Authority, Consensus and Governance*

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Abstract

We characterize optimal corporate boards when shareholders face a trade-off between improving information sharing between the board and management and reducing distortions in decision-making arising out of managerial agency. We show that allocating authority to management is suboptimal. Authority should be held by a supervisory board that may be imperfectly aligned with both shareholders and management. Even when management has captured all authority and the board only has an advisory role, the optimal board may be designed to withhold information from management. Optimal advisory boards must however be able to create consensus with management, making the allocation of authority irrelevant.

JEL classification: C72, D71, D72, D74, D82, G34.

Key Words: cheap talk, delegation, intermediation, consensus, supervisory boards, advisory boards, governance, hierarchies.

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1 Introduction

Effective communication is important for taking efficient decisions. Successful exchange of information between the board and management of a corporation is a key determinant of shareholder value. In practice, such communication is often constrained by the fact that management has its own agency that predisposes it towards one of the decisions under consideration. For instance, management may favor going ahead with an investment motivated in part by the joy of empire-building, or be biased towards rejecting a raider's offer due to private benefits of retaining control. If such conflicts are strong, management may withhold important information from a board of directors that acts presumably in shareholder interest. From the normative perspective of maximizing shareholder value, what should an optimal board look like in such situations?

To answer this question we consider an environment where both the board as well as management have *expertise* or private information relevant for the decision facing the corporation. For instance, management may have information about the value of an innovative investment, whereas the board may have legal, regulatory or financial expertise about potential future costs. The information held by either party is valuable for everyone but the possibility of freely sharing this information is constrained by potential conflicts of interest.

In such situations shareholders face a fundamental trade-off. If they choose a board that shares the management's interests then information transmission between the manager and a sympathetic board should be quite effective and the final decision of the board will be well informed. However, decision-making will be distorted away ex-post from shareholder value maximization and towards management value maximization. In contrast, if shareholders choose a board that is less sympathetic to management, ex-post decision-making will be closer to shareholder interests although at the cost of poor information transmission between management and a skeptical board. We show that the optimal board will often be imperfectly aligned with both shareholders and management, balancing the gain from improved information flows against the cost of distorted decision-making. In effect, shareholders will gain by replacing the agency problem between shareholders and management by two smaller agency problems, one between management and the board and a second one between the board and shareholders.

This argument on the benefit of a board with intermediate alignment assumes two things. First, it supposes that the board's approval is necessary for the final decision so that the board has *supervisory authority*. Second, it requires that shareholders cannot freely share the private information obtained by expert board members. If shareholders could commit to revealing this information to all parties, they would never need to consider aligning the board with management and should hold decision-making authority themselves. Only when such commitment is absent, aligning the supervisory board at least partially with management is likely to be important for improving information flows.

The effective supervisory authority of the board may also be quite limited in practice. Often management controls the implementation of approved projects and the board only has limited powers to modify fine details of corporate plans brought before it by management. The board can at best approve or turn down management proposals taking into account its own expertise and information and any information that management provides in its efforts to persuade the board. In the extreme situation where management has completely captured the firm and can implement any decision it wishes with or without approval from the board, authority is held by management and the board is not an effective supervisor. Nonetheless, the expertise of the board allows it to have an *advisory role* that is important for shareholder value. One of the main objectives of this paper is to understand the role of advisory boards in situations where effective authority has been captured by management.

A conflict of interest between an advisory board and management can only hamper information flows between the board and management without affecting in any way the distortion in the final decision-making that is fully controlled by management. Management can always ignore an advisory board. We show that the shareholder value maximizing advisory board must be at least as management aligned as the optimal supervisory board. However, the optimally aligned advisory board may also have a conflict of interest with management. When the manager is uncertain about the value of pursuing his favored agenda, imprecise information from the advisory board preserves managerial doubt about the benefits of insisting on his agenda. This limits the distortion arising out of managerial control over actual decision making and may benefit shareholders in ex-ante expected terms even after adjusting for the expected costs of relatively poor information transmission. Indeed, in contrast to the case where the board has supervisory authority, shareholders may strictly prefer a conflict between an advisory board and management even when they can commit to perfectly revealing the board's information to management.

In order to determine the shareholder value maximizing level of conflict between an advisory board and management we develop a notion of agreement between the board and management that we call *consensus*. Consensus obtains when each side agrees with the final decision given its own information and the information revealed endogenously in equilibrium. Consensus is not necessary for successful information exchange and it may obtain even when there is a conflict of interest between board and management. When consensus obtains, the allocation of decision-making authority is irrelevant. We show that the optimal advisory board cannot be too conflicted with management— it must be sufficiently aligned so that it can create consensus.

Since authority is irrelevant when consensus obtains, the optimal advisory board is also an optimal supervisory board but determined subject to the additional constraint that the board obtain managerial consensus. The loss in shareholder value from letting authority move from the board to management is equal to the loss in value from keeping authority with the board but imposing the additional constraint of consensus. Requiring consensus is equivalent to handing management authority, provided board alignment is chosen optimally. It follows that shareholders can never find it strictly optimal to give authority over decision-making to management. When authority has effectively been captured by management, shareholders will find it optimal to design an advisory board that is able to induce management to always follow the board's advice. In effect, management hands back authority to the optimal advisory board.

Does shareholder control of the board necessarily lead to a loss in shareholder welfare? If shareholders always agree with the final decisions made by the board we say that the board obtains *shareholder consensus*. We show that the ability to generate shareholder consensus is a necessary property of the optimal board at the optimal allocation of authority. It follows that shareholders do not need to commit to cede control to the expert board. The optimal board need only be an intermediary with final decision-making authority concentrated in a perfectly shareholder aligned board member. This is true as long as shareholders do not observe the details of deliberations between the rest of the board and management and often even when they do. In this sense, we provide a defense of the point of view that shareholders should control decision-rights in a corporation in order to maximize shareholder welfare, as espoused for example by Bebchuk (2005). It is never strictly optimal for shareholders to hand final decision making authority to management and always at least weakly optimal for shareholders to hold authority themselves.

Taken together, our results show that shareholder preferences of over alternative board structures are driven by differences in their transparency. By transparency we mean a lack of impediments to information flows between the board and management and between the board and shareholders. Ideally, shareholders would like to commit to full transparency and reveal the board's information to all parties, holding authority themselves. When such commitment is infeasible, shareholders may like to introduce a lack of transparency between the expert tier of the board and the management created via a conflict between the two. In such cases, final authority can be held by a shareholder aligned supervisory tier that does not observe the deliberations of the lower expert tier with management. In contrast, in cases where effective supervisory authority has been captured by management, shareholders may prefer a lack of transparency even when committing to perfectly reveal the board's information is feasible. The optimal advisory board may withhold information from management while being sufficiently management aligned in order to create consensus and recapture authority.

Beyond the particular context of designing corporate boards, these results further our understanding of the role of authority in organization design. Arrow (1974) suggests that governance by authority is a defining feature of organizations while governance by consensus is a "polar alternative" whose costs are likely to rise "when either interests or information differ among the members of an organization" (chapter 4, pp. 70). We pursue this intuition in a formal model of strategic communication under differences of both information and interests. We show that governance by consensus is the optimal response to a loss of authority but the costs of governance may sometimes be lower when the interests of the board and management differ. Our focus on a difference in interests places this paper in the literature that takes an agency-theoretic approach to understanding organizations based on a conflict in preferences between owners and managers (Alchian and Demsetz (1972), Jensen and Meckling (1976)). The emphasis on information transmission reconciles our conflict-based approach in part with the approach that views firms as information processing hierarchies (Williamson (1975), Radner (1992)).

Our results on supervisory boards use and build on existing delegation results in the literature, in particular those of Dessein (2002). In contrast to the usual framework with continuous actions and one-sided private information considered in the literature on cheap talk games (Crawford and Sobel, 1982) we work in a binary decision setting with two-sided private information. The coarseness of decisions captures the institutional feature that the board only has limited powers to modify management proposals and monitor their implementation. The presence of private information allows the board to have a non-trivial advisory role even when effective authority has been captured by management.[1]

The introduction of different pieces of private information for the board and management allows us to bring out in greater detail the difference between the alignment of the board with management (which affects information flows) and the allocation of authority to the board or management (which affects distortions in decision-making). We show that it is best for shareholders to keep supervisory authority in the hands of the board. When this can be done, shareholders would prefer a perfectly shareholder aligned board and commit to reveal the information held by the board. Only when such commitment is infeasible can shareholders gain by choosing a board that is partially aligned with management. The conflict between shareholders and the expert supervisory board illustrates the benefits of a separation of ownership from control. The conflict between the board and management illustrates the benefits of limiting managerial agency even at the cost of poor information transmission. In this sense, we provide a rationale for hierarchies or deep authority structures in organizations.[2]

Aghion and Tirole (1997) also analyze the optimal allocation of authority within organizations. They draw a distinction between formal and real authority and show that often the party with formal authority will delegate authority to another agent with information. Communication is equivalent to delegation of real authority to the informed agent since the latter will take/induce its own ideal decision in either case. Intermediation also has no role to play. In our setting in contrast, the board and management have different pieces of information but no agent has superior

[1] Although we analyze a binary decision problem with two-sided private information, we identify a close similarity, in terms of equilibria, payoffs and comparative static properties, with the canonical model of Crawford and Sobel (1982) with a continuum of possible decisions but one-sided private information. Because of this, many results originally established in the Crawford-Sobel set-up extend to our setting and we make heavy use of this 'equivalence' throughout the paper. Since our model has two-sided private information however we are also able to generate some novel results that have no direct parallel in the model where only one agent has private information relevant for the decision.

[2] We focus on the case where the supervisory board is a delegate, i.e., has decision-making power. We do not consider the possibility of more elaborate delegation schemes (see Alonso and Matouschek 2008) and neither do we consider intermediation by an agent without decision-making power (see, e.g., Goltsman et al. (2009), Blume et al. (2009), Ivanov (2009), Ambrus et al. (2011) for results in the CS framework). Because of the coarseness of decisions and the presence of two-sided private information, it is not staightforward to carry over results on optimal intermediation mechanisms defined in the CS framework. As we show, the optimal supervisory board need only be an intermediary in our setting while the optimal advisory board will effectively recapture decision-making authority.

information. Neither party is guaranteed its own ideal decision under either communication or delegation. Still, the ability to allocate effective formal authority ex-ante to the board is important for shareholders even when the board is allowed to subsequently delegate its authority to management as a function of its own information.

Our work is closely related to questions on corporate governance raised by Harris and Raviv (2005, 2008, 2010). Introducing two-sided private information in the Crawford and Sobel (1982) model of strategic information transmission, they show that a principal is better off allowing the agent to have decision-making authority if his own information is less important.[3] This is despite the fact that the principal can always delegate authority at the interim stage after obtaining information. Since delegation by an informed principal creates an adverse selection problem, allocating authority to the agent is often ex-ante optimal. In contrast, we introduce a second instrument for shareholders (the principal) that is distinct from authority/control, namely the alignment of the board (the intermediary) with management (the agent). Once the alignment is chosen optimally ex-ante, management control of the firm is never strictly optimal for shareholders. We also allow the board to delegate authority to management at the interim stage as a function of its own information. This has no effect in our setting because communication at the interim stage is a perfect substitute for delegation accompanied by communication.

Agastya et al. (2011) introduce receiver private information about the actual conflict of interest between the sender and receiver in a Crawford-Sobel framework. When the ex-ante expected conflict is small, sender uncertainty about it forces communication to be quite informative, leading the receiver to prefer retaining authority over delegating to the sender. In contrast, Baldenius et al. (2010) show that the receiver may prefer to delegate to the sender only when the sender's bias is small. They also employ a Crawford-Sobel set up in which the receiver may choose to either obtain the sender's information or an independent piece of information. Unlike us, these papers do not consider alignment as an additional instrument that makes the allocation of authority to management suboptimal from the ex-ante perspective of shareholders.[4]

[3] Chen (2009) and de Barreda (2011) also introduce a two-sided private information in the form of a noisy signal of the sender's signal that is obtained by the receiver. The allocation of authority is not a question asked by these papers.

[4] Somewhat more distantly related is the paper by Adams and Ferreira (2007), who model a board as a device that probabilitically forces management to give up control ex-post. If the expected intervention is very likely, management will not provide information to an unfriendly board.

Beyond corporate governance, our results provide insights on the practice of collective decision-making by specialized committees of possibly biased agents (see, for example, Li, Rosen and Suen (2001)). Our analysis of advisory boards in particular sheds light on the problem of choosing a lobbyist from the perspective of an interest group, the capture of regulatory agencies by groups they are meant to regulate, as well as the value to voters from creating a conflict between different branches of government.

The rest of the paper is organized as follows. Section 2 contains our results on the structure of communication and the possibility of consensus. Section 3 characterizes the optimal supervisory and advisory boards. Section 4 presents results on shareholder consensus and board structure. Section 5 contains our concluding remarks and all proofs are in the Appendix.

2 Supervisory and Advisory Boards

2.1 Model

A principal or owner of a firm has to choose between a status quo or an alternative. We think of the principal as the shareholders collectively. The status quo is safe and we normalize its value to shareholders equal to zero. The alternative has uncertain value $x-y$ for shareholders where $x \in [0,1]$ and $y \in [y_L, y_H]$. If shareholders observed x and y then they would like to choose the alternative if $x - y > 0$ and the status quo otherwise. We assume however that shareholders are uninformed and x is the private information or expertise of management whereas y is the private information or expertise of the board. Let F_x and F_y denote the common knowledge priors associated with the random variables x and y with densities f_x and f_y. We assume that x and y are statistically independent and, for tractability, assume throughout that F_x and F_y are uniform.

