(x_k - y_k) | I_i].$$

Note that $\sum_{k \neq i} \tilde{p}_k^i = 1$ and that the last term equals 0 because $\mathbb{E}[x_k | I_i] = y_k$. Plugging in $\mathbb{E}[\theta | I_i]$ and $\mathbb{E}\left[\sum_{k \neq i} \tilde{p}_k^i a_k | I_i\right]$ into the first-order condition, we get the conjectured strategy (A3).

Next, consider the best response of director $i, i \in J_{NC}$. For him, $\mathbb{E}[\theta|I_i] = X + Y - y_i + x_i$ and by the same argument as above, $\mathbb{E}\left[\sum_{k \neq i} \tilde{p}_k^i a_k | I_i\right] = \sum_{k \neq i} \tilde{p}_k^i g_k + X + Y$. Plugging in these values into the first-order condition, we again get the conjectured equilibrium strategy (A4).

The coefficients g_i can be found by solving the system of linear equations (A5) for $i = 1, ..., N$. This system coincides with (8) when $p_i = \frac{1}{N}$ for all i.

It is straightforward to prove that the equilibrium (A3)–(A5) is a unique linear equilibrium. This can be done similar to the analysis of the benchmark case by conjecturing a general linear equilibrium and plugging in the conjectured strategies into the first-order condition above. The proof is omitted for space considerations.

Lemma A.2 (properties of g_i).

    (i) There is a unique solution to the system of linear equations (A5), which takes the form $g_i = \lambda_{ii} b_i + \sum_{j \neq i} \lambda_{ij} b_j$, where $\lambda_{ii}, \lambda_{ij} \in (0, 1)$ if $r_i > 0$, and $\lambda_{ii} = 1, \lambda_{ij} = 0$ if $r_i = 0$. The coefficients λ_{ij} satisfy $\sum_j \lambda_{ij} = 1$ for all i.

    (ii) If $p_i = \frac{1}{N}$ and $r_i = r$ for all i, then $g_i = \omega b_i + (1 - \omega) \bar{b}_{-i}$, where $\omega = \frac{N - 1 + Nr}{N - 1 + N^2 r}$.

Proof of Lemma A.2. Because (A5) is a system of linear equations on g_i with constant terms equal to $\frac{p_i}{p_i + r_i} b_i$, the solution to this system takes the form $g_i = \lambda_{i1} b_1 + ... + \lambda_{iN} b_N$ for some λ_{ij}. To find $(\lambda_{1i}, ..., \lambda_{Ni})$ for a particular i, we differentiate each equation in (A5) with respect to b_i and derive a system of N linear equations on N coefficients $\lambda_{1i}, ..., \lambda_{Ni}$. The properties of λ_{ij} in (i) and the statement of (ii) follow directly from solving this system.

Lemma A.3 (equilibrium strategies at the communication stage).

    (i) Suppose that conditional on director i not communicating his signal, other directors believe that the expected value of x_i is y_i. Then director i has incentives to communicate x_i if and only if it satisfies $H_i(x_i - y_i) > 0$, where

$$H_i(\delta) = \delta^2 + 2\delta \left(b_i - \sum_{k \neq i} \tilde{p}_k^i g_k \right) - \frac{c_i}{1 - \frac{p_i^2}{p_i + r_i}}. \tag{A6}$$

    For any $c_i > 0$, $H_i(\delta)$ has two roots δ_i^- and δ_i^+, which satisfy $\delta_i^- < 0 < \delta_i^+$.

    (ii) In any equilibrium, the strategy of director i at the communication stage is characterized by an interval $[t_i, T_i]$ such that x_i is communicated if and only if $x_i \notin [t_i, T_i]$. The necessary and sufficient conditions for the four possible types of equilibria are:

        (a) Equilibrium with $-k_i < t_i < T_i < k_i$ exists if and only if $t_i - y_i = \delta_i^-$ and $T_i - y_i = \delta_i^+$.
        (b) Equilibrium with $-k_i = t_i < T_i < k_i$ exists if and only if $-k_i - y_i > \delta_i^-$ and $T_i - y_i = \delta_i^+$.
        (c) Equilibrium with $-k_i < t_i < T_i = k_i$ exists if and only if $t_i - y_i = \delta_i^-$ and $k_i - y_i < \delta_i^+$.
        (d) Equilibrium with $-k_i = t_i < T_i = k_i$ exists if and only if $-k_i > \delta_i^-$ and $k_i < \delta_i^+$.

Proof of Lemma A.3. (i) Suppose that the equilibrium communication and noncommunication regions of director i are some sets C_i and NC_i, $C_i \cup NC_i = [-k_i, k_i]$. That is, the director communicates his signal x_i if and only if $x_i \in C_i$. Denote $y_i = \mathbb{E}[x_i | x_i \in NC_i]$.

