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Committees as Active Audiences: Reputation Concerns and Information Acquisition

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Abstract

We study committees that acquire information, deliberate and vote. A member cares about state-dependent decision payoffs and about his reputation for expertise. The state remains unobserved, even after the decision has been taken. In such inconclusive environments, in equilibrium, a member's internal (peer) reputation is based on deliberation patterns, while members' external (market) reputation is based on the observed group decision. Either form of reputation concerns create strategic complementarity among members' effort levels. Internal reputations create stronger incentives to become informed than external reputations, and their strength grows in committee size; external reputations create no incentives in large committees. If prior information favors a state, internal – not external – reputations may hinder deliberation. In equilibrium, reputation concerns lead to additional information acquisition without affecting the expected reputations. Nevertheless, moderate rates of reputation concerns relax members' participation constraints, by counteracting the often predicted underprovision of information in committees. **Keywords**: committee decision making, reputation concerns, information acquisition, peers, markets

JEL codes: D71, D83

1 Introduction

Committees of experts often operate in environments in which conclusive evidence about the right decision is hard to obtain, even after the decision has been taken. For example, Gabel and Shipan (2004, p. 544) have argued that in the health care profession the correct treatment decision is not known, making it hard to "empirically evaluate the accuracy and performance of expert panels in prescribing treatments." In such settings, rather than evaluating the decision, it seems natural to evaluate the expertise of committee members. A reputation for being well-informed about the matter at hand is then a valuable asset, as continued membership may depend on sufficient proof of expertise. In this paper, we study how in such inconclusive environments a concern with one's reputation for expertise and an interest in state-dependent payoffs determine members' willingness to acquire decision-relevant information, deliberate and vote.

We extend the Visser and Swank (2007) model of committees of experts in two ways. First, we endogenize the quality of the information that members privately have. It is the outcome of each member's investment in information gathering. Second, we assume that members care not only about their reputation with an external observer (the 'market') but also with his fellow committee members. A concern with one's internal or peer reputation is almost a natural byproduct of having a committee of experts: we show that comparing notes during the meeting amounts to assessing competence.

The main takeaways from our paper are that concerns with internal reputations are a strong motivator to acquire information and that its strength grows in committee size. The latter result stands in sharp contrast to the conventional wisdom that committee decision making discourages members to acquire information. The result does not stem from an assumption like more members means more peer pressure. Instead, a member's internal reputation is modeled as a representative peer's updated belief about this member's competence. A member can exert effort to become informed. The effort of a competent member is more likely to produce a signal that matches the state than the effort of a less competent member. Thus, the efforts of two competent members are more likely to lead to