We will often refer to the alternative as a decision to 'invest' in a project with the status quo being the default option of not investing. Managerial expertise x then reflects specialized knowledge of the operational details of the project whereas the board's expertise y may be about legal or regulatory issues. Alternatively, the firm may be faced with choice between accepting a raider's offer or adopting an anti-takeover measure. In such a case, management may have private information about the intrinsic value of the firm under current management whereas the board may have expertise in evaluating the legality of anti-takeover measures proposed by management or in estimating the value of keeping alive the interest of potential raiders in the market for corporate control.[5]

The central conflict of interest in this paper is between management and shareholders. Management is biased in favor of the alternative and the value of the alternative to management is the sum of shareholder value $x - y$ and a private benefit b_m whereas the value of the status quo is zero. Thus, management would ideally like to invest if and only if $x - y + b_m > 0$. The managerial bias parameter $b_m > 0$ reflects managerial agency in the form of private benefits of empire-building and expanded control.[6]

We wish to determine the composition of the board and the optimal allocation of authority from the ex-ante perspective of shareholders. We capture the composition of the board simply by a bias parameter $b_d \in [0, b_m]$ that captures the board's "ideological" alignment with management. The value of the alternative to the board is $x - y + b_d$ while the value of the status quo is zero. In general, the board may consist of both shareholder aligned members (such as independent directors) or management aligned members (friends or associates of management). If the board takes its final decision via majority voting then we may think of b_d as the bias of the median board member.[7]

We suppose that b_d is chosen at the ex-ante stage by shareholders.[8] Subsequently, the board learns its information y while management learns x following which the board and management

[5]Nothing depends on the status quo being safe and we may think of $x - y$ as the net (possibly negative) benefit of the alternative relative to the status quo. We also permit the relative importance of the two sources of information to vary, e.g., by writing $y = kz$, where z is a random variable capturing the board's information and $k \geq 0$ a scalar parameter that measures the relative importance of the two sources of information for the decision at hand.

[6]The importance of managerial agency in corporate governance and performance has been extensively analyzed (See, e.g., Jensen and Meckling, 1976). In this paper, we take this agency as given and suppose that the bias b_m is a necessary cost of having a manager with payoff-relevant expertise x. We assume as well that all private information is unverifiable and contracts are incomplete so that management is not perfectly aligned with shareholders even after an optimal provision of incentives. We also abstract away from reputational concerns. Apart from difficulties in enforcing reputational schemes when information is noisy and unverifiable, it may not also be optimal to fire a manager with valuable firm-specific capital (e.g., expertise x about the firm) that her replacement will take time to build. See Section 5 for a more detailed discussion of many of these issues.

[7]Alternatively, we may assume that the board maximizes a weighted sum of the welfare of its shareholder aligned members (with zero bias) and management aligned members (with bias b_m), with the weights being proportional to the size of each group. In this scenario, the ratio b_d/b_m measures the proportion of management aligned board members or the "bargaining power" of the management aligned lobby.

[8]In reality, both management and shareholders have a say in board composition. In this paper we take a normative approach and focus on determining the necessary properties of shareholder value maximizing boards.

communicate. Communication between the board and management is strategic and takes the form of cheap talk. Communication is followed by the final decision taken by the agent holding authority. We will contrast two alternative allocations of authority in the analysis to follow. In the first case, the board has final decision-making authority and any decision made by the firm must obtain the board's approval. We call this the case of a *supervisory board*.[9] In the second case, management has total control over the firm and can take any decision it wants even in defiance of the board's wishes. The composition of the board is relevant in this case only because of the information held by the board. We call this the case of an *advisory board*. We wish to identify the shareholder value maximizing choice of b_d both in the case of a supervisory board and an advisory board. In doing so, we also determine the value of authority, i.e., the relative merits of supervisory and advisory boards after the composition of the board b_d has been optimized.

Throughout the paper we impose the parameter restrictions $y_L < 1$ and $y_H > b_m$. If instead $y_L \geq 1$, then shareholders are not interested in obtaining information about x and can do no better than choosing perfectly shareholder aligned supervisory board that never chooses the alternative. Similarly, if $y_H \leq b_m$, then management is not interested in obtaining information about y and an advisory board has no role to play. Even with a supervisory board, management will necessarily be uninformative since it prefers to choose the alternative regardless of the state of the world. In such cases, shareholders can do no better than choosing a perfectly shareholder aligned supervisory board that chooses the alternative as a function of y. Our results are more interesting in the complementary case where $y_L < 1$ and $y_H > b_m$ and each party has an interest in learning the other party's information.

2.2 Communication

We consider the case of a supervisory board first. We model this as a simple game where management first sends a cheap talk message μ to the board, possibly as a function of x, following which

[9] Notice that even a supervisory board can only approve or reject a proposal brought forward to it by management and that will be implemented ultimately by management. This implicitly captures a situation where most of the effective authority within the firm is in the hands of management and the board has a limited ability to monitor management ex-post and limit its agency. The board also has no control over the details of the decision facing the corporation (such as the size or location of the investment) and management entirely controls this 'agenda-setting' aspect of the firm. A supervisory board may however turn down (or approve) a management proposal.

the board takes the final decision after taking into account its own information y. If $b_d = b_m$, then the management and board have perfectly aligned interests. Therefore they should be willing to perfectly share their information in order to implement the optimal decision rule given their common interests. This involves investing whenever $x - y + b_m > 0$. For the rest of this section we focus on determining the nature of communication in the more interesting case where $b_d \neq b_m$ and there is a conflict of interest between the board and management.

Given any message μ from the management, the board will prefer to invest whenever its own signal y is less than a threshold value $t = E[x|\mu] + b_d$. From the perspective of management, the expected payoff from sending message μ is the expected value of the investment times the probability that investment occurs, i.e., the expected payoff equals

$$\Pr[y < t]\,[x - E(y|y < t) + b_m] \equiv q(x + b_m) - \int_0^q F_y^{-1}(z)dz, \tag{1}$$

where $q = \Pr[y < t] = F_y(t)$ is probability that the board chooses the alternative. The last expression is a supermodular function of x and q that is concave in q. It follows that management's communication strategy must take an "interval partitional" form, i.e., management will disclose an endogenously determined interval within which x lies. Proposition 1 describes the equilibrium set.

Proposition 1 *Suppose $b_d \neq b_m$ and assume a supervisory board. In any cheap talk equilibrium, management discloses the interval $[c_{i-1}, c_i)$ in which x lies, $0 = c_0 < .. < c_i < ... c_N = 1$, where*

$$c_i = E[y|t_i < y < t_{i+1}] - b_m, i = 1, ..., N-1. \tag{2}$$

Following management's message that $x \in [c_{i-1}, c_i)$, the board chooses the alternative iff $y < t_i$ where

$$t_i = E[x|c_{i-1} < x < c_i] + b_d, i = 1, ..., N. \tag{3}$$

There exists $N^*(b_d, b_m) < \infty$ that is an upper bound on the number of distinct thresholds t_i that can be induced in equilibrium.

Figure 1 illustrates Proposition 1. In the figure we take $b_m = \frac{3}{16}$ and $b_d = 0$. For these parameter values, there is an informative equilibrium in which the management sends two distinct messages. The 'low' message μ' reveals that $x < c_1 = \frac{1}{8}$ whereas the 'high' message μ reveals that $x > \frac{1}{8}$.[10]

[10] In the figure, management information $x \in [0, 1]$ while the board's information $y \in [0, \frac{22}{16}]$. The figure also shows

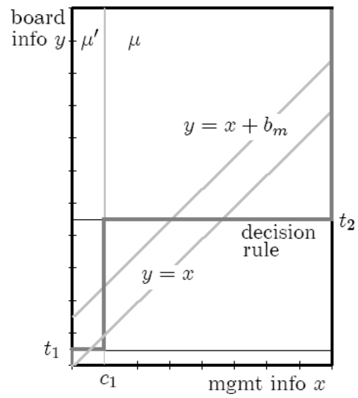

Figure 1: Decision Rule under Supervision

For the low message μ', the board chooses the alternative whenever $y < t_1 = E[x|x < \frac{1}{8}] = \frac{1}{16}$ whereas for the high message the board chooses the alternative whenever $y < t_2 = E[x|x > \frac{1}{8}] = \frac{9}{16}$. The resulting step function depicts the decision rule that is implemented in equilibrium— below the step function the alternative is chosen by the board whereas above the step function the status quo is chosen.[11] The cutoff type c_1 is indifferent between the two decisions, but *conditional* on the event that the message sent makes a difference for the decision, i.e., on the event that the board's information y is in between the two thresholds t_1 and t_2.

Proposition 1 shows that the equilibrium set of our cheap talk game with binary decisions and two-sided private information is similar to that of the cheap talk game with one-sided private information and continuous actions considered in Crawford and Sobel (1982, henceforth CS). In fact, when $t_i \in [y_L, y_H]$ for all i, under our distributional assumptions the equilibrium conditions (2) and (3) can be rewritten to obtain the difference equation

$$l_{i+1} = l_i + 4B, i = 1, ..., N, \tag{4}$$

where $l_i = c_i - c_{i-1}$ is the length of the ith interval in the manager's announcement strategy and

the decision rule that would be used if shareholders had all the information and authority (the line $y = x$) and the rule that would be used if management had all the information and authority (the line $y = x + b_m$). Any cheap talk game also has a babbling equilibrium where the board does not attach any meaning to the management's messages and so the management cannot do better than being uninformative.

[11] A decision rule chooses a decision (status quo or alternative) as a function of x and y. We say that a particular decision rule is an equilibrium decision rule, or implemented in equilibrium, if that mapping from states to decisions is the outcome of equilibrium play between management and the board for some equilibrium.

$B = b_m - b_d$ measures the net conflict of interest between the board and management. This is identical to the equilibrium difference equation obtained in the leading uniform-quadratic example of CS. The fact that the lengths increase for higher values of x reflects the fact that the the manager's incentive to overstate the case for investing limits his credibility and forces him to disclose coarser information exactly when x is high and the case for investing is strong.

The similarity with CS extends beyond the double uniform (uniform-quadratic) case. As (1) illustrates, from the perspective of management (the sender), the game with a supervisory board is like a CS game where x is the information of the sender and $q \in [0, 1]$, the probability with which the board chooses the alternative, the 'action' of the receiver. Of course, the action q depends on the board's payoff relevant information y. Further, when $t_N > y_H$, the corresponding action q of the receiver hits the upper boundary ($q = 1$), whereas if $t_1 < y_L$ the action hits the lower boundary ($q = 0$). In such cases, even under the double uniform assumption, (4) does not obtain. Relative to CS, in our model the space of possible actions q is bounded and the conflict of interest between the sender and the receiver in general exhibits only a weak and not strict upward bias (Gordon, 2007). Nonetheless, there is a maximal number of messages $N^*(b_m, b_d)$ that can be sent in any equilibrium and in what follows we assume that this "most informative" equilibrium is the one that is played in the game between the board and management.[12]

Proposition 1 characterizes all equilibria in the game where management first communicates with the board following which the board takes a decision. Call this sequence of moves mb^*, where we use the asterisk to denote the allocation of decision-making authority to the supervisory board. For our next result we focus on an alternative allocation of authority and characterize the equilibria of the game bm^* in which the board first speaks to management following which management takes the final decision. In bm^* decision-making authority is held by management and the board only has an advisory role.

Proposition 2 *Fix $b_d \neq b_m$ and assume an advisory board. In any cheap talk equilibrium, board*

[12] Because we do not have strict upward bias, the equilibrium refinement proposed in Chen, Kartik and Sobel (2008) does not apply in general in our setting. Whenever it does, the most informative equilibrium is the only equilibrium that satisfies it. Given our distributional assumptions, there is a unique equilibrium with N partitional elements for $1 \leq N \leq N^*$. Furthermore, the most informative equilibrium with N^* elements maximizes the receiver's ex-ante payoffs.

discloses the interval $[t'_{i-1}, t'_i)$ *in which* y *lies,* $y_L = t'_0 < ... < t'_i < ... < t'_M = y_H$ *where*

$$t'_i = E[x|c'_{i-1} < x < c'_i] + b_d, i = 1, ..., M-1. \quad (5)$$

Following the board's message that $y \in [t'_{i-1}, t'_i)$*, management chooses the alternative iff* $x > c'_i$ *where*

$$c'_i = E[y|t'_i < y < t'_{i+1}] - b_m, i = 1, ..., M. \quad (6)$$

There exists $M^*(b_d, b_m) < \infty$ *that is an upper bound on the number of distinct cutoffs* c'_i *that can be induced in equilibrium.*

This result is the analogue of Proposition 1 for the case where decision-making authority is held by the management instead of the board.[13] While the structure of equilibria characterized by Propositions 1 and 2 look qualitatively similar, the two games result in different outcomes. The decisions that are taken as a function of x and y in an equilibrium of the game mb^*, where the board has supervisory authority, are in general not identical to the decisions that can be supported in an equilibrium of bm^*, where the board is an advisor. In the rest of this section we further characterize the similarities and differences between the decision rules that can be implemented in equilibria of the two games mb^* and bm^* for fixed b_d and b_m.