First, we derive the payoff of each director, taking the outcome of the communication stage as given. Suppose that signals $x_1, ..., x_N$ were realized and that during the communication stage signals $x_i, i \in J_C$ were communicated and signals $x_i, i \in J_{NC}$ were not. Denote $Q_i = \frac{p_i}{p_i + r_i}$ and

$\delta_i = x_i - y_i$. From (A2) and the equilibrium actions (A3)–(A4) at the decision-making stage, the utility of director i after the communication stage is

$$
\begin{aligned}
U_i = &-\sum_{j \in J_C} p_j \left(g_j - b_i - \sum_{k \in J_{NC}} \delta_k - \varepsilon \right)^2 \\
&-\sum_{j \in J_{NC}} p_j \left(g_j - b_i - (1 - Q_j)\delta_j - \sum_{k \in J_{NC}, k \neq j} \delta_k - \varepsilon \right)^2 \\
&-r_i \sum_{k \neq i, k \in J_C} \tilde{p}_k^i (g_i - g_k)^2 - r_i \sum_{k \neq i, k \in J_{NC}} \tilde{p}_k^i (g_i - g_k - Q_k \delta_k)^2
\end{aligned}
\tag{A7}
$$

for $i \in J_C$, and

$$
\begin{aligned}
U_i = &-\sum_{j \in J_C} p_j \left(g_j - b_i - \sum_{k \in J_{NC}} \delta_k - \varepsilon \right)^2 \\
&-\sum_{j \in J_{NC}} p_j \left(g_j - b_i - (1 - Q_j)\delta_j - \sum_{k \in J_{NC}, k \neq j} \delta_k - \varepsilon \right)^2 \\
&-r_i \sum_{k \neq i, k \in J_C} \tilde{p}_k^i (g_i + Q_i \delta_i - g_k)^2 - r_i \sum_{k \neq i, k \in J_{NC}} \tilde{p}_k^i (g_i - g_k + Q_i \delta_i - Q_k \delta_k)^2
\end{aligned}
\tag{A8}
$$

for $i \in J_{NC}$.

Consider the decision of director 1 whether to pay c_1 to communicate his signal x_1. The director does not know other directors' signals and the noise term ε and thus conditions his decision on all possible values of $x_2, ..., x_N, \varepsilon$. Suppose that among the remaining signals, signals $x_i, i \in J_C$ lie in their respective regions C_i and are thus communicated, and signals $x_i, i \in J_{NC}$ lie in their respective regions NC_i and are not communicated. If the director communicates his signal, then by (A7), his payoff upon communication, U_1^C, is equal to

$$
\begin{aligned}
U_1^C = &-\sum_{j \in J_C \cup \{1\}} p_j \left(g_j - b_1 - \sum_{k \in J_{NC}} \delta_k - \varepsilon \right)^2 \\
&-\sum_{j \in J_{NC}} p_j \left(g_j - b_1 - (1 - Q_j)\delta_j - \sum_{k \in J_{NC}, k \neq j} \delta_k - \varepsilon \right)^2 \\
&-r_1 \sum_{k \neq 1, k \in J_C} \tilde{p}_k^1 (g_1 - g_k)^2 - r_1 \sum_{k \neq 1, k \in J_{NC}} \tilde{p}_k^1 (g_1 - g_k - Q_k \delta_k)^2
\end{aligned}
$$

If the director does not communicate his signal, then by (A8), his payoff, U_1^{NC}, is equal to

$$
\begin{aligned}
U_1^{NC} = &-\sum_{j \in J_C} p_j \left(g_j - b_1 - \delta_1 - \sum_{k \in J_{NC}} \delta_k - \varepsilon \right)^2 \\
&-p_1 \left(g_1 - b_1 - (1 - Q_1)\delta_1 - \sum_{k \in J_{NC}} \delta_k - \varepsilon \right)^2 \\
&-\sum_{j \in J_{NC}} p_j \left(g_j - b_1 - (1 - Q_j)\delta_j - \delta_1 - \sum_{k \in J_{NC}, k \neq j} \delta_k - \varepsilon \right)^2 \\
&-r_1 \sum_{k \neq 1, k \in J_C} \tilde{p}_k^1 (g_1 - g_k + Q_1 \delta_1)^2 - r_1 \sum_{k \in J_{NC}} \tilde{p}_k^1 (g_1 - g_k + Q_1 \delta_1 - Q_k \delta_k)^2.
\end{aligned}
$$

The director averages these payoffs over all possible values of $x_2, ..., x_N, \varepsilon$ and chooses to communicate his signal if and only if

$$
\int U_1^C f_2 ... f_N f_\varepsilon dx_2 ... dx_N d\varepsilon > c_1 + \int U_1^{NC} f_2 ... f_N f_\varepsilon dx_2 ... dx_N d\varepsilon.
\tag{A9}
$$

If we open the brackets in U_1^C and U_1^{NC}, it is easy to see that the expressions inside the integrals are some linear combinations of quadratic terms $\delta_i^2, \varepsilon^2$, interaction terms $\delta_i \delta_j, \delta_i \varepsilon$, linear terms δ_i, ε, and a constant. Note also that the signal of director $k, k \neq 1$ enters U_1^C and U_1^{NC} with a non-zero coefficient only if $x_k \in NC_k$; that is, for $k \in J_{NC}$. Also, because $\delta_i = x_i - \mathbb{E}[x_i | x_i \in NC_i]$,

$$
\int_{NC_i} \delta_i f_i(x_i) dx_i = 0.
$$

Therefore, on both sides of (A9), all linear terms for $\delta_i, i \geq 2$, all interaction terms $\delta_i \delta_j, i \geq 2$, and all terms including ε integrate to zero. Hence, only quadratic terms ε^2 and $\delta_i^2, i \in J_{NC} \cup \{1\}$, the linear term δ_1, and the constant remain. Note also that the constant terms and the coefficients for terms ε^2 and $\delta_i^2, i \in J_{NC}$ are the same in U_1^C and U_1^{NC}. Besides, the integral over δ_i^2 is taken

