Expertise, Structure, and Reputation of Corporate Boards

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Abstract

This paper studies the implications of directors's expertise for optimal board structure. The expertise of directors is particularly important when the company's management does not cooperate with the board, and directors must rely on their own judgment when making decisions. The results of this paper demonstrate that even when the board acts in its shareholders' best interests, its expertise can harm shareholders' value by discouraging an opportunistic management from collecting and sharing valuable information. This effect takes place when a priori management and shareholders disagree on the optimal strategy, and despite management's free access to information. Under those circumstances, an optimal board structure emerges: shareholders' value is maximized when the board is inherently biased against management. Moreover, when directors are concerned about their reputations as experts, the incentives of management to cooperate with the board change. We show that management might gain more power on the expense of shareholders' value if the uncertainty about directors' expertise is high or if a priori directors are not perceived as experts.

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Introduction

The composition of corporate boards is a central theme of the corporate governance debate. In public companies, shareholders rely on the board of directors to perform a variety of tasks: approve major transactions, set strategy, monitor and advise the company's senior management, and appoint and replace the CEO. Which types of directors can be expected to serve the interests of shareholders? This question has become particulary important in light of the recent trends in corporate governance. The Sarbanes-Oxley Act of 2002, the increased role played by proxy advisory firms in directors elections (Alexander et al (2008)), the regulation of enabling shareholders with an easier proxy access,[1] and the shift from plurality to majority voting system in directors elections (Kahan and Rock (2010)), have given shareholders more power and put directors under a tighter scrutiny.

One would expect shareholders to demand a composition of experts serving on their company's board. Presumably, directors who demonstrate high levels of industry knowledge, experience, formal education, social ties, or intellect, will make better decisions. Nevertheless, while the quality of board's members is potentially important, the ability of the board to protect the assets of shareholders and add value crucially depends on the nature of cooperation between the board and the management. The latter has an exclusive access to information and resources of the firm. For this reason, directors' expertise would contribute to the firm's success especially in times when management does not cooperate with the board, and directors must rely on their own judgment when making decisions. When management cooperates and shares information with the board, the expertise of directors is potentially less important.[2] At the same time, the incentives of the company's management to cooperate with the board changes with directors' expertise and other characteristics such as affiliation and reputational concerns. Therefore, the optimal composition of corporate boards must account for the interaction between board members and the company's management.

The goal of this paper is to study the optimal structure of corporate boards, focusing on the expertise of directors. The analysis starts by asking whether shareholders should demand a high level of expertise from their board members. Is there a dark side for directors' expertise? Secondly, the effect of directors' affiliation (with incumbent management or any other third party) on shareholder's value is studied. Should the affiliation of directors with the company's management be restricted? Could it be optimal for shareholders to structure a board whose members are inherently biased against the incumbent management and therefore would frequently challenge its view? Finally, the paper explores the consequences of the recent rise

[1] The cornerstone of proxy access is the new Exchange Act Rule 14a-11, which provides that stockholders complying with the eligibility and other requirements of the rule can include the stockholders' nominees for director in a company's proxy materials. For more details on this regulation see, for example, Fisch (2011).

[2] This description applies to large companies whose CEOs are well established. For start-ups companies, for example, venture capital funds often times obtain board seats and play an important advisory role regardless of the management's input.

of shareholders' power on board's functionality. With more power in shareholders' hand, directors are more concerned about being seen as able business people who add value to their shareholders.[3] How much control should shareholders have on the identity of elected directors? Do CEOs whose board members are worried about their career prospects gain more power and real authority over decision making? And if so, how does it affect firm's value? Answering the questions above would have obvious policy implications with respect the corporate governance of public companies.

In order to study these questions the paper develops a model of board's expertise. In the model, the firm has an investment opportunity whose value to shareholders is uncertain (for example, the value from an acquisition depends on the synergies with the target). Shareholders are represented by the board of directors. The board has the sole deciding authority on the investment policy of the firm. Before making its decision, the board solicits information from the manager of the company.

The manager can collect and share information about the profitability of the investment opportunity. The likelihood that the manager becomes informed increases with the amount of resources expended on such activity. The manager, however, does not incur the direct costs of spending these resources. While the board observes the amount of resources spent by the manager, it does not know whether the manager eventually becomes informed, and if so, what is the content of this information. These are privy to the manager. If the manager learns about the investment's profitability and decides to share this information with the board, he must do so honestly. That is, the collected information is verifiable and it cannot be manipulated once it is disclosed. The manager might not have the incentives to collect and share information with the board. In particular, the manager is interested in exploiting the investment opportunity regardless of its profitability (for example, the manager has a desire to build an empire whether or not it adds value to shareholders). This conflict of interests between the manager and shareholders creates a tension within the firm which is the focus of the model.

Apart from the manager's report, the board can rely on the expertise of its directors. In particular, a board with a business expertise obtains private but imperfect information about the investment's profitability. A non-expert board (hereafter, a layman board) has no such private information. While the expert board obtains information which is not publicly available, it is less precise than the information that the manager can collect. In particular, the expert board would optimally ignore its private information once it gets access to the manager's information. Thus, in this model, the board's expertise is an imperfect substitute for the manager's exclusive information.

At the starting point of the analysis the board's interests are aligned with maximizing the value of shareholders. For a given amount of information that the manager obtains, shareholders

[3] A strong reputation presumably aids in retaining old board seats and gaining new ones, a weak reputation the opposite. Fama and Jensen (1983) conjecture that "outside directors have incentives to develop reputations as experts in decision control" and that the directors "use their directorships to signal to internal and external markets for decision agents that they are experts."

are always better off with a higher level of board's expertise, and vis-a-versa. However, the first result demonstrates that, in equilibrium, shareholders' value increases with the board's expertise if and only if a priori the investment opportunity is profitable. Thus, the board's expertise can *harm* shareholders' value exactly in those circumstances in which it is needed the most, that is, when shareholders and the manager disagree on the ex-ante benefit from investment. This result is even more striking given the assumptions that the board is maximizing shareholders' value and the manager incurs no direct cost by collecting information (no hold up motive). The result challenges the view that more expertise on corporate boards unambiguously improves firm's policy, and it is consistent with the ambiguous empirical finding about value of directors' expertise.[4]

To see the intuition behind this result, note that despite the free access to information the manager may choose not to collect any. While collecting information increases the likelihood that the manager finds favorable evidence whose disclosure will convince the board to approve the project, it also increases the risk that the evidence are against the project. In the latter case the manager conceals the evidence, but the board takes this possibility into account and accordingly becomes more pessimistic about the project. This persuasion effect imposes an indirect cost on the manager from collecting information. Importantly, the significance of this cost depends on the expertise of the board. Through this channel, the board's expertise affects the manager's incentives to collect information, which in turn, affects shareholders' value.

When a priori the investment opportunity seems non-profitable, the layman board would reject the project unless the manager provides evidence that prove otherwise. Thus, when the board is a layman the manager's net return form collecting information is very high. By contrast, when the board is an expert, it becomes possible that the board would approve the project even in the absence of hard evidence in its support. In order to avoid the risk of finding an evidence against the project, the manager will collect less information. Overall, the manager's incentives to collect information decrease with the board's expertise. Since the manager's information is more valuable than the expert board's information, shareholders' value would decrease with the board's expertise as well. A symmetric argument proves that shareholders' value increases with the board's expertise when a priori the investment opportunity seems profitable.

The second result in the paper demonstrates that if the structure (preferences) of the board can be freely designed, it can be optimal to appoint directors who are not committed to maximizing shareholders' value. An optimal board structure (affiliated directors) emerges when the

[4]For example, Guner, Malmendier, and Tate (2008) find that firms with investment bankers on their boards undertake worse acquisitions. Defond, Hann, and Hu (2005) document a positive stock market reaction to the appointment of directors with accounting knowledge to the audit committee, but not to the appointment of other financial experts. Fich (2005) finds that the cumulative abnormal return in response to the addition of a director who is CEO of another firm is significantly greater the higher the industry-adjusted ROA of his firm. However, the effect is insignificant and sometimes even negative, if the new director holds an MBA or is an academic.

manager has sufficient access to information, shareholders and the manager disagree on the prospects of the project, and the level of directors' expertise is relatively high. In those circumstances, the firm's value is maximized when the board is set to be biased *against* the manager's agenda. That is, the presence of so called "watchdogs" on the board and directors who are not afraid of "rocking the boat" can be valuable.[5] By contrast to the existing literature, this result implies that shareholders can gain from supporting dissenting nominees for the board who would benefit from challenging the incumbent management's view.[6]

Intuitively, when the board is biased against taking the project, the manager realizes that the project would be rejected unless he provides the board with hard evidence that justify investment. Thus, the bias increases the incentives of the manager to collect and share information with the board. The benefit for shareholders from having an informative decision making outweighs the possibility that the biased board would reject profitable projects, especially when the manager has sufficient access to information but his incentives to collect it are weak. According to the previous result, this would be the case when (given the available public information) the project is not expected to be profitable and the board's expertise is high.

The last part of the analysis studies directors' reputational concerns. When the quality of board's members is uncertain, directors might benefit from building up their reputation as experts, earning shareholders' trust in their capability to add value.[7] We introduce board's reputational concerns to the basic model in order to explore the effect of an increase in shareholders' power on the willingness of the manager to collect and communicate information with the board. In the modified model, shareholders form their beliefs on the board's expertise based on the board's decision to approve the project, and the board derives a direct utility from these beliefs. In order to create the impression that the board consists of experts, both the expert and the layman board reject projects which a priori seem profitable, and approve projects which a priori seem not profitable. In equilibrium, the board behaves as if it has private information even when it is uninformed, and under-reacts to the available public information. Thus, concerns for reputation (endogenously) distort the board's behavior from maximizing shareholders' value.[8]

The analysis reveals that the channel through which the board's concerns for reputation affect shareholders' value is mainly through its effect on the manager's incentives to cooperate with the board. In particular, the third result shows that the board's concerns for reputation destroy shareholders' welfare if and only if the common prior belief that the board is an expert

[5] Director who represents a large shareholder whose interests are not aligned with dispersed shareholders and the incumbent management's agenda is another plausible candidate.

[6] For example, Adams and Ferreira (2007), Almazan and Suarez (2003), and Chakraborty and Yilmaz (2011) argue that "friendly boards", that is, boards who are affiliated with incumbent management, are optimal.

[7] While the first result indicates that shareholders do not necessarily benefit from having an expert board, reputation for expertise might be valuable for directors if, for example, the demand for directors' expertise varies across firms and directors can simultaneously serve on more than one board.

[8] The assumptions in model ensure that concerns for reputation do not entirely crowd out the board's fiduciary duty to maximize its shareholders' value.

is low or the uncertainty about the board's expertise is high. Moreover, when the likelihood that the board is an expert is relatively low and shareholders and the manager disagree on the profitability of the project, the board's reputational concerns increase the manager's power on the expense of shareholders' value. Thus, when concerns for reputation are seemingly needed the most, shareholders' pressure on board members achieves exactly the opposite outcome. This result challenges the idea that giving more power to shareholders in determining the identity of directors is necessarily beneficial.

The intuition for this result is the following. When the likelihood that the board is an expert is low, the manager has incentives to collect information such that the layman board is relatively more likely to approve the project conditional on non-disclosure of information. Thus, the rejection of the project signals shareholders that the board is an expert, and reputational concerns for expertise create additional private benefits for the board to reject the project. Consequently, the (indirect) marginal cost of collecting information increases and the manager has fewer incentives to collect information. The decline in the amount of information that the manager shares with the board leads to more inefficient decisions by the board and hence reduces shareholders' value.

Overall, the analysis in this paper has policy implications with respect to several important issues. It suggests that demanding a minimum level of expertise from independent directors (to be eligible to serve on the board of a public company) can harm shareholders when the conflict of interests with their manager is significant. In those circumstances, it may be useful to encourage the appointment of directors whose agenda is not necessarily consistent with maximizing shareholders' value, but it contrasts the incumbent management's agenda. Moreover, putting directors under more pressure, a reflection of recent trends in the corporate governance in public U.S companies, can achieve the opposite outcome: instead of more discipline, managers might gain more power on the expense of shareholders' value. This suggests that the amount of control that shareholders have on the identity of elected directors should be treated with caution.

The paper proceeds as follows. The remainder of this section discusses the relationship to the existing literature. Section 1 presents the baseline model in which the board is value-maximizing and it has no reputational concerns. Section 2 analyzes the optimal structure of the board, and its interaction with directors' expertise. Section 3 introduces board's concerns for reputation and studies its effect on the manager's incentives to collect information and on shareholders' value. Section 4 concludes. All omitted proofs are collected in the Appendix.

Relation to the Literature

The agency literature has already identified instances in which more information or transparency can hurt the principal. For example, in Cremer (1995), Dewatripont, Jewitt and Tirole (1999) and Holmstrom (1999), the improvement in information flows alleviates an adverse selection problem (it is easier to detect agent's type) but creates a moral hazard problem (the agent exerts less effort).[9] Hermalin and Weisbach (2011) argue that managers will need to be compensated for the harm caused them by having an expert board, and that the increase in compensation is the cost of having an expert board. They also show that the quality of the board can induce the manager to pursue actions that are not in the shareholders' best interest. In the context of building a reputation for expertise, Prat (2005) shows that transparency of actions taken by the agent is detrimental since it might create incentives for the agent to conform to some expected behavior, thereby disregarding useful private information. Different from these studies, the task of the agent (the company's manager) in the present model is to collect information (at not direct cost) and then communicate it to the principal (the board). Therefore, the channel through which expertise might harmful is fundamentally different in the present paper.

Closely related is a study by Kamenica and Gentzkow (2010) who show that a sender can benefit from persuasion if the (uninformed) receiver does not take the sender's preferred action by default. In their model the sender can freely choose the conditional distribution of the signal he collects. Key to their results is that the sender cannot conceal information once the signal realization is known. The present paper extends their framework by showing that when the sender has the ability to conceal information, the receiver's private information can deprive the sender's incentives to collect and disclose information. Kamenica and Gentzkow also argue that making preferences (between sender and receiver) more aligned might reduce the extent of communication in equilibrium. The present paper shows that if the alignment of preferences can be freely chosen, the extent of communication is always maximized by widening the gap in preferences. Moreover, if the misalignment of preferences is determined endogenously by receiver's reputational concerns, quite the opposite happens: the extent of communication in equilibrium increases if and only if misalignment of preferences decreases.

Our paper is also related to Adams and Ferreira (2007), Baldenius, Melumad and Meng (2010), Chakraborty and Yilmaz (2011), and Harris and Raviv (2005, 2008, 2010). Building on insights in Dessein (2002), these studies employ two-sided private information in the Crawford and Sobel (1982) model of strategic information transmission, and analyze optimal delegation between the board (or shareholders) and the manager.[10] In these studies information is non-verifiable, and hence, unlike the present study, misalignment of preferences always reduces the amount of information that is revealed in equilibrium. Moreover, in these studies the board's information is incremental to the the manager' information, while in the present paper the board's expertise is an imperfect substitute. Lastly, only Harris and Raviv (2008) and

[9] Similarly, Rajan (1992) and von Thadden (1995) show how investor's inability to commit to abstain from rent extraction has adverse effects on the agent's incentives: in both cases, her informational monopoly allows a firm's exclusive lender to dictate the terms of continuation finance, thus distorting the firm's investment choice.

[10] The present paper does not address the question of optimal delegation, instead it focuses on the role of directors' expertise on the incentives of management to collect and share information. Nevertheless, since the manager's preferred action is independent of the fundamentals, in the present setup it is never optimal (from shareholders' point of view) to delegate decision making to the manager.

Baldenius, Melumad and Meng (2010) explore a setup in which information is endogenous. However, in both studies it is the principal who can acquire information at some cost, whereas in the current paper it is the agent who can at no direct cost collect information.

In the context of reputation, Song and Thakor (2006) study a model of information transmission in which both the manager and the board have career concerns. Similar to present paper, in their model the board has private information about its expertise and the project's profitability. However, in their model, the manager is entirely uninformed and is not allowed to collect information on the project. Instead, the manager can limit the amount of private information that is observed by the board. Therefore, unlike our model, the board in Song and Thakor (2006) has the potential of adding value to shareholders simply because it obtains information that is unavailable to the manager. The tension between the manager and the board is the outcome of the their conflicting career concerns, whereas in our model it is the outcome of managerial opportunism.

Finally, studying the incentives of agents to invest in information, Milbourn, Schockley and Thakor (2001) show that manager's career concerns can cause the manager to over-invest in information. By contrast, the present paper shows how the career concerns of the board affect the manager's incentives to invest in information, and find that it can cause the manager to under-invest in information.

1 A Model of Board's Expertise

In this section we study the effect of the board's expertise on the interaction between board members and the company's management, subject to the assumption that board members have no reputational concerns and their interests are aligned with maximizing shareholders' value.

1.1 Setup

A firm is facing with an investment opportunity. The firm is run by a manager, controlled by the board of directors, and it is wholly owned by shareholders. All agents are risk neutral. The board is treated as a monolithic entity. In particular, the manager is not part of the board and the analysis abstracts from coordination aspects between directors.

The value of the firm depends on the business strategy that is implemented as well as on the fundamentals. We denote the implemented strategy by $a \in \{0, 1\}$ and the state of the world by $\omega \in \{0, 1\}$. For example, the company might debate between internal and external growth strategies, and the profitability of each strategy could be a function of the organizational culture of the company, the supply of potential targets, the depth of the product markets, and so on. We will often refer to decision a as an investment in a project, and hence say that the project is approved when $a = 1$ and the project is rejected when $a = 0$. To capture that the idea that the profitability of a particular decision a is uncertain, we assume that the value of the firm to shareholders is given by,

$$v(a, \omega) = 1_{\{a=\omega\}}$$

Thus, from shareholders' perspective, the firm should invest in the project if and only if the probability that $\omega = 1$ is greater than $\frac{1}{2}$. We let $p \equiv \Pr[\omega = 1] \in (0, 1)$ be the common prior beliefs on ω.

The manager of the firm has the opportunity to collect information and learn about ω. We denote by $e \in [0, \bar{e}]$ the amount of resources the manager spends on collecting information, where $\bar{e} \in (0, 1]$. For example, the manager can invest in research and development, solicit consultants' opinions, or engage in competitive intelligence, in order to "test" and explore the project's profitability. These investments in information generate a signal about the true quality of the project ω, and the precision of the signal is increasing in the resources expended on such information. In particular, with probability e the manager perfectly observes ω, and with the complement probability the manager remains completely uninformed about ω.

We assume that the manager does not incur any direct costs by collecting information. As will become clear in the analysis below, in many cases the manager finds it optimal not to collect information despite the free access to information.[11] Whether or not the manager becomes informed, and the content of the signal he observes, are his own private information. However, the board observes the amount of resources e that are spent by the manager. For example, learning about the benefit from an acquisition requires the manager to spend time meeting with the target's board members and senior management, consulting investment bankers and lawyers, etc'. These activities are likely to be at least partly observed and noticed within the firm. Thus, we assume that board members have an idea of how much effort their manager has invested in becoming informed about the profitability of the investment opportunity. While the learning intensity e is observable, it is not contractible. Hence that the board cannot explicitly contract the provision of learning.[12]

The information that the manager collects is hard and verifiable. For example, if the agenda on the board's table is a particular acquisition, the manager can provide the board with the analysis of valuation models, financing commitment from bankers, lawyers' opinion about the legal feasibility of the takeover, and so on. Thus, if the manager obtains private information and decides on disclosing it to the board, the information cannot be manipulated. For the same reason, if the manager does not obtain any private information, he cannot reveal or convey any other information credibly.[13] Nevertheless, the manager might strategically decide to conceal

[11] The assumption that the manager does not incur direct costs of collecting information is not material for our results. We make this assumption in order to abstract from potential hold-up problems a la Burkart et al. (1997), and focus on the persuasion effect of information collection.

[12] Given our assumption that there are no direct costs associated with e, if e is not observed by the board, the only equilibrium would be an equilibrium in which the manager is fully informed about the ω. Thus, the observability of e is a credible commitment by the manager to remain partly uninformed. Nevertheless, all that is needed for our results is that there is non-zero probability that the board observes e, or that the manager incurs direct costs from collecting information.

[13] In the existing setup, allowing for "cheap talk" would not change the amount of information that is disclosed

the information from the board. We denote by

$$\sigma_e(\omega) : [0,1] \times \{0,1\} \to [0,1]$$

the probability that the manager chooses *not to disclose* information conditional on spending e resources on collecting information and conditional on observing state ω. We assume that the manager does not incur any direct costs or benefits from disclosure. We let $m \in \{\omega, \phi\}$ be the outcome of the manager's disclosure decision, where ϕ stands for non-disclosure.

The manager of the firm is inherently biased. That is, his incentives are not necessarily aligned with maximizing shareholders' value. In its simplest form, the agency problem in our model states that the manager derives utility from investing in the project regardless of how much value it generates to shareholders. We assume that,

$$u_M(a, \omega) = a$$

For example, if action $a = 1$ represents external growth through acquisitions, an empire-building manager might benefit from the acquisition strategy even if it does not maximize the value of shareholders. The preferences of the manager are common knowledge.