We begin by showing that given an allocation of authority the details of the communication protocol (or game form) does not affect the equilibrium decision rules. To understand this, compare the game mb^* with the game bmb^*. In bmb^* the board first communicates with management, following which management communicates with the board, following which the board takes a final decision. In both mb^* and bmb^* final decision-making authority is held by the board but more extensive multi-stage communication is permitted in the latter. Since in our setting both parties are privately informed it is not clear a priori whether or not the restriction on communication by the board in mb^* has any effect on the decisions taken by the board.

Our next result shows that the equilibrium decision rules are not affected by the details of the communication protocol. In the first part of the result we compare the game mb^* with the games bmb^* as well as b^*mb^*. The game b^*mb^* is similar to bmb^* except that the board can also take a unilateral decision in the first round instead of choosing to communicate with management.

[13] As with mb^*, we also focus on the most unique informative equilibrium of bm^* with M^* partition elements, throughout what follows.

If it does the latter, then management speaks to the board following which the board takes a decision. The first part of Proposition 3 shows that the equilibrium decision rules are identical in these three games in which decision-making authority is held by the board. The second part of the result provides the same result for the analogous games bm^*, mbm^* and m^*bm^* in all of which management holds decision-making authority and the board just has an advisory role.

Proposition 3 *Fix $b_d \neq b_m$.*

1. *The set of equilibrium decision rules is identical across the games mb^*, bmb^* and b^*mb^* in which the board has authority.*
2. *The set of equilibrium decision rules is identical across the games bm^*, mbm^* and m^*bm^* in which management has authority.*

Proposition 3 shows that, given an allocation of decision-making authority, extended communication by the two parties has no additional benefit in our setting. While the proof contains some important technical details, the intuition is relatively straightforward— the information that the two parties can bring to bear on the decision depends on their conflict of interest and each party can take this conflict (and the other party's incentives) into account even with one round of communication by conditioning on the event when its own message makes a difference for the decision.[14]

In the case of a supervisory board, decision-making authority is held by the board. We ask next if allowing such a supervisory board to delegate decision-making authority to management, possibly as a function of its private information y, makes a difference for our results. We capture the possibility of delegation by a supervisory board with the game b^*m^* in which the board may first take a unilateral decision or communicate with management. In the latter case, it hands over decision making authority and lets management take the final decision. The first part of our next result compares b^*m^* with mb^*, the baseline case with a supervisory board. The second part compares the analogous game m^*b^* with bm^*, the baseline case with an advisory board.

Proposition 4 *Fix $b_d \neq b_m$.*

[14] Krishna and Morgan (2004) (see also Aumann and Hart, 2003) show in the CS setting that simultaneous communication may expand the equilibrium set since it allows the players to create jointly controlled lotteries via simultaneous use of randomized messages. We do not pursue the analysis of simultaneous communication in this paper.

1. *Any equilibrium decision rule of b^*m^* is also an equilibrium decision rule of mb^*. If an equilibrium decision rule of mb^* is not an equilibrium decision rule of b^*m^*, then there is a more informative equilibrium of mb^* with a decision rule that is an equilibrium decision rule of b^*m^*.*

2. *Any equilibrium decision rule of m^*b^* is also an equilibrium decision rule of bm^*. If an equilibrium decision rule of bm^* is not an equilibrium decision rule of m^*b^*, then there is a more informative equilibrium of bm^* with a decision rule that is an equilibrium decision rule of m^*b^*.*

Given our focus on the most informative equilibrium, Proposition 4 shows that the possibility of delegation of authority by a supervisory board to management has no effect on outcomes. Similarly, if management has authority, delegation by management to the advisory board at the interim stage cannot alter the set of achievable outcomes. In essence, the party with authority may wish to exercise that authority without engaging in communication only when it has extreme information. In the absence of such extreme information each party is interested in the information held by the other. In such cases, communication is driven by the commonality of interest between the two parties and it does not matter for outcomes whether or not authority is also delegated as long as communication is informative.[15]

Taken together the results in this section show that a conflict of interest between the board and management necessarily results in coarse communication between the two parties. Given an allocation of authority, it is this conflict that determines the incentives to communicate and the decision rules that can be implemented in equilibrium. The precise details of the communication protocol are not important for determining shareholder value. Neither is the possibility of transfer of authority from one agent to the other given an initial allocation of authority to the board or management. In the next section we ask if and when the initial allocation of authority can also be irrelevant for shareholder value.

[15] Ivanov (2009) demonstrates in the CS setting that an uninformed receiver may prefer to communicate with the sender through a suitably biased but uninformed strategic third party (see also Ambrus et al., 2011). This recreates the optimal intermediation mechanism of Goltsman et al (2009) (see also Blume et al 2009). We allow delegation at the interim stage by an informed board to management and vice versa, but do not allow either party to choose an uninformed third party intermediary at the ex-ante or interim stage.

2.3 Consensus

The decision rules that can be implemented in an equilibrium for the game mb^* with a supervisory board are not in general identical to the decision rules that can be implemented in an equilibrium of bm^* where the board is an advisor. We show now that an equilibrium decision rule does not depend on the allocation of authority when the equilibrium displays a property that we call *consensus*. Consensus obtains when the agent *without* decision-making authority agrees with (i.e., does not *wish* to overturn) the final decision made by the agent who has such authority, given his own information and the information revealed by the equilibrium play of the game. Thus, in mb^* where the board has decision-making authority, consensus obtains when the manager agrees with every possible board decision after every possible sequence of messages sent in equilibrium and never wishes to overturn the board's decision after it is made even if he could do so. Similarly, in bm^* where management has authority, consensus obtains when the board never wishes to overturn the management's final decision if it had the power to do so. Notice that consensus is not a requirement of equilibrium but rather a property that a particular equilibrium may or may not possess. The next result identifies necessary and sufficient conditions for consensus to obtain in any equilibrium of mb^* with N messages (respectively, of bm^* with M messages).

Proposition 5 *Fix $b_d \neq b_m$. When consensus obtains in an equilibrium of mb^* (respectively, bm^*), the same decision rule can be implemented in an equilibrium of bm^* (resp., mb^*) in which decision-making making authority is held by the other party.*

1. *In mb^*, with a supervisory board, consensus obtains iff (i) $E[y|y > t_N] \geq 1 + b_m$ or $t_N = y_H$ and (ii) $E[y|y < t_1] \leq b_m$ or $t_1 = y_L$.*
2. *In bm^*, with an advisory board, consensus obtains iff (i) $E[x|x > c'_M] + b_d \geq y_H$ or $c'_M = 1$ and (ii) $E[x|x < c'_1] + b_d \leq y_L$ or $c'_1 = 0$.*

Proposition 5 shows that the allocation of authority to the board or management matters for shareholder value only if the corresponding equilibrium does not display consensus. If the equilibrium displays consensus, the same decision rule could be implemented in equilibrium if authority was moved from the board to management, or vice versa. Consensus obtains in an equilibrium of mb^* whenever the extreme types of the manager, $x = 0$ and $x = 1$, agree with every possible board decision that they may encounter on the path of play. Every interior cutoff type c_i agrees which each decision because such a type is indifferent between decisions conditional on his message making a difference for the decision. This implies that all other non-indifferent types also agree with every possible board decision. Consequently, the same decision rule can be implemented in an equilibrium of bm^*.

While Proposition 5 applies to any equilibrium, given a monotonicity property of the equilibrium cutoffs and thresholds, it can be shown that the most informative equilibrium is most likely to yield consensus in the following sense: if an equilibrium with N' messages yields consensus then so will an equilibrium with $N > N'$ messages. The monotonicity property that yields this conclusion shows that $t_{1:N} \leq t_{1:N'}$ and $t_{N:N} \geq t_{N':N'}$, where $t_{i:N}$ is the ith threshold used by the board in a N message equilibrium, and $t_{i:N'}$ that in a N' message equilibrium, with $N > N'$. In this sense, more informative communication raises the possibility of consensus and minimizes the need for the use of authority.[16]

To gain further insight into Proposition 5, it is useful to contrast our situation with two-sided private information with a benchmark case of one sided private information. Consider for instance the case where the board has supervisory authority but no agent has any information about y. Instead, all parties work with $E[y]$, the expected value of y. In such a case it is easy to see that in any informative equilibrium, management can send at most two messages, a high message revealing $x > b_m + E[y]$ following which the board chooses to invest and a low message $x < b_m + E[y]$ following which the board chooses the status quo. Notice that such an equilibrium, when it exists, displays consensus since management agrees with the board's decision to implement what is in fact management's ideal decision rule. Similarly, when management holds authority and the board is an advisor but no agent has any information about x, in any informative equilibrium the board will recommend the alternative whenever $y < b_d + E[x]$ and management will follow the board's advice. Once again, when such an equilibrium exists it displays consensus because the board must agree with management's decision to implement the board's ideal decision rule. In contrast to these benchmark cases with one-sided private information, the equilibria of our model with two

[16] Since the two parties have conflicting interests, one can never obtain agreement ex-post, i.e, if all private information becomes public. Consensus is not therefore a notion of ex-post agreement. Rather it is a property of the amount of information that is consistent with incentives and that can be revealed in equilibrium. Even when consensus obtains, the two parties only agree with the decision but typically do not agree on the value of the decision.

sided private information can involve information exchange that is more detailed than a coarse recommendation to invest or not. In general however, the resulting equilibrium decision rule will not implement the ideal decision rule of any party given the jointly available information. Indeed, it may not even display consensus. Nevertheless, as we show below, the notion of consensus is the key determinant of the value of authority in our setting.

It is useful also to contrast consensus with the notion of posterior implementablility introduced by Green and Laffont (1997) in a mechanism design context. A decision rule is posterior implementable if it is incentive compatible for each agent to reveal his information after taking into account the information that will be revealed by the other party during the implementation of the mechanism. As such, posterior implementability imposes constraints on the mechanism that are stronger than the usual notion of interim incentive compatibility but weaker than ex-post incentive compatibility. Green and Laffont (1997) motivate posterior implementability as a reduced form approach to modeling a two-stage process of communication followed by 'ex-post ratification'. If a decision rule is posterior implementable then no agent 'regrets' the message that he sends in the communication stage after learning the message sent (not necessarily the information held) by the other party. It is not difficult to see that every equilibrium decision rule characterized by Propositions 1 and 2 is posterior implementable. This follows from observing that with a supervisory board any cutoff type of management c_i is indifferent between decisions conditional on $y \in [t_{i-1}, t_i]$, and the latter is the only kind of information about y that is needed to implement the equilibrium decision rule. However, since an equilibrium may not display consensus, posterior implementability is a weaker notion of ex-post ratification than consensus.

3 Optimal Boards and the Value of Authority

In this section we begin by providing a characterization of the optimal alignment of a supervisory board b_d^* from the ex-ante perspective of shareholders. Subsequently, we determine the optimal alignment of an advisory board b_d^{**} and identify the value to shareholders of allocating authority to the board versus management given optimal board alignment.

Proposition 6 *Suppose $y_H > 1 + b_m$ and $y_L = 0$. With an expert supervisory board, the optimal board alignment $b_d^* = b_m$ if $b_m \leq \frac{1}{6}$. For $b_m > \frac{1}{2\sqrt{2}}$, $b_d^* = 0$. For intermediate values of $b_m \in (\frac{1}{6}, \frac{1}{2\sqrt{2}})$,*

$b_d^* \in (0, b_m)$ *and the optimal supervisory board has a conflict of interest with both shareholders and management.*

Proposition 6 follows directly from Proposition 5 in Dessein (2002). In particular, the parameter restriction on y_H, y_L and b_m ensures that all the thresholds t_i in Proposition 1 are interior, $t_i \in [y_L, y_H]$ for all i. As a result the equilibrium sets, ex-ante payoffs and the value of delegation can be characterized using the analysis of Crawford and Sobel (1982) and Dessein (2002).[17]

Proposition 6 states that when managerial agency is sufficiently small ($b_m < \frac{1}{6}$) it does not pay the shareholders to impair information exchange between the board and management since the cost of such information loss outweighs the benefits of choosing a board that is more closely aligned with shareholders. In contrast, when $b_m > \frac{1}{2\sqrt{2}}$ managerial agency is sufficiently value destructive for shareholders to entirely forego eliciting information from management. The optimal choice of b_d in this case ensures that the board makes its decision without learning anything about the manager's information x. In the intermediate case $b_m \in (\frac{1}{6}, \frac{1}{2\sqrt{2}})$, the shareholders limit the distortion in decision-making by choosing board that is only partially management aligned and partially shareholder aligned. Although this leads to some information loss, the loss is swamped by the gain from reducing distortions in decision-making away from management's ideal and towards what is optimal for shareholders.

For the parameter values of Figure 1, in particular with $b_m = \frac{3}{16}$, the optimal alignment of a supervisory board b_d^* equals $\frac{5}{32}$. Figure 2 depicts the nature of communication and the equilibrium decision rules at this optimum. In the most informative equilibrium, management sends four possible messages, labelled $\mu_1, ..., \mu_4$ in the figure, identified by the successive cutoff values of c_1, c_2 and c_3. For each message, the board chooses the alternative if y is less than the corresponding threshold t_i, and the status quo otherwise. The resulting decision rule is a step function that is also depicted in the figure.