over the same set NC_i on both sides of (A9). Hence, the integrals over terms ε^2 and $\delta_i^2, i \in J_{NC}$ on the two sides of (A9) cancel out. Finally, δ_1^2 and δ_1 do not enter the expression for U_1^C and only enter U_1^{NC}. The coefficient for δ_1^2 in the expression for U_1^{NC} is equal to $-A$, where

$$A = (1 - p_1) + p_1 (1 - Q_1)^2 + r_1 Q_1^2 = 1 - \frac{p_1^2}{p_1 + r_1} > 0,$$

and the coefficient for δ_1 is equal to $2B$, where

$$B = \sum_{k \neq 1} p_k (g_k - b_1) + p_1 (1 - Q_1)(g_1 - b_1) - r_1 Q_1 \left(g_1 - \sum_{k \neq 1} \bar{p}_k^1 g_k \right)$$
$$= \left(1 - \frac{p_1^2}{p_1 + r_1} \right) \left(\sum_{k \neq 1} \bar{p}_k^1 g_k - b_1 \right).$$

Hence, (A9) is equivalent to

$$A \delta_1^2 - 2B \delta_1 - c_1 > 0. \tag{A10}$$

Because $A > 0$, (A10) is equivalent to $H_1(x_1 - y_1) > 0$, where $H_1(\cdot)$ is given by (A6) in the statement of the lemma. The corresponding quadratic equation, $H_1(\delta) = 0$, always has two different roots $\delta_1^- < \delta_1^+$, given by $\frac{B \pm (B^2 + Ac_1)^{1/2}}{A}$, and $\delta_1^- < 0 < \delta_1^+$.

(ii) Because $\delta_1 = x_1 - y_1$, (A10) implies that the noncommunication region is always some interval $[t_1, T_1]$. If one of the boundaries (t_1 or T_1) is interior—that is, lies inside $(-k_1, k_1)$—then the director should be indifferent between communicating and not communicating his signal at this point. This implies that (A10) should be satisfied as an equality and hence $t_1 - y_1$ or $T_1 - y_1$ should coincide with δ_1^- or δ_1^+, respectively. If the right boundary T_1 coincides with k_1, then (A10) should be violated at k_1, implying that $k_1 - y_1$ should be smaller than δ_1^+ (being positive, it is always greater than $\delta_1^- < 0$). Similarly, if the left boundary t_1 coincides with $-k_1$, then (A10) should be violated at $-k_1$, implying that $-k_1 - y_1$ should be greater than δ_1^- (being negative, it is always smaller than $\delta_1^+ > 0$).

Lemma A.4 (firm value). Suppose that at the communication stage, director i communicates his signal if and only if $x_i \notin [t_i, T_i]$, and let $y_i = E[x_i | x_i \in [t_i, T_i]]$. Then expected firm value is given by

$$\mathbb{E}(V) = V_0 - \mathbb{E}\varepsilon^2 - \sum_{i=1}^{N} p_i g_i^2 - \sum_{i=1}^{N} \left[1 - p_i + p_i \left(\frac{r_i}{p_i + r_i} \right)^2 \right] \int_{t_i}^{T_i} (x_i - y_i)^2 f_i(x_i) dx_i,$$

where g_i solves (A5).

Proof of Lemma A.4. Denote $\delta_i = x_i - y_i$ and $Q_i = \frac{p_i}{p_i + r_i}$. For any given realization of $x_1, ..., x_N$, suppose that signals $x_i, i \in J_C$ are communicated and signals $x_i, i \in J_{NC}$ are not. Using the derivations in the proof of Lemma A.3, firm value, $V(x_1, ..., x_N, \varepsilon)$, is equal to

$$V_0 - \sum_{i \in J_C} p_i \left[g_i - \sum_{k \in J_{NC}} \delta_k - \varepsilon \right]^2 - \sum_{j \in J_{NC}} p_j \left[g_j - \delta_j (1 - Q_j) - \sum_{k \in J_{NC}, k \neq j} \delta_k - \varepsilon \right]^2,$$

and expected firm value is

$$\mathbb{E}(V) = \int [V(x_1, ..., x_N, \varepsilon)] f_1(x_1) ... f_N(x_N) f_\varepsilon(\varepsilon) dx_1 ... dx_N d\varepsilon.$$

By the same argument as in the proof of Lemma A.3, the integral over all linear terms δ_i, ε and interaction terms $\delta_i \delta_j, \delta_i \varepsilon$ equals 0. Also, because all quadratic terms $\delta_i^2, \varepsilon^2$ enter additively, the integral over these terms equals the sum of the corresponding integrals for individual signals. The coefficient before δ_i^2 for $i \in J_C$ is 0, and the coefficient before δ_i^2 for $i \in J_{NC}$ is $-[1 - p_i + p_i (1 - Q_i)^2]$. The coefficient before ε^2 is -1. Finally, note that $i \in J_{NC}$ if and only if $x_i \in [t_i, T_i]$. Integrating over all possible realizations of $x_1, ..., x_N$, we get

$$\mathbb{E}(V) = V_0 - \mathbb{E}\varepsilon^2 - \sum_{i=1}^{N} p_i g_i^2 - \sum_{i=1}^{N} \left[1 - p_i + p_i (1 - Q_i)^2 \right] \int \delta_i^2 \cdot \mathbf{1}\{x_i \in [t_i, T_i]\} f_i(x_i) dx_i,$$

which is equivalent to the expression in the statement of the lemma.