Since managers are often biased and self-interested, shareholders allocate the decision making authority with their elected board. We assume that the board has the full discretion over decision a and that the board is maximizing shareholders' value,

$$u_B(a, \omega) = v(a, \omega)$$

The board, however, does not have the expertise of the manager and therefore has limited access to information. In particular it cannot collect new information about ω, unless the manager shares his information with the board. Overall, before the board is making the decision whether to invest in the project, it has three sources of information it can use for this purpose. First, the board uses available public information embedded in the prior beliefs p. Second, the board takes into account the manager's report m and the amount of resources e that the manager spent on collecting this information. Last, the board uses its own expertise.

In our view, the board's expertise reflects board members previous knowledge based on their business experience (e.g., former executives and directors in other companies) or profession (e.g., lawyers, accountants, bankers, academics, etc.). There are two types of boards in the model, an expert ($\rho = 1$) and a layman ($\rho = 0$). The layman board has no excess information about ω beyond what is publicly available or is provided by the manager, whereas the expert board has private information on the profitability of the project. In particular, the expert board privately observes a signal $s \in [\underline{s}, \bar{s}]$ where the interval is potentially unbounded. We let f_ω and F_ω be the density and cumulative functions, respectively, for the probability of receiving signal s if the

by the manager in any equilibrium.

true state of the world is ω. We assume that the functions $f_{\omega}(\cdot)$ are continuous and that the likelihood function $l(s) \equiv \frac{f_1(s)}{f_0(s)}$ is strictly increasing in $[\underline{s}, \bar{s}]$ (monotone likelihood ratio (MLR) condition).

The underlining assumption of the model is that the board's expertise plays a role only when the manager does not cooperate and share information with the board. This reflects our view that board's expertise is valuable only to the extent that the manager has no incentives or is unable to provide information. Indeed, we will show that regardless of its expertise, the board would find it optimal to defer to the manager's view if the manager discloses its information about ω. To ensure that the board's expertise can add value in the absence of additional information, we assume that there exists $\hat{s} \in (\underline{s}, \bar{s})$ such that $l(\hat{s}) = 1$. When the expert board observes signal $\hat{s}$ his posterior beliefs are given by the prior p. This assumption implies that an expert board would condition the decision to invest in the project on its private information, if no information beyond what is publicly available is provided. To simplify the analysis we assume that $\lim_{s \to \bar{s}} l(s) = \infty$ and $\lim_{s \to \underline{s}} l(s) = 0$. Under these assumptions the expert board becomes perfectly informed about the true state of the world once the signal approaches the boundaries of its support. These assumptions on the limit behavior of $l(\cdot)$ are unnecessary for our main results. Quite the opposite, we will show that even though the precision of the information that the expert board obtains is unbounded, the expertise of a value-maximizing board can dimmish shareholders' value.

We assume that the expertise of the board is the board's private information. Shareholders and the manager share the common prior that the board is an expert ($\rho = 1$) with probability $\lambda \in [0, 1]$. Alternatively, one can interpret λ as the probability that the board observes an informative signal s, and $1 - \lambda$ as the probability that it remains uninformed. The expertise of the board is independent of the fundamentals ω.

In order to simplify the notation going forward, we say that the board receives signal $s \in [\underline{s}, \bar{s}]$ where the layman board receives signal $s = \hat{s}$ with probability one, and the expert board receives $s \in [\underline{s}, \bar{s}]$ according to $f_{\omega}(\cdot)$. We denote the probability that the board decides on $a = 1$ by

$$a_{e,m}(s) : [0, \bar{e}] \times \{0, 1, \phi\} \times [\underline{s}, \bar{s}] \to [0, 1]$$

Overall, the sequence of events unfolds as follows. First the manager decides how much resources e to invest in collecting information about ω. Given his decision on e, if the manager does not observe ω then no information is revealed to the board. If the manager observes ω, he can decide on the probability σ that this information is disclosed to the board. Given the observation of e, the message m given by the manager, and its private signal s, the board updates its beliefs on ω and decides on a, the probability that the project is implemented. Last, the state of the world ω is realized.

Before we turn into the analysis, it is important to note that in this model the board cannot commit to a particular decision rule. Therefore, given all the available information, the board always takes the ex-post efficient decision. With commitment, it is possible to induce the manager to collect all the available information ($e = \bar{e}$).[14] For example, if the board commits to accepting the project if and only if the manager discloses information that $\omega = 1$, then the manager would always have the incentives to collect as much information as possible and fully disclose it.

1.2 Analysis

We solve the game backward. We start with the board's decision whether to invest in the project. Suppose the manager invested e resources in collecting information, and that conditional on observing state ω, the manager' strategy is not to disclose the information with probability $\sigma_e^*(\omega)$. There are two scenarios to consider. First, if the manager discloses information about ω, the board's private information becomes redundant regardless of the quality of this information. In particular, since the board is maximizing shareholders' value, it is strictly optimal for the board to choose $a = \omega$ for any e and s. Second, if the manager does not disclose information, the board forms its beliefs about ω given its private signal s, knowledge of e, and the expectations that the manager would follow disclosure strategy $\sigma_e^*(\omega)$. The board chooses $a = 1$ if and only if its posterior beliefs that $\omega = 1$ is greater than $\frac{1}{2}$.

We denote by q the posterior probability that $\omega = 1$ conditional solely on the event that the manager does not disclose information about ω. Note that q is a function of the prior beliefs p , the manager's disclosure policy $\sigma_e^*(\omega)$, and the amount of resources the manager invests in collecting information e. However, q is not a function of s. Applying Bayes' rules, for any $s \in [\underline{s}, \bar{s}]$ the board's posterior beliefs conditional on non-disclosure and conditional on observing the private signal s are given by $\frac{l(s)}{l(s)+\frac{1-q}{q}}$. Therefore, the board will approve the project if and only if $s \geq s^*(q)$ where $s^*(q) \equiv l^{-1}\left(\frac{1-q}{q}\right)$. The pair (s, q) is a sufficient statistic for the information that is available to the board conditional on non-disclosure of ω by the manager. The following lemma summarizes the board's decision whether to approve the project.

Lemma 1 *For any e and $\sigma_e^*(\omega)$ the board's approval decision is given by,*[15]

$$a_{e,m}^*(s) = \begin{cases} \omega & \text{if } m = \omega \\ 1 \cdot \{s \geq s^*(q(e, p, \sigma_e^*(\omega)))\} & \text{if } m = \phi \end{cases}$$

where

$$q(e, p, \sigma_e(\omega)) \equiv p \frac{e\sigma_e(1) + (1 - e)}{e[p\sigma_e(1) + (1 - p)\sigma_e(0)] + (1 - e)} \tag{1}$$

[14] Note that as long as $\bar{e} < 1$ the first best is not attainable even with such commitment.

[15] Unless $m = \phi$ and $s = l^{-1}\left(\frac{1-q}{q}\right)$, the board's response is uniquely determined by manager's decision how much information to collect and disclose. We implicitly assume that the board plays a pure strategies.

Consider the manager's disclosure policy once the decision on how much information to collect has been made. If the manager does not learn about ω then the manager cannot disclose information. Suppose the manager observes state ω. The manager has correct expectations regrading the board's reaction to his disclosure decision as described by Lemma 1. In particular, the manager realizes that if he discloses information about ω the board will choose $a = \omega$. However, if the manager chooses not to disclose information then the board's decision depends on the content and quality of its signal, as well as on the inference from the manager's decision not to disclose information. As expected, the next lemma proves that in equilibrium $\sigma_e^*(\omega) = 1 - \omega$.

Lemma 2 *In equilibrium the manager discloses information about $\omega = 1$ and withholds information about $\omega = 0$.*

Lemma 2 implies that $\sigma_e^*(0) > \sigma_e^*(1)$ and therefore in equilibrium $q(e, p, \sigma_e(\omega)) \leq p$. This confirms our intuition that when the manager is biased toward approval of the project, non-disclosure always conveys information that ω is more likely to be zero. Indeed, from the manager's point of view, the benefit from disclosure arises only if he can provide evidence that would convince the board to invest in the project. After all, the manager derives utility only from the project's approval and regardless of the true state of the world. According to Lemma 1, conditional on disclosure, the board would approve the project if and only if $\omega = 1$. Thus, the manager has more incentives to disclose information when he observes $\omega = 1$.

Lemma 1 and Lemma 2 establish and characterize the equilibrium of the sub-game that is induced by the manager's decision over e, the precision of his signal. We turn into studying the manager's decision of how much resources e he should spend on collecting information, anticipating his own disclosure policy and the board's response.

We let $\alpha(q, x) \in [0, 1]$ be the probability that the expert board accepts the project if an outsider (for example, the manager) believes that $\Pr[\omega = 1] = x$ and the expert board, prior to observing its signal s, believes that $\Pr[\omega = 1] = q$. Therefore, if the manager successfully learns about ω but he decides not disclose this information, he would expect the expert board to accept the project with probability $\alpha(q, \omega)$. If the manager fails to learn about ω, he expects the expert board to accept the project with probability $\alpha(q, p)$. For any $x \in [0, 1]$, the function $\alpha(q, x)$ is given by,[16]

$$\alpha(q, x) = 1 - xF_1(s^*(q)) - (1 - x) F_0(s^*(q)) \tag{2}$$

The ex-ante utility of the manager is the unconditional probability that the board approves

[16]Lemma A.1 in the appendix shows that our assumptions on f_ω (and in particular, the MLR property) imply that $\alpha(q, x)$ strictly increases in its both arguments, it is linear in x, and for all $q \in [0, 1]$ and $x \in [0, 1]$, $\alpha(1, x) = 1$ and $\alpha(0, x) = 0$.

the project. Let $q(e) \equiv \frac{p-ep}{1-ep}$ then the manager's expected utility is given by,

$$\mathbb{E}\left[u_M(e)\right] = ep + e(1-p)\begin{bmatrix} \lambda\alpha\left(q(e),0\right) \\ +(1-\lambda)\cdot 1_{\left\{q(e)\geq\frac{1}{2}\right\}} \end{bmatrix} + (1-e)\begin{bmatrix} \lambda\alpha\left(q(e),p\right) \\ +(1-\lambda)\cdot 1_{\left\{q(e)\geq\frac{1}{2}\right\}} \end{bmatrix} \tag{3}$$

There are three terms in (3) to consider. The first term corresponds to events in which the manager successfully collects information about ω and finds out that $\omega = 1$. Under those circumstances, the manager can guarantee that the board approves the project by sharing this information with the board. The second and the third terms correspond to the events in which the manager does not disclose information. The second term is the event in which the manager successfully collects information about ω, but he finds out that $\omega = 0$. According to Lemma 2, if the manager observes $\omega = 0$ he would strategically withhold this information. The probability that the manager ascribes to the event that the expert board approves the investment despite the lack of disclosure is given by $\alpha(q(e),0)$. The layman board is expected to accept the project with probability one if $q \geq \frac{1}{2}$ and reject it otherwise. The third term represents the event in which the manager fails to collect information despite his effort. In this event, the manager has no information to share, and hence he relies on the board's decision conditional on non-disclosure. The difference between the second and third terms comes from the correlation between the manager's information about ω and the signal that the expert board observes. In particular, when the manager withholds information about ω, he is more pessimistic and believes that the probability that the board would reject the project is higher than when the manager is uninformed about ω. The following lemma describes useful comparative statics of $\mathbb{E}\left[u_M(e)\right]$.

Lemma 3 *For any $e \in [0,1]$ the manager's expected utility increases in λ if and only if $q(e) \geq \frac{1}{2}$, and it increases in p.*

The conflict of interests between the manager and shareholders, and hence between the manager and the board, is relatively weak when the prior belief that the project is profitable is high. Therefore, it is not surprising that the manager is more likely to be successful in persuading the board to invest in the project when p is higher.

The comparative statics of the manager's utility with respect to λ is more subtle. Lemma 3 reveals that despite the conflict of interests between the manager and the board, the manager can in fact benefit from being a subordinate of an expert board. Moreover, the manager benefits from board's expertise exactly when the conflict of interests between the manager and shareholders is relatively strong, that is, when the prior belief that the investment is profitable is low. Intuitively, when $q(e) < \frac{1}{2} \Leftrightarrow p < \frac{1}{2-e}$ the layman board would never approve the investment unless the manager provides and evidence which suggests that investment is in fact profitable. By contrast, even without receiving such evidence from the manager, the expert board might approve the project if it receives a positive signal about the investment's profitability. Thus, when p is low, an expert board is more likely to approve the investment than the layman board. By contrast, when p is high, the layman board would approve the project if no information is provided by the manager while the expert board would reject the project if it observes a negative signal about the project's profitability. Thus, when p is high, a layman board is more likely to approve the investment. This explains why the manager could benefit from the presence of high board's expertise.

The manager's optimal investment of resources in collecting information and the equilibrium of the entire game is characterized by the following proposition.

Proposition 1 *An equilibrium always exists. In any equilibrium the manager discloses information about ω if and only if $\omega = 1$. If information is disclosed, the board approves the project. Moreover, let $e^*(\lambda)$ be the amount of information the manager collects in equilibrium and let $q_{\min}(\bar{e}, p) \equiv \arg\min_{q \in [q(\bar{e}), p]} \left\{ \frac{1-\alpha(q,q)}{1-q} \right\}$. Then,*

(i) If $p < \frac{1}{2}$ then $e^*(0) = \bar{e}$, $e^*(\lambda)$ is non-increasing in λ, and $e^*(1) < \bar{e}$ if and only if $q_{\min} > q(\bar{e})$. Moreover, the layman board rejects the project conditional on non-disclosure.

(ii) If $p \geq \frac{1}{2}$ then there exist $e^+ < \bar{e}$ and $\lambda^+ > 0$ (where $\lambda^+ < 1$ if and only if $q_{\min} < \frac{1}{2}$) such that:

- *If $\lambda \leq \lambda^+$ then $e^*(\lambda) = e^+$ and the layman board accepts the project conditional on non-disclosure.*
- *If $\lambda > \lambda^+$ then $e^*(\lambda) > e^+$, $e^*(\lambda)$ is non-increasing in λ, and the layman board rejects the project conditional on non-disclosure.*

(iii) If $p \neq \frac{1}{2}$ then $e^*(\lambda)$ increases in p for any λ. There exists $\lambda^- \in \left(0, \lambda^+\right]$ such that if $\lambda \leq \lambda^-$ then $e^*(\lambda)$ drops to zero at $p = \frac{1}{2}$.

Proposition 1 has several interesting aspects. First, while the manager does not incur direct costs from collecting information, still he may strategically choose to remain partly uninformed ($e^*(\lambda) < \bar{e}$). The reason is that being informed imposes *indirect* costs on the manager. To see why, recall that conditional on observing ω, the manager discloses information if and only if $\omega = 1$. Thus, conditional on non-disclosure, the board concludes that either the manager has failed to collect information about ω, or that the manager observes $\omega = 0$. The more resources the manager spends on collecting information, the higher is the probability that he learns about ω. Since the board observes e, the board weighes more heavily the possibility that the manager strategically conceals information about $\omega = 0$, and adjusts its posterior beliefs downward. All else equal, the higher is e the lower is the likelihood that the board approves the project conditional on non-disclosure. Since ex-ante there is a positive probability that the manager learns and withholds the information that $\omega = 0$, the manager trades off this risk with the chance of finding out that $\omega = 1$ and thereby persuading the board to accept the project.

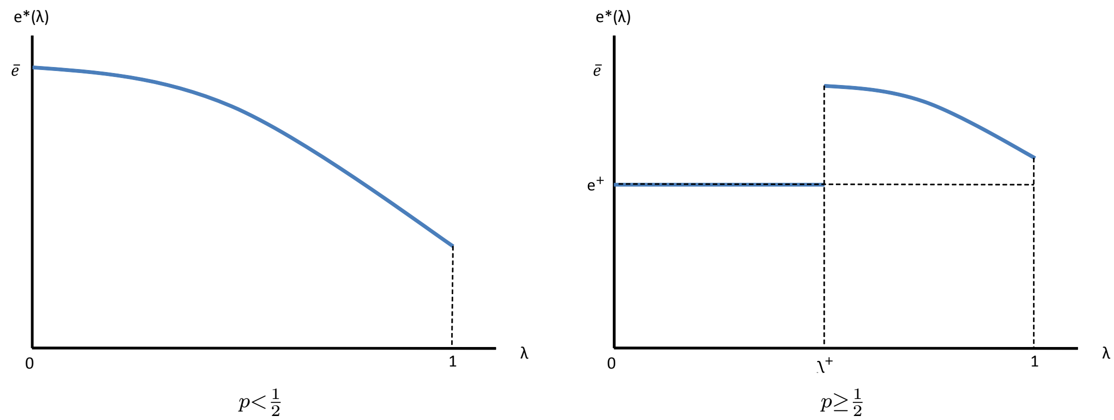

Figure 1 - The amount of information that is collected by the manager in equilibrium

Second, Proposition 1 characterizes the circumstances under which the manager decides not to collect all the available information. To gain some intuition, suppose $p < \frac{1}{2}$ and note that (3) can be rewritten as

$$\mathbb{E}\left[u_M\left(q\right)\right] = 1 - \left(1-p\right)\left[\frac{1-\lambda\alpha\left(q,q\right)}{1-q}\right] \tag{4}$$

Therefore, the manager's utility is uniquely determined by q, the posterior beliefs that $\omega = 1$ conditional on non-disclosure. The manager's decision of how much information to collect is equivalent to his decision about $q \in \left[q\left(\bar{e}\right), p\right]$. For each q, the term $\alpha\left(q,q\right)$ in (4) corresponds to the ex-ante probability (prior to observing the signal about ω) that the manager ascribes to the event that the expert board accepts the project conditional on non-disclosure. Suppose the manager can perfectly observe ω if he wishes to, that is, $\bar{e} = 1$. It follows from (4) that the manager chooses $q > 0$ (or equivalently $e < 1$) if and only if there exists $q \in (0, p]$ such that $\lambda\alpha\left(q,q\right) > q$. Intuitively, when $p < \frac{1}{2}$ the layman board always rejects the project conditional on non-disclosure. Therefore, the probability that the board accepts the project conditional on non-disclosure is $\lambda\alpha\left(q,q\right)$. This is also marginal and indirect cost from collecting an extra unit of information. As long as $\lambda\alpha\left(q,q\right)$ is greater than q, the marginal benefit from collecting information, the manager can gain from not-collecting all the available information.[17]

Third, Proposition 1 also highlights that the amount of information that the manager collects in equilibrium can decrease in the board's expertise. That is, managers are less likely to collect

[17] The requirement that $q_{\min} > q\left(\bar{e}\right)$ generalizes the conditional above for any threshold $\bar{e}$ and ensures that there exists a level of expertise above which the manager always refrains from investing the maximum amount of resources in collecting information.

and share information with the board, if the board has substantial expertise. To understand this result, note that in absence of more information the layman board will reject the project when $p < \frac{1}{2}$. Thus, the only way the manager can convince the layman board to accept the project is by collecting and revealing evidence that $\omega = 1$. The benefit from collecting information is high. However, as the expertise of the board increases, there is a possibility that an expert board will find out that the project is worthwhile taking even in the absence of evidence from the manager. This would be the case when the signal s is sufficiently high. This effect decreases the incentives of the manager to collect information.

When $p \geq \frac{1}{2}$ the dynamic is almost reversed. The layman board will accept the project in absence of disclosure. Therefore, the benefit from collecting information is low. As the expertise of the board increases, there is a possibility that an expert board will find out that the project is not sufficiently attractive and reject it. This increases the incentives of the manager to collect information. As figure 1 illustrates, $e^* (\lambda)$ can be non-monotonic when $p \geq \frac{1}{2}$.

Finally, Proposition 1 demonstrates that almost everywhere the optimal level of resources that the manager spends on collecting information increases with p. This is intuitive since the higher is p, the more likely it is that the manager learns that $\omega = 1$. Thus, the net return from collecting information increases with p. Nevertheless, if $\lambda \leq \lambda^-$ the equilibrium level of e falls discretely at $p = \frac{1}{2}$. For any $p < \frac{1}{2}$ the layman board would reject the project in the absence of managerial disclosure. Therefore, if the likelihood that the board is a layman is sufficiently high ($\lambda \leq \lambda^-$), the manager has enough incentives to collect information. However, when $p = \frac{1}{2}$ the layman board is willing to accept the project even if the manager does not collect and share his private information. For this reason, the incentives of the manager to collect information about ω fall at $p = \frac{1}{2}$.

While the amount of information that is collected by the manager does not necessarily increases with p in equilibrium, the probability that the board approves the project in equilibrium does. Recall that the probability that the board approves the project is exactly the manager's expected utility. As p increases, it is easier for the manager to persuade the board that the project is profitable and hence the probability that board approves it increases. Corollary 1 concludes this observation and reveals the effect of board's expertise on the likelihood that the project is undertaken in equilibrium.

Corollary 1

(i) If $p < \frac{1}{2}$ the probability that the project is approved in equilibrium is strictly increasing in λ.

(ii) If $p \geq \frac{1}{2}$ the probability that the project is approved in equilibrium is strictly increasing in λ if and only if $\lambda \geq \lambda^+$, and the minimum of this value is obtained at λ^+.