Figure 2 provides some geometric intuition for the trade-offs that shareholders face in choosing the optimal bias b_d^*. To see the intuition, we evaluate shareholder payoffs at the optimum b_d^* relative to the case where $b_d = b_m$ and the supervisory board is perfectly aligned with management. In the latter case the alternative is chosen whenever x and y lie below the manager's ideal line $y = x + b_m$

[17] Similar results will obtain when $y_H < 1 + b_m$ or $y_L \neq 0$ although in such cases we may have corner solutions and the CS equations will not immediately apply. We avoid an explicit calculation of expressions for b_d^* in such cases as it does not add any further insight.

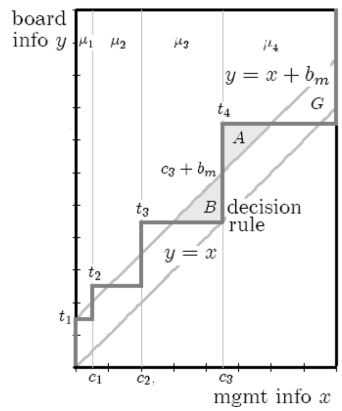

Figure 2: Communication with Optimal Supervision

depicted in the figure. Relative to this case, shareholders face both gains and losses when they choose $b_d = b_d^*$ as depicted by the two triangular regions A and B in the figure associated with the cutoff c_3. When $b_d = b_d^*$, investment occurs when x and y lie in the region A whereas it does not when x and y lie in region B. Both are suboptimal from the manager's perspective since ideally he would like not to invest in region A and to invest in region B. From the shareholders' perspective however, investing is undesirable in region A while avoiding investment is desirable in region B which lies above the shareholders' ideal line $y = x$. Since region A is further away from the shareholders ideal line $y = x$ compared to region B however, shareholders incur a net loss in expectation over these two areas. This is the loss from strategic information transmission associated with the cutoff c_3. Identical remarks apply for each pair of triangular areas on two sides of each of the other managerial cutoffs c_2 and c_1 and the sum of these net losses is the total loss from imperfect communication between the manager and an imperfectly aligned board.

However, relative to when $b_d = b_m$, shareholders also gain in expectation when x and y lie in the region G depicted in Figure 2. In this region, the supervisory board with alignment b_d^* prevents management undertaking an investment that would have occurred if instead b_d was equal to b_m and the board was perfectly aligned with management. The expected increase in shareholder value from avoiding investment in region G is the gain from the authority of a board that is imperfectly aligned with management. When $b_m \leq \frac{1}{6}$, Proposition 6 states that the loss from imperfect communication dominates the gain from the board's authority and it is suboptimal to create a conflict between board and management. But when $b_m > \frac{1}{6}$, as in the case depicted in Figure 2, shareholders will

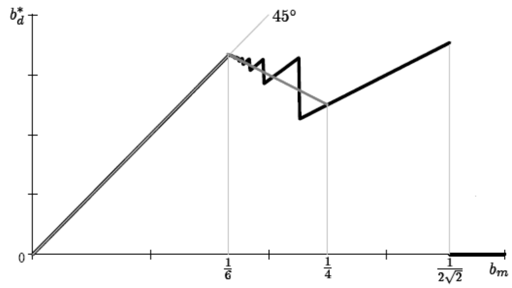

Figure 3: Optimal Alignment b_d^*

find it optimal to create a conflict between management and a supervisory board, trading off the loss from imperfect communication against the gain from the board's authority.

Figure 3 plots the alignment of the optimal supervisory board b_d^* as a function of the underlying managerial bias b_m under the parameter restrictions of Proposition 6. When the basic conflict of interest b_m between management and shareholders is small relative to the value of information held by management shareholders will gain by choosing a board that is closely aligned with management. But when this basic conflict is large, shareholders will gain by creating an additional conflict between management and the board. Notice that by the envelope theorem the optimized shareholder value must be decreasing in b_m. Even after board composition has been optimally chosen, higher values of b_m will be associated with lower firm performance all else held equal. Since optimal board alignment is a response to an agency problem b_d^* may be non-monotonic in managerial agency and firm performance.[18]

We turn next to the optimal alignment b_d^{**} of an advisory board. To this end, let $V_{b\text{-}authority}(b_d; b_m)$ be the ex-ante expected shareholder value when the supervisory board controls decision-making. By definition, the optimal alignment b_d^* of a supervisory board solves

$$\max_{b_d} V_{b\text{-}authority}(b_d; b_m). \tag{7}$$

[18]It can be shown that when $b_d^* \in (0, b_m)$, $b_d^* = \frac{N_*^2-1}{N_*^2+2} b_m$ where N_* is the number of messages sent in the most informative equilibrium by management to the optimal supervisory board. Furthermore, N_* is equal to either the integer least upper bound or the integer greatest lower bound of $\sqrt{\frac{2}{6b_m-1}}$ and for values of $b_m \in (\frac{1}{6}, \frac{1}{2\sqrt{2}})$ that allow one to ignore these integer constraints, $b_d^* = \frac{1}{4} - \frac{1}{2} b_m$ for $b_m \leq \frac{1}{4}$ and $b_d^* = \frac{1}{2} b_m$ for $b_m > \frac{1}{4}$. The discontinuities in Figure 3 arise from the integer constraints on N_*.

Similarly, let $V_{m\text{-}authority}(b_d; b_m)$ be the ex-ante expected shareholder value when management controls decision-making and the board has only an advisory role. By definition, the optimal alignment of an advisory board b_d^{**} solves

$$\max_{b_d} V_{m\text{-}authority}(b_d; b_m). \tag{8}$$

The following result characterizes the optimal advisory board.

Proposition 7 *The optimal advisory board b_d^{**}, which is the solution to the program in (8), is also the solution to the program in (7) but subject to the additional constraint that b_d and b_m must be such that the board and management reach consensus.*

If consensus does not obtain with an advisory board then shareholder value can be raised by raising b_d slightly. This either lowers the loss from imperfect communication or raises the number of distinct messages used in the most informative equilibrium. Consequently, in solving the program (8), it is harmless to impose the constraint that consensus obtains. But if consensus obtains, the allocation of authority is irrelevant and so b_d^{**} must in fact also solve the program in (7) subject to the additional constraint of consensus.[19]

Proposition 7 contains our key insight on optimal corporate governance from the perspective of shareholders. Relative to allocating authority to management and optimizing over the alignment of the resulting advisory board, allocating authority to an optimally aligned supervisory board avoids the requirement that the board and management reach consensus. Instead, the optimal supervisory board may sometimes use the force of its authority to over-rule management. This is beneficial for shareholders. Consequently, shareholders can never find it strictly optimal to allocate authority to management and doing so is weakly optimal only when the allocation of authority is irrelevant. In fact, Proposition 7 allows us to pin down exactly the value of the board's authority for shareholders.

Corollary 1 *The loss to shareholders from allocating authority to management equals the loss from requiring that the board and management reach consensus, assuming optimal choice of the board's alignment.*

[19] For Proposition 7 it is necessary that communication be unrestricted and that the most informative equilibrium is played. The result does not obtain if, for instance, players can only send binary messages, e.g., by voting on the decision.

If the board loses effective authority to management, it is not optimal for shareholders to allow management to use the force of its authority with positive probability. The optimal response is to alter the board's alignment in order to make management unwilling to take decisions in defiance of the board's wishes. To achieve this, the optimal advisory board must be weakly more management aligned than the optimal supervisory board. The next result makes this precise under the parameter restrictions of Proposition 6.

Proposition 8 *Assume $y_L = 0$ and $y_H \geq 1 + b_m$. The shareholder value maximizing advisory board is weakly more management aligned than the shareholder value maximizing supervisory board, $b_d^{**} \geq b_d^*$ with equality iff consensus obtains at b_d^*.*

The first part of the result follows from observing that if consensus does not obtain when $b_d = b_d^*$, to obtain consensus it is necessary to raise the alignment of the board closer to b_m. Consensus obtains at b_d^* if for instance $b_d^* = b_m$, in which case we must also have $b_d^{**} = b_m$. Even when $b_d^* < b_m$, consensus can obtain if for instance y_H is large enough. In such cases $b_d^{**} = b_d^* < b_m$ and the optimal advisory board is conflicted with management. However, the allocation of authority is irrelevant for shareholder value.

If consensus does not obtain at b_d^*, the allocation of authority matters for shareholder value and $b_d^{**} > b_d^*$. But we may still have $b_d^{**} < b_m$ so that the optimal advisory board is conflicted when management. By choosing such an advisory board shareholders in effect commit to withhold information from management. The board provides coarse or imprecise advice to management resulting in losses arising from imperfect communication. However, coarse advice from the board also preserves managerial uncertainty about the value of his favored decision even when x is large. This leads the manager to voluntarily forego the investment, tempering his agency and enabling shareholders to partially overcome the value loss created by imperfect communication. For the parameter values of the example depicted in Figures 1 and 2 with $b_m = \frac{3}{16}$, consensus is not obtained at $b_d^* = \frac{5}{32}$. It follows from Proposition 8 that $b_d^{**} > b_d^*$ and computations verify that $b_d^{**} = \frac{17}{100} < b_m$ at which point consensus is just obtained.[20]

[20] In general, the consensus constraint may hold with slack at $b_d = b_d^{**}$ because $V_{b\text{-}authority}(b_d; b_m)$ is not globally concave in b_d.

4 Shareholder Consensus and Transparency

So far we have shown that shareholders should optimally allocate supervisory authority to the board, choosing the alignment of the board optimally as well. In doing so we have assumed that the shareholders can commit to respecting themselves the authority of the board. Our next result shows that such commitment is not necessary when the supervisory board's alignment is optimally chosen since in such cases shareholders will agree with every possible final decision of the board.

Proposition 9 *With the optimal board and at the optimal allocation of authority, shareholders will agree with the final decision, provided they do not observe the deliberations between the board and management.*

Proposition 9 shows that the optimal board must obtain 'shareholder consensus'. It follows from the following two observations. First, shareholders will necessarily agree with a board decision to choose the status quo because both the management and the board are biased against the status quo relative to shareholders and a recommendation from the board against the direction of its own bias will meet with shareholder approval. Furthermore, shareholders will also agree with the *optimal* board's decision to choose the alternative. This is because the optimal board is weakly better in expected terms than a perfectly shareholder aligned board and shareholders always agree ex-post with the decision of a perfectly shareholder aligned board.

The possibility of shareholder consensus sheds light both on features of one-tier boards that are commonly observed in the U.S., Canada and the U.K. as well as those of two-tier boards that are more common in continental Europe (see, e.g., Cadbury (1995), Maassen (2002)). One tier boards usually have both executive as well as independent members and integrate the advisory function of a corporate board with its supervisory role. In contrast, two-tier boards tend to separate these two functions. The lower tier provides advice on decision management and typically has executive members. The upper tier is concerned exclusively with a supervisory role and typically contains only independent directors as well as founding family members with controlling interests who are presumably more aligned with shareholders.

Proposition 9 shows that the optimal board may be designed as a two-tier structure with a perfectly shareholder aligned upper tier that has final decision-making authority. As long as the lower tier is also chosen optimally, and as long as the upper tier does not observe the details of the deliberations between the lower tier and management, shareholder aligned decision-making authority within the board does not jeopardize shareholder welfare. In this sense, shareholder board membership and activism is consistent with shareholder value maximization as long as the activist belongs to the supervisory upper tier and there is a lack of transparency between the upper and lower tiers.[21]

To get more insight into the effect of transparency and shareholder authority on shareholder value, we finally to the question of identifying the optimal decision rule when shareholders can commit to reveal y. Using the close correspondence of the our model with the CS framework, we can use well-known results established in that context to obtain the following result.[22]

Proposition 10 *When the board has decision-making authority, shareholders benefit from revealing y perfectly to management and the board, allocating authority to a perfectly shareholder aligned board.*

When shareholders can commit to reveal y, it is optimal for them to allow management to take its own optimal action unless y is higher than a cut-off value equal to $1 - b_m$ in which case the alternative is not chosen. This can be implemented by a two-tier board where all board members observe y, with the lower perfectly management aligned tier first communicating privately with management and then with the perfectly shareholder aligned upper tier that holds final decision making rights.

If the information of the board arrives to all board members from some expert outside auditor or consultant then it may be feasible to commit to reveal it to all parties and Proposition 10 applies.[23]

[21] The two-tier structure is not necessary for this interpretation since we may always label the tiers as different mutually opaque subcommittees of a one-tier board. Moreover, the lack of transparency between the two tiers is sufficient but not necessary for obtaining shareholder consensus. Even if shareholders observe the messages (but not the signals) of the board and management, shareholder consensus may obtain, especially if communication takes place according to the extended protocol bmb^* as long as b_m is not too small. Decision-irrelevant changes in the communication protocol may therefore have a bearing for third-party (shareholder) consensus.

[22] We use the optimal arbitration mechanism identified by Goltman et al (2009) in the Crawford and Sobel context. See also Holmstrom (1984), Melumad and Shibano (1991), Dessein (2002).

[23] Proposition 10 also implies that shareholders will benefit if, for instance, a management aligned board member privately "leaks" the board's information to management. If this is anticipated, shareholders should allocate authority to a perfectly shareholder aligned board.