Proofs of main results

Proof of Lemma 1. Suppose, on the contrary, there exists an equilibrium where director i conceals his signal when $x_i \in NC_i$, where $\Pr(NC_i) > 0$. Let $y_i = \mathbb{E}[x_i | x_i \in NC_i]$. According to Lemma A.3, director i finds it optimal to conceal x_i if and only if $H_i(x_i - y_i) < 0$, where $H_i(\delta)$ is given by (A6). If $H_i(\delta)$ does not have any roots, then $H_i(\delta) \geq 0 \; \forall \delta$ whenever $c_i \leq 0$, and hence we get a contradiction. If $H_i(\delta)$ has roots $\delta_i^- \leq \delta_i^+$, then any $x_i \in NC_i$ must satisfy $\delta_i^- < x_i - y_i < \delta_i^+$. Integrating this inequality over NC_i, we get

$$\delta_i^- \Pr(NC_i) < \int_{NC_i} x f(x) dx - y_i \Pr(NC_i) < \delta_i^+ \Pr(NC_i) \Leftrightarrow \delta_i^- < 0 < \delta_i^+.$$

However, when $c_i \leq 0$, the roots of $H_i(\delta)$ always lie on the same side of zero: they are both negative (positive) if $b_i - \sum_{k \neq i} \bar{p}_k^i g_k \geq 0 \; (\leq 0)$. This contradicts $\delta_i^- < 0 < \delta_i^+$ and proves that there is no equilibrium with $\Pr(NC_i) > 0$.

Proof of Proposition 1. The statement of Proposition 1 follows from Lemma A.1 for the case $b_i = 0$ and $p_i = \frac{1}{N}$ for all i.

Proof of Proposition 2. Let y_i be the equilibrium expected value of x_i conditional on it not being communicated. According to Lemma A.3 (i) for the case $b_i = 0$ and $p_i = \frac{1}{N}$, director i finds it optimal to communicate his signal if and only if

$$(x_i - y_i)^2 > \frac{c_i}{1 - \frac{1}{N}\frac{1}{1+Nr_i}}. \tag{A11}$$

Hence, there always exists an equilibrium where a director communicates x_i if and only if $|x_i| > d_i = (\frac{c_i}{1 - \frac{1}{N}\frac{1}{1+Nr_i}})^{1/2}$. Indeed, in this equilibrium $y_i = 0$ due to the symmetry of the distribution, and hence by (A11), communicating x_i if and only if $|x_i| > d_i$ is optimal.

Moreover, when the distribution is single-peaked at zero, this equilibrium is unique. First, there is no other equilibrium where the communication interval is interior. According to (A11), any such equilibrium is characterized by $[t_i, T_i]$ and $y_i = \mathbb{E}[x_i | x_i \in [t_i, T_i]]$, such that $T_i - y_i = y_i - t_i = d_i$. It follows that $y_i = \frac{t_i + T_i}{2}$; that is, the conditional expectation over $[t_i, T_i]$ coincides with the middle of the interval. Because the distribution is symmetric and single-peaked at zero, this is only possible for $y_i = 0$. Hence, no other interior equilibrium exists. Second, there is no boundary equilibrium. Suppose, for example, that there is a boundary equilibrium with the noncommunication interval $[t_i, k_i], t_i > -k_i$. According to Lemma A.3 (ii), this is only an equilibrium if $t_i - y_i = -d_i$ and $k_i - y_i < d_i$. Summing up these two expressions, we get $y_i > \frac{t_i + k_i}{2}$, where $\frac{t_i + k_i}{2} > 0$. However, for a single-peaked symmetric distribution, the conditional expectation over $[t_i, k_i]$ is strictly smaller than $\frac{t_i + k_i}{2}$ when $\frac{t_i + k_i}{2} > 0$, which contradicts $y_i > \frac{t_i + k_i}{2}$. Similarly, there is no boundary equilibrium in which the noncommunication interval is $[-k_i, T_i], T_i < k_i$.

If the distribution has more than one peak, there could be multiple equilibria at the communication stage. For example, for a two-peak distribution that is symmetric around zero, has peaks at points $(-z, z)$, and is symmetric in the neighborhood of each peak, there are three equilibria with $y_i \in \{-z, 0, z\}$ if c_i is sufficiently small. For a uniform distribution, the condition $\mathbb{E}[x_i | x_i \in [t_i, T_i]] = \frac{t_i + T_i}{2}$ is satisfied for any interval $[t_i, T_i]$, and hence there is a continuum of equilibria characterized by some noncommunication interval of length $2d_i$.

Proof of Lemma 2. The statement of the lemma follows from Lemma A.4 for the case $b_i = 0$ and $p_i = \frac{1}{N}$ for all i.