(iii) The probability that the project is approved in equilibrium is strictly increasing in p.

Interestingly, it follows from Corollary 1 that a higher board's expertise does not necessarily reduces the likelihood that the project is approved. One might expect that an expert board would be able to counteract the manager's bias toward the project's approval. However, Corollary 1 suggests that the board fails to do so exactly when a priori shareholders and the manager disagree on the benefit from the project, that is, when $p < \frac{1}{2}$. This, however, does not necessarily imply a greater inefficiency. An informed board might act based on its private information which may contrast the available public evidence. Nevertheless, we will demonstrate below, that higher expertise can in fact decrease shareholder's value, even though the board's objective is to maximize their value.

Shareholders' Welfare

Unlike the manager, shareholders derive value from the investment in the project if and only if $\omega = 1$. Thus, their expected welfare is exactly the probability that $a = \omega$. Given the amount of resources spent by the manager on collecting information, shareholders' value is given by,

$$V(e, \lambda) = p \left(e + (1-e) \begin{bmatrix} \lambda\alpha(q(e), 1) \\ +(1-\lambda) \cdot 1_{\left\{q(e) \geq \frac{1}{2}\right\}} \end{bmatrix} \right) + (1-p) \begin{bmatrix} 1 - \lambda\alpha(q(e), 0) \\ -(1-\lambda) \cdot 1_{\left\{q(e) \geq \frac{1}{2}\right\}} \end{bmatrix} \tag{5}$$

The first term corresponds to scenarios in which the board chooses $a = 1$ conditional on $\omega = 1$. This happens if either the board discloses information that $\omega = 1$ or if conditional on non-disclosure the board finds it optimal to accept the project. The second term corresponds to scenarios in which the board chooses $a = 0$ conditional on $\omega = 0$. Since the manager never discloses information about $\omega = 0$, the project is rejected only if conditional on non-disclosure the board finds it optimal to reject the project.

Lemma 4 *For any e and λ shareholders' value $V(e, \lambda)$ strictly increases in e and λ. In equilibrium, shareholders' value $V(e^*(\lambda), \lambda)$ is non-decreasing in $\bar{e}$.*

Lemma 4 demonstrates that shareholders's value increases with the amount of information that either their manager or board obtain. This is intuitive since in both cases the probability that the "correct" action is taken is higher. Indeed, since the manager's disclosure policy is strategic, whether or not the manager discloses information, all else equal, more information is revealed if the manager spends more resources on collecting information. Therefore, the value-maximizing board is more likely to make the right decision. Similarly, given the amount of resources that the manager spends on collecting information, an expert board is more likely to take the right decision and shareholders are better off. Consist with the former observation, Lemma 4 also shows that shareholders' value in equilibrium increases with the amount of information that the manager can potentially collect, $\bar{e}$.

The next proposition demonstrates that despite the positive effect of λ on $V(e, \lambda)$ and because the amount of resources e that the manager spends on collecting information can decrease with λ, shareholders's value in equilibrium might decrease with the board's expertise as well.

Proposition 2 *Let $\lambda^*(\bar{e}, p)$ be the (highest) level of board's expertise that maximizes shareholders' welfare in equilibrium.*

(i) If $p < \frac{1}{2}$ then there exists $\underline{e} \leq 1$ such that $\lambda^*(\bar{e}, p) < 1$ for all $\bar{e} \in [\underline{e}, 1]$ if and only if there exists $q \in (0, p]$ such that $\alpha(q, q) > q$.

(ii) If $p \geq \frac{1}{2}$ then $\lambda^*(\bar{e}, p) \geq \lambda^+ > 0$.

Proposition 2 implies that when the manager has sufficient access to information ($\bar{e}$ is high) and his decision to acquire information is endogenous, shareholders do not necessarily benefit from obtaining the board with the highest expertise. This effect takes place especially when a priori shareholders and the manager disagree on the prospects of the project.

To see the intuition, recall that the manager trades off two forces. On the one hand, the manager benefits from collecting information since this way he can persuade the board, regardless of its type, to accept the project if the evidence is supportive. On the other hand, there is a risk that the evidence is not favorable. In this case, despite the manager's attempt to conceal this information, the board would infer that the evidence are not supportive and reject the project. This latter force may discourage the manager's incentives to collect information. As we explain below, the board's expertise changes this tradeoff in a non-trivial way.

Suppose that a priori shareholders and the manager disagree on the benefit from taking the project, that is, $p < \frac{1}{2}$. The layman board always rejects the project unless the manager provides a supportive evidence that $\omega = 1$. If in addition $\alpha(q, q) \leq q$ for all $q \in (0, p]$ then the expert board on average over-rejects the project. Therefore, the marginal benefit from collecting information is always higher than its marginal costs. In those circumstances, according to Proposition 1, the manager cannot benefit from leaving discretion over the project to the board. The manager will spend as many resources as possible on collecting information, regardless of the board's expertise. As Lemma 4 indicates, when the amount of information that is collected by the manager is fixed, shareholders benefit from a higher expertise of their value-maximizing board.

However, as long as the possibility that the expert board would over-accept the project exists (that is, there exists $q \in (0, p]$ such that $\alpha(q, q) > q$), the manager could benefit from not collecting all the available information on ω. In particular, if the board is *unlikely* to be an expert, the probability that the project is accepted conditional on non-disclosure is small. Therefore, the implicit cost of collecting information is small as well. The manager would be better off by collecting information, thereby persuading the layman board to approve the investment which would otherwise be rejected. But, if the likelihood that the board is an expert is high, the implicit cost of collecting information becomes significant. The manager might try to exploit the possibility that an expert board accepts the project conditional on non-disclosure. In order to do so, the manager would collect less information, ensuring that his decision not to disclose information is not interpreted as his attempt to conceal bad news on the project. Overall, when $p < \frac{1}{2}$ the board's expertise diminishes the incentives of the manager to collect information. If the manager has enough access to information ($\bar{e} \in [\underline{e}, 1]$), the evidence that is provided by the manager is more valuable than the board's expertise and shareholders would benefit from the presence of a layman board. Furthermore, in the appendix we show that if $\bar{e} = 1$ then shareholders' value is maximized by a layman board ($\lambda^* = 0$).

Consider instead the alternative case in which a priori shareholders and the manager agree on the benefit from the project, that is, $p \geq \frac{1}{2}$. The layman board would accept the project if no information other than what is publicly available is revealed. Thus, if the likelihood that the board is an expert is low ($\lambda < \lambda^+$) the manager has no incentives to collect information and risking the possibility that he finds evidence against the project, evidence that he would have to conceal. However, if the board is likely to be an expert, the manager's net return from collecting information increases since it is not longer guaranteed that the board would accept the project in the absence of hard evidence in its support. Since the manager collects more information, shareholders would benefit from the board's expertise ($\lambda^* \geq \lambda^+$). In the appendix we give conditions on $\alpha(q, q)$ which guarantee that $\lambda^* < 1$ as well. Therefore, even if $p \geq \frac{1}{2}$ shareholders' value does not necessarily increase monotonically with the board's expertise, and an optimal level of expertise emerges.

As a final remark, it follows from Proposition 2 that even when the board is value-maximizing, its expertise adds value to shareholders only when it is needed the least, that is, when a priori shareholders and the manager agree on the benefit from taking the project. When the conflict between shareholders and the manager is a priori significant, not only the board's expertise does not help, it in fact distorts efficient decision making even further.

2 Optimal Board Structure

In this section we relax the assumption that the board is maximizing shareholders' value. In particular, we assume that the board would accept the project if and only if it believes that the probability that $\omega = 1$ is greater than $\beta \in (0, 1)$.[18] If $\beta > \frac{1}{2}$ then the board over-rejects the project compared to shareholders' first best, and if $\beta < \frac{1}{2}$ the board over-accepts the project. In the previous section the assumption was that $\beta = \frac{1}{2}$. The goal of the present section is to understand in the context of the persuasion game that is presented in section 1 whether there are benefits for shareholders from appointing directors whose interests are misaligned, and if

[18]Formally, one can define the board's preferences as $u_B(a, \omega) = v(a, \omega) + (1 - 2\beta) \cdot 1_{\{a=1\}}$.

so, how these benefits interact with the board's expertise.[19]

Consistent with our view that board's characteristics matter only in the absence of the manager's cooperation, by design, if the manager discloses information about ω then the board would defer to the manager's view regardless of its expertise and bias. Conditional on non-disclosure, however, the layman board accepts the project if and only if $q \geq \beta$ while the expert board accepts the project if and only the observed signal s is greater than $s^*(q,\beta) \equiv l^{-1}\left(\frac{\beta}{1-\beta}\frac{1-q}{q}\right)$.

As β increases the probability that the board accepts the project declines for any given level of posterior beliefs. For this reason, and since the manager's sole objective is to maximize the probability that the project is approved, the manager's expected utility in equilibrium decreases with β. Yet, taking power from the (biased) manager does not necessarily mean that shareholders are better off. A biased board would be taking ex-post inefficient decisions. Unless the board's bias changes the incentives of the manager to collect information and share it with the board, shareholders would be worse off by having a biased board. There is hope that a biased board would benefit shareholders only if consequently the manager is incentivized to collect more information than otherwise.

We define by β^* the level of the board's bias that maximizes the ex-ante value of shareholders. Since β^* does not have to be unique, we refine its definition to be the "optimal" bias that is the closest in absolute terms to $\frac{1}{2}$. The next proposition demonstrates that when the manager has sufficient access to information ($\bar{e}$ is high), a board which is biased against the manager can create value for its shareholders.

Proposition 3 *There exist* $\bar{\lambda}_p > 0$ *and* $\lambda_p^+ > 0$ *such that:*

(i) *If* $p < \frac{1}{2}$ *and* $\lambda \leq \bar{\lambda}_p$ *or* $p \geq \frac{1}{2}$ *and* $\lambda \in \left[\lambda_p^+, \bar{\lambda}_p\right]$ *then there exists* $e_\lambda \leq 1$ *such that if* $\bar{e} \in [e_\lambda, 1]$ *then* $\beta^* = \frac{1}{2}$.

(ii) *If* $p < \frac{1}{2}$ *and* $\lambda > \bar{\lambda}_p$ *or* $p \geq \frac{1}{2}$ *and* $\lambda \notin \left[\lambda_p^+, \bar{\lambda}_p\right]$ *then there exists* $e_\lambda < 1$ *such that if* $\bar{e} \in [e_\lambda, 1]$ *then* $\beta^* > \frac{1}{2}$.

There are several interesting implications for Proposition 3. First, when $\bar{e}$ is sufficiently high then a bias can be optimal only if the bias is *against* the manager, that is, the board is biased toward rejecting the project. The result above is very different from the existing literature on optimal board structure that builds on the advisory role of boards (e.g., Chakraborty and Yilmaz (2011)). This literature argues that in order to facilitate meaningful discussion and

[19] The analysis in this section implicitly assumes that the board's characteristics β and λ are independent of each other. In practice, however, directors who are affiliated with the management may also have a higher level of business expertise (thus low β could imply high λ and vice versa). This correlation may create a non-trivial trade-off which is partly left out from the present analysis.

communication within the board room (cheap talk a la Crawford and Sobel (1982)), directors should be affiliated with the management. In other words, an optimal board structure implies that the board is biased toward the company's management. By contrast, the present analysis highlights that shareholders' value is maximized only if directors inherently take the opposite view from the management.[20] In this respect, the result has the spirit of Dewatripont and Tirole (1999) who show that a benefit of creating advocates within organizations is the generation of information on the pros and cons of alternative policies.

As was discussed above, if $\beta^* \neq \frac{1}{2}$ then it is necessary that in equilibrium that manager collects and shares more information than he would have if the board was unbiased. To see the intuition for this result, recall that if the manager collects supportive evidence for the project the board can be convinced to approve the project regardless of its characteristics. As the board becomes more biased against the project, the manager realizes that the only realistic way to convince the board to approve the project is by providing hard evidence. Thus, when information is hard, a wider gap between the preferences of the manager (sender) and the board (receiver) can in fact facilitate collection and revelation of information. When the manager has sufficient access to information ($\bar{e}$ is high), the benefit for shareholders from having a more informative decision making outweighs the possibility that the board would reject profitable projects.

Proposition 3 also highlights the interaction between the board's bias and the board's expertise. When $p < \frac{1}{2}$ then biasing the board away from maximizing shareholders' value can be optimal only if the likelihood that the board is an expert is sufficiently high ($\lambda > \bar{\lambda}_p$). Intuitively, when $p < \frac{1}{2}$ the layman board would reject the project in absence of hard evidence from the manager. Therefore, as long as the likelihood that the board is an expert is low, the manager has already enough incentives in place to collect and share information with the board, even if the board is unbiased. Only when the board is likely to be an expert there is room for improving the cooperation between the manager and the board. This can be done by biasing the board against the manager.[21]

When $p \geq \frac{1}{2}$ then biasing the board away from maximizing shareholders' value can be optimal if the likelihood that the board is an expert is relatively low. In this case, the board would accept the project even without any supportive evidence for the project. Thus, the manager has very little incentives to collect information when the board is unbiased. Biasing the board against the approval of the project would make collection and disclosure of hard evidence the only feasible way through which the manager can convince the board to accept the project.

[20] The analysis does not rule out the possibility that when $\bar{e}$ is low β^* could be smaller than $\frac{1}{2}$. This depends on the curvature of f_ω.

[21] In the appendix we show that if $\bar{\lambda}_p \geq 1$ then $\lambda_p^+ < 1$ and and $\bar{\lambda}_p < 1$ if and only if there exists $q \in \left(0, \min\left\{p, \frac{1}{2}\right\}\right)$ such that $\alpha(q, q) > q$.

3 Board's Reputational Concerns For Expertise

When there is uncertainty about the level of the business expertise of the directors serving on the board, directors might have incentives to develop reputation for being experts. In this section we study the effect of directors' concerns for reputation on the value of the firm. Unlike the previous section in which the board's deviation from maximizing shareholders' value was given exogenously (presumably, a reflection of the caproate charter at the time of the firm's incorporation), in this section any deviation would be a consequence of directors attempt to build up reputation for expertise.

3.1 Modified Setup

We modify the basic model as follows. First, we augment the model with the board's concerns for its reputation as an expert. In particular, the board's preferences are given by,

$$u_B(a,\omega) = v(a,\omega) + \Gamma(\Pr[\rho = 1|\mathcal{F}]) \tag{6}$$

where $\Pr[\rho = 1|\mathcal{F}]$ is shareholders' beliefs that the board is an expert conditional on the available public information, denoted by $\mathcal{F}$. The function $\Gamma(\cdot)$ is the direct utility the board obtains from gaining a certain level of reputation. We conduct the analysis under the assumption that $\Gamma(\cdot)$ is a strictly increasing and continuous function. The assumption that $\Gamma(\cdot)$ is strictly increasing implies that directors are rewarded in the market for having high reputation as experts. As was mentioned in the introduction, even though Proposition 2 above indicates that shareholders do not necessarily benefit from having an expert board, board members might still care about being seen as able business people. We also normalize the reputation function by setting $\Gamma(0) = 0$.

While the board is concerned about its reputation, we assume that the board also put positive weight on shareholders' value. That is, the highest gain from building up reputation does not exceed the gain from making the right decision for shareholders. This captures the idea that career concerns, while important, do not entirely override the board's fiduciary duty to its shareholders. Later we will show that assuming $\Gamma(1) < \bar{\Gamma} \in (0,1]$ will guarantee the existence of equilibrium.

Shareholders form their beliefs on the board's expertise based on the board's decision a whether to approve or reject the project. Shareholders, however, do not observe the manager's decision how much information to collect, its disclosure decision, or the content of the message sent from the manager to the board. So the communication and interaction in the board-room is entirely confidential. Moreover, we focus attention on shareholders' interim beliefs on the board's expertise. We assume that shareholders do not observe the realization of the project before they form their expectation. Presumably, it takes a while until the investment's return is realized. Overall, the available public information for shareholders is given by $\mathcal{F} = \{a, p\}$.

In order to focus the analysis on the reputational concerns of the board we simplify the information structure by assuming that the expert's board private signal is binary. In particular, the expert board privately observes signal $s \in \{0, 1\}$ where $\Pr[s = \omega|\omega] = \pi$ and $\pi \in (1/2, 1)$ is the precision of the board's signal. Higher π represents more informative signal. To ensure that the board's expertise can add value in the absence of additional information, we assume that

$$1 - \pi < p < \pi \tag{7}$$

This assumption guarantees that when no information beyond what is publicly available is provided, the expert board would condition the decision to invest in the project on its private information. Last, we assume that the manager has full access to information, that is, $\bar{e} = 1$.[22]

3.2 Analysis of Reputational Concerns

Shareholders do not observe the amount of information that the manager collects, nor do they observe the manager's disclosure decision. Hence, they form their beliefs based on their expectation of the manager's behavior. For this reason, from the manager's and the board's point of view, shareholders' beliefs on the board's expertise as a function of the board's decision a are fixed in equilibrium. Since these beliefs can affect the board's decision to approve the project, it can also have an indirect effect on the manager's decision how much information to collect and disclose. Overall, an equilibrium of the game is a solution to the following fixed point problem:

1. *The manager's effort decision e maximizes his expected utility where shareholders' beliefs on ρ conditional on a, the board approval decision conditional on e, and the manager's own disclosure strategy conditional on e and ω, are taken as given.*

2. *For any e and ω, the manager's disclosure strategy maximizes his expected utility where shareholders' beliefs on ρ conditional on a and the board approval decision conditional on e, are taken as given.*

3. *For any m, e, and s, the board's approval decision maximizes its expected utility where shareholders' beliefs on ρ conditional on a and the manager's disclosure strategy are taken as given.*

4. *Whenever possible, shareholders' beliefs on ρ conditional a are consistent with Bayes' rule where the manager's effort decision, disclosure role, and the board's approval decision, are taken as given.*

[22] While the current information structure is not literally a special case of setup that is studied in the previous sections, it can be shown that all the results in previous sections continue to hold under the new modified structure.

A solution for the fixed point problem that is described above is not guaranteed under all circumstances. In particular, if the board put relatively high weight on how its expertise is perceived by shareholders then an equilibrium may not exist. The flavor of why non-existence of equilibrium can emerge in the current setting is the following. Suppose, for example, that shareholders believe that an expert board is more likely than a layman board to reject the project. If the board cares too much about its reputation then regardless of its actual level expertise the board has incentives to take the action that maximizes its reputation. In the example above, the board would reject the project even if taking the project would benefit shareholders. The board's behavior is therefore inconsistent with shareholders' beliefs.

At the same time, if shareholders believe that the expert and the layman board follow the same decision rule, as long as the board put positive weight on shareholders' value, both the expert and the layman board have strict incentives to take the action that maximizes shareholders' value conditional on their private information. Inconsistently with shareholders' expectation, the layman and the expert board would behave differently. All in all, an equilibrium of the game may not exist. The next lemma provides a sufficient condition for the existence of equilibrium. Hereafter the analysis implicitly assumes that this condition is met.

Lemma 5 *For any* (p, λ, π) *there exists* $\bar{\Gamma} \in (0, 1]$ *such that if* $\Gamma(1) \leq \bar{\Gamma}$ *an equilibrium exists.*

In principle there may exist equilibria of the game which involve off-equilibrium events. This would be the case if unconditionally on the manager's disclosure, either the project is expected to be accepted with probability one, or it is accepted with probability zero. We make two restrictions on the off-equilibrium beliefs which, in our view, eliminate unreasonable off-equilibrium beliefs that shareholders may have. First, we require that the off-equilibrium beliefs are credible in the sense of Grossman and Perry (1986). Thus, we focus attention on Perfect Sequential Equilibria. Second, note that the formulation of the game imposes lower bounds on shareholders' beliefs about the board's expertise which are bounded away from zero: whenever it is optimal for the layman board to deviate to an off-equilibrium action, there is a strictly positive probability that the expert board finds its optimal to deviate as well. For example, if the layman board finds it optimal to deviate and approve the project, it must be that the expert board who observes $s = 1$ is also better off by deviating from the equilibrium strategy and approving the project. A symmetric argument follows if in equilibrium the project is never rejected. For this reason, we assume that the off-equilibrium beliefs cannot lie below these lower bounds.

In Lemma A.4 in the appendix we show that for any equilibrium that satisfy these restrictions, unconditionally on the manager's disclosure decision, there is a strictly positive probability that the board accepts or rejects the project. Therefore, there are no off-equilibrium events within this class of equilibria.

We start the analysis with the observation that the manager's incentives to disclose information about ω are very similar to the those analyzed in Lemma 2. In particular, regardless of the board's behavior conditional on non-disclosure, the manager is more likely to disclose information about $\omega = 1$ than information about $\omega = 0$. Therefore, in any equilibrium, $q(e, p, \sigma_e(\omega)) \leq p$. Moreover, unless the manager believes that the board would approve the project with probability ω, the manager has strict incentives to disclose information about $\omega = 1$ and withholds information about $\omega = 0$. Since it is a weakly dominating strategy for the manager to disclose information if and only if $\omega = 1$, we assume hereafter that the manager plays pure strategies and follows this disclosure rule.