In this ideal situation shareholders would like complete transparency about the board's information y. Moreover, they do not need to choose a board that is even partially aligned with management. Instead they can keep final decision-making authority themselves. Only when committing to reveal y is not feasible do shareholders need to consider aligning the board with management. By choosing an expert tier of the supervisory board that is not perfectly aligned with management, shareholders in effect create a lack of transparency between the board and management. Even in such cases, as Proposition 9 reveals, shareholders may hold final decision-making authority without any loss of welfare, provided the shareholder aligned upper tier does not observe the deliberations between management and the lower expert tier of the board with alignment b_d^*.

Proposition 10 does not apply when it is not possible to freely share the board's information with all parties. This may be the case if for instance the signal y is privately observed by a particular member or subcommittee imperfectly aligned with both shareholders and management. In such cases only coarse information about x and y can be brought to bear upon the decision and the optimal alignment of the expert supervisory board is determined by the ex-ante trade-off faced by shareholders between information transmission and distortions in decision-making in the communication game between board and management.

Proposition 10 is also limited to the case where the board has supervisory authority. It does not apply to situations where management has captured authority and the board only has an advisory role. As shown in the previous section, when $b_d^{**} < b_m$ shareholders prefer a lack of transparency between an advisory board and management created via a conflict between the two. But, in sharp contrast to the case with a supervisory board, this is optimal for shareholders even when it is feasible for them to commit to reveal the board's information y via choosing $b_d = b_m$. Since management holds authority it cannot be prevented from choosing the alternative when $y > 1 - b_m$ and shareholders may then prefer imperfect transparency and coarse information transmission.

5 Discussion and Conclusion

We characterize shareholder value maximizing boards in situations where the board has expertise but a manager with independent expertise also wields considerable effective power over the organization. In such situations, effective information transmission between the board and management is a key determinant of shareholder value. We show that shareholders prefer that the board hold effective supervisory authority. Furthermore, when it is feasible for shareholders to commit to reveal the board's information, shareholders would like to do so and align the board perfectly with shareholders. Only when such commitment is not feasible, do shareholders need to consider aligning the board at least partially with management in order to improve information transmission. Even in such cases, final decision-making authority can be held by shareholders as long as they do not observe the details of the deliberations between the management and the expert tier of the board.

Our model of strategic information transmission is different from the canonical model of Crawford and Sobel (1982) because of the presence of two-sided private information and because of the coarseness of decisions.[24] Because of these differences, aligning the board even partially with management is necessary only when committing to reveal the board's information is not feasible. The presence of two-sided private information also allows us to understand the forces determining the composition of the board when authority is held by management. In such cases the information held by the board is the only thing that allows it to have a non-trivial role in determining shareholder welfare. We show that such advisory boards may often be designed to provide coarse information to management. Nevertheless, the information must be detailed enough for management to heed the board's advice and hand back effective authority to the board.

Our results depend on the fact that contracting solutions and career or reputational concerns do not perfectly eliminate managerial agency. However they are consistent with limited forms of such incentive provision. For instance, in an environment with noisy observability of long run value $x-y$, the managerial bias parameter b_m may simply reflect managerial rents from possessing superior expertise about firm prospects. If a possibly unbiased replacement will take time to acquire similar expertise, it will not be optimal to fire the biased manager. Similarly, attempts by shareholders to contractually align management by providing an equity share $\alpha \in (0,1)$ will keep the essence of our problem unchanged. With an equity share α, managerial payoffs from choosing the alternative is equal to $\alpha(x-y)+b_m$ whereas the payoff to shareholders is $(1-\alpha)(x-y)$. Our model extends to this setting but with the effective managerial bias now equal to b_m/α. Our results on optimal board design then apply given a choice of α. We leave for future research a full analysis of the interaction between the optimal choice of incentive contracts α and governance b_d as a function of

[24] Nevertheless, our analysis has a rough correspondence with similar exercises in the CS framework. Our analysis of supervisory boards correspond to the allocation of decision rights to an intermediary by the receiver whereas our analysis of advisory boards corresponds to the sender giving an intermediary control over information transmission.

the underlying agency b_m.[25]

It is possible to think of alternative specifications of managerial agency and governance that give rise to forces similar to those analyzed in this paper. While we have interpreted the managerial bias parameter b_m in non-pecuniary terms such as private benefits of empire-building or control, it could equally be interpreted in terms of behavioral biases such as hubris or overconfidence. Similarly, the board's bias b_d has so far been interpreted in terms of ideological sympathy for management that summarizes in a simple way the net effect of the structure and composition of the board. In an alternative specification, we may think of b_m in terms cash or other resources that the manager directly steals from shareholders while implementing his favored decision after it is approved by the board. In such cases, the board may also be able to obtain a cut b_d of the manager's share of the loot leaving only $b_m - b_d$ for management. In contrast to the set-up of this paper, such a self-serving board has an added effect on shareholder welfare. It may mitigate the agency problem not only by improving communication but also via directly forcing the manager to share his pecuniary gains with the board, reducing management's incentives to push his biased agenda in the first place. In contrast, if the board's bias b_d arises out of additional resources that the board also steals from shareholders, then shareholders have to trade off the gains from improved communication (as measured by $b_m - b_d$) against not only the distortion in decision-making but also the loss from increased looting by both the management and the board (as measured by $b_m + b_d$). We leave a full investigation of these model variations for future research.

6 Appendix

6.1 Proofs

Proof of Proposition 1. For any message μ sent by the manager the board chooses the alternative if $y < t(\mu) = E[x|\mu] + b_d$ and the status quo otherwise. Let $q(\mu) = \Pr[y < t(\mu)] \in [0, 1]$ and notice that the manager's expected payoff from sending the message μ and inducing $t(\mu)$ is $q(\mu)(x + b_m -$

[25] Non-equity contracts such as executive options or golden parachutes may also have value in our setting. Notice however that contractual solutions are expensive in that they force shareholders to pay part of the surplus to management and/or the board, in contrast to the mechanisms of "ideological" alignment that we focus on. It follows that contracts, even when they are feasible, may not be used at all or used in conjunction with the type of alignment mechanisms that we use. See Krishna and Morgan (2008).

$E[y|y < t(\mu)]$. The last expression can be rewritten as $U(x,q) = q(x+b_m) - \int_0^q F_y^{-1}(z)dz$. This is supermodular in q and x and concave in q.

We show first that only a finite number of distinct $q(\mu) = F_y(t(\mu))$ may be induced in equilibrium. In a babbling equilibrium only one q is induced in equilibrium. So consider an informative equilibrium with two distinct q and q' with $q < q'$ and $q, q' \in [0,1]$. The corresponding thresholds are t and t' with $t < t'$. Since the manager types who prefers to induce q (resp., q') reveals a weak preference for inducing it, by continuity and supermodularity of $U(x,q)$ there exists an unique x^* who is indifferent between q and q'. By the concavity of $U(x,q)$ it follows that $F_y(x^* + b_m) \in (0,1)$ and so

$$t < x^* + b_m < t'.$$

Furthermore, by the supermodularity of $U(x,q)$, it follows that q cannot be induced by any type $x > x^*$ (they prefer q') and q' cannot be induced by any type $x < x^*$ (they prefer q). Since $t(\mu) = E[x|\mu] + b_d$, it follows that

$$t \leq x^* + b_d \leq t'.$$

But then there exists $\varepsilon > 0$ such that $t' - t > b_m - b_d > \varepsilon$. Since y lies in a compact set, it follows that at most $\varepsilon(y_H - y_L)$ thresholds (t's or q's) can be induced in equilibrium.

Consider an equilibrium with $N < \infty$ distinct thresholds $t_1, ..., t_N$. A cutoff type $x = c_i$ is indifferent between two successive thresholds t_i, t_{i+1} with $t_i < t_{i+1}$, $i = 1, .., N-1$, iff

$$\Pr[y < t_{i+1}][c_i + b_m - E(y|y < t_{i+1})] = \Pr(y < t_i)[c_i + b_m - E(y|y < t_i)],$$

which can be rewritten as

$$c_i + b_m = \frac{\int_{t_i}^{t_{i+1}} zF_y(z)dz}{\Pr[t_i < y < t_{i+1}]} = E[y|t_i < y < t_{i+1}].$$

The result now follows.■

Proof of Proposition 2. Analogous to the proof of Proposition 1.■

Proof of Proposition 3. We prove part 1 of the result. The proof of part 2 is analogous.

We start by comparing the games mb^* and bmb^*. Notice that the decision rule implemented by any equilibrium of mb^*can be replicated by an equilibrium of bmb^* in which the board is uninformative in stage 1. We wish to prove that any equilibrium of bmb^* results in a decision rule that is also an equilibrium decision rule of mb^*.

The proof proceeds as follows. We find necessary properties of an equilibrium of bmb^*. These properties imply that the board simply wishes to know from management if x is above or below a cutoff value $\widehat{c}(y)$ that depends on the board's information y. The board then chooses the alternative if and only if $x > \widehat{c}(y)$. Further, the set of types y that wish to use the same decision rule, corresponding to a particular value of the cutoff $\widehat{c}$, must be an interval i.e., such y must lie between two threshold values. The necessary relationship between these cutoffs and thresholds imply that the same decision rule is part of an equilibrium of mb^* as well.

Consider an equilibrium of bmb^*. Let μ_d be a message received by the manager from the board in the first stage and let μ_m be a message received by the board from management in the second stage. Let $\mu = (\mu_d,\, \mu_m)$ and $x(\mu) = E[x|\mu_m, \mu_d]$. In the third decision-making stage, the board would like to choose the alternative iff

$$y < x(\mu) + b_d \equiv t(\mu). \tag{9}$$

Consider now the manager's problem in the second stage given a message μ_d from the board. Let $F_y(.|\mu_d)$ be the updated beliefs about y from the manager's perspective given μ_d. The expected payoff to the management from sending a message μ_m is

$$F_y(t(\mu)|\mu_d)[x + b_m - E(y|y < t(\mu), \mu_d)],$$

provided $F_y(t(\mu)|\mu_d) > 0$, and zero otherwise. The manager of type x is then weakly prefers a message $\mu_m$to a message μ'_m, $t(\mu_m, \mu_d) < t(\mu'_m, \mu_d)$ iff

$$x + b_m \leq E[y|t(\mu_m, \mu_d) < y < t(\mu'_m, \mu_d), \mu_d], \tag{10}$$

with equality in the case of indifference. Using arguments identical to those in the proof of Proposition 1 it follows that the manager's strategy after each μ_d can be represented by a finite partition of $[0, 1]$ where each partition element is an interval. Let the cutoffs $\{c_i(\mu_d)\}_{i=0}^{N(\mu_d)}$ represent the partition with $N(\mu_d)$ elements where $[c_{i-1}(\mu_d), c_i(\mu_d)]$ is the ith element. Let μ^i_m denote the manager's message corresponding to the event that $x \in [c_{i-1}(\mu_d), c_i(\mu_d)]$ with $x_i(\mu_d) = E[x|\mu^i_m, \mu_d]$ and $t_i(\mu_d) = x_i(\mu) + b_d$. In what follows we identify a μ_d with the managerial partition that it leads to $\{c_i(\mu_d)\}_{i=0}^{N(\mu_d)}$.

We turn now to the board's problem in stage 1 of bmb^*. If after sending a message μ_d, a board type y learns no decision relevant information from management if $N(\mu_d) = 1$ or if $y \leq t_1(\mu_d)$

or if $y \geq t_{N(\mu_d)}(\mu_d)$. Otherwise, type y learns decision relevant information from management; in particular, $N(\mu_d) > 1$ and there exists i with $1 \leq i < N(\mu_d)$ with

$$t_i(\mu_d) \leq y \leq t_{i+1}(\mu_d), \tag{11}$$

where the first inequality is strict if $i = 1$ and the second if $i = N - 1$. For y satisfying (11), if the board sends the message μ_d in stage 1, then in stage 3 the board chooses the status quo when it learns from management that $x < c_i(\mu_d)$ where

$$c_i(\mu_d) + b_m = E[y|t_i(\mu_d) < y < t_{i+1}(\mu_d)], \tag{12}$$

and

$$E[x|x < c_i(\mu_d)] + b_d \leq x_i(\mu_d) + b_d = t_i(\mu_d) \leq y, \tag{13}$$

with at least one strict inequality. And the board chooses the alternative if it learns that $x > c_i(\mu_d)$ since

$$E[x|x > c_i(\mu_d)] + b_d \geq x_{i+1}(\mu_d) + b_d = t_{i+1}(\mu_d) \geq y, \tag{14}$$

with at least one strict inequality. Call such a stage 1 message from the board type y, a decision relevant message for type y.

Observe first that every type y must in equilibrium strictly prefer to send a decision relevant message, if one exists, to sending a decision irrelevant one. A board type y may not have any decision relevant message μ_d if $y \leq t_1(\mu_d)$ for all μ_d. Let Y_L be the (possibly empty) set of types who choose the alternative in equilibrium regardless of the message they send and the message sent back by the management. If $y \in Y_L$ then so is all $y' < y$. Similarly, types y with $y \geq t_{N(\mu_d)}(\mu_d)$ for all μ_d also do not have a decision relevant message since such types choose the status quo in equilibrium regardless of the message they send and the message sent back by the management. Let Y_H be the (possibly empty) set of such types. If $y \in Y_H$ then so is all $y' > y$. Notice from (10) that the behavior of board types in $Y_L \cup Y_H$ does not affect the communication incentives of the manager since their decision does not vary with management's message. Let Y^* be the complementary set of board types who send a decision-relevant message in equilibrium. If Y^* is empty, then the board learns no information from the management in the second stage. Such equilibria implement decision rules corresponding to the babbling equilibrium of mb^* and there is nothing left to prove. Accordingly we focus on the case where the set Y^* is non-empty in what follows.