Proof of Proposition 3. Because contributions of individual directors to firm value enter additively, we can examine the effect of each individual r_i separately. Consider the term reflecting the contribution of director i:

$$V_i(r_i) = -\left[1 - \frac{1}{N} + \frac{1}{N}\left(\frac{Nr_i}{1+Nr_i}\right)^2\right]\int_{-d_i}^{d_i} x^2 f_i(x)dx, \quad d_i = \left(\frac{c_i}{1 - \frac{1}{N}\frac{1}{1+Nr_i}}\right)^{1/2}.$$

Because by assumption, $\left(\frac{c_i}{1-\frac{1}{N}}\right)^{1/2} < k_i$, then $d_i < k_i$ for any $r_i \geq 0$. It can be shown that $\lim_{r_i \to 0} V_i'(r_i) = f_i\left(c_i^{1/2}(1-\frac{1}{N})^{-1/2}\right)c_i^{3/2}\left(1-\frac{1}{N}\right)^{-3/2} > 0$, which implies that firm value is maximized at some strictly positive r_i, potentially infinitely large.

Proof of Lemma 3. The proof is based on Lemma A.3. Suppose that $b_i > \bar{g}_{-i}$. Then the coefficient for the linear term in the quadratic equation $H_i(\delta) = 0$ given by (A6) is $2(b_i - \bar{g}_{-i}) > 0$. It follows that the roots (δ_i^-, δ_i^+) of this equation satisfy $\delta_i^- + \delta_i^+ < 0$.

First, I show that the equilibrium communication strategy of director i is boundary—that is, either signal k_i or signal $-k_i$ is not communicated in equilibrium. According to Lemma A.3 (ii), if the communication strategy were interior, then director i would communicate x_i if and only if $x_i \notin [t_i, T_i]$, where $t_i - y_i = \delta_i^-$, $T_i - y_i = \delta_i^+$, and $y_i = \mathbb{E}[x_i | x_i \in [t_i, T_i]]$. Because the distribution is uniform, $y_i = \frac{t_i + T_i}{2}$, which would imply that $\delta_i^- + \delta_i^+ = 0$, contradicting the fact that $\delta_i^- + \delta_i^+ < 0$. Hence, the equilibrium must be boundary.

Next, I show that there is no equilibrium where $-k_i$ is communicated and k_i is not communicated. Suppose that such an equilibrium exists. By Lemma A.3 (ii), this equilibrium is characterized by the noncommunication interval $[t_i, k_i]$, $t_i > -k_i$, where $t_i - y_i = \delta_i^-$ and $k_i - y_i < \delta_i^+$. Summing up these two expressions, we get $t_i + k_i - 2y_i < \delta_i^- + \delta_i^+$. However, $y_i = \frac{t_i + k_i}{2}$ and hence $0 = t_i + k_i - 2y_i < \delta_i^- + \delta_i^+ < 0$, which is a contradiction.

Therefore, all equilibria are characterized by a noncommunication interval $[-k_i, T_i]$, where $T_i \leq k_i$. According to Lemma A.3 (ii), in order for an equilibrium with $T_i < k_i$ to exist, T_i must satisfy $T_i - \frac{T_i - k_i}{2} = \delta_i^+ \Leftrightarrow T_i = 2\delta_i^+ - k_i$. Hence, $T_i < k_i$ is an equilibrium if and only if $\delta_i^+ < k_i$. In order for an equilibrium with $T_i = k_i$ to exist, k_i must satisfy $k_i - \frac{k_i - k_i}{2} < \delta_i^+ \Leftrightarrow k_i < \delta_i^+$. Hence, there is a unique equilibrium characterized by the noncommunication interval $[-k_i, T_i]$, $T_i = \min\{2\delta_i^+ - k_i, k_i\}$.

Following similar arguments, it can be shown that if $b_i < \bar{g}_{-i}$, there is a unique equilibrium characterized by the noncommunication interval $[t_i, k_i]$, $t_i = \max\{-k_i, k_i + 2\delta_i^-\}$. Finally, if $b_i = \bar{g}_{-i}$, then the coefficient for the linear term in the equation $H_i(\delta) = 0$ is equal to zero. It follows that there is a continuum of equilibria characterized by a point $y_i \in [-k_i + d_i, k_i - d_i]$, such that director i communicates his signal if and only if $|x_i - y_i| > d_i = \left(\frac{c_i}{1 - \frac{1}{N}\frac{1}{1+Nr_i}}\right)^{1/2}$. As shown in the proof of Proposition 5, firm value is the same in all these equilibria.

Proof of Proposition 4. Suppose, for example, that $b_1 > \bar{g}_{-1}$. Then, according to Lemma 3, director 1 communicates his signal if and only if $x_1 > T_1 = -k_1 + 2\delta_1^+$, where

$$\delta_1^+ = -(b_1 - \bar{g}_{-1}) + \left((b_1 - \bar{g}_{-1})^2 + \frac{c_1}{1 - \frac{1}{N}\frac{1}{1+Nr_1}}\right)^{1/2}.$$

According to Lemma A.2, $\frac{d}{db_1}\bar{g}_{-1} = \frac{1}{N-1}\sum_{j=2}^{N}\lambda_{j1}$, where $\lambda_{j1} < 1$. Thus, $\frac{d}{db_1}\bar{g}_{-1} < 1$ and $\frac{d(b_1 - \bar{g}_{-1})}{db_1} > 0$. This implies that $b_1 - \bar{g}_{-1}$ increases with b_1 and hence remains positive as b_1 increases further. Thus, the communication region continues to take the form $[-k_1 + 2\delta_1^+, k_1]$. Moreover, δ_1^+ decreases in $(b_1 - \bar{g}_{-1})$ and hence decreases as b_1 increases. Hence, the director reveals more information as his directional bias increases. Note also that because $b_1 - \bar{g}_{-1}$ does not depend on r_1, δ_1^+ decreases with r_1 and hence the director reveals more information as his conformity bias increases. The proof for the case $b_1 < \bar{g}_{-1}$ is similar.