Consider the board's response to the amount of information that is collected and disclosed by the manager. If the manager discloses information to the board about ω ($m = \omega$), then regardless of the board's expertise and the content of the board's own private information, the board updates its posterior belief to $\Pr[\omega = 1] = m$. Therefore, given the board's expectations on how in equilibrium shareholders form their beliefs about its expertise, both types of the board have incentives to take exactly the same action. Indeed, the board would accept the project if and only if $\omega \geq \frac{1+\Delta}{2}$, where $\Delta \equiv \Gamma(\Pr[\rho = 1|a = 0]) - \Gamma(\Pr[\rho = 1|a = 1])$ is independent of the board's expertise and is determined in equilibrium. The assumption that $\Gamma(1) < 1$ gauntness that $|\Delta| < 1$ and hence the unique response of the board to the manager's disclosure is to accept the project if and only if it is evident that $\omega = 1$. Overall, in this setup, the board's concerns for reputation do not distort the board's behavior if the manager shares his information with the board.

More generally, the above discussion suggests that the board would accept the project if and only if $\Pr[\omega = 1|\rho, s, q] \geq \frac{1+\Delta}{2}$. Recall that in any equilibrium and from the board's point of view, Δ is fixed. Therefore, if in equilibrium an expert board is more likely than a layman board to reject (accept) the project then $\Delta > (<)\, 0$ and reputational concerns for expertise distort the board's decision from maximizing shareholders' value toward over-rejection (over-approval) of the project.

Obviously, the direct effect of this distortion in the board's behavior on shareholders' welfare cannot be positive. However, in the appendix we show that under many circumstances the direct effect is in fact zero. That is, if the amount of resources that the manager invests in collecting information is fixed on its equilibrium level in the absence of board's reputational concerns, and then reputational concerns are added to the board's behavior, in most cases shareholders' value is unchanged.[23]

As was mentioned above, the board's reputational concerns for expertise also have an *indirect* effect through the incentives of the manager to collect and share information. Taking into account this indirect effect, the next lemma illustrates the way in which reputational concerns for expertise distort the board's behavior in equilibrium.

[23] In Lemma A.9 in the appendix it is proved that if $p < \frac{1}{2}$, or $\lambda \leq \frac{1}{\pi} \frac{1+(2\pi-1)^2}{(3-2\pi)+(2\pi-1)^2}$, or $\Gamma(1)$ is sufficiently small, then in any equilibrium the direct effect of board's reputational concerns on shareholders' welfare is zero.

Lemma 6 *In equilibrium the board over-rejects the project ($\Delta^* > 0$) if and only if $q(e^*) > \frac{1}{2}$.*

Recall that conditional on disclosure both types of board behave similarly and reputational concerns do not distort the board's behavior. Distortion in the board's behavior arises only when the manager does not disclose information. Thus, Lemma 6 suggests that in order to create the impression that board members have private information about the prospects of the project, the layman board imitates the behavior of the expert board. This gives incentives for both types of the board to distort their decision making conditional on non-disclosure.

In particular, in any equilibrium shareholders correctly anticipate the amount of resources the manager invests in collecting information, and hence they know $q(e^*)$. From shareholders' point of view, an expert board seemingly ignores useful public information. It rejects projects which a-priori seem profitable, and vis-a-versa. Nevertheless, this behavior would be optimal if the board's private information about the project's profitability is sufficiently precise (which is the case according to (7)). In order to create the impression that the board is in fact an expert, the board would under-react to the public information conditional on non-disclosure. In particular, the board over-approves the project when the posterior belief conditional on non-disclosure $q(e^*)$ is lower than $\frac{1}{2}$, and over-rejects the projects when $q(e^*)$ is greater than $\frac{1}{2}$. This result is similar in spirit to Prendergast and Stole's (1996) work which demonstrates that investment distortions arise from managers attempting to influence perceptions of their expertise by exaggerating their private information.

The manager's behavior is central to the analysis. Therefore, it is important to understand how the board's reputational concerns affect the manager's power, that is, the manager ability to persuade the board to accept the project (the manager's preferred strategy).

Lemma 7 *In equilibrium, reputational concerns decrease the unconditional probability that the project is accepted if and only if $p \geq \frac{1}{2}$ and $\lambda < \frac{1}{\pi(3-2\pi)}$.*

Interestingly, in most cases, the manager benefits from having his board subject to reputational concerns. In particular, Lemma 7 shows that the board's reputational concerns always increase the manager's power even when a priori shareholders and manager disagree on the benefit from taking the project ($p < \frac{1}{2}$), times at which shareholders' reliance on the board's performances is relatively more important.

As was discussed in section 1, an increase in the manager's power does not necessarily come on the expense of shareholders' value. This is because the interaction between shareholders and the manager is not a zero-sum game. By collecting more information the manager can improve the decision making process and thereby enlarge the size of the pie that shareholders and the manager share. The next result characterizes the effect of board's reputational concerns for expertise on shareholders' welfare.

Proposition 4 *In equilibrium concerns for reputation destroy shareholders' welfare if and only if* $\lambda < \lambda^*_{p,\pi}$ *where*

$$\lambda^*_{p,\pi} \equiv \begin{cases} \frac{1}{\pi(3-2\pi)} & \text{if } p \geq \frac{1}{2} \\ \frac{1}{2\pi} & \text{if } p < \frac{1}{2} \end{cases} \tag{9}$$

The intuition behind Proposition 4 is the following. When $\lambda \geq \lambda^*_{p,\pi}$ the likelihood that the board is an expert is relatively high. In order to maximize the probability that the project is accepted by the board, the manager collects information such that the expert board is more likely than the layman board to accept the project conditional on non-disclosure. The approval of the project signals shareholders that the board is an expert and shareholders accordingly update upward their beliefs about the board's expertise. For this reason, reputational concerns for expertise create additional benefits for the board to accept the project, and the board is expected to approve the project even if the project does not benefit shareholders. The manager rationally anticipates this distortion in the board's behavior and adjusts the level of information he collects about the project. In particular, when the board is subject to reputational concerns the manager can collect more information and at the same time keep the probability that the board accepts the project conditional on non-disclosure unchanged. Therefore, the manager has more incentives to collect and share information with the board. Despite the deviation of the board from maximizing shareholders' value, this indirect effect benefits shareholders. A symmetric argument shows that because of reputational concerns the manager has fewer incentives to collect and share information with the board when $\lambda < \lambda^*_{p,\pi}$. Consequently, shareholders' value decreases in those cases.

Overall, the reasoning above shows that the channel through which board's concerns for reputation affect shareholders' value is mainly through its effect on the manager's incentives to cooperate with the board.[24]

Proposition 4 suggests that shareholders benefit from a bias in the board's behavior, a bias that is created by reputational concerns, if and only if this bias is toward approval of the project. Seemingly, this contrasts Proposition 3 which demonstrates that the optimal bias in the board's behavior should be *against* the project's approval. To see why there is no contradiction, note that Proposition 3 characterizes the *optimal* level of bias in the board's behavior when shareholders have full discretion on the board's structure. Proposition 3 does not preclude the possibility that a board with a bias toward the project's approval would yield a higher value for shareholders than an unbiased board. It only proves that one can always find a bias against the project's approval which would yield even a higher value for shareholders. In the current section, the bias in the board's behavior is determined endogenously by reputational concerns

[24] When $\lambda \geq \lambda^*_{p,\pi}$ the direct effect of board's reputational concerns for expertise is negative while the indirect effect is positive. Therefore, it is clear that the indirect effect dominates the direct effect. When $\lambda < \lambda^*_{p,\pi}$ the indirect and the direct effects are both negative. Therefore, on the face of it, it is not clear which effect is dominating. However, Lemma A.9 in the appendix proves that when $\lambda \leq \lambda^*_{p,\pi}$ the direct effect is zero. Therefore, the indirect effect always dominates the direct effect.

for expertise, and the concept of equilibrium put constraints on the level of bias that can arise in this framework.

Finally, Proposition 4 suggests that putting more pressure on the board and thereby increasing board members' awareness for their reputation can either benefit or hurt shareholders, depending on how λ is compared with $\lambda^*_{p,\pi}$. Note that $\lambda^*_{p,\pi} \in \left(\frac{1}{2}, 1\right)$. Therefore, when the common belief about the board's expertise is low $\left(\lambda < \frac{1}{2}\right)$ or when the uncertainty about the board's expertise is the highest $\left(\lambda = \frac{1}{2}\right)$, seemingly the circumstances under which concerns for reputation are the most effective, shareholders' pressure on board members achieves exactly the opposite outcome. This result challenges the idea that giving more power to shareholders in determining the identity of directors is beneficial.

4 Conclusions

This paper studies the effect of board's expertise, affiliation, and concerns for being seen as expert, on shareholders' value. The underlying premise of the paper is that managers have exclusive access to superior sources of information. Hence, the board's expertise plays a role and has the potential to enhance shareholders' value, if and only if the manager does not cooperate and share his own information with the board. Under these assumptions, we show that when the board acts in the best interests of shareholders but the manager does not, shareholders' value decreases with the expertise of the board exactly in times when a priori the manager and shareholders disagree on the optimal strategy. In those circumstances, affiliated and opportunistic board members could enhance the value of the firm. In particular, shareholders would benefit from the appointment of dissenting directors who are more likely to challenge the incumbent management. Finally, we demonstrate that when the value maximizing board has concerns for its reputation, the board behaves more like an expert and under-reacts to public information. We show that this effect can reduce the incentives of the manager to collect information and thereby adversely affect shareholders' value.

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5 Appendix

5.1 Proofs of Section I

Lemma A.1 *Let*

$$\alpha(q,p,\beta) \equiv 1 - pF_1(s^*(q,\beta)) - (1-p)F_0(s^*(q,\beta)) \tag{A1}$$

where $s^*(q,\beta) = l^{-1}\left(\frac{\beta}{1-\beta}\frac{1-q}{q}\right)$. *Then for any* $q \in [0,1]$ *and* $p \in [0,1]$ *and* $\beta \in (0,1)$

(*i*) $\alpha(q,p,\beta) = p\alpha(q,1,\beta) + (1-p)\alpha(q,0,\beta)$.

(*ii*) $\alpha(q,p,\beta) = 1 \Leftrightarrow q = 1$ *and* $\alpha(q,p,\beta) = 0 \Leftrightarrow q = 0$.

(*iii*) $\alpha(q,p,\beta)$ *is continuous and differentiable in all arguments.*

(*iv*) $\frac{\partial\alpha(q,p,\beta)}{\partial q} > 0$, $\frac{\partial\alpha(q,p,\beta)}{\partial p} > 0$, *and* $\frac{\partial\alpha(q,p,\beta)}{\partial\beta} < 0$

Proof of Lemma A.1. Property (i), the linearity of $\alpha(q,p,\beta)$ in p, follows directly from expression $(A1)$. Consider property (ii) and note that $\alpha(q,p,\beta) = 1$ if and only if $pF_1(s^*(q,\beta)) + (1-p)F_0(s^*(q,\beta)) = 0$. Since F_ω is strictly increasing in s, and strictly positive for any $s > \underline{s}$, we have $\alpha(q,p) = 1 \Leftrightarrow s^*(q,\beta) = \underline{s}$. Given the definition of $s^*(q,\beta)$ and the MLR property, this happens if and only if $q = 0$. A similar (and symmetric) argument proves that $\alpha(q,p,\beta) = 1 \Leftrightarrow q = 1$. Part (iii) follows from (4) and the continuity and differentiability of F_ω. Consider part (iv). From (A1) it follows that $\frac{\partial\alpha(q,p,\beta)}{\partial q} = -[pf_1(s^*(q,\beta)) + (1-p)f_0(s^*(q,\beta))]\frac{\partial s^*(q,\beta)}{\partial q}$ where $\frac{\partial s^*(q,\beta)}{\partial q} = \frac{-1}{\frac{\beta}{1-\beta}q^2\frac{\partial l(s)}{\partial s}|_{s=^*(q,\beta)}} < 0$ due to the MLR property. It follows that $\frac{\partial\alpha(q,p,\beta)}{\partial q} > 0$ for any $p \in [0,1]$ and $q > 0$. Since $\alpha(0,p,\beta) = 0$ and $\alpha(q,p,\beta) \in [0,1]$ is continuous and differentiable everywhere, $\frac{\partial\alpha(q,p,\beta)}{\partial q}|_{q=0} > 0$ as well as required. A similar argument shows that $\frac{\partial\alpha(q,p,\beta)}{\partial\beta} < 0$. Finally, $\frac{\partial\alpha(q,p,\beta)}{\partial p} = F_0(s^*(q,\beta)) - F_1(s^*(q,\beta))$ and since the MLR property implies $F_1(s) < F_0(s)$ for any s, we get $\frac{\partial\alpha(q,p,\beta)}{\partial p} > 0$ for any q. ■

Proof of Lemma 2. Consider the manager's disclosure policy once the decision on how much information to collect has been made. Recall that the manager derives utility only from the project's approval and regardless of the true state of the world. Therefore, the manager's expected utility is exactly the probability that the board chooses $a = 1$. Suppose the board believes in equilibrium that $q(e,p,\sigma_e(\omega)) = q_0$. It follows from Lemma 1 and the above discussion that conditional on the effort decision e and on observing ω the manager's expected utility is given by,

$$\mathbb{E}[u_M(\sigma)|\omega] = \sigma\left[\lambda\alpha(q_0,\omega) + (1-\lambda)\cdot 1_{\left\{q_0 \geq \frac{1}{2}\right\}}\right] + (1-\sigma)\omega$$

where $\sigma \in [0,1]$ is the actual probability that the manager does not disclose information about ω to the board. Note that in equilibrium q_0 is fixed by the board's expectations of the manager's behavior and hence q_0 is independent of σ.

The marginal benefit from an increase in the probability of non-disclosure is given by $\lambda\alpha(q_0,\omega) + (1-\lambda)\cdot 1_{\left\{q_0 \geq \frac{1}{2}\right\}} - \omega$. Thus, in any equilibrium $\sigma_e^*(0) \geq \sigma_e^*(1)$ (and hence $q \leq p$).

Moreover, note that if $\alpha(q_0,\omega) \in (0,1)$ the manager has strict incentives to disclose information about $\omega = 1$ and strict incentives to conceal information about $\omega = 0$. Therefore, a stochastic disclosure rule is feasible in equilibrium only if $\alpha(q,\omega) \in \{0,1\}$. Given our observation that $q(e,p,\sigma_e(\omega)) \leq p < 1$ and the properties of $\alpha(q,p)$ as given by Lemma A.1, a stochastic disclosure rule is feasible in equilibrium only if $q = 0$. When $q = 0$ the manager knows with certainty that the board would reject the project with probability one unless it discloses information that $\omega = 1$. This immediately implies that in any equilibrium the manager has strict incentives to disclose information that $\omega = 1$ and hence $\sigma_e^*(1) = 0$. At the same time, the manager knows with certainty that the board would reject the project with probability one whether the manager withholds or discloses information about ω being zero. For this reason, and since a stochastic disclosure rule is feasible in equilibrium only if $e = 1$, its implementation does not affect the manager's decision over e, the board's decision over a, and the welfare of shareholders. Therefore, without the loss of generality, the manager does not adopt stochastic disclosure rules and $\sigma_e^*(\omega) = 1 - \omega$ as required. ■

Proof of Lemma 3. We start with the comparative static of $\mathbb{E}[u_M(e)]$ with respect to λ. Suppose $q(e) < \frac{1}{2}$. Then, according to (4)

$$\frac{\partial \mathbb{E}[u_M(e)]}{\partial \lambda}|_{q(e)<\frac{1}{2}} = e(1-p)\,\alpha(q(e),0) + (1-e)\,\alpha(q(e),p)$$

which is non-negative. Moreover, according to Lemma 2, it is strictly positive as long as $q(e) > 0 \Leftrightarrow e < 1$. Suppose $q(e) \geq \frac{1}{2}$. Then, according to (4)

$$\frac{\partial \mathbb{E}[u_M(e)]}{\partial \lambda}|_{q(e)\geq\frac{1}{2}} = -e(1-p)\left[1-\alpha(q(e),0)\right] - (1-e)\left[1-\alpha(q(e),p)\right]$$

which is non-positive. Moreover, according to Lemma 2, it is strictly negative unless $q(e) = 1$. Since according to Lemma 3 $q(e) \leq p$ and by assumption $p < 1$, we always have $q(e) < 1$.

Consider the comparative static of $\mathbb{E}[u_M(e)]$ with respect to p. Suppose p and e are such that $q(e) < \frac{1}{2}$. According to (4)

$$\begin{aligned}\frac{\partial \mathbb{E}[u_M(e)]}{\partial p}|_{q(e)<\frac{1}{2}} &= e\left[1-\lambda\alpha(q(e),0)\right] + e(1-p)\,\lambda\frac{\partial\alpha(q(e),0)}{\partial q}\frac{\partial q(e)}{\partial p} \\ &\quad + (1-e)\,\lambda\left[\frac{\partial\alpha(q(e),p)}{\partial q}\frac{\partial q(e)}{\partial p} + \frac{\partial\alpha(q(e),p)}{\partial p}\right]\end{aligned}$$

Note that it follows from Lemma 3 that $\frac{\partial q(e)}{\partial p} > 0$ and from Lemma 2 that $\frac{\partial \alpha(q(e),p)}{\partial q} > 0$ for any p. Therefore, $\frac{\partial \mathbb{E}[u_M(e)]}{\partial p}|_{p<\frac{1}{2}} > 0$ as required. Suppose $q(e) > \frac{1}{2}$. Then

$$\begin{aligned}\frac{\partial \mathbb{E}\left[u_M(e)\right]}{\partial p}|_{q(e)>\frac{1}{2}} &= e\lambda\left[1-\alpha\left(q(e),0\right)\right] + e(1-p)\lambda\frac{\partial \alpha\left(q(e),0\right)}{\partial q}\frac{\partial q(e)}{\partial p} \\ &\quad + (1-e)\lambda\left[\frac{\partial \alpha\left(q(e),p\right)}{\partial q}\frac{\partial q(e)}{\partial p} + \frac{\partial \alpha\left(q(e),p\right)}{\partial p}\right]\end{aligned}$$

and for the same consideration as above, $\frac{\partial \mathbb{E}[u_M(e)]}{\partial p}|_{q(e)>\frac{1}{2}} > 0$ as required. Lastly, note that $\mathbb{E}\left[u_M(e)\right]$ jumps upward at $q(e) = \frac{1}{2}$ and hence, globally, $\mathbb{E}\left[u_M(e)\right]$ increases in p as required ■

Proof of Proposition 1. We prove the Proposition for the more general case in which the board accepts the project if and only if it believes that $\Pr[\omega = 1] \geq \beta$ where $\beta \in (0,1)$. Section 1 is the special case in which $\beta = \frac{1}{2}$.

In any equilibrium $q(e) = \frac{p-ep}{1-ep}$ and hence there is a one-to-one (inverse) relationship between the amount of effort that the manager put in collecting information e and the posterior beliefs that the board has conditional on non-disclosure q. Going forward, it would be useful to rewrite explicitly the manager's expected utility in terms of q (and recall that q is a function of p). It follows from (4) that,

$$\mathbb{E}\left[u_M(q)\right] = 1 - \lambda(1-p)\left[\frac{\frac{1}{\lambda} - \alpha(q,q,\beta) - \frac{1-\lambda}{\lambda}\cdot 1_{\{q\geq\beta\}}}{1-q}\right] \tag{A2}$$

where $q \in \left[\underline{q}, p\right]$ and $\underline{q} = \frac{p-\bar{e}p}{1-\bar{e}p}$.

We start by proving the existence of the equilibrium. To show the existence, it is sufficient to show that $\mathbb{E}\left[u_M(q)\right]$ has a maximum. Recall that $\alpha(q,q,\beta)$ is continuous and differentiable everywhere in q. Therefore, if $p < \beta$ the function $\mathbb{E}\left[u_M(q)\right]$ is continuous over $q \in \left[\underline{q}, p\right]$ and a maximum exists. Suppose $p \geq \beta$. The function $\mathbb{E}\left[u_M(q)\right]$ is continuous over $\left[\max\left\{\beta, \underline{q}\right\}, p\right]$ and $\left[\underline{q}, \beta\right)$. Therefore, if $\mathbb{E}\left[u_M(q)\right]$ has a maximum over $\left[\underline{q}, \beta\right)$ it obtains a maximum over $\left[\underline{q}, p\right]$ as well. Otherwise, if $\mathbb{E}\left[u_M(q)\right]$ does not obtain a maximum over $\left[\underline{q}, \beta\right)$ it must be that $\sup_{q\in\left[\underline{q},\beta\right)} = \lim_{q\nearrow\beta}\mathbb{E}\left[u_M(q)\right]$. Note however that $\mathbb{E}\left[u_M(\beta)\right] \geq \lim_{q\nearrow\beta}\mathbb{E}\left[u_M(q)\right]$ and therefore the maximum of $\mathbb{E}\left[u_M(q)\right]$ over $\left[\underline{q}, p\right]$ is the maximum over $[\beta, p]$. Overall, we conclude that an equilibrium always exists.