Consider type $y \in Y^*$ who in equilibrium sends the decision relevant message μ_d, inducing the decision rule of choosing the alternative iff it learns from management that $x > c_i(\mu_d) \in (0, 1)$. The expected payoff to $y \in Y^*$ from inducing the cutoff $c_i(\mu_d)$ is

$$(1 - F_x(c_i(\mu_d)))(E[x|x > c_i(\mu_d)] + b_d - y) = \int_{q'}^{1} F_x^{-1}(z)dz - (1 - q')(y - b_d), \tag{15}$$

where $q' \equiv F_x(c_i(\mu_d))$. The last expression is concave in q' and supermodular in q', y. For any two distinct cutoffs c and c' where $c < c'$ (possibly corresponding to different decision relevant messages μ_d and μ_d'), type $y \in Y^*$ weakly prefers to induce a cutoff c iff, using (15),

$$y \leq E[x|c < x < c'] + b_d, \tag{16}$$

with indifference in case of equality. It follows that any $y \in Y^*$ can be indifferent between inducing at most two distinct cutoffs c and c'.

For every $y \in Y^*$ that induces a unique cutoff in equilibrium denote by $\widehat{c}(y) \in (0, 1)$ this cutoff. For $y \in Y^*$ who are indifferent between and induce multiple distinct cutoffs, choose $\widehat{c}(y) \in [0, 1]$ to be the higher of the two. For $y \in Y_0$ who prefer to always choose the status quo in equilibrium define $\widehat{c}(y) = 0$ whereas for $y \in Y_1$ who prefer to always choose the alternative in equilibrium define $\widehat{c}(y) = 1$. Using (16) and the supermodularity and concavity of the expression in (15) , $\widehat{c}(y)$ must be an increasing step function of y with a finite number of steps. Therefore, the inverse image of $\widehat{c}$ is a finite partition of Y where each partition element is an interval.

For the case where Y_0 and Y_1 are both non-empty, let $\{\widehat{c}_i\}_{i=0}^{N}$ be value of $\widehat{c}$ along each of its $N < \infty$ horizontal segments, with $\widehat{c}_0 = 0 < c_1 < ... < \widehat{c}_N = 1$ and let $[\widehat{t}_i, \widehat{t}_{i+1})$ be the inverse image of $\widehat{c}_i$, $\widehat{t}_0 = y_L < \widehat{t}_1 < ... < \widehat{t}_{N+1} = y_H$. By construction, $y = \widehat{t}_i$ indifferent between inducing the cutoffs $\widehat{c}_i$ and $\widehat{c}_{i-1}$, any $y \in (\widehat{t}_i, \widehat{t}_{i+1})$ strictly prefers to induce $\widehat{c}_i$ in equilibrium, any $y \notin [\widehat{t}_i, \widehat{t}_{i+1}]$ strictly prefers to induce some $\widehat{c}_j \neq \widehat{c}_i$ and, furthermore,

$$\widehat{c}_i + b_m = E[y|\widehat{t}_i < y < \widehat{t}_{i+1}],\ i = 1, ..., N - 1,$$

and

$$\widehat{t}_i = E[x|\widehat{c}_{i-1} < x < \widehat{c}_i] + b_d,\ i = 1, ..., N.$$

From Proposition 1, it follows that the cutoffs $\{\widehat{c}_i\}_{i=0}^{N}$ together with the thresholds $\{\widehat{t}_i\}_{i=1}^{N}$ is a N message equilibrium of mb^*.

The arguments for the case where either Y_0 or Y_1 is empty is entirely analogous and we omit the details. The equivalence of b^*mb^* with bmb^* follows from observing that the management's communication incentives does not depend on the behavior of types in Y_0 or Y_1 and so it does not matter if these types take their decision at stage 1 or 3.■

Proof of Proposition 4. We prove part 1 of the result. The proof of part 2 is analogous.

We show first that an equilibrium decision rule of b^*m^* is also an equilibrium decision rule of bmb^* and so, by Proposition 3, also of mb^*. Consider an equilibrium of b^*m^*. We construct an strategy profile that implements the same decision in an equilibrium of . Let Y_L be the set of y who choose the alternative in b^*m^* and Y_H the set that choose the status quo, with Y^* the set who send a message and let management make the final decision. If Y^* is empty, then the same decision rule can be implemented by the equilibrium of bmb^* where the first two rounds involve babbling. So suppose Y^* is non-empty.

Let all $y \in Y^*$ use the same communication strategy in stage 1 of bmb^* as in b^*m^*. Pick an arbitrary $y' \in Y^*$ and let $y \in Y_L \cup Y_H$ use the communication strategy of y' in stage 1 of bmb^*. Suppose that after a message μ_d, management chooses the alternative in b^*m^* iff $x > c(\mu_d)$. In bmb^*, let management recommend the alternative if $x > c(\mu_d)$ and the status quo otherwise. Suppose all $y \in Y^*$ follow the management's recommendation in stage 3 of bmb^* while all $y \in Y_L$ choose the alternative and all $y \in Y_H$ choose the status quo regardless of management's recommendation.

Using arguments that are detailed in the proof of Proposition 3, we show now that such behavior is an equilibrium of bmb^*. In stage 3, types $y \in Y^*$ will find it in their interest to follow management's recommendation, using (13) and (14) in particular; while $y \in Y_L \cup Y_H$ will prefer to take their specified decisions since they preferred to take an unilateral decision without knowledge of x in the original equilibrium of b^*m^*. Given this, management will infer that its own message is irrelevant for the behavior of $y \in Y_L \cup Y_H$. In determining the cutoff $c(\mu_d)$ of their recommendation, management will only condition on the communication strategy of $y \in Y^*$ and will therefore arrive at the same cutoff as they did in b^*m^*. Because the strategy profile in bmb^* leads to the same outcome as in b^*m^*, no board type has an incentive to deviate in the first stage either. This shows that an equilibrium decision rule of b^*m^* is an equilibrium decision rule of bmb^* and so of mb^*.

In the other direction, consider first any informative equilibrium of mb^* with $N > 1$. Construct the following strategy profile for b^*m^*. Types $y > t_N$ take the status quo in stage 1 while $y < t_1$ take the alternative. All other $y \in [t_i, t_{i+1}]$ reveal the interval they belong to, $1 \le i < N$, following which management chooses the alternative iff $x > c_i$. Using the definitions of the cutoffs c_i and thresholds t_i in Proposition 1, it is straightforward to show that this is an equilibrium of b^*m^* that implements the same decision rule.

To complete the proof, consider the babbling equilibrium of mb^*. We show that whenever the same decision rule corresponding the babbling equilibrium of mb^* cannot be implemented in b^*m^*, then there is another informative equilibrium of bm^* with $N = 2$. By the arguments of the previous paragraph, the decision rule of this informative equilibrium can be implemented as an equilibrium of b^*m^*. We proceed through a number of different cases.

Case 1: $y_H \geq 1 + b_m$ or $y_L \leq b_m$.

Suppose first $y_H \geq 1 + b_m$. Consider the strategy profile of b^*m^* where in stage 1 board types y take the alternative if

$$y < \widehat{t} \equiv E[x] + b_d, \tag{17}$$

choosing the status quo otherwise, and no type delegates the decision to management. If any type deviates and delegates the decision to management with a message μ, then management forms beliefs that $y_\mu \equiv E[y|\mu] = y_H$. Since $y_H \geq 1 + b_m$, management takes the status quo regardless of x following any such message. Since management's decision does not depend on x, all board types prefer to take their decision in the first stage as a function of whether or not $y < \widehat{t}$. As a result, the decision rule corresponding to the babbling equilibrium of mb^* is also an equilibrium decision rule of b^*m^*. A similar argument obtains where $y_L \leq b_m$ in which case we keep the board's behavior unchanged but give management the off the path of play beliefs $y_\mu = y_L$. Since $y_L \leq b_m$, management then takes the alternative regardless of x, implying in turn that no board type wants to deviate from its specified behavior in stage 1 of b^*m^*.

Case 2: $y_H < 1 + b_m$ and $y_L > b_m$.

Consider next the case where $y_H < 1 + b_m$ and $y_L > b_m$. For any beliefs $y_\mu \in [y_L, y_H]$ of management in the second stage, management is indifferent between the two decisions iff $x = \widehat{c}_\mu \equiv y_\mu - b_m \in (0, 1)$. Therefore, management will never take the same decision for all x. The expected payoff for board type y from sending message μ and inducing beliefs y_μ is

$$(1 - F_x(\widehat{c}_\mu))(E[x|x > \widehat{c}_\mu] + b_d - y). \tag{18}$$

There are three subcases to consider depending on the value of $\widehat{t}$ relative to y_L and y_H.

Case 2a: $y_L \leq \widehat{t} \leq y_H$

Suppose that $y_L \leq \widehat{t} \leq y_H$ with $y_H < 1 + b_m$ and $y_L > b_m$. Then type $\widehat{t}$, in particular, will prefer to send any message μ that induces a cutoff $\widehat{c}_\mu \in (0,1)$ to taking a decision unilaterally. If it does the latter, by the definition of $\widehat{t}$ in (17), type $\widehat{t}$ earns an expected payoff of zero. If $\widehat{t}$ sends the message μ instead, by (18) the alternative is chosen with strictly positive probability, and conditional on this the expected payoff is strictly positive since $\widehat{t} < E[x|x > \widehat{c}_\mu] + b_d$ for $\widehat{c}_\mu \in (0,1)$. In such cases the babbling equilibrium decision rule of mb^* is not an equilibrium of b^*m^*.

We show now that in such cases a $N = 2$ message equilibrium exists in mb^*. For any $c \in [0,1]$, consider the two element partition given by the left element $[0,c]$ and the right element $[c,1]$. For c sufficiently small but positive, by disclosing the left element, type c will induce the board to choose the status quo and this is the most preferred decision for c sufficiently small, using $y_L > b_m > b_d$. If instead c discloses the right element, then the board will choose the alternative iff $y \leq \widehat{t} + \varepsilon \in (y_L, y_H]$ for some $\varepsilon > 0$ and small. It follows that such a type c strictly prefers to disclose the left element. Now consider c sufficiently close to 1. If c discloses the left interval, then the board will be induced to choose the alternative iff $y \leq \widehat{t} - \varepsilon \in [y_L, y_H)$ for some $\varepsilon > 0$ and small. If instead, type c discloses the right interval, the the board will choose the alternative iff $y < 1 + b_d - \varepsilon'$ for some $\varepsilon' > 0$ and small. Since $1 + b_m > y_H$ and $1 + b_d > \widehat{t}$ a cutoff type c sufficiently close to 1 strictly prefers to induce the higher threshold $1 + b_d - \varepsilon'$ to $\widehat{t} - \varepsilon$, i.e., to disclose the right interval. Since the preference of the cutoff type c switches from the left to the right interval as c moves from zero to one, by continuity and the intermediate value theorem it follows that there exists $c^* \in (0,1)$ who is indifferent between the two intervals. Such a partition constitutes a $N = 2$ message equilibrium of mb^*.

Case 2b: $\widehat{t} > y_H$

It remains to consider the cases where $y_H < 1 + b_m$ and $y_L > b_m$ but either $\widehat{t} > y_H$ or $\widehat{t} < y_L$. We consider the case $\widehat{t} > y_H$ first. In this case, if the board takes its decision unilaterally in stage 1 of b^*m^*, it always chooses the alternative. However (18) obtains and so a board type y weakly prefers to unilaterally choose the alternative over sending a message μ and inducing beliefs y_μ and the cutoff $\widehat{c}_\mu \in (0,1)$ iff $y \leq E[x|x < \widehat{c}_\mu] + b_d$. Since $\widehat{c}_\mu = y_\mu - b_m$ and $y_\mu \in [y_L, y_H]$, we conclude that the decision rule corresponding to the babbling equilibrium of mb^* can be implemented in an equilibrium of b^*m^* if

$$y_H \leq t' \equiv E[x|x < y_H - b_m] + b_d < \widehat{t}.$$

In such an equilibrium, all y take the alternative in stage 1 of b^*m^*. If any type delegates the decision to management together with a message μ, then management forms the belief $y_\mu = y_H$ and takes the alternative iff $x > y_H - b_m$. However, when $y_H \leq t'$ all board types y weakly prefer to choose the alternative unilaterally in stage 1 of b^*m^*.