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Proof of Proposition 5. Using Lemma A.4 for $p_i = \frac{1}{N}$ and a uniform distribution of x_i on $[-k_i, k_i]$, expected firm value is given by

$$\mathbb{E}(V) = V_0 - \mathbb{E}\varepsilon^2 - \frac{1}{N}\sum_{i=1}^{N} g_i^2 - \sum_{i=1}^{N}\left[1 - \frac{1}{N} + \frac{1}{N}\left(\frac{Nr_i}{1+Nr_i}\right)^2\right]\frac{1}{3k_i}\left(\frac{T_i - t_i}{2}\right)^3, \qquad (A12)$$

where $[t_i, T_i]$ is the noncommunication region of director i. Note that firm value only depends on the length $T_i - t_i$ of the noncommunication interval and not on its location.

(i) To prove the statement, I show that $\lim_{b_1 \to 0+} \frac{d}{db_1}\mathbb{E}(V) > 0$ and $\lim_{b_1 \to 0-} \frac{d}{db_1}\mathbb{E}(V) < 0$.

(1) First, consider $b_1 > 0$. Our goal is to prove that $\lim_{b_1 \to 0+} \frac{d}{db_1}\mathbb{E}(V) > 0$.

Because $b_2 = ... = b_N = 0$, then according to Lemma A.2, $g_i = \lambda_{i1}b_1$, where $\lambda_{i1} \in [0, 1)$ for $i \neq 1$ and $\lambda_{11} \in (0, 1]$. For $i \neq 1$, $\bar{g}_{-i} = (\frac{1}{N-1}\sum_{k \neq i}\lambda_{k1})b_1 > 0 = b_i$ because $\lambda_{11} > 0$. Also, $\bar{g}_{-1} = (\frac{1}{N-1}\sum_{k \neq 1}\lambda_{k1})b_1 < b_1$ because $\lambda_{k1} < 1$ for all k. Since $\bar{g}_{-i} > b_i$ and $\bar{g}_{-1} < b_1$, then, according to Lemma 3, the equilibrium noncommunication regions are $[-k_1, T_1], [t_2, k_2], ..., [t_N, k_N]$, where $T_1, t_2, ..., t_N$ satisfy

$$T_1 = \min\{-k_1 + 2\delta_1^+, k_1\}, \qquad (A13)$$

$$t_i = \max\{k_i + 2\delta_i^-, -k_i\},$$

We have assumed that k_i is sufficiently large, such that the equilibrium is interior: $\delta_i^+ < k_i$ and $\delta_i^- > -k_i$. Hence, $T_1 = -k_1 + 2\delta_1^+$ and $t_i = k_i + 2\delta_i^-$. The roots δ_i^-, δ_i^+ are given by

$$\delta_1^+ = (\bar{g}_{-1} - b_1) + \left((\bar{g}_{-1} - b_1)^2 + \frac{c_1}{1 - \frac{1}{N}\frac{1}{1+Nr_1}}\right)^{1/2},$$

$$\delta_i^- = (\bar{g}_{-i} - b_i) - \left((\bar{g}_{-i} - b_i)^2 + \frac{c_i}{1 - \frac{1}{N}\frac{1}{1+Nr_i}}\right)^{1/2}.$$

Note that $\frac{d}{db_1}\sum_{i=1}^{N}g_i^2 = 2\sum_{i=1}^{N}g_i\frac{dg_i}{db_1}$. Because $g_i = \lambda_{i1}b_1 \to 0$ when $b_1 \to 0+$ and $\left|\frac{dg_i}{db_1}\right| \leq \max\{\lambda_{i1}\}$, then $\lim_{b_1 \to 0+}\frac{d}{db_1}\sum_{i=1}^{N}g_i^2 = 0$. Hence, using (A12) and (A13),

$$\lim_{b_1 \to 0+}\frac{d}{db_1}\mathbb{E}(V) = -\frac{1}{k_1}\left[1 - \frac{1}{N} + \frac{1}{N}\left(\frac{Nr_1}{1+Nr_1}\right)^2\right](\delta_1^+)^2 \lim_{b_1 \to 0+}\frac{d\delta_1^+}{db_1}$$

$$+ \sum_{i=2}^{N}\frac{1}{k_i}\left[1 - \frac{1}{N} + \frac{1}{N}\left(\frac{Nr_i}{1+Nr_i}\right)^2\right](\delta_i^-)^2 \lim_{b_1 \to 0+}\frac{d\delta_i^-}{db_1}.$$

Since $\bar{g}_{-1} - b_1 = (\frac{1}{N-1}\sum_{k \neq 1}\lambda_{k1} - 1)b_1$ and $\bar{g}_{-i} - b_i = (\frac{1}{N-1}\sum_{k \neq i}\lambda_{k1})b_1, i \geq 2$, then

$$\lim_{b_1 \to 0+}\frac{d\delta_1^+}{db_1} = \frac{1}{N-1}\sum_{k \neq 1}\lambda_{k1} - 1 < 0,$$

$$\lim_{b_1 \to 0+}\frac{d\delta_i^-}{db_1} = \frac{1}{N-1}\sum_{k \neq i}\lambda_{k1} \geq \frac{\lambda_{11}}{N-1} > 0.$$

Since $\lim_{b_1 \to 0+}(\delta_1^+)^2 > 0$ and $\lim_{b_1 \to 0+}(\delta_i^-)^2 > 0$, we conclude that $\lim_{b_1 \to 0+}\frac{d}{db_1}\mathbb{E}(V) > 0$.