We prove part (i) of the proposition. Suppose $p < \beta$. We let q_λ^* be the maximizer of $\mathbb{E}\left[u_M(q)\right]$ at λ. According to Lemma A.1, $\alpha(q,q,\beta)$ increases in q for all $q \in [0,p]$. Hence, according to (A2), for any $p \geq x > y \geq \underline{q}$ we have $\mathbb{E}\left[u_M(x)\right] > \mathbb{E}\left[u_M(y)\right]$ if and only if

$$\lambda > \Lambda(x,y) \equiv \frac{x-y}{(1-y)\,\alpha(x,x) - (1-x)\,\alpha(y,y)} \tag{A3}$$

where $\Lambda(x,y)>0$ for all $x>y$. Let $\underline{q}\leq q_1^*<...<q_M^*\leq p$ be the set of all maximizers at some $\hat{\lambda}\in[0,1]$. We proceed with the proof of part (i) in a couple of steps.

First, consider $\lambda>\hat{\lambda}$ and let q_λ^* be a maximizer of $\mathbb{E}[u_M(q)]$ at λ. Suppose by the way of contradiction that $q_\lambda^*<q_M^*$. Since q_λ^* is a maximizer at λ, it follows from (A3) that $\lambda\leq\Lambda(q_M^*,q_\lambda^*)$. Since q_M^* is a maximizer at $\hat{\lambda}$, it follows from (A3) that $\hat{\lambda}\geq\Lambda(q_M^*,q_\lambda^*)$. The assumption that $\lambda>\hat{\lambda}$ implies $\Lambda(q_M^*,q_\lambda^*)\geq\lambda>\hat{\lambda}\geq\Lambda(q_M^*,q_\lambda^*)$ yielding a contradiction. Therefore, if $\lambda>\hat{\lambda}$ then any maximizer of $\mathbb{E}[u_M(q)]$ at λ is weakly higher than any maximizer of $\mathbb{E}[u_M(q)]$ at $\hat{\lambda}$. Second, consider $\lambda<\hat{\lambda}$ and let q_λ^* be a maximizer of $\mathbb{E}[u_M(q)]$ at λ. Suppose by the way of contradiction that $q_\lambda^*>q_1^*$. Since q_λ^* is a maximizer at λ, it follows from (A3) that $\lambda\geq\Lambda(q_\lambda^*,q_1^*)$. Since q_1^* is a maximizer at $\hat{\lambda}$ it follows from (A3) that $\hat{\lambda}\leq\Lambda(q_\lambda^*,q_1^*)$. The assumption that $\lambda<\hat{\lambda}$ implies $\Lambda(q_\lambda^*,q_1^*)\leq\lambda<\hat{\lambda}\leq\Lambda(q_\lambda^*,q_1^*)$, a contradiction. Overall, we proved that q_λ^* is non-decreasing in λ when $p<\beta$.

Next, we show that $q_{\lambda=0}^*=\underline{q}$. According to (A3), if $q_{\lambda=0}^*>\underline{q}$ then the optimality of $q_{\lambda=0}^*$ with respect to $\lambda=0$ implies that $0\geq\Lambda\left(q_{\lambda=0}^*,\underline{q}\right)$. This contradicts the observation that $\Lambda(x,y)>0$ for any $x>y$. Therefore, $q_{\lambda=0}^*=\underline{q}$.

Next, we show that q_λ^* is flat if and only if the function $q_{\min}>\underline{q}$. We proved that q_λ^* is increasing in λ and that $q_{\lambda=1}^*=\underline{q}$. Therefore, q_λ^* is flat if and only if $q_{\lambda=1}^*=\underline{q}$ as well. From (A3) it follows that this holds if and only if $1\leq\Lambda\left(q,\underline{q}\right)$ for all $q\in\left[\underline{q},p\right]$. Note that

$$1\leq\Lambda\left(q,\underline{q}\right)\Leftrightarrow\frac{1-\alpha(q,q,\beta)}{1-q}\geq\frac{1-\alpha\left(\underline{q},\underline{q},\beta\right)}{1-\underline{q}}$$

and hence $q_{\lambda=1}^*=\underline{q}$ if and only if $q_{\min}=\underline{q}$ as required.

Finally, since $q\leq p<\beta$ the layman board always rejects the offer conditional on non-disclosure. This completes the proof of part (i).

We prove part (ii) of the proposition. Suppose $p\geq\beta$. According to (A2), if $q\geq\beta$ then $\mathbb{E}[u_M(q)]=1-\lambda(1-p)\left[\frac{1-\alpha(q,q,\beta)}{1-q}\right]$ and the choice of q, conditional on $q\geq\beta$, is independent of λ. We denote this choice by $q^+\equiv q(e^+)\in[\beta,p]$. q^+ is a maximizer at λ if and only if $\mathbb{E}[u_M(q)]\leq\mathbb{E}[u_M(q^+)]$ for all $q\in\left[\underline{q},\beta\right)$. From (A2) this condition holds if and only if $\lambda\leq\lambda^+$ where

$$\lambda^+\equiv\min_{q\in\left[\underline{q},\beta\right]}\left\{\frac{1}{\alpha(q,q,\beta)+(1-q)\left[\frac{1-\alpha(q^+,q^+,\beta)}{1-q^+}\right]}\right\}\tag{A4}$$

Note that $\lambda^+>0$ and since $\frac{1-\alpha\left(q^+,q^+\right)}{1-q^+}>0$, λ^+ is well defined. Thus, if $\lambda\leq\lambda^+$ then $q_\lambda^*=q^+$ and the layman board always accepts the project conditional on non-disclosure. If $\lambda>\lambda^+$ then $q_\lambda^*\in\left[\underline{q},\beta\right)$ and the layman board always rejects the project conditional on non-disclosure. For all $\lambda\in\left(\lambda^+,1\right]$ one can repeat the analysis above for the case $p<\beta$ and hence q_λ^* is non decreasing in this interval. Finally, according to (A4), $\lambda^+<1$ if and only if there exists $q\in\left[\underline{q},\beta\right)$ such that $\frac{1-\alpha(q,q,\beta)}{1-q}<\frac{1-\alpha\left(q^+,q^+,\beta\right)}{1-q^+}$. Since q^+ is the minimizer of $\frac{1-\alpha(q,q)}{1-q}$ over $[\beta,p]$, this implies that $\lambda^+<1$ if and only if $q_{\min}<\beta$. Note that implicitly it is assumed that

$\underline{q}(p) < \beta \Leftrightarrow \bar{e} > \frac{1}{p}\frac{p-\beta}{1-\beta}$. Otherwise, the proposition applies for $\lambda^{+} = 1$.

Finally, we prove part (iii) and show that e^{*} increases in p expect maybe at $p = \beta$. Suppose $p \neq \beta$ and consider a small increase in p. Unless the constraint $q \leq p$ binds, then according to (A2) the decision on the optimal q is invariant to p. Therefore e^{*} must increase in order to keep q on the same level of q^{*}. If, however, $q^{*} = p$ then $e^{*} = 0$ and hence it can only increase. Suppose $p = \beta$. If for all $q < \beta$

$$\lambda < \frac{1}{\alpha(q, q, \beta) + (1-q)\left[\frac{1-\alpha(\beta,\beta,\beta)}{1-\beta}\right]}$$

Then q^{*}_{λ} jumps from $\arg\min_{q \in [\underline{q}, \beta)} \left\{ \frac{\frac{1}{\lambda} - \alpha(q,q,\beta)}{1-q} \right\} < \beta$ to β. Note that the right hand side is strictly positive and its minimum over $[\underline{q}, \beta]$ is well defined. Letting $\lambda^{-} \equiv \min_{q \in [\underline{q}, \beta]} \left\{ \frac{1}{\alpha(q,q,\beta)+(1-q)\left[\frac{1-\alpha(\beta,\beta,\beta)}{1-\beta}\right]} \right\}$ and noting that $\frac{1-\alpha(\beta,\beta,\beta)}{1-\beta} \geq \frac{1-\alpha\left(q^{+},q^{+},\beta\right)}{1-q^{+}}$ for any $p \geq \beta$ complete the proof. ■

Proof of Corollary 1. We prove the corollary for the general case of a biased board. We let

$$\Upsilon(q, \beta, \lambda) \equiv \frac{\frac{1}{\lambda} - \alpha(q, q, \beta) - \frac{1-\lambda}{\lambda} \cdot 1_{\{q \geq \beta\}}}{1-q} \tag{A5}$$

Consider part (i) of the corollary ($p < \beta$) and recall that $\mathbb{E}[u_M]$ is exactly the probability that the project is approved. For any $\lambda_1 < \lambda_2$ it follows from (A2) and (A5), and from the optimality of $q^{*}_{\lambda_2}$ with respect to λ_2, that

$$\Upsilon\left(q^{*}_{\lambda_2}, \beta, \lambda_2\right) \leq \Upsilon\left(q^{*}_{\lambda_1}, \beta, \lambda_2\right)$$

Since $\lambda_1 < \lambda_2$ then

$$\Upsilon\left(q^{*}_{\lambda_1}, \beta, \lambda_2\right) < \Upsilon\left(q^{*}_{\lambda_1}, \beta, \lambda_1\right)$$

Over all, for all $\lambda_1 < \lambda_2$ it must be that

$$\Upsilon\left(q^{*}_{\lambda_2}, \beta, \lambda_2\right) < \Upsilon\left(q^{*}_{\lambda_1}, \beta, \lambda_1\right)$$

This implies that $\mathbb{E}[u_M(q^{*}_1, \lambda_1)] > \mathbb{E}[u_M(q^{*}_2, \lambda_2)]$ as required.

Consider part (ii) of the corollary ($p \geq \beta$). According to Proposition 1, if $\lambda < \lambda^{+}$ then $q^{*}_{\lambda} = q^{+} \geq \beta$ for all λ in this region, where q^{+} is independent of λ. According to (A2),

$$\mathbb{E}\left[u_M\left(q^{+}, \lambda\right)\right] = 1 - \lambda(1-p)\left[\frac{1-\alpha(q^{+}, q^{+}, \beta)}{1-q^{+}}\right]$$

which is strictly decreasing in λ. If $\lambda \geq \lambda^{+}$ then $q^{*}_{\lambda} < \beta$. Similar to the proof of part (i), $\mathbb{E}[u_M(q^{*}_{\lambda}, \lambda)]$ is strictly increasing in λ. Lastly, note that according to the proof Proposition 1, at $\lambda = \lambda^{+}$ the manager is indifferent between choosing q^{+} and and the optimal q within $[\underline{q}, \beta)$. Therefore, $\mathbb{E}[u_M(q^{*}_{\lambda}, \lambda)]$ is unchanged in this point. This implies that λ^{+} is the unique minimum.

The last part can be shown by the way of contradiction. If $\mathbb{E}\left[u_M\left(q\left(e^*\left(\lambda,p\right)\right)\right)\right]$ is non-increasing in p, then for the larger p the manager can always choose the same level of $e^*\left(\lambda,p\right)$ and the board is strictly more likely to approve the deal. This is true since not only the probability of finding that $\omega=1$ is higher, but also, conditional on non-disclosure, the board has a higher posterior belief that $\omega=1$, and hence it is more likely to approve the project. The manager might do better by choosing $e\neq e^*\left(\lambda,p\right)$, but this implies that $\mathbb{E}\left[u_M\left(e\right)\right]$ increases even further. ■

Proof of Lemma 4. We prove the Lemma for the special case of $\beta=\frac{1}{2}$. It follows from (6) that $V\left(e\right)$ can be rewritten as

$$V\left(q\right)=1-\left(1-p\right)\left[\frac{q}{1-q}-\lambda\left(\frac{q}{1-q}\alpha\left(q,1\right)-\alpha\left(q,0\right)\right)-\frac{2q-1}{1-q}\left(1-\lambda\right)\cdot 1_{\left\{q\geq\frac{1}{2}\right\}}\right] \tag{A6}$$

We prove $V\left(q,\beta\right)$ strictly decreases in q. According to (A6)

$$\frac{\partial V\left(q\right)}{\partial q}|_{q<\frac{1}{2}}=-\left(1-p\right)\left[\frac{1-\lambda\alpha\left(q,1\right)}{\left(1-q\right)^2}-\lambda\left(\frac{q}{1-q}\frac{\partial\alpha\left(q,1\right)}{\partial q}-\frac{\partial\alpha\left(q,0\right)}{\partial q}\right)\right]$$

where

$$\frac{\partial\alpha\left(q,p\right)}{\partial q}=-\left[pf_1\left(s^*\left(q\right)\right)+\left(1-p\right)f_0\left(s^*\left(q\right)\right)\right]\frac{\partial s^*\left(q\right)}{\partial q}$$

Therefore,

$$\frac{q}{1-q}\frac{\partial\alpha\left(q,1\right)}{\partial q}-\frac{\partial\alpha\left(q,0\right)}{\partial q}=f_0\left(s^*\left(q\right)\right)\left[1-\frac{q}{1-q}l\left(s^*\left(q\right)\right)\right]\frac{\partial s^*\left(q\right)}{\partial q}$$

and since $s^*\left(q\right)\equiv l^{-1}\left(\frac{1-q}{q}\right)$ we conclude that $\frac{q}{1-q}\frac{\partial\alpha(q,1)}{\partial q}-\frac{\partial\alpha(q,0)}{\partial q}=0$. Therefore,

$$\frac{\partial V\left(q\right)}{\partial q}|_{q<\frac{1}{2}}=-\left(1-p\right)\frac{1-\lambda\alpha\left(q,1\right)}{\left(1-q\right)^2}<0$$

as required. Next,

$$\begin{aligned}\frac{\partial V\left(q\right)}{\partial q}|_{q\geq\frac{1}{2}} &= \frac{\partial V\left(q\right)}{\partial q}|_{q<\frac{1}{2}}-\left(1-p\right)\frac{\partial}{\partial q}\left[\frac{2q-1}{1-q}\left(1-\lambda\right)\right]\\ &= \frac{\partial V\left(q\right)}{\partial q}|_{q<\frac{1}{2}}-\frac{\left(1-p\right)\left(1-\lambda\right)}{\left(1-q\right)^2}<0\end{aligned}$$

We established that $\frac{\partial V(q)}{\partial q}<0$ and hence $\frac{\partial V(q)}{\partial e}>0$ as required.

We prove the comparative static with respect to λ. According to (A6),

$$\frac{\partial V(q)}{\partial \lambda}|_{q<\frac{1}{2}} = (1-p)\left[\frac{q}{1-q}\alpha(q,1) - \alpha(q,0)\right]$$

Recall

$$\alpha(q,p) = 1 - pF_1(s^*(q)) - (1-p)F_0(s^*(q))$$

and hence

$$\frac{q}{1-q}\alpha(q,1) - \alpha(q,0) = \frac{q}{1-q}(1 - F_1(s^*(q))) - (1 - F_0(s^*(q)))$$

using $\frac{f_1(s^*(q))}{f_0(s^*(q))} = \frac{1-q}{q}$ we get

$$\frac{q}{1-q}\alpha(q,1) - \alpha(q,0) = f_0(s^*(q))\left[\frac{1-F_1(s^*(q))}{f_1(s^*(q))} - \frac{1-F_0(s^*(q))}{f_0(s^*(q))}\right]$$

The MLR property implies that $\frac{f_1(s)}{1-F_1(s)} < \frac{f_0(s)}{1-F_0(s)}$ for all s and hence the RHS is strictly positive. We establish that $\frac{\partial V(q)}{\partial \lambda}|_{q<\frac{1}{2}} > 0$. Next, it follows from (A6) that

$$\frac{\partial V(q)}{\partial \lambda}|_{q\geq\frac{1}{2}} = (1-p)\left[-\frac{q}{1-q}(1-\alpha(q,1)) + (1-\alpha(q,0))\right]$$

using $1-\alpha(q,\omega) = F_\omega(s^*(q))$ and $\frac{f_1(s^*(q))}{f_0(s^*(q))} = \frac{1-q}{q}$ we get

$$\frac{\partial V(q)}{\partial \lambda}|_{q\geq\frac{1}{2}} = (1-p)f_0(s^*(q))\left[\frac{F_0(s^*(q))}{f_0(s^*(q))} - \frac{F_1(s^*(q))}{f_1(s^*(q))}\right]$$

And the MLR property implies that this term is strictly positive.

Finally, we show that in equilibrium shareholders' welfare is non-decreasing in $\bar{e}$. By revealed preferences of the manager, q^* is better than any other $q \in [\underline{q}, p]$. Now, if $\bar{e}$ increases then the manager can also choose from $[\underline{q}-\varepsilon, \underline{q}]$. By revealed preferences, the manager will potentially switch to $[\underline{q}-\varepsilon, q^*]$ but not to $[q^*, p]$ since the choice of q^* is still available. Therefore, q^* is non increasing, and according to Lemma 5, it must be the that $V(e)$ is non decreasing. Note this holds regardless of the preferences of the board. ■

Proof of Proposition 2. Suppose $p < \frac{1}{2}$. If $\alpha(q,q) \leq q$ for all $q \in (0,p]$ then if follows from (A2) that when $\bar{e} = 1$ it must be that $q^*_{\lambda=1} = 0$ and from Proposition 1 that $q^*_\lambda = 0$ for all $\lambda \in [0,1]$. Therefore, $V^*_\lambda(0)$ is invariant to λ and, by definition, $\lambda^* = 1$ as required. So there is no $\underline{e} \leq 1$ such that $\lambda^* < 1$ for all $\bar{e} \in [\underline{e}, 1]$.

Suppose there exists $q_0 \in (0,p]$ such that $\alpha(q_0,q_0) > q_0$. It follows from Proposition 1 that $q^*_{\lambda=0} = \underline{q}$ for all $\bar{e} \leq 1$. Hence, according to (A6), shareholders' welfare in equilibrium when

$\lambda = 0$ is given by

$$V^*_{\lambda=0}\left(\underline{q}\right) \equiv 1 - (1-p)\frac{\underline{q}}{1-\underline{q}}$$

Similarly, (A6) implies that shareholders' welfare in equilibrium when $\lambda = 1$ is given by

$$V^*_{\lambda=1}\left(\underline{q}\right) \equiv 1 - (1-p)\left[\frac{q^*_{\lambda=1}\left(\underline{q}\right)}{1-q^*_{\lambda=1}\left(\underline{q}\right)} - \left(\frac{q^*_{\lambda=1}\left(\underline{q}\right)}{1-q^*_{\lambda=1}\left(\underline{q}\right)}\alpha\left(q^*_{\lambda=1}\left(\underline{q}\right),1\right) - \alpha\left(q^*_{\lambda=1}\left(\underline{q}\right),0\right)\right)\right]$$

From Proposition 1 it also follows that $q^*_{\lambda=1}\left(\underline{q}\right) = \rho\left(\underline{q}\right) \equiv \arg\min_{q\in\left[\underline{q},p\right]}\left\{\frac{1-\alpha(q,q)}{1-q}\right\}$. Since there exists $q_0 \in (0,p]$ such that $\alpha(q_0,q_0) > q_0$ it follows that $\rho(0) > 0$. That is, the global minimum of $\frac{1-\alpha(q,q)}{1-q}$ is given at $\rho(0) > 0$. Therefore, $\rho\left(\underline{q}\right) = \rho(0)$ for all $\underline{q} \in [0,\rho(0)]$. Note, similar to the proof of Lemma 4, that the term $\frac{q}{1-q}\alpha(q,1) - \alpha(q,0)$ is strictly positive for all $q \in (0,p]$. Thus, for all $\underline{q} \in [0,\rho(0)]$ it follows that $V^*_{\lambda=0}\left(\underline{q}\right) > V^*_{\lambda=1}\left(\underline{q}\right)$ if and only if

$$\underline{q} < \bar{q} \equiv \frac{\frac{\rho(0)}{1-\rho(0)} - \left(\frac{\rho(0)}{1-\rho(0)}\alpha(\rho(0),1) - \alpha(\rho(0),0)\right)}{1 + \frac{\rho(0)}{1-\rho(0)} - \left(\frac{\rho(0)}{1-\rho(0)}\alpha(\rho(0),1) - \alpha(\rho(0),0)\right)}$$

and note that $\bar{q} \in (0,\rho(0))$. Let $\underline{e}$ satisfy $\bar{q} = \frac{p-\underline{e}p}{1-\underline{e}p}$, then $\bar{e} \in [\underline{e},1] \Leftrightarrow \underline{q} \in [0,\bar{q}]$ and if $\bar{e} \in [\underline{e},1]$ it follows that $V^*_{\lambda=0}\left(\underline{q}\right) > V^*_{\lambda=1}\left(\underline{q}\right)$. Therefore, $\lambda^* < 1$ as required.

Suppose $p \geq \frac{1}{2}$. For any $\bar{e}$ it follows from proposition 1 that if $\lambda_1 < \lambda^+(\bar{e}) < \lambda_2$ then $q^*_{\lambda_1} > q^*_{\lambda_2}$. By Lemma 4, $V^*_{\lambda_2}\left(\underline{q}\right)$ is strictly higher than $V^*_{\lambda}\left(\underline{q}\right)$ for any $\lambda \in \left[0,\lambda^+(\bar{e})\right)$. This establishes that $\lambda^* \geq \lambda^+(\bar{e})$ (which is strictly positive according to (A4)).