In contrast, when $t' < y_H < \widehat{t}$ the babbling decision rule of mb^* cannot be supported as an equilibrium of mb^*. We show now that in such cases a $N = 2$ message equilibrium exists in mb^*. To see this, once again consider a two element partition $[0, c]$ and $[c, 1]$ with cutoff $c \in [0, 1]$ and use the intermediate value theorem. For c small enough, the board will choose the status quo when management discloses the left element of the partition (since $y_L > b_m > b_d$) and the alternative when management discloses the right element (since $y_H < \widehat{t}$) and the cutoff type c strictly prefers to disclose the left element. On the other hand, for $c = y_H - b_m$, the board will choose the alternative iff $y < t'$ when management discloses the left element and the alternative for sure when management discloses the right element. The last fact follows from observing that $y_H > t' = E[x|x < y_H - b_m] + b_d$ and that $y_H < \widehat{t} = E[x] + b_d$ implies $y_H < E[x|x > y_H - b_m] + b_d$. Furthermore, the cutoff type $c = y_H - b_m$ strictly prefers the right interval, i.e., to induce the board to choose the alternative for sure over using the interior threshold $t' < y_H$ since $c + b_m = y_H$. It follows that the cutoff type c switches its preference from the left to the right interval as c goes from zero to $y_H - b_m$. Continuity and the intermediate value theorem then guarantee the existence of a $N = 2$ message equilibrium.

Case 2c: $\widehat{t} < y_L$

Finally, consider the case where $y_H < 1 + b_m$ and $y_L > b_m$ with $\widehat{t} < y_L$. In this case, if the board takes its decision unilaterally in stage 1 of b^*m^*, it always chooses the status quo. But (18) obtains and so a board type y weakly prefers to choose the status quo unilaterally over sending a message μ and inducing beliefs y_μ and the cutoff $\widehat{c}_\mu \in (0, 1)$ iff $y \geq E[x|x > \widehat{c}_\mu] + b_d$. Using arguments analogous to that for the previous case it follows that when

$$y_L \geq t'' \equiv E[x|x > y_L - b_m] + b_d > \widehat{t},$$

the decision rule corresponding to babbling equilibrium of mb^* can be implemented in b^*m^*. In this equilibrium, the board always chooses the status quo. On the other hand, when $\widehat{t} < y_L < t''$, then this decision rule cannot be implemented in b^*m^*. However, arguments identical to the previous case show that a $N = 2$ message equilibrium of mb^* exits with a decision rule that can be implemented in b^*m^*.■

Proof of Proposition 5. Consider first the case of a supervisory board and the game mb^*. Pick any equilibrium with N messages and consider $x \in [c_{i-1}, c_i]$, $i = 1, ..., N$. If following the (equilibrium) message sent by such a type the board chooses the status quo, the payoff to type x is 0. Given the board's decision, the expected payoff from the alternative is instead

$$x + b_m - E[y|t_i < y] \leq c_i + b_m - E[y|t_i < y].$$

Since for $i < N$,

$$c_i + b_m = E[y|t_i < y < t_{i+1}] \leq E[y|t_i < y],$$

we conclude that type x agrees with the board's decision to choose the status quo for all $x \in [c_{i-1}, c_i]$ for $i < N$ and also for $i = N$ as long as $1 + b_m < E[y|y > t_N]$ and $t_N < y_H$. Notice that if $t_N = y_H$, the board never chooses the status quo after the message sent by $x \in (c_{i-1}, c_i]$. Similarly, if following the (equilibrium) message sent by $x \in [c_{i-1}, c_i]$, $i = 1, ..., N$, the board chooses the alternative, the expected payoff to type x is

$$x + b_m - E[y|y < t_i] \geq c_{i-1} + b_m - E[y|y < t_i].$$

Since for $i > 1$,

$$c_{i-1} + b_m = E[y|t_{i-1} < y < t_i] \geq E[y|y < t_i],$$

we conclude that type x is better off with the board's decision to invest (gets at least as much as the payoff of 0 from the status quo) for $x \in [c_{i-1}, c_i]$ for $i > 1$ and also for $i = 1$ as long as $b_m > E[y|y < t_1]$ and $t_1 < y_L$. Notice that if $t_1 = y_L$, the board never chooses the alternative after the message sent by $x \in [c_{i-1}, c_i]$. Identical arguments cover the case of an advisory board and the game bm^*.

To complete the proof suppose consensus obtains in a N message equilibrium of the game mb^*. Consider first the case where $t_N < y_H$ and $t_1 > y_L$. It is straightforward to verify that the thresholds $t'_i = t_i$, $i = 1, ..., N$, $t'_0 = y_L$ and $t'_{N+1} = y_H$ with corresponding cutoffs $c'_{i+1} = c_i$ for $i = 0, ..., N$ and $c'_{N+1} = 1$ define a $N + 1$ message equilibrium of the game bm^*. Analogous arguments obtain in the case where either $t_N = y_H$ or $t_1 = y_L$, in which case the equivalent equilibrium in bm^* has either N or $N - 1$ messages.■

Proof of Proposition 6. In the case where $y_L = 0$ and $y_H > 1 + b_m$, $t_i \in (y_L, y_H)$ for all $i = 1, ..., N$ and so the CS equations apply. The result follows from Proposition 5 in Dessein (2002).■

Proof of Proposition 7. Suppose the manager has authority and $b_d < b_m$. Consider the most informative equilibrium with $M \geq 1$ messages with thresholds $y_L = t'_0 < ... < t'_M = y_H$ and cutoffs

$$c'_i = \frac{t'_{i-1} + t'_i}{2} - b_m,\ i = 1, ..., M. \tag{19}$$

Let $V_m(b_d, b_m)$ be shareholder value in this equilibrium and let $\widehat{V} = V_m(b_m, b_m)$ be shareholder value at $b_d = b_m$. Letting $\Delta = y_H - y_L$, we can write

$$V_m(b_d, b_m) = \widehat{V} + \sum_{i=1}^{M} T_i, \tag{20}$$

where, for $i = 1, ..., M$,

$$T_i = \int_{c'_i}^{\max[0,\min[t'_i - b_m, 1]]} \int_{x+b_m}^{t_i} (x-y)\frac{1}{\Delta} dy dx - \int_{\max[0, t'_{i-1} - b_m]}^{c_i} \int_{t'_{i-1}}^{x+b_m} (x-y)\frac{1}{\Delta} dy dx. \tag{21}$$

We wish to show that if this M message equilibrium does not display consensus and it is the most informative equilibrium then shareholder value can be raised by altering b_d. For this purpose it suffices to show that the second term, $\sum_{i=1}^{M} T_i$, on the rhs of (20) is either negative or has a non-zero derivative with respect to b_d when $b_d < b_m$.

Case 1: $M \geq 2$.

Using (19) it is easy to verify that whenever $i > 1$ and $i < M$

$$T_i = -\frac{1}{24\Delta} l_i'^3, \tag{22}$$

where $l'_i = t'_i - t'_{i-1}$ is the length of the ith interval in the board's strategy. For $i = M$, notice using Proposition 2 that $t'_{M-1} < 1 + b_m$ so that

$$T_M = \begin{cases} \frac{1}{6\Delta}\left(t'_{M-1} - (1+b_m)\right)^2 \left(t'_{M-1} + 2b_m - 1\right) & \text{if } c'_M \geq 1, \\ -\frac{1}{24\Delta} l_M'^3 + \mathbf{1}_{y_H > 1 + b_m} \frac{1}{6\Delta y}\left(y_H - (1+b_m)\right)^2 \left(y_H + 2b_m - 1\right) & \text{if } c'_M < 1. \end{cases} \tag{23}$$

where $\mathbf{1}_{\{.\}}$ is the indicator function. For $i = 1$, notice using Proposition 2 that $t'_1 > 0$ and $y_L < b_m$ whenever $c'_1 \leq 0$ and $t'_1 > b_m$ whenever $c'_1 > 0$. Using this,

$$T_1 = \begin{cases} -\frac{1}{6\Delta}\left(b_m - t_1'\right)^2\left(t_1' + 2b_m\right) & \text{if } c_1' \leq 0, \\ -\frac{1}{24\Delta} l_1'^3 - \mathbf{1}_{y_L < b_m}\frac{1}{6\Delta}\left(b_m - y_L\right)^2\left(y_L + 2b_m\right) & \text{if } c_1' > 0. \end{cases} \tag{24}$$

Further, since the equilibrium does not display consensus, from Proposition 5 we must either have $c_M' < 1$ or $c_1' > 0$.

Case 1a. $c_M' < 1$, $c_1' > 0$.

In this case

$$\begin{aligned} V_m &= \widehat{V} - \frac{1}{24\Delta}\sum_{i=1}^{M} l_i'^3 - \mathbf{1}_{y_L < b_m}\frac{1}{6\Delta}\left(b_m - y_L\right)^2\left(y_L + 2b_m\right) \\ &\quad + \mathbf{1}_{y_H > 1 + b_m}\frac{1}{6\Delta y}\left(y_H - (1 + b_m)\right)^2\left(y_H + 2b_m - 1\right). \end{aligned} \tag{25}$$

The first and last two terms do not depend on b_d and so it suffices to show that $\sum_{i=1}^{M} l_i'^3$ is strictly decreasing in b_d, which follows from the results in CS (see in particular Theorem 4 and expression (25) on pp. 1442 of CS).

Case 1b. $c_M' < 1$, $c_1' \leq 0$.

In this case

$$\begin{aligned} V_m &= \widehat{V} - \frac{1}{24\Delta}\sum_{i=2}^{M} l_i'^3 - \frac{1}{6\Delta}(b_m - t_1')^2(t_1' + 2b_m) \\ &\quad + \mathbf{1}_{y_H > 1 + b_m}\frac{1}{6\Delta}\left(y_H - (1 + b_m)\right)^2\left(y_H + 2b_m - 1\right). \end{aligned} \tag{26}$$

It follows immediately that if $y_H \leq 1 + b_m$, then $V_m < \widehat{V}$ and choosing a perfectly management aligned board is better than choosing $b_d < b_m$. So suppose $y_H > 1 + b_m$. Using expression 25 on pp. 1442 in CS,

$$\sum_{i=2}^{M} l_i'^3 = \sum_{j=1}^{M-1} l_j'^3 = \frac{(y_H - t_1')^3}{(M-1)^2} + 4B(y_H - t_1')((M-1)^2 - 1),$$

where $B = b_m - b_d$. Then

$$\frac{\partial}{\partial b_d}\left(\sum_{i=2}^{M} l_i'^3\right) = -\left[\left(\frac{3(y_H - t_1')^2}{(M-1)^2} + 4M(M-2)B^2\right)\frac{\partial t_1'}{\partial b_d} + 8M(M-2)B(y_H - t_1')\right] < 0, \tag{27}$$

since $\frac{\partial t_1'}{\partial b_d} = \frac{2M(M-1)}{2M-1} > 0$ using the equilibrium formulas in Section 6.2. Furthermore,

$$\frac{\partial}{\partial b_d}((b_m - t_1')^2(t_1' + 2b_m)) = 3(t_1' - b_m)^2 \frac{\partial t_1'}{\partial b_d}. \tag{28}$$

Using (26) through (28) it follows that $\frac{\partial V_m}{\partial b_d} > 0$ iff

$$-\frac{M(M-2)B(y_H - t_1')}{3} + \left[\frac{1}{2}(t_1' - b_m)^2 - \frac{1}{24}(\frac{3(y_H - t_1')^2}{(M-1)^2} + 4M(M-2)B^2)\right]\frac{\partial t_1'}{\partial b_d} < 0. \tag{29}$$

Notice that the last expression is increasing in $t_1' < y_H$ and therefore in b_d since $\frac{\partial t_1}{\partial b_d} = \frac{2M(M-1)}{2M-1} > 0$. Furthermore, using the equilibrium equations in Section 6.2, it can be verified that for there to be no $M+1$ partition equilibrium with $c_1' \leq 0$ it is necessary and sufficient that $b_d < \bar{b}_d^{M+1} = \frac{2M^2 b_m - y_H}{2M(M+1)}$. It suffices now to show that the expression in (29) is negative when evaluated at $b_d = \bar{b}_d^{M+1}$. Using the expressions for $\frac{\partial t_1'}{\partial b_d}$ and t_1' some manipulation yields the equivalent inequality

$$y_H^2\left(4M^3 - 3M + 7\right) + 4b_m y_H\left(2M^4 - M^3 - 9M^2 - M - 1\right) + 4b_m^2 M\left(4M^3 + 3M + 1\right) > 0. \tag{30}$$

But this is easily verified to be true using $M \geq 2$ and $y_H > 1 + b_m$.

Case 1c. $c_M' \geq 1$, $c_1' > 0$.

In this case

$$\begin{aligned} V_m &= \widehat{V} - \frac{1}{24\Delta}\sum_{i=1}^{M-1} l_i'^3 + \frac{1}{6\Delta}\left(t_{M-1}' - (1+b_m)\right)^2\left(t_{M-1}' + 2b_m - 1\right) \\ &\quad - \mathbf{1}_{y_L < b_m}\frac{1}{6\Delta}\left(b_m - y_L\right)^2\left(y_L + 2b_m\right). \end{aligned} \tag{31}$$

This is the mirror-image of the previous case. Using arguments analogous to the previous case, one can show that $\frac{\partial V_m}{\partial b_d} > 0$ for all b_d such that there exists no $M+1$ partition equilibrium with $c_{M+1}' \geq 1$ and we suppress the details.

Case 2. $M = 1$.

There are three subcases to consider for this case in which the board plays babbling and management uses a cutoff $c_1' = E[y] - b_m$.

Case 2a. $c_1' \leq 0$.