(2) Consider $b_1 < 0$. Using similar arguments, it can be shown that $\lim_{b_1 \to 0-}\frac{d}{db_1}\mathbb{E}(V) < 0$.

(3) Consider $b_1 = 0$. Then, $g_i = 0$ for any i and hence there are multiple equilibria at the communication stage, characterized by a noncommunication region of length $2d_i = $

$2\left(\dfrac{c_i}{1-\frac{1}{N}\frac{1}{1+Nr_i}}\right)^{1/2}$. According to (A12), firm value depends only on the length of the noncommunication interval. Thus, firm value is exactly the same in all these equilibria and by continuity equals $\lim_{b_1\to 0+}\mathbb{E}(V)=\lim_{b_1\to 0-}\mathbb{E}(V)$.

Combining cases (1)–(3) together, we conclude that firm value has a local minimum at the point $b_1=0$. Due to the symmetry of the problem, this implies that firm value is maximized at $b_1=\pm b$, where b is strictly positive, potentially infinitely large.

(ii) It can be shown that for any $i_0\in\{1,...,N-1\}$, $\lim_{b\to 0+}\frac{d}{db}\mathbb{E}(V)>0$. The proof is similar to the proof of Part (i) and is therefore omitted.

Proof of Proposition 6. Consider any possible allocation of control $(p_1,...,p_N)$, $\sum p_i=1$. Without loss of generality, suppose that $p_1\geq p_2\geq ...\geq p_N$.

According to Lemma A.4, when the distribution of all signals is uniform on $[-k,k]$, $r_i=0$ and $c_i=c$, expected firm value, $\mathbb{E}_{(p_1,...,p_N)}(V)$, is given by

$$V_0-\mathbb{E}\varepsilon^2-\frac{1}{3k}(1-p_1)\min\left\{\left(\frac{c}{1-p_1}\right)^{1/2},k\right\}^3-\frac{1}{3k}\sum_{i=2}^{N}(1-p_i)\min\left\{\left(\frac{c}{1-p_i}\right)^{1/2},k\right\}^3.$$

Note that $(\frac{c}{1-p_i})^{1/2}\geq k\Leftrightarrow p_i\geq 1-\frac{c}{k^2}$.

First, suppose that c is sufficiently large: $c\geq k^2$. Then $\min\{(\frac{c}{1-p_i})^{1/2},k\}=k$ for all i and hence there is no communication regardless of $(p_1,...,p_N)$. In this case, expected firm value is $V_0-\mathbb{E}\varepsilon^2-\frac{k^2}{3}(N-1)$, which does not depend on $(p_1,...,p_N)$. Hence, in this case, allocation of control does not matter. In particular, the allocation $(1,0,...,0)$ is optimal.

Second, suppose that $c<k^2$. When control is allocated to one director: $p_1=1$, $p_i=0$ for $i>1$, expected firm value is given by

$$\mathbb{E}_{(1,0,...,0)}(V)=V_0-\mathbb{E}\varepsilon^2-\frac{1}{3k}\sum_{i=2}^{N}c^{3/2}.$$

Consider any other possible allocation of control $(p_1,...,p_N)$, $p_1\geq p_2\geq ...\geq p_N$. Our goal is to show that $\mathbb{E}_{(1,0,...,0)}(V)-\mathbb{E}_{(p_1,...,p_N)}(V)\geq 0$, which is equivalent to

$$(1-p_1)\min\left\{\left(\frac{c}{1-p_1}\right)^{1/2},k\right\}^3+\sum_{i=2}^{N}\left[(1-p_i)\min\left\{\left(\frac{c}{1-p_i}\right)^{1/2},k\right\}^3-c^{3/2}\right]\geq 0. \quad (A14)$$

There are two possible cases: $p_1\geq 1-\frac{c}{k^2}$ and $p_1<1-\frac{c}{k^2}$. Suppose first that $p_1\geq 1-\frac{c}{k^2}$. Let $M\in\{1,...,N\}$ be such that $p_i\geq 1-\frac{c}{k^2}$ for $i=2,...,M$ and $p_i<1-\frac{c}{k^2}$ for $i=M+1,...,N$. Then (A14) is equivalent to

$$(1-p_1)k^3+\sum_{i=2}^{M}\left[(1-p_i)k^3-c^{3/2}\right]+\sum_{i=M+1}^{N}\left[(1-p_i)\left(\frac{c}{1-p_i}\right)^{3/2}-c^{3/2}\right]\geq 0. \quad (A15)$$

Note that $(1-p_i)(\frac{c}{1-p_i})^{3/2}-c^{3/2}=c^{3/2}\left[(1-p_i)^{-1/2}-1\right]\geq 0$ and hence the last component is non-negative. The sum of the first two components of (A15) is also non-negative:

$$k^3\left(M-\sum_{i=1}^{M}p_i\right)-(M-1)c^{3/2}\geq(M-1)\left(k^3-c^{3/2}\right)\geq 0.$$

Hence, all components of (A15) are non-negative and thus, indeed, (A14) is satisfied.