Next, we argue that if $\bar{e} = 1$ and the following condition holds

$$1 < \max_{q\in\left(0,\frac{1}{2}\right)}\left\{\frac{\alpha(q,q)}{q}\right\} < \min_{q\in\left[\frac{1}{2},p\right]}\left\{\frac{1-\alpha(q,q)}{1-q}\right\} \tag{A7}$$

then $\lambda^* < 1$ even when $p \geq \frac{1}{2}$. First note that if $1 < \max_{q\in\left(0,\frac{1}{2}\right)}\left\{\frac{\alpha(q,q)}{q}\right\}$ then there exists $q_0 \in \left(0,\frac{1}{2}\right)$ such that $1 > \frac{1-\alpha(q_0,q_0)}{1-q_0}$. This implies according to (A2) that $q^*_{\lambda=1} > 0$. Secondly, since $1 < \min_{q\in\left[\frac{1}{2},p\right]}\left\{\frac{1-\alpha(q,q)}{1-q}\right\}$ then $\frac{1-\alpha(q_0,q_0)}{1-q_0} < \min_{q\in\left[\frac{1}{2},p\right]}\left\{\frac{1-\alpha(q,q)}{1-q}\right\}$ and hence when $\lambda = 1$ then the manager strictly prefers $q_0 > 0$ over any $q \in \left[\frac{1}{2},p\right]$. Therefore, according to (A4), $\lambda^+ < 1$ and $V^*_{\lambda=1} < 1$. Last, we argue that at $\lambda = \lambda^+$ the manager strictly prefers $q = 0$. According to (A4), λ^+ satisfies

$$\frac{\frac{1}{\lambda^+} - \alpha\left(q^*_{\lambda^+},q^*_{\lambda^+}\right)}{1-q^*_{\lambda^+}} = \min_{q\in\left[\frac{1}{2},p\right]}\left\{\frac{1-\alpha(q,q)}{1-q}\right\}$$

where $q_{\lambda^+}^* \in \arg\min_{q\in\left[0,\frac{1}{2}\right)} \frac{\frac{1}{\lambda^+}-\alpha(q,q)}{1-q}$. Therefore, by the contradicting assumption, $q_{\lambda^+}^* > 0$. This implies that

$$\frac{1}{\lambda^+} > \frac{\frac{1}{\lambda^+} - \alpha\left(q_{\lambda^+}^*, q_{\lambda^+}^*\right)}{1 - q_{\lambda^+}^*}$$

and hence $\frac{\alpha\left(q_{\lambda^+}^*, q_{\lambda^+}^*\right)}{q_{\lambda^+}^*} > \frac{1}{\lambda^+}$. Overall,

$$\frac{\alpha\left(q_{\lambda^+}^*, q_{\lambda^+}^*\right)}{q_{\lambda^+}^*} > \frac{\frac{1}{\lambda^+} - \alpha\left(q_{\lambda^+}^*, q_{\lambda^+}^*\right)}{1 - q_{\lambda^+}^*} = \min_{q\in\left[\frac{1}{2},p\right]} \left\{\frac{1-\alpha\left(q,q\right)}{1-q}\right\}$$

This contradicts the assumption that $\max_{q\in\left(0,\frac{1}{2}\right)} \left\{\frac{\alpha(q,q)}{q}\right\} < \min_{q\in\left[\frac{1}{2},p\right]} \left\{\frac{1-\alpha(q,q)}{1-q}\right\}$. We conclude that $q_{\lambda^+}^* = 0$. Therefore, $V_{\lambda^+}^* = 1 > V_{\lambda=1}^*$ implying that $\lambda^* < 1$. ∎

5.2 Proofs of Section II

We introduce new notation for the proofs of section 2. For any $\bar{e}$, β, and λ we let $q_{\bar{e},\lambda,\beta}^*$ be the manager's decision in equilibrium, $V_{\lambda,\beta}\left(q\right)$ be shareholders' expected value for any q, and $V_{\bar{e},\lambda,\beta}^* \equiv V_{\lambda,\beta}\left(q_{\bar{e},\lambda,\beta}^*\right)$. We omit the script for p as it remains fixed throughout the arguments.

Lemma A.2. *For any $\lambda \in [0,1]$ and $p \in (0,1)$, $\lim_{\beta\to 1} q_{\bar{e},\lambda,\beta}^* = \underline{q}$.*

Proof of Lemma A.2. Suppose by the way of contradiction that $\lim_{\beta\to 1} q_{\bar{e},\lambda,\beta}^* > \underline{q}$. Thus, there exists $\{\beta_n\}_{n=1}^{\infty}$ such that $q_{\bar{e},\lambda,\beta_n}^* > \underline{q}$, $\beta_n > p$ for all n, and $\lim_{n\to\infty} \beta_n = 1$. Therefore, for all n, the layman board rejects the project with probability one. The optimalty of $q_{\bar{e},\lambda,\beta_n}^*$ implies that for all n

$$\lambda \geq \frac{q_{\bar{e},\lambda,\beta_n}^* - \underline{q}}{\alpha\left(q_{\bar{e},\lambda,\beta_n}^*, q_{\bar{e},\lambda,\beta_n}^*, \beta_n\right)\left(1-\underline{q}\right) - \alpha\left(\underline{q},\underline{q},\beta_n\right)\left(1-q_{\bar{e},\lambda,\beta_n}^*\right)}$$

Note that $\alpha\left(q_{\bar{e},\lambda,\beta_n}^*, q_{\bar{e},\lambda,\beta_n}^*, \beta_n\right) < \alpha\left(\underline{q},\underline{q},\beta_n\right) + \alpha\left(p,p,\beta_n\right)$ and hence the r.h.s is strictly greater than

$$\begin{aligned}
& \frac{q_{\bar{e},\lambda,\beta_n}^* - \underline{q}}{\left[\alpha\left(\underline{q},\underline{q},\beta_n\right) + \alpha\left(p,p,\beta_n\right)\right]\left(1-\underline{q}\right) - \alpha\left(\underline{q},\underline{q},\beta_n\right)\left(1-q_{\lambda}^*\left(\beta_n\right)\right)} \\
= \quad & \frac{1}{\alpha\left(p,p,\beta_n\right)\left(\frac{1-\underline{q}}{q_{\bar{e},\lambda,\beta_n}^* - \underline{q}}\right) + \alpha\left(\underline{q},\underline{q},\beta_n\right)}
\end{aligned}$$

we conclude that for all n

$$\lambda > \frac{1}{\alpha\left(p,p,\beta_n\right)\left(\frac{1-\underline{q}}{q^*_{\bar{e},\lambda,\beta_n}-\underline{q}}\right)+\alpha\left(\underline{q},\underline{q},\beta_n\right)}$$

Note, however, that $\lim_{n\to\infty}\alpha\left(p,p,\beta_n\right)=\alpha\left(p,p,1\right)=0$ for all $p<1$ and $\lim_{n\to\infty}\frac{1-\underline{q}}{q^*_{\bar{e},\lambda,\beta_n}-\underline{q}}<\infty$ (since $\lim_{\beta\to 1}q^*_{\bar{e},\lambda,\beta_n}>\underline{q}$). Therefore, for n sufficiently large, the r.h.s of the above inequality is strictly greater than 1, implying $\lambda>1$, a contradiction. ■

Lemma A.3 *Suppose there exists $q_0\in(0,p]$ such that $\Upsilon\left(q_0,\frac{1}{2},\lambda\right)<\frac{1}{\lambda}$ where*

$$\Upsilon\left(q,\beta,\lambda\right)\equiv\frac{\frac{1}{\lambda}-\alpha\left(q,q,\beta\right)-\frac{1-\lambda}{\lambda}\cdot 1_{\{q\geq\beta\}}}{1-q} \tag{A8}$$

Then, there exists $e_\lambda<1$ such that if $\bar{e}\in[e_\lambda,1]$ then $\beta^*>\frac{1}{2}$.

Proof of Lemma A.3. Note that for any $\lambda\in[0,1]$ and $\beta\in(0,1)$ the manager's expected utility is given by

$$\mathbb{E}\left[u_M\left(q,\beta\right)\right]=1-\lambda\left(1-p\right)\Upsilon\left(q,\beta,\lambda\right) \tag{A9}$$

Since λ is fixed in this proof, we don't subscript notation whenever there is no risk of confuison.We start by proving that there exists $e_\lambda<1$ such that if $\bar{e}\in[e_\lambda,1]$ then $\beta^*\geq\frac{1}{2}$. Suppose on the contrary that there exists $\{\bar{e}_n\}$ such that for all n: $\bar{e}_n<1$, $\lim_{n\to\infty}\bar{e}_n=1$, and $\beta^*_n<\frac{1}{2}$. Hereafter, to ease the exposition, we denote $q^*_{\bar{e}_n,\beta=\frac{1}{2}}$ as $q^*_{n,1/2}$ and $q^*_{\bar{e}_n,\beta^*_n}$ as q^*_n. There are several implications. First, this means that $q^*_{n,\frac{1}{2}}>q^*_n\geq\underline{q}_n$ for all n. Otherwise, it must be that $\beta^*=\frac{1}{2}$. Secondly, according to Lemma A.2, $\lim_{\beta\to 1}q^*_{\bar{e}_n,\lambda,\beta}=\underline{q}_n$ for all n. This implies, according to (6) (trivially modified for general β), that by choosing β sufficiently close to 1 shareholders can guarantee an expected payoff of $p\bar{e}_n+(1-p)$. Therefore, for all n, $V^*_{\bar{e}_n,\beta^*_n}\geq p\bar{e}_n+(1-p)$ and hence $\lim_{n\to\infty}V^*_{\bar{e}_n,\beta^*_n}=1$. Therefore, $\lim_{n\to\infty}q^*_n=0$.

Let us focuss on n sufficiently large such that $\underline{q}_n<q_0$. Since there exists $q_0\in(0,p]$ such that $\Upsilon\left(q_0,\frac{1}{2},\lambda\right)<\frac{1}{\lambda}$ it must be that $q^*_{n,1/2}>0$ for all n such that $\underline{q}_n<q_0$. The optimality of $q^*_{n,1/2}$ with respect to $\beta=\frac{1}{2}$ implies that

$$\Upsilon\left(q^*_{n,1/2},\frac{1}{2},\lambda\right)<\Upsilon\left(\underline{q}_n,\frac{1}{2},\lambda\right)$$

and

$$\Upsilon\left(q^*_{n,1/2},\frac{1}{2},\lambda\right)\leq\Upsilon\left(q^*_n,\frac{1}{2},\lambda\right)$$

The optimality of q^*_n with respect to β^*_n implies that

$$\Upsilon\left(q^*_n,\beta^*_n,\lambda\right)\leq\Upsilon\left(q^*_{n,1/2},\beta^*_n,\lambda\right)$$

Note that $\Upsilon(q,\beta,\lambda)$ strictly increases in β. Therefore

$$\Upsilon\left(q_n^*,\beta_n^*,\lambda\right) \leq \Upsilon\left(q_{n,1/2}^*,\beta_n^*,\lambda\right) < \Upsilon\left(q_{n,1/2}^*,\frac{1}{2},\lambda\right) \leq \Upsilon\left(q_n^*,\frac{1}{2},\lambda\right)$$

There are several cases to consider. First, suppose $\lim_{n\to\infty}\beta_n^* > 0$. Since $\lim_{n\to\infty} q_n^* = 0$ then $\beta_n^* > q_n^*$ for sufficiently large n. Therefore, $\lim_{n\to\infty}\Upsilon\left(q_n^*,\beta_n,\lambda\right) = \frac{1}{\lambda} = \lim_{n\to\infty}\Upsilon\left(q_n^*,\frac{1}{2},\lambda\right)$. This implies that $\lim_{n\to\infty}\Upsilon\left(q_{n,1/2}^*,\frac{1}{2},\lambda\right) = \frac{1}{\lambda}$ as well. Recall however, that optimality of $q_{\frac{1}{2},n}^*$, implies that that $\Upsilon\left(q_{n,1/2}^*,\frac{1}{2},\lambda\right) \leq \Upsilon\left(q_0,\frac{1}{2},\lambda\right)$ for all n. Therefore, $\lim_{n\to\infty}\Upsilon\left(q_{n,1/2}^*,\frac{1}{2},\lambda\right) \leq \Upsilon\left(q_0,\frac{1}{2},\lambda\right) < \frac{1}{\lambda}$, yielding a contradiction.

Second, suppose $\lim_{n\to\infty}\beta_n^* = 0$. We argue that it must be that $\lim_{n\to\infty} q_{\bar{e}_n,\beta=\frac{1}{2}}^* > 0$. Otherwise, if $\lim_{n\to\infty} q_{\frac{1}{2},n}^* = 0$ then $\lim_{n\to\infty}\Upsilon\left(q_{n,1/2}^*,\frac{1}{2},\lambda\right) = \frac{1}{\lambda}$. But, the optimality of $q_{n,1/2}^*$ with respect to $\beta = \frac{1}{2}$ implies $\Upsilon\left(q_{n,1/2}^*,\frac{1}{2},\lambda\right) \leq \Upsilon\left(q_0,\frac{1}{2},\lambda\right)$ for all n. Hence, $\lim_{n\to\infty}\Upsilon\left(q_{n,1/2}^*,\frac{1}{2},\lambda\right) < \frac{1}{\lambda}$ yielding a contradiction. If $\lim_{n\to\infty} qq_{n,1/2}^* > 0$ and since $\lim_{n\to\infty}\beta_n^* = 0$ then $q_{n,1/2}^* \geq \beta_n^*$ for n sufficiently large. Therefore, $\lim_{n\to\infty}\Upsilon\left(q_{n,1/2}^*,\beta_n^*,\lambda\right) = \lim_{n\to\infty}\frac{1-\alpha\left(q_{n,1/2}^*,q_{n,1/2}^*,\beta_n^*\right)}{1-q_{n,1/2}^*} = 0$. But then, $\lim_{n\to\infty}\Upsilon\left(q_n^*,\beta_n^*,\lambda\right)$ is either $\frac{1}{\lambda} - \inf_n\left\{\alpha\left(q_n^*,q_n^*,\beta_n^*\right)\right\}$ or $1 - \inf_n\left\{\alpha\left(q_n^*,q_n^*,\beta_n^*\right)\right\}$. Either way , unless $\inf_n\left\{\alpha\left(q_n^*,q_n^*,\beta_n^*\right)\right\} = 1$, it is strictly greater than zero, contradicting the conclusion that $\Upsilon\left(q_n^*,\beta_n^*,\lambda\right) \leq \Upsilon\left(q_{n,1/2}^*,\beta_n^*,\lambda\right)$. Note that if $\inf_n\left\{\alpha\left(q_n^*,q_n^*,\beta_n^*\right)\right\} = 1$ then $\inf_n\left\{\alpha\left(q_n^*,1,\beta_n^*\right)\right\} = \inf_n\left\{\alpha\left(q_n^*,0,\beta_n^*\right)\right\} = 1$ as well (since otherwise $\inf_n\left\{\alpha\left(q_n^*,q_n^*,\beta_n^*\right)\right\} < 1$). This implies that the probably of approval conditional on non-disclosure converges to one and hence $\sup_n\left\{V_{\bar{e}_n,\beta_n^*}\right\} = p < 1$. We get a contradiction and conclude that there exists $e_\lambda < 1$ such that if $\bar{e} \in [e_\lambda, 1]$ then $\beta^* \geq \frac{1}{2}$.

To complete the proof it is left to show that there exists $e_\lambda < 1$ and $\beta_\lambda \in \left(\frac{1}{2},1\right)$ such that if $\bar{e} \in [e_\lambda, 1]$ then $V_{\bar{e},\lambda,\beta_\lambda}^* > V_{\bar{e},\lambda,1/2}^*$. Recall from Lemma A.2 that for any $\bar{e} < 1$ we have

$$\lim_{\beta\to 1} V_{\bar{e},\lambda,\beta}^* = p\bar{e} + (1-p)$$

Since $\Upsilon\left(q_0,\frac{1}{2},\lambda\right) < \frac{1}{\lambda}$ then $q_{\bar{e}=1,\beta=1/2}^* > 0$. Let $e_{\lambda,1}$ be such that $q\left(e_{\lambda,1}\right) = q_{\bar{e}=1,\lambda,\beta=1/2}^*$. Since $q_{\bar{e}=1,\lambda,\beta=1/2}^* > 0$ then $e_{\lambda,1} < 1$. For any $\bar{e} > e_{\lambda,1}$ note that it must be that $q_{\bar{e},\lambda,\beta=1/2}^* = q_{\bar{e}=1,\lambda,\beta=1/2}^*$ and hence $V_{\bar{e},\lambda,\beta=1/2}^* = V_{\lambda,\beta=1/2}\left(q_{\bar{e}=1,\lambda,\beta=1/2}^*\right)$. Since $V_{\lambda,\beta}(q)$ increases in λ for a given q (Lemma 4), $V_{\lambda,\beta=1/2}\left(q_{\bar{e}=1,\lambda,\beta=1/2}^*\right) \leq V_{\lambda=1,\beta=1/2}\left(q_{\bar{e}=1,\lambda,\beta=1/2}^*\right)$. Also, since $q_{\bar{e}=1,\lambda,\beta=1/2}^* > 0$ then $V_{\lambda=1,\beta=1/2}\left(q_{\bar{e}=1,\lambda,\beta=1/2}^*\right) < 1$ and is independent of $\bar{e}$ and β. Let

$$e_\lambda \equiv \max\left\{1 - \frac{1 - V_{\lambda=1,\beta=1/2}\left(q_{\bar{e}=1,\lambda,\beta=1/2}^*\right)}{p}, e_{\lambda,1}\right\}$$

By construction, $pe_\lambda + (1-p) > V_{\lambda=1,\beta=1/2}\left(q^*_{\bar{e}=1,\lambda,\beta=1/2}\right)$ and $V^*_{\bar{e},\lambda,\beta=1/2} \le V_{\lambda=1,\beta=1/2}\left(q^*_{\bar{e}=1,\lambda,\beta=1/2}\right)$ for all $\bar{e} > e_\lambda$. Since $\lim_{\beta\to 1} V^*_{\bar{e},\lambda,\beta} = p\bar{e} + (1-p)$ for any $\bar{e} > e_\lambda$ there is β sufficiently close to 1 such that $V^*_{\bar{e},\lambda,\beta} > V^*_{\bar{e},\lambda,\beta=1/2}$. This implies that $\beta^* > \frac{1}{2}$ as required. ■

Proof of Proposition 3. We start the proof for the case $\lambda = 0$ and show that if $p \in \left(\frac{1}{2}, \frac{1}{2-\bar{e}}\right)$ then $\beta^* > \frac{1}{2}$ and otherwise $\beta^* = \frac{1}{2}$. To ease the exposition, for the case where $\lambda = 0$ we omit the subscript of λ. According to (A9), when $\lambda = 0$ the manager's expected utility is given by

$$\mathbb{E}\left[u_M(q,\beta)\right] = 1 - (1-p)\left[\frac{1 - 1_{\{q\ge\beta\}}}{1-q}\right]$$

If $\beta > p$ then $\beta > q$ as well and according to (A8) $\mathbb{E}\left[u_M(q,\beta)\right] = \frac{p-q}{1-q}$. The manager will choose the lowest possible q which is $\underline{q}$. In the equilibrium, the layman board approves the projects if and only if the manager reveals that $\omega = 1$. Therefore, shareholders' welfare is given by $V^*_{\bar{e},\beta>p} = p\bar{e} + (1-p)$.

If $\beta \le p$ and the manager chooses $q \in [\beta, p]$ then the board accepts the project with probability one conditional on the non-disclosure (and therefore unconditionally as well). Thus, by choosing $q \in [\beta, p]$ the manager can guarantee that highest possible utility, 1. By contrast, conditional on choosing $q < \beta$ the manager has strictly incentives to choose $q = \underline{q}$. In this case the manager obtains $\frac{p-\underline{q}}{1-\underline{q}} < 1$. Therefore, in equilibrium, if $\beta \le p$ then $q^* \ge \beta$ and shareholders' welfare is $V_{\bar{e},\beta\le p} = p$.

We conclude that $V^*_{\bar{e},\beta>p} > V^*_{\bar{e},\beta\le p} \Leftrightarrow p < \frac{1}{2-\bar{e}}$. Therefore, if $p \le \frac{1}{2}$ then $p < \frac{1}{2-\bar{e}}$ and $\arg\max_{\beta\in(0,1)} V^*_{\bar{e},\beta} = (p,1)$. Since $\frac{1}{2} \in (p,1)$ then $\beta^* = \frac{1}{2}$. If $p \ge \frac{1}{2-\bar{e}}$ then $\arg\max_{\beta\in(0,1)} V^*_{\bar{e},\beta} \supseteq (0,p]$. Since $\frac{1}{2} \in (0,p]$ then $\beta^* = \frac{1}{2}$. If $p \in \left(\frac{1}{2}, \frac{1}{2-\bar{e}}\right)$ then $\arg\max_{\beta\in(0,1)} V^*_{\bar{e},\beta} = (p,1)$ and hence any $\beta \in (p,1)$ is strictly greater than $\frac{1}{2}$. Therefore, $\beta^* = p > \frac{1}{2}$. Overall, we proved that when $\lambda = 0$ then if $p \in \left(\frac{1}{2}, \frac{1}{2-\bar{e}}\right)$ then $\beta^* > \frac{1}{2}$ and otherwise $\beta^* = \frac{1}{2}$.