In this case management always chooses the alternative so that shareholder value in the babbling equilibrium can be written as

$$E[x-y] = \Pr[x - y < -b_m]E[x-y|x-y<-b_m] + \Pr[x-y > -b_m]E[x-y|x-y > -b_m], \tag{32}$$

using the law of iterated expectations. Since $y_H > b_m$, $\Pr[x - y < -b_m] > 0$ and the first term on the rhs of (32) strictly negative so that the second term is strictly greater than the lhs. But since the second term on the rhs of (32) is shareholder value from a perfectly management aligned board, it follows that b_d has not been chosen optimally.

Case 2b. $c_1' \geq 1$.

In this case management never chooses the alternative so that shareholder value in the babbling equilibrium is equal to zero. Since the equilibrium does not display consensus, type y_L must prefer the alternative, i.e., $y_L < E[x] + b_d$. Moreover, $c_1' \geq 1$ implies $y_H \geq 1 + b_m$. Straightforward arguments now show that there exists a $M = 2$ partition equilibrium with $c_2' \geq 1$ and either $c_1' \leq 0$ with $t_1' = E[x] + b_d$ or $c_1' \in (0,1)$ with $t_1' = \frac{2}{3} + \frac{1}{3}y_L - \frac{2}{3}(b_m - 2b_d)$, using the formulas derived in Section 6.2.

Case 2c. $c_1' \in (0,1)$.

The expected payoff is, using arguments similar to those for case 1,

$$\begin{aligned} V_m &= \widehat{V} - \frac{1}{24\Delta}\left(y_H - y_L\right)^3 - \mathbf{1}_{y_L < b_m}\frac{1}{6\Delta}\left(b_m - y_L\right)^2\left(y_L + 2b_m\right) \\ &\quad + \mathbf{1}_{y_H > 1 + b_m}\frac{1}{6\Delta}\left(y_H - (1 + b_m)\right)^2\left(y_H + 2b_m - 1\right). \end{aligned} \tag{33}$$

It follows that if $y_H \leq 1 + b_m$, b_d has not been optimally chosen. So suppose henceforth that $y_H > 1 + b_m$.

Construct a 2 partition equilibrium with threshold t_1' and cutoffs c_1' and c_2' as follows. For t_1' close to $y_H > 1 + b_m$, c_1' is close to $E[y] - b_m \in (0,1)$ while c_2' is close to $y_H - b_m$, implying type t_1' prefers sending the higher message. On the other hand, for t_1' close to y_L, c_1' is close to $y_L - b_m$ while c_2' is close to $E[y] - b_m \in (0,1)$. Type t_1' now prefers to send the lower message iff

$$y_L < E[x|y_L - b_m < x < E[y] - b_m] + b_d. \tag{34}$$

If the last inequality holds, then by the intermediate value theorem we have a two partition equilibrium. Otherwise, consider raising the alignment of the board to $b_d' > b_d$ till (34) holds. From (33), raising the alignment to b_d' keeps shareholder value unchanged as long as there is no two partition equilibrium. Furthermore, there must exist $b_d' < b_m$ for which (34) holds since at b_d equal to b_m the rhs of (34) is strictly greater than y_L. For b_d close to the value at which (34) holds with equality, $c_2' < 1$ and since $y_H > 1 + b_m$ such a two partition equilibrium cannot have consensus. From case 1 we know that shareholder value is strictly increasing in board alignment from this point, yielding the desired result.■

Proof of Proposition 8. In the case where $y_L = 0$ and $y_H > 1 + b_m$, $t_i \in (y_L, y_H)$ for all $i = 1, ..., N$ and so the CS equations apply for a supervisory board. The consensus condition (ii) then becomes $E[y|y < t_1] \leq b_m$ and it must always hold in the most informative equilibrium. This follows from observing that $c_1 = \frac{1}{N} - 2B(N-1)$ so that

$$t_1 = \frac{c_1}{2} + b_d = \frac{1}{2N} - B(N-1) + b_d,$$

where $B = b_m - b_d$. Further, $E[y|y < t_1] = \frac{t_1}{2} \leq b_m$ iff $t_1 \leq 2b_m$. If the last inequality does not hold then

$$\frac{1}{2N} - B(N-1) > 2b_m - b_d \geq 2B,$$

implying $B < \frac{1}{2N(N+1)}$. But then a $N+1$ message equilibrium exists.

Since $t_N = \frac{1+c_{N-1}}{2} + b_d$ and $c_{N-1} = 1 - (\frac{1}{N} + 2B(N-1))$, we conclude $E[y|y > t_N]$ is increasing in b_d. Thus, if consensus is not obtained at $b_d = b_d^*$ it can only obtain for larger b_d, yielding $b_d^{**} \geq b_d^*$ and the result follows via Proposition 7. ■

Proof of Proposition 9. If the optimal supervisory board chooses the status quo after a message μ from management, then $y > E[x|\mu] + b_d > E[x|\mu]$, implying shareholders agree with such a decision. On the other hand, the expected shareholder value from the optimal supervisory board with alignment b_d^* equals $\Pr[\text{alt.}|b_d^*]E[x - y|\text{alt.}, b_d^*]$. The last expression is weakly greater than the shareholder value from a shareholder aligned board and the latter must yield non-negative expected payoff to shareholders. But then the expectation $E[x - y|\text{alt.}, b_d^*]$ must be non-negative whenever $\Pr[\text{alt.}|b_d^*] > 0$, implying shareholders must also agree with a decision to choose the alternative at the optimum.■

Proof of Proposition 10. Because of the ex-ante payoff equivalence with the CS framework, the decision-rule implemented by the optimal arbitration mechanism in Goltsman et al (2009) (see also Dessein, 2002) is better for shareholders compared to the decision rule implemented by the optimal supervisory board of Proposition 6. In our context, this decision rule consists of allowing management to choose the alternative as long as $x - y + b_m > 0$ and $y < 1 - b_m$ and to choose the status quo otherwise.■

6.2 Formulas for Equilibrium Cutoffs and Thresholds

6.2.1 Supervisory Board

Assume a supervisory board. Using Proposition 1, for each $N \geq 1$ we provide an explicit characterization of the unique N message equilibrium given by the cutoff managerial types $\{c_i\}_{i=0}^N$ with $c_0 = 0$ and $c_N = 1$ and the threshold board types $\{t_i\}_{i=1}^N$. Let $l_i = c_i - c_{i-1}$ so that $c_i = \sum_{j=1}^i l_j$. Define $B = b_m - b_d > 0$ and for $N \geq 2$ let

$$\begin{aligned}
y_L^*(N) &= \frac{1}{2N} + [Nb_d - (N-1)\, b_m], \\
y_H^*(N) &= 1 - \frac{1}{2N} + [Nb_d - (N-1)\, b_m], \\
y_L^{**}(N) &= \frac{1}{2N-1} y_H + (1 - \frac{1}{2N-1})[Nb_d - (N-1)b_m], \\
y_H^{**}(N) &= (1 - \frac{1}{2N-1}) + \frac{1}{2N-1} y_L + (1 - \frac{1}{2N-1})[Nb_d - (N-1)\, b_m].
\end{aligned}$$

Case 1 **(**$t_1 \geq y_L$, $t_N \leq y_H$**)**. Such an equilibrium with $N \geq 2$ messages exists iff $y_L \leq y_L^*(N)$, $y_H \geq y_H^*(N)$ and $l_1 > 0$, where

$$\begin{aligned}
l_1 &= \frac{1}{N} - 2B(N-1), \\
l_i &= l_1 + 4B(i-1),\ i = 2, ..., N.
\end{aligned}$$

Case 2 **(**$t_1 < y_L$, $t_N \leq y_H$**)**. Such an equilibrium with $N \geq 2$ messages exists iff $y_L > y_L^*(N)$, $y_H \geq y_H^{**}(N)$ and $l_1 > 0$, $l_2 > 0$ where

$$\begin{aligned}
l_1 &= \frac{1}{2N-1} + (1 - \frac{1}{2N-1}) y_L + (1 - \frac{1}{2N-1})[(N-1)b_d - Nb_m], \\
l_2 &= \frac{1 - l_1}{N-1} - 2B\ (N-2), \\
l_i &= l_2 + 4B(i-2),\ i = 3, ..., N.
\end{aligned}$$

Case 3 **(**$t_1 \geq y_L$, $t_N > y_H$**)**. Such an equilibrium with $N \geq 2$ messages exists iff $y_L \leq y_L^{**}(N)$, $y_H < y_H^*(N)$ and $l_1 > 0$, $l_N > 0$ where

$$\begin{aligned}
1 - l_N &= (1 - \frac{1}{2N-1}) y_H + (1 - \frac{1}{2N-1})[(N-1)b_d - Nb_m], \\
l_1 &= \frac{1 - l_N}{N-1} - 2B(N-2), \\
l_i &= l_1 + 4B(i-2),\ i = 2, ..., N-1.
\end{aligned}$$

Case 4 **(**$t_1 < y_L$, $t_N > y_H$**)**. Such an equilibrium with $N \geq 2$ messages exists iff $y_L > y_L^{**}(N)$, $y_H < y_H^{**}(N)$ and $l_1 > 0$, $l_2 > 0$, $l_N > 0$ where

$$\begin{aligned}
l_1 &= \frac{1}{2(N-1)} y_H + (1 - \frac{1}{2(N-1)}) y_L + [(N-2)b_d - (N-1)b_m], \\
1 - l_N &= (1 - \frac{1}{2(N-1)}) y_H + \frac{1}{2(N-1)} y_L + [(N-2)b_d - (N-1)b_m], \\
l_2 &= \frac{y_H - y_L}{N-1} - 2B\ (N-3), \\
l_i &= l_2 + 4B(i-2),\ i = 3, ..., N-1.
\end{aligned}$$

6.2.2 Advisory Board

Assume an advisory board. Using Proposition 2, for each $M \geq 1$, we provide an explicit characterization of the unique M message equilibrium given by the threshold board types $\{t'_i\}_{i=0}^{M}$ with $t'_0 = y_L$ and $t'_M = 1$ and the cutoff managerial types $\{c'_i\}_{i=1}^{M}$. Let $l'_i = t'_i - t'_{i-1}$ so that $t'_i = y_L + \sum_{j=1}^{i} l'_j$. Define $B = b_m - b_d > 0$ and for $M \geq 2$ let

$$\begin{aligned}
x_L^*(M) &= \frac{1}{2M} y_H + (1 - \frac{1}{2M}) y_L - [Mb_m - (M-1)b_d], \\
x_H^*(M) &= (1 - \frac{1}{2M}) y_H + \frac{1}{2M} y_L - [Mb_m - (M-1)b_d], \\
x_L^{**}(M) &= y_L + \frac{1}{2(M-1)} - [Mb_m - (M-1)b_d], \\
x_H^{**}(M) &= y_H - \frac{1}{2(M-1)} + [Mb_m - (M-1)b_d].
\end{aligned}$$

Case 1 **(**$c'_1 \geq 0$, $c_M \leq 1$**)**. Such an equilibrium with $M \geq 2$ messages exists iff $0 \leq x_L^*(M)$, $1 \leq x_H^*(M)$ and $l'_1 > 0$, where

$$\begin{aligned}
l'_1 &= \frac{1}{M}(y_H - y_L) - 2B(M-1), \\
l'_i &= l'_1 + 4B(i-1),\ i = 2, ..., M.
\end{aligned}$$

Case 2 **(**$c'_1 < 0$, $c'_M \leq 1$**)**. Such an equilibrium with $M \geq 2$ messages exists iff $0 > x_L^*(M)$, $1 \geq x_H^{**}(M)$ and $l'_1 > 0$, $l'_2 > 0$ where

$$\begin{aligned}
l'_1 + y_L &= \frac{1}{2M-1} y_H - (1 - \frac{1}{2M-1})[(M-1)b_m - Mb_d], \\
l'_2 &= \frac{y_H - y_L - l'_1}{M-1} - 2B\ (M-2), \\
l'_i &= l'_2 + 4B(i-2),\ i = 3, ..., M.
\end{aligned}$$

Case 3 ($c'_1 \geq 0$, $c'_M > 1$). Such an equilibrium with $M \geq 2$ messages exists iff $0 \leq x^{**}_L(M)$, $1 < x^*_H(M)$ and $l'_1 > 0$, $l'_M > 0$ where

$$\begin{aligned} y_H - l'_M &= (1 - \frac{1}{2M-1}) + \frac{1}{2M-1} y_L - (1 - \frac{1}{2M-1})[(M-1)b_m - Mb_d], \\ l'_1 &= \frac{y_H - y_L - l'_M}{N-1} - 2B(M-2), \\ l'_i &= l'_1 + 4B(i-2),\ i = 2, ..., M-1. \end{aligned}$$

Case 4 ($c'_1 < 0$, $c'_M > 1$). Such an equilibrium with $M \geq 2$ messages exists iff $0 > x^{**}_L(M)$, $1 < x^{**}_H(M)$ and $l'_1 > 0$, $l'_2 > 0$, $l'_M > 0$ where

$$\begin{aligned} l'_1 + y_L &= \frac{1}{2(M-1)} - [(M-2)b_m - (M-1)b_d], \\ y_H - l'_M &= 1 - \frac{1}{2(M-1)} - [(M-2)b_m - (M-1)b_d], \\ l'_2 &= \frac{1}{M-1} - 2B\ (M-3), \\ l'_i &= l'_2 + 4B(i-2),\ i = 3, ..., M-1. \end{aligned}$$

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