Second, suppose that $p_1<1-\frac{c}{k^2}$ and hence $p_i<1-\frac{c}{k^2}$ $\forall i$. Then (A14) is equivalent to $c^{3/2}(1-p_1)^{-1/2}+c^{3/2}\sum_{i=2}^{N}\left[(1-p_i)^{-1/2}-1\right]\geq 0$, which is satisfied because both components are non-negative.

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Proof of Proposition 7. Let f and c be the density of directors' signals and directors' cost of communication, respectively, and let $[-k,k]$ be the support of the distribution. If $p_i = 1$ and $p_j = 0$ for $j \neq i$, then $d_i = \min\{(\frac{c}{1-\frac{1}{1+r_i}})^{1/2}, k\}$ and $d_j = d = \min\{c^{1/2}, k\}$ for $j \neq i$. Hence, according to Lemma A.4, expected firm value is given by

$$V_0 - \mathbb{E}\varepsilon^2 - \left(\frac{r_i}{1+r_i}\right)^2 \int_{-d_i}^{d_i} x^2 f(x) dx - \sum_{j \neq i} \int_{-\min\{c^{1/2},k\}}^{\min\{c^{1/2},k\}} x^2 f(x) dx. \qquad (A16)$$

The first and third component of (A16) do not depend on i, and the second component is a function of r_i. Consider the function

$$g(r) = \left(\frac{r}{1+r}\right)^2 \int_{-d(r)}^{d(r)} x^2 f(x) dx,$$

where $d(r) = \min\{c^{1/2}(\frac{r}{1+r})^{-1/2}, k\}$. In the region where $d(r) = k$, $g(r)$ is proportional to $(\frac{r}{1+r})^2$ and hence is increasing in r. In the region where $d(r) = c^{1/2}(\frac{r}{1+r})^{-1/2}$, it can be shown that $g'(r) > 0$ is equivalent to

$$-\frac{1}{2} c^{1/2} \left(\frac{r}{1+r}\right)^{-3/2} \left(\frac{r}{1+r}\right)^2 d^2(r) f(d(r)) + \frac{2r}{1+r} \int_0^{d(r)} x^2 f(x) dx > 0. \qquad (A17)$$

Because $f(x)$ is non-increasing for $x > 0$, $\int_0^{d(r)} x^2 f(x) dx \geq d^2(r) f(d(r)) d(r)$ and substituting this inequality into (A17), we see that (A17) is always satisfied. Finally, $g(r)$ is continuous at the point where $d(r)$ switches from $c^{1/2}(\frac{r}{1+r})^{-1/2}$ to k. Hence, the function $g(r)$ is increasing in r, which proves that (A16) is maximized when $i \in \arg\min_j\{r_j\}$. ∎

Lemma A.5. Suppose directors' utility is given by (22), where $w(r) = 1 - r$. Then firm value is maximized at $(r_1^*, ..., r_N^*)$, where r_i^* is strictly positive.

Proof of Lemma A.5. We start by deriving the equilibrium strategies and expected firm value for a general function $w(r)$. Repeating the proof of Lemma A.1, it is easy to show that the equilibrium action of director i at the decision-making stage is given by (10) for directors who communicated their signals, and by

$$a_i^* = \sum_{j \in J_C} x_j + \sum_{j \in J_{NC}, j \neq i} y_j + Q_i x_i + (1 - Q_i) y_i$$

for directors who did not communicate their signals, where $Q_i = \frac{w(r_i) p_i}{w(r_i) p_i + r_i}$. Using these expressions and repeating the proof of Lemma A.3, director i reveals x_i at the communication stage if and only if $|x_i| > d_i = (\frac{c_i}{A_i})^{1/2}$, where

$$A_i = w(r_i)(1 - p_i) + \frac{w(r_i) p_i r_i}{w(r_i) p_i + r_i}.$$

It follows that d_i decreases in r_i if and only if (23) is satisfied.

Repeating the proof of Lemma A.4, expected firm value is given by

$$\mathbb{E}(V) = V_0 - \mathbb{E}\varepsilon^2 - \sum_{i=1}^N \left[1 - p_i + p_i \left(\frac{r_i}{w(r_i) p_i + r_i}\right)^2\right] \int_{-d_i}^{d_i} x_i^2 f_i(x_i) dx_i. \qquad (A18)$$

Special case: $w(r) = 1 - r$

Suppose $w(r) = 1 - r$, $r \in [0, 1]$. Plugging this into (23), d_i decreases in r_i if and only

$$f(r) \equiv r^2 \left(1 - 2p + 2p^2 - p^3 \right) + 2r \left(p - p^2 + p^3 \right) - p^3 < 0,$$

where $1 - 2p + 2p^2 - p^3 = (1 - p)\left(p^2 - p + 1 \right) > 0$. Since $f(0) < 0$ and $f(1) = 1 > 0$, then $f(r) < 0 \Leftrightarrow r < \hat{r}$ for some $\hat{r} \in (0, 1)$. In addition, using (23) and (A18), it can be shown that

$$\lim_{r_i \to 0} \frac{\partial \mathbb{E}(V)}{\partial r_i} = f_i \left(c_i^{1/2}(1 - p_i)^{-1/2} \right) c_i^{3/2}(1 - p_i)^{-3/2} p_i,$$

which is strictly positive. Hence, firm value is maximized at some strictly positive r_i, potentially, infinitely large.

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