We prove the proposition for the general case $\lambda > 0$. For any p we define,

$$\bar{\lambda}_p \equiv \inf_{q\in\left(0,\min\left\{p,\frac{1}{2}\right\}\right]} \left\{\frac{q}{\alpha\left(q,q,\frac{1}{2}\right)}\right\} \tag{A10}$$

$$\lambda_p^+ \equiv \min_{q\in\left[0,\frac{1}{2}\right]} \left\{\frac{1}{\alpha\left(q,q,\frac{1}{2}\right) + (1-q)\min_{q\in\left[\frac{1}{2},\max\left\{p,\frac{1}{2}\right\}\right]}\left\{\frac{1-\alpha\left(q,q,\frac{1}{2}\right)}{1-q}\right\}}\right\} \tag{A11}$$

and note that $\bar{\lambda}_p > 0$ and $\lambda_p^+ > 0$. Moreover, $\bar{\lambda}_p \ge 1$ if and only if $q \ge \alpha\left(q,q,\frac{1}{2}\right)$ for all $q \in \left(0, \min\left\{p,\frac{1}{2}\right\}\right]$ which holds if and only if the minimum of $\frac{1-\alpha(q,q)}{1-q}$ over the range $\left[0, \min\left\{p,\frac{1}{2}\right\}\right]$ is obtained at $q = 0$. $\lambda_p^+ \ge 1$ if and only if for all $q \in \left[0,\frac{1}{2}\right]$ we have $\frac{1-\alpha\left(q,q,\frac{1}{2}\right)}{1-q} \ge \min_{q\in\left[\frac{1}{2},p\right]}\left\{\frac{1-\alpha\left(q,q,\frac{1}{2}\right)}{1-q}\right\}$. In other words, the minimum of $\frac{1-\alpha(q,q)}{1-q}$ over the range $\left[0, \max\left\{p,\frac{1}{2}\right\}\right]$

is obtained at some $q \geq \frac{1}{2}$.

Suppose $p < \frac{1}{2}$ and $\lambda \leq \bar{\lambda}_p$ or $p \geq \frac{1}{2}$ and $\lambda \in \left[\lambda_p^+, \bar{\lambda}_p\right]$. Note that if $\lambda \leq \bar{\lambda}_p$ then $\frac{1}{\lambda} \leq \frac{\frac{1}{\lambda}-\alpha\left(q,q,\frac{1}{2}\right)}{1-q}$for all $q \in \left(0, \min\left\{p, \frac{1}{2}\right\}\right]$. If in addition $\lambda > \lambda_p^+$ then from (A11) it follows that $\frac{1}{\lambda} < \frac{1-\alpha\left(q,q,\frac{1}{2}\right)}{1-q}$ for all $q \in \left[\frac{1}{2}, p\right]$ as well. Either way, for all λ in this range, if $\bar{e} = 1$ then $q^*_{\bar{e}=1,\lambda,\beta=\frac{1}{2}} = 0$. Therefore, shareholders' value is maximized when the board is unbiased and $\beta^* = \frac{1}{2}$. This proves the first part of the Proposition.

Suppose $p < \frac{1}{2}$ and $\lambda > \bar{\lambda}_p$ or $p \geq \frac{1}{2}$ and $\lambda \notin \left[\lambda_p^+, \bar{\lambda}_p\right]$. In the former case, according to (A10) there exist $q_0 \in (0, p]$ such that $\frac{1}{\lambda} > \frac{\frac{1}{\lambda}-\alpha\left(q_0,q_0,\frac{1}{2}\right)}{1-q_0}$. In the latter case, if $\lambda < \lambda_p^+$ then there exists $q_0 \in \left[\frac{1}{2}, p\right]$ such that $\frac{1}{\lambda} > \frac{1-\alpha\left(q_0,q_0,\frac{1}{2}\right)}{1-q_0}$. If $\lambda > \bar{\lambda}_p$ then exists is $q_0 \in \left(0, \frac{1}{2}\right]$ such that $\frac{1}{\lambda} > \frac{\frac{1}{\lambda}-\alpha\left(q_0,q_0,\frac{1}{2}\right)}{1-q_0}$. Either way, there exists $q_0 \in (0, p]$ such that $\Upsilon\left(q_0, \frac{1}{2}, \lambda\right) < \frac{1}{\lambda}$. Lemma A.3, establishes the result. ■

5.3 Proofs of Section III

Lemma A.4 *In any equilibrium (that satisfy the restrictions in section III of the analysis) there is a strictly positive probability that the project is approved by the board and a strictly positive probability that the project is rejected.*

Proof of Lemma A.4. We start the proof by showing that unconditionally $\Pr[a = 1] > 0$ in any equilibrium. Suppose by the way of contradiction that there is an equilibrium in which $\Pr[a = 1] = 0$. This implies that the manager's expected utility is zero. But then, the manager can do strictly better by choosing $e = \bar{e} > 0$. In that case, there is probability $\bar{e}p > 0$ that the manger learns that $\omega = 1$, discloses this information to the board, and the board accepts the project with probability one conditional on this disclosure. Therefore, in any equilibrium it must be that $\Pr[a = 1] > 0$ unconditionally and hence a contradiction.

Next, we prove in several steps that unconditionally in equilibrium $\Pr[a = 1] < 1$. First, we argue that if $\Pr[a = 1] = 1$ then the manager conceals information with strictly positive probability. Otherwise, it must be that $e = 1$ and the manager discloses information about ω regardless of its realization. But in this case, there is a strictly positive probability that $\omega = 0$ and therefore, a strictly positive probability that the board rejects the project. This leads to a contradiction.

Second, suppose the manager does not disclose information. Conditional on non-disclosure, the board with signal $s = 0$ has the highest incentives to reject the project. Thus, if there exists an equilibrium in which $\Pr[a = 1] = 1$, it is necessary that

$$q \geq \frac{1}{1 + \frac{1-\pi}{\pi}\frac{1-\Gamma\left(\hat{\lambda}\right)+\Gamma(\lambda)}{1+\Gamma\left(\hat{\lambda}\right)-\Gamma(\lambda)}} \tag{A12}$$

where $\hat{\lambda} \equiv \Pr[\rho = 1|a = 0]$. Given our assumption that $p < \pi$ and the observation that $q \leq p$, it follows that $\frac{q(1-\pi)}{q(1-\pi)+(1-q)\pi} < \frac{1}{2}$. Hence, it is necessary that $\Gamma\left(\hat{\lambda}\right) - \Gamma(\lambda) < 0$ which holds if and only if $\hat{\lambda} < \lambda$. Note that the worst beliefs on the board's expertise that shareholders might have conditional on observing the decision to reject the project are formed when the board accepts the project if and only if $s = 1$. These beliefs are given by $\underline{\lambda} \equiv \frac{1}{1+\frac{1-\lambda}{\lambda}\frac{1}{q(1-\pi)+(1-q)\pi}} \in (0, \lambda)$. Thus, in any RPS equilibrium it must be that $\hat{\lambda} \in [\underline{\lambda}, \lambda]$.

Third, beliefs $\hat{\lambda} \in [\underline{\lambda}, \lambda]$ are not credible if there exists beliefs λ' such that if conditional on the observation that $a = 0$ shareholders's beliefs switch from $\hat{\lambda}$ to λ' and at the same time it is optimal for the board to behaves consistently with those beliefs given the manager's equilibrium effort. In what follows we demonstrate that any belief $\hat{\lambda} \in [\underline{\lambda}, \lambda]$ is not credible in the above sense.

Consider beliefs that are consistent with the following: the expert board accepts the project if and only if $s = 1$ and the layman board accepts the project with probability δ. Then

$$\lambda'(\delta) \equiv \Pr[\rho = 1 | a = 0] = \frac{1}{1 + \frac{1-\lambda}{\lambda}\frac{1-\delta}{q(1-\pi)+(1-q)\pi}}$$

Note that $\lambda'(\delta)$ spans $[\underline{\lambda}, 1]$ and it increases in δ. Therefore, if there exists δ such that

$$\frac{1}{1 + \frac{1-\Gamma(\lambda(\delta))+\Gamma(\lambda)}{1+\Gamma(\lambda(\delta))-\Gamma(\lambda)}} = q$$

then the beliefs $\hat{\lambda}$ are not credible. If δ as required above does not exist then it must be that $q > \frac{1}{1+\frac{1-\Gamma(1)+\Gamma(\lambda)}{1+\Gamma(1)-\Gamma(\lambda)}}$. This is because (A12) implies that $q \geq \frac{1}{1+\frac{1-\Gamma(\underline{\lambda})+\Gamma(\lambda)}{1+\Gamma(\underline{\lambda})-\Gamma(\lambda)}}$ and $t(x) \equiv \frac{1}{1+\frac{1-\Gamma(x)+\Gamma(\lambda)}{1+\Gamma(x)-\Gamma(\lambda)}}$ is increasing and continuous in x.

Suppose $q > \frac{1}{1+\frac{1-\Gamma(1)+\Gamma(\lambda)}{1+\Gamma(1)-\Gamma(\lambda)}}$ and consider beliefs that are consistent with the following: the board rejects the project if and only if $s = 0$. Then, $\lambda' \equiv \Pr[\rho = 1 | a = 0] = 1$ and beliefs $\hat{\lambda}$ are not credible if

$$\frac{1}{1 + \frac{1-\pi}{\pi}\frac{1-\Gamma(1)+\Gamma(\lambda)}{1+\Gamma(1)-\Gamma(\lambda)}} \geq q$$

Since $\pi > p \geq q$ and $\Gamma(1) > \Gamma(\lambda)$ then the above condition always holds.

We conclude that any beliefs $\hat{\lambda} \in [\underline{\lambda}, \lambda]$ are not credible, and hence there is no RPS equilibrium in which unconditionally $\Pr[a = 1] = 1$. ■

Lemma A.5

(*i*) *There is an equilibrium in which $q^* = 0$ if and only if $p \leq \frac{1}{2}$ and $\lambda \leq \frac{1}{2\pi}$. In this equilibrium, conditional on non-disclosure, the board rejects the project with probability one.*

(*ii*) *There is an equilibrium in which* $q^* = \frac{1}{1+\frac{\pi}{1-\pi}\frac{1-\Delta^*}{1+\Delta^*}}$ *if and only if either*

$$\max\left\{\frac{1-\lambda\pi\left(3-2\pi\right)}{\left(1-\lambda\pi\right)\left(2\pi-1\right)}, \frac{p-\pi}{p\left(1-\pi\right)+\pi\left(1-p\right)}\right\} < \Delta^* < \min\left\{0, 2\lambda\pi-1, 2p-1\right\} \tag{A13}$$

or

$$2p-1 < \Delta^* < \min\left\{0, 2\lambda\pi-1\right\} \tag{A14}$$

where Δ^* *satisfies*

$$\Delta^* \equiv \Gamma\left(\frac{1}{1+\frac{1-\lambda}{\lambda}\frac{1}{q^*(1-\pi)+(1-q^*)\pi}}\right) - \Gamma\left(\frac{1}{1+\frac{1-\lambda}{\lambda}\frac{\frac{p-q^*}{1-p}}{\frac{p-q^*}{1-p}+[q^*\pi+(1-q^*)(1-\pi)]}}\right) \tag{A15}$$

In this equilibrium, conditional on non-disclosure, the board accepts the if and only if $s=1$.

(*iii*) *There is an equilibrium in which* $q^* = \frac{1+\Delta^*}{2}$ *if and only if*

$$0 < \Delta^* < \min\left\{\frac{1-\lambda}{1+\lambda\left(1-2\pi\right)}, \frac{1-\lambda\pi\left(3-2\pi\right)}{\left(1-\lambda\pi\right)\left(2\pi-1\right)}, 2p-1\right\} \tag{A16}$$

where Δ^* *satisfies*

$$\Delta^* = \Gamma\left(1\right) - \Gamma\left(\frac{1}{1+\frac{1-\lambda}{\lambda}\frac{\frac{p-q^*}{1-p}+1}{\frac{p-q^*}{1-p}+[q^*\pi+(1-q^*)(1-\pi)]}}\right) \tag{A17}$$

In this equilibrium, conditional on non-disclosure, the board rejects the project if and only if $s=0$.

(*iv*) *There is no other equilibrium.*

Proof of Lemma A.5. Shareholders belief depends only on a but not on e or m, and hence from the manager and the board's point of view, they are fixed. Let Δ^* be the equilibrium value of $\Gamma\left(\Pr\left[\rho=1|a=0\right]\right) - \Gamma\left(\Pr\left[\rho=1|a=1\right]\right)$ and not that $\Gamma\left(1\right) < 1$ guarantees that $\Delta^* \in (-1,1)$.

Suppose the manager chooses q and does not disclose the information. Recall that conditional on non-disclosure the layman board accepts the project if and only if $q \geq \frac{1+\Delta^*}{2}$. The expert board with signal $s \in \{0,1\}$ accepts the project if and only if $q > \frac{1}{1+\frac{\pi}{1-\pi}\frac{1-\Delta^*}{1+\Delta^*}}$ when $s=1$ and if and only if $q > \frac{1}{1+\frac{1-\pi}{\pi}\frac{1-\Delta^*}{1+\Delta^*}}$ when $s = 0$. Thus,

$$\alpha\left(q,p,\Delta^*\right) = \begin{cases} 0 & \text{if } q < \frac{1}{1+\frac{\pi}{1-\pi}\frac{1-\Delta^*}{1+\Delta^*}} \\ p\pi + (1-p)(1-\pi) & \text{if } q \in \left[\frac{1}{1+\frac{\pi}{1-\pi}\frac{1-\Delta^*}{1+\Delta^*}}, \frac{1}{1+\frac{1-\pi}{\pi}\frac{1-\Delta^*}{1+\Delta^*}}\right) \\ 1 & \text{if } q \geq \frac{1}{1+\frac{1-\pi}{\pi}\frac{1-\Delta^*}{1+\Delta^*}} \end{cases} \tag{A18}$$

The manager's expected utility is given by

$$\mathbb{E}\left[u_M\left(q,\Delta^*\right)\right] = 1 - \lambda\left(1-p\right)\left[\frac{\frac{1}{\lambda} - \alpha\left(q,q,\Delta^*\right) - \frac{1-\lambda}{\lambda}\cdot 1_{\left\{q \geq \frac{1+\Delta^*}{2}\right\}}}{1-q}\right] \tag{A19}$$

From (A18) and (A19) it follows that the manager optimal decision of q is in the set $\left\{0, \min\left\{\frac{1}{1+\frac{\pi}{1-\pi}\frac{1-\Delta^*}{1+\Delta^*}}, p\right\}, \min\left\{\frac{1+\Delta^*}{2}, p\right\}, \min\left\{\frac{1}{1+\frac{1-\pi}{\pi}\frac{1-\Delta^*}{1+\Delta^*}}, p\right\}\right\}$. This establishes part (iv) of Lemma A.5.

Recall that Lemma A.4 establishes that there is no RPS equilibrium in which the project is accepted with probability one. Therefore, $q^* = \frac{1}{1+\frac{1-\pi}{\pi}\frac{1-\Delta^*}{1+\Delta^*}}$ is never an equilibrium. If $\frac{1}{1+\frac{1-\pi}{\pi}\frac{1-\Delta^*}{1+\Delta^*}} \leq p$ the manager has strict incentives to deviate to $\frac{1}{1+\frac{1-\pi}{\pi}\frac{1-\Delta^*}{1+\Delta^*}}$ and obtain the highest welfare possible, one. Therefore, we must require that in any equilibrium $\frac{1}{1+\frac{1-\pi}{\pi}\frac{1-\Delta^*}{1+\Delta^*}} > p$ which holds if and only if

$$\Delta^* > \frac{p-\pi}{p\left(1-\pi\right)+\pi\left(1-p\right)} \tag{A20}$$

For any $\Delta^* \in (-1,1)$, application of (A19) implies:

- $\mathbb{E}\left[u_M\left(0,\Delta^*\right)\right] > \mathbb{E}\left[u_M\left(\frac{1+\Delta^*}{2},\Delta^*\right)\right]$ if and only if

$$\Delta^* > \frac{1-\lambda}{1+\lambda\left(1-2\pi\right)} \tag{A21}$$

- $\mathbb{E}\left[u_M\left(0,\Delta^*\right)\right] > \mathbb{E}\left[u_M\left(\frac{1}{1+\frac{\pi}{1-\pi}\frac{1-\Delta^*}{1+\Delta^*}},\Delta^*\right)\right]$ if and only if

$$\Delta^* > 2\lambda\pi - 1 \tag{A22}$$

- $\mathbb{E}\left[u_M\left(\frac{1+\Delta^*}{2},\Delta^*\right)\right] > \mathbb{E}\left[u_M\left(\frac{1}{1+\frac{\pi}{1-\pi}\frac{1-\Delta^*}{1+\Delta^*}},\Delta^*\right)\right]$ if and only if

$$\Delta^* < \frac{1-\lambda\pi\left(3-2\pi\right)}{\left(1-\lambda\pi\right)\left(2\pi-1\right)} \tag{A23}$$

Before we find conditions for the existence of equilibrium, we should mention that unless $q = p$ there is no equilibrium in which the board (a layman or an expert) plays a mixed strategy. The reason is that the manager will always find it optimal to marginally increase q and thereby discretely increase the probably that the project is accepted.

Consider an equilibrium in which $q^* = 0$. In this equilibrium, regardless of its expertise the board accepts the project conditional on disclosure and rejects the project conditional on non-disclosure and, therefore, $\Delta^* = 0$. Condition (A20) does not bind when $\Delta^* = 0$. Condition (A21) implies that the option $q > \frac{1}{2}$, if feasible, always dominates $q = 0$. Hence, this equilibrium exits only if $p \leq \frac{1}{2}$ (if $q = p = \frac{1}{2}$ the layman board is indifferent and hence we assume that he would reject the project). When $p < \frac{1}{2}$, condition (A22) requires that $2\lambda\pi - 1 < 0$. We conclude, an equilibrium with $q^* = 0$ exists if and only if $p < \frac{1}{2}$ and $2\lambda\pi - 1 < 0$. This establishes part (i) of the Lemma A.5.

Consider an equilibrium in which $q^* = \frac{1}{1+\frac{\pi}{1-\pi}\frac{1-\Delta^*}{1+\Delta^*}}$. In this equilibrium, the layman board rejects the project conditional on non-disclosure and hence $\Delta^* < 0$. The option $q^* = \frac{1}{1+\frac{\pi}{1-\pi}\frac{1-\Delta^*}{1+\Delta^*}}$ is feasible if and only if $p \geq \frac{1}{1+\frac{\pi}{1-\pi}\frac{1-\Delta^*}{1+\Delta^*}}$. Since $p > 1 - \pi$ this condition never binds given the requirement that $\Delta^* < 0$. Condition (A20) and the reversed of condition (A22) imply that it is necessary that

$$\frac{p - \pi}{p(1-\pi) + \pi(1-p)} < \Delta^* < \min\{0, 2\lambda\pi - 1\}$$

If $\frac{1+\Delta^*}{2} \leq p$ then we also need to require the reversed of condition (A23). This yields (A13) in the statement of the Lemma. If $\frac{1+\Delta^*}{2} > p$ then the option $q = \frac{1+\Delta^*}{2}$ is not feasible and noting that $2p - 1 > \frac{p-\pi}{p(1-\pi)+\pi(1-p)}$ yields condition (A14) in the statement of the Lemma. Moreover, in order to be consistent with shareholders' expectation, Δ^* must be the fixed point of (A15). Note that the r.h.s of (A15) decreases in Δ^*, it is strictly negative, and bounded away from below from minus one. Therefore, there exists a unique solution for (A15). This establishes the part (ii) of Lemma A.5.

Consider an equilibrium in which $q^* = \frac{1+\Delta^*}{2}$. In this equilibrium, the layman board accepts the projects with probability one and hence $\Delta^* > 0$. If $\Delta^* > 0$ then (A20) does not bind. The option $q = \frac{1+\Delta^*}{2}$ is feasible if and only if $p \geq \frac{1+\Delta^*}{2}$. Combining condition (A23) and the reversed of condition (A21) yields condition (A16). Moreover, in order to be consistent with shareholders' expectation, Δ^* must be the fixed point of (A17). Note that the r.h.s of (A17) is increasing in Δ^*, strictly positive, and it is bounded away from above from 1. Therefore, there exists a solution to (A17). ■

Lemma A.6 *For any (p, λ, π) there exists $\bar{\Gamma} \in (0, 1]$ such that if $\Gamma(1) \leq \bar{\Gamma}$ an equilibrium exists. Moreover, if equilibrium exists then it has the following form:*

(i) If $p < \frac{1}{2}$ and $\lambda < \frac{1}{2\pi}$ then $q^* = 0$.

(ii) If $p < \lambda\pi < \frac{1}{2}$ or $p < \frac{1}{2}$ and $\lambda \geq \frac{1}{2\pi}$ or $p \geq \frac{1}{2}$ and $\lambda \geq \frac{1}{\pi(3-2\pi)}$ then $q^* = \frac{1}{1+\frac{\pi}{1-\pi}\frac{1-\Delta^*}{1+\Delta^*}}$.

(iii) If $p \geq \frac{1}{2}$ and $\lambda < \frac{1}{\pi(3-2\pi)}$ then $q^* = \frac{1+\Delta^*}{2}$.

Proof of Lemma A.6. Lemma A.5 provides necessary and sufficient conditions for the existence of equilibrium. We prove Lemma A.6 in several steps.

First suppose (p, λ, π) satisfy $\lambda < \frac{1}{2\pi}$ and $p \leq \frac{1}{2}$ then according to part (i) of Lemma A.5, for any Γ such that $\Gamma(1) \leq 1$ there is an equilibrium in which $q^* = 0$.

Second, suppose (p, λ, π) satisfy $\lambda < \frac{1}{\pi(3-2\pi)}$ and $p > \frac{1}{2}$ then it follows from parts (iii) and (ii) of Lemma A.5 that conditions (A13) and (A14) never hold but condition (A16) can potentially hold. Therefore, the only candidate for equilibrium is $q^* = \frac{1+\Delta^*}{2}$. Let

$$\bar{\Gamma} \equiv \min\left\{\frac{1-\lambda}{1+\lambda(1-2\pi)}, \frac{1-\lambda\pi(3-2\pi)}{(1-\lambda\pi)(2\pi-1)}, 2p-1\right\}$$

and note that $\bar{\Gamma} \in (0,1)$. Therefore, for any $\Gamma(\cdot)$ such that $\Gamma(1) < \bar{\Gamma}$ the solution for (A17) must be strictly positive and smaller than $\bar{\Gamma}$ and hence satisfies condition (A16). Therefore, an equilibrium in which $q^* = \frac{1+\Delta^*}{2}$ exists.

Third, suppose (p, λ, π) satisfy $\frac{1}{2\pi} < \lambda < \frac{1}{\pi(3-2\pi)}$ and $p < \frac{1}{2}$. It follows from parts (iii) and (ii) of Lemma A.5 that conditions (A16) and (A13) never hold but condition (A14) can potentially hold. Therefore, the only candidate for equilibrium is $q^* = \frac{1}{1+\frac{\pi}{1-\pi}\frac{1-\Delta^*}{1+\Delta^*}}$. Let

$$\bar{\Gamma} \equiv 1-2p$$

and note that $\bar{\Gamma} \in (0,1)$. Therefore, for any $\Gamma(\cdot)$ such that $\Gamma(1) < \bar{\Gamma}$ the solution for (A15) must be strictly negative and greater than $-\bar{\Gamma}$ and hence satisfies condition (A14). Therefore, an equilibrium in which $q^* = \frac{1}{1+\frac{\pi}{1-\pi}\frac{1-\Delta^*}{1+\Delta^*}}$ exists.

Finally suppose (p, λ, π) satisfy $\lambda \geq \frac{1}{\pi(3-2\pi)}$. It follows from parts (iii) and (ii) of Lemma A.5 that condition (A16) never holds but conditions (A13) and (A14) can potentially hold. Therefore, the only candidate for equilibrium is $q^* = \frac{1}{1+\frac{\pi}{1-\pi}\frac{1-\Delta^*}{1+\Delta^*}}$. Let

$$\bar{\Gamma} \equiv -\max\left\{\frac{1-\lambda\pi(3-2\pi)}{(1-\lambda\pi)(2\pi-1)}, \frac{p-\pi}{p(1-\pi)+\pi(1-p)}\right\}$$

and note that $\bar{\Gamma} \in (0,1)$. Moreover, according to part (ii) of Lemma A.5, wherever $p < \frac{1}{2}$ or $p \geq \frac{1}{2}$ an equilibrium in which $q^* = \frac{1}{1+\frac{\pi}{1-\pi}\frac{1-\Delta^*}{1+\Delta^*}}$ exists if and only if $-\bar{\Gamma} < \Delta^* < 0$ (a combination of (A13) and (A14)) and (A15) holds. Therefore, for any $\Gamma(\cdot)$ such that $\Gamma(1) < \bar{\Gamma}$ the solution for (A15) must be strictly negative and greater than $-\bar{\Gamma}$ and an equilibrium in which $q^* = \frac{1}{1+\frac{\pi}{1-\pi}\frac{1-\Delta^*}{1+\Delta^*}}$ exists.

The second part of the Lemma follows directly from the arguments above. It is only left to show that if $p < \lambda\pi < \frac{1}{2}$ then there exists a reputation function such that an equilibrium exists and $q^* = \frac{1}{1+\frac{\pi}{1-\pi}\frac{1-\Delta^*}{1+\Delta^*}}$. Note that when $p < \lambda\pi < \frac{1}{2}$ then conditions (A13) and (A16) don't hold. Condition (A14) becomes $2p-1 < \Delta^* < 2\lambda\pi - 1$. Therefore, $q^* = \frac{1}{1+\frac{\pi}{1-\pi}\frac{1-\Delta^*}{1+\Delta^*}}$ is a candidate for equilibrium. The right hand side of (A15) decreases in q and is strictly negative. Therefore it is greater than $\Gamma\left(\frac{1}{1+\frac{1-\lambda}{\lambda}\frac{1}{p(1-\pi)+(1-p)\pi}}\right)-\Gamma(1)$ and smaller than $\Gamma\left(\frac{1}{1+\frac{1-\lambda}{\lambda}\frac{1}{\pi}}\right)-\Gamma\left(\frac{1}{1+\frac{1-\lambda}{\lambda}\frac{p}{p+(1-p)(1-\pi)}}\right)$. Hence if the function $\Gamma(\cdot)$ satisfies

$$2p-1<\Gamma\left(\frac{1}{1+\frac{1-\lambda}{\lambda}\frac{1}{p(1-\pi)+(1-p)\pi}}\right)-\Gamma(1)$$

and

$$\Gamma\left(\frac{1}{1+\frac{1-\lambda}{\lambda}\frac{1}{\pi}}\right)-\Gamma\left(\frac{1}{1+\frac{1-\lambda}{\lambda}\frac{p}{p+(1-p)(1-\pi)}}\right)<2\lambda\pi-1$$

Then an equilibrium exists. Note that this constrains Γ only at 4 points and hence there exists a reputation function that satisfy these conditions. ■

Proof of Lemma 5. The proof follows directly from the first part of Lemma A.6. ■

Lemma A.7 *Suppose the board is value maximizing and is not subject to career concerns.*

(*i*) *If* $p<\frac{1}{2}$ *and* $\lambda<\frac{1}{2\pi}$ *then* $q^*=0$.

(*ii*) *If* $p<\frac{1}{2}$ *and* $\lambda\geq\frac{1}{2\pi}$ *or* $p\geq\frac{1}{2}$ *and* $\lambda\geq\frac{1}{\pi(3-2\pi)}$ *then* $q^*=1-\pi$.

(*iii*) *If* $p\geq\frac{1}{2}$ *and* $\lambda<\frac{1}{\pi(3-2\pi)}$ *then* $q^*=\frac{1}{2}$.

Proof of Lemma A.7. When the board is value maximizing and is not subject to reputation concerns then Δ is exogenously fixed at zero. In that case, conditions (A15) are not required (A17) in Lemma A.5 are not required as Δ is determined independently of shareholders' expectations of the board's behavior. The statement in Lemma A.7 then follows by using the same logic of Lemma A.6 for the case where $\Delta=0$. For brevity we omit these arguments. The only place where a difference exists is when $p<\lambda\pi<\frac{1}{2}$. According to Lemma A.6, there are reputation functions for which there is an equilibrium in which $q^*=\frac{1}{1+\frac{\pi}{1-\pi}\frac{1-\Delta^*}{1+\Delta^*}}$. However, this equilibrium exists if and only if Δ is bounded away from zero (in particular, when $2p-1<\Delta^*<2\lambda\pi-1$), and hence cannot be tan equilibrium when $\Delta=0$. ■

Lemma A.8

(*i*) *If* $p<\frac{1}{2}$ *and* $\lambda<\frac{1}{2\pi}$ *then reputation concerns weakly destroy shareholders' welfare.*

(*ii*) *If* $p<\frac{1}{2}$ *and* $\lambda\geq\frac{1}{2\pi}$ *or* $p\geq\frac{1}{2}$ *and* $\lambda\geq\frac{1}{\pi(3-2\pi)}$ *then reputation concerns weakly improve shareholders' welfare.*

(*iii*) *If* $p\geq\frac{1}{2}$ *and* $\lambda<\frac{1}{\pi(3-2\pi)}$ *then reputation concerns weakly destroy shareholders' welfare.*

Proof of Lemma A.8. Consider shareholders' welfare for a given level of q and Δ. According to (A6)

$$V(q,\Delta)=1-(1-p)\left[\frac{q}{1-q}-\lambda\left(\frac{q}{1-q}\alpha(q,1,\Delta)-\alpha(q,0,\Delta)\right)-\frac{2q-1}{1-q}(1-\lambda)\cdot 1_{\left\{q\geq\frac{1+\Delta}{2}\right\}}\right] \tag{A24}$$

where $\alpha(q,p,\Delta)$ is given by (A18). Note that $V(0,\Delta)=1$ for any Δ and that $V\left(\frac{1}{1+\frac{\pi}{1-\pi}\frac{1-\Delta}{1+\Delta}},\Delta\right)$ and $V\left(\frac{1+\Delta}{2},\Delta\right)$ decrease in Δ. There are three cases to consider. First, suppose $p<\frac{1}{2}$ and $\lambda\leq\frac{1}{2\pi}$. According to Lemma A.7 shareholders's welfare is 1 in the absence of reputation concerns. According to Lemma A.6 when the board is subject to reputation concerns shareholders's welfare can be either 1 or $V\left(\frac{1}{1+\frac{\pi}{1-\pi}\frac{1-\Delta}{1+\Delta}},\Delta\right)<1$ if in addition $p<\lambda\pi$. Thus, shareholders welfare weakly decreases when the board had reputation concerns.

Second, suppose $p<\frac{1}{2}$ and $\lambda>\frac{1}{2\pi}$ or $p>\frac{1}{2}$ and $\lambda\geq\frac{1}{\pi(3-2\pi)}$. According to Lemma A.7 shareholders's welfare is given by $V(1-\pi,0)$ in the absence of reputation concerns. According to Lemma A.6 when the board is subject to reputation concerns shareholders's welfare is $V\left(\frac{1}{1+\frac{\pi}{1-\pi}\frac{1-\Delta}{1+\Delta}},\Delta\right)$ where $\Delta<0$. Since $V\left(\frac{1}{1+\frac{\pi}{1-\pi}\frac{1-\Delta}{1+\Delta}},\Delta\right)$ decreases in Δ and at $\Delta=0$ we have $V\left(\frac{1}{1+\frac{\pi}{1-\pi}\frac{1-\Delta}{1+\Delta}},\Delta\right)=V(1-\pi,0)$, shareholders welfare increases when the board had reputation concerns.

Third, suppose $p>\frac{1}{2}$ and $\lambda<\frac{1}{\pi(3-2\pi)}$. According to Lemma A.7 shareholders's welfare is given by $V\left(\frac{1}{2},0\right)$ in the absence of reputation concerns. According to Lemma A.6 when the board is subject to reputation concerns shareholders's welfare is $V\left(\frac{1+\Delta}{2},\Delta\right)$ where $\Delta>0$. Since $V\left(\frac{1+\Delta}{2},\Delta\right)$ decreases in Δ and at $\Delta=0$ we have $V\left(\frac{1+\Delta}{2},\Delta\right)=V\left(\frac{1}{2},0\right)$, shareholders welfare decreases when the board had reputation concerns. ■

Lemma A.9 *If $p<\frac{1}{2}$ or $\lambda\leq\frac{1}{\pi}\frac{1+(2\pi-1)^2}{(3-2\pi)+(2\pi-1)^2}$ then in any equilibrium the direct effect of board's reputational concerns on shareholders' welfare is zero. In all other circumstances, the direct effect is strictly negative only if $\Gamma(1)$ is sufficiently large.*

Proof of Lemma A.9. The direct effect of board's reputation concerns measures the change in shareholders' welfare while keeping the manager's effort in collecting information on its equilibrium level in the absence of reputation concerns. There are several cases to consider. First, suppose $p<\frac{1}{2}$ and $\lambda<\frac{1}{2\pi}$. According to Lemma A.7 in the absence of reputation concerns $q^*=0$ in equilibrium. According to (A24) $V(0,\Delta)$ is invariant to Δ and hence reputation has no direct effect on shareholders' welfare.

Second, suppose $p<\frac{1}{2}$ and $\lambda\geq\frac{1}{2\pi}$or $p\geq\frac{1}{2}$ and $\lambda\geq\frac{1}{\pi(3-2\pi)}$. According to Lemma A.7 in the absence of reputation concerns $q=1-\pi$. According to Lemma A.6, with reputation concerns $q=\frac{1}{1+\frac{\pi}{1-\pi}\frac{1-\Delta}{1+\Delta}}$ where $\Delta<0$. Note that since an equilibrium exists only if $\frac{1}{1+\frac{1-\pi}{\pi}\frac{1-\Delta^*}{1+\Delta^*}}>p$ (otherwise the manager has strict incentives to choose $q=\frac{1}{1+\frac{1-\pi}{\pi}\frac{1-\Delta^*}{1+\Delta^*}}$ inducing the board to accept the project with probability one) and since $p > 1-\pi$ then $\frac{1}{1+\frac{1-\pi}{\pi}\frac{1-\Delta^*}{1+\Delta^*}} > 1-\pi$. Thus, according to (A24) and (A18), if $1-\pi < \frac{1+\Delta}{2}$ then $V(1-\pi,\Delta) = V(1-\pi,0)$ and reputation has no direct effect on shareholders' welfare. If $1-\pi \geq \frac{1+\Delta}{2}$ Then $V(1-\pi,\Delta) = V(1-\pi,0) - \frac{(1-p)(2\pi-1)(1-\lambda)}{\pi}$ and hence the direct effect is negative. Note that according to Lemma A.5 part (ii) if $p < \frac{1}{2}$ and $\lambda \geq \frac{1}{2\pi}$ or $p \geq \frac{1}{2}$ and $\lambda \geq \frac{1}{\pi(3-2\pi)}$ then either (A13) or (A14) must be satisfied. In particular, if $p < \frac{1}{2}$ and $\frac{1}{\pi(3-2\pi)} > \lambda > \frac{1}{2\pi}$ then condition (A14) is satisfied but not condition (A13). Since $1-2\pi < 2p-1$ if and only if $1-\pi < p$ then in this case $1-\pi < \frac{1+\Delta}{2}$ and there is no direct effect. If $\lambda \geq \frac{1}{\pi(3-2\pi)}$ then the combination of conditions (A13) and (A14) become

$$\max\left\{\frac{1-\lambda\pi(3-2\pi)}{(1-\lambda\pi)(2\pi-1)}, \frac{p-\pi}{p(1-\pi)+\pi(1-p)}\right\} < \Delta^* < 0 \tag{A13}$$

Note that $\frac{p-\pi}{p(1-\pi)+\pi(1-p)} < 1-2\pi \Leftrightarrow p \geq \frac{1}{2}$. Hence, if $p < \frac{1}{2}$ then $\Delta^* > 1-2\pi$ and there is no direct effect. If $p \geq \frac{1}{2}$ and $\frac{1-\lambda\pi(3-2\pi)}{(1-\lambda\pi)(2\pi-1)} < 1-2\pi \Leftrightarrow \lambda > \frac{1+(2\pi-1)^2}{\pi(3-2\pi)+\pi(2\pi-1)^2}$ then there are reputation functions for which $\Delta^* < 1-2\pi$ and (A13) is satisfied. For these functions, the direct effect is negative.

Third, suppose $p \geq \frac{1}{2}$ and $\lambda < \frac{1}{\pi(3-2\pi)}$. According to Lemma A.7 in the absence of reputation concerns $q = \frac{1}{2}$. According to Lemma A.6, with reputation concerns $q = \frac{1+\Delta}{2}$ where $\Delta > 0$. Therefore, $\frac{1+\Delta}{2} > \frac{1}{2}$. As before, an equilibrium exists only if $\frac{1}{1+\frac{1-\pi}{\pi}\frac{1-\Delta^*}{1+\Delta^*}} > p$ and since $\pi > \frac{1}{2}$ and $\Delta^* > 0$ then $\frac{1}{1+\frac{1-\pi}{\pi}\frac{1-\Delta^*}{1+\Delta^*}} > \frac{1}{2}$. Moreover, According to Lemma A.5 part (iii) if $p \geq \frac{1}{2}$ and $\lambda < \frac{1}{\pi(3-2\pi)}$ then condition (A16) must hold. Therefore, $\Delta^* < 2p-1$. Note that $2p-1 < 2\pi-1 \Leftrightarrow p < \pi$ which always holds. Moreover, $\frac{1}{2} > \frac{1}{1+\frac{\pi}{1-\pi}\frac{1-\Delta^*}{1+\Delta^*}} \Leftrightarrow \Delta^* < 2\pi-1$. Therefore, $\frac{1}{2} \in \left(\frac{1}{1+\frac{\pi}{1-\pi}\frac{1-\Delta^*}{1+\Delta^*}}, \frac{1}{1+\frac{1-\pi}{\pi}\frac{1-\Delta^*}{1+\Delta^*}}\right)$. In that case, according to (A24) and (A18) $V\left(\frac{1}{2},\Delta\right) = V\left(\frac{1}{2},0\right)$ and there is no direct effect. ■

Proof of Lemma 6. According to Lemma A.6 and Lemma A.5, if in equilibrium $\Delta^* \leq 0$ then $q^* < \frac{1+\Delta^*}{2} < \frac{1}{2}$ and if $\Delta^* > 0$ then $q^* = \frac{1+\Delta^*}{2} > \frac{1}{2}$. This completes the proof ■

Proof of Lemma 7. Suppose $p < \frac{1}{2}$ and $\lambda < \frac{1}{2\pi}$. According to Lemma A.7, in the absence of reputation concerns the manager chooses $q^* = 0$ and his expected utility is given by p. According to Lemma A.6, in the presence of reputation concerns, the manager's chooses either $q^* = 0$ or $q^* = \frac{1}{1+\frac{\pi}{1-\pi}\frac{1-\Delta^*}{1+\Delta^*}}$ where $\Delta^* < 0$. In the former case the manager's expected utility is p as well. In the latter case, the manager's expected utility is smaller than p if and only if

$$\mathbb{E}\left[u_M\left(\frac{1}{1+\frac{\pi}{1-\pi}\frac{1-\Delta^*}{1+\Delta^*}}, \Delta^*\right)\right] \geq p \Leftrightarrow \Delta^* \leq 2\lambda\pi - 1$$

According to Lemma A.5, if $q^* = \frac{1}{1+\frac{\pi}{1-\pi}\frac{1-\Delta^*}{1+\Delta^*}}$ then either (A13) or (A14) must hold. However, when $p < \frac{1}{2}$ and $\lambda < \frac{1}{2\pi}$ then only condition (A14) can hold. Condition (A14) implies that $\Delta^* < 2\lambda\pi - 1$. Therefore, in this region the manager weakly gains power.

Suppose $p < \frac{1}{2}$ and $\lambda \geq \frac{1}{2\pi}$ or $p \geq \frac{1}{2}$ and $\lambda \geq \frac{1}{\pi(3-2\pi)}$. According to Lemma A.7, in the absence of reputation concerns the manager chooses $q^* = 1 - \pi$ and his expected utility is given by p

$$1 - (1-p)\left[\frac{1 - 2\lambda\pi\,(1-\pi)}{\pi}\right]$$

According to Lemma A.6, in the presence of reputation concerns, the manager's chooses $q^* = \frac{1}{1+\frac{\pi}{1-\pi}\frac{1-\Delta^*}{1+\Delta^*}}$ where $\Delta^* < 0$. It can be verified that

$$\mathbb{E}\left[u_M\left(\frac{1}{1+\frac{\pi}{1-\pi}\frac{1-\Delta^*}{1+\Delta^*}}, \Delta^*\right)\right] > 1 - (1-p)\left[\frac{1 - 2\lambda\pi\,(1-\pi)}{\pi}\right]$$

and hence the manager always gains power in this region.

Last, suppose $p \geq \frac{1}{2}$ and $\lambda < \frac{1}{\pi(3-2\pi)}$. According to Lemma A.7, in the absence of reputation concerns the manager chooses $q^* = \frac{1}{2}$ and his expected utility is given by $1 - \lambda\,(1-p)$. According to Lemma A.6, in the presence of reputation concerns, the manager's chooses $q^* = \frac{1+\Delta^*}{2}$ where $\Delta^* > 0$. It can be verified that

$$\mathbb{E}\left[u_M\left(\frac{1+\Delta^*}{2}, \Delta^*\right)\right] < 1 - \lambda\,(1-p)$$

and hence the manager always loses in this region. ■

Proof of Proposition 4. Let $\lambda^*_{p,\pi} \equiv \frac{1}{2\pi}$ if $p < \frac{1}{2}$ and $\lambda^*_{p,\pi} \equiv \frac{1}{\pi(3-2\pi)}$ if $p \geq \frac{1}{2}$ and the second part of Proposition 4 follows directly from Lemma A.8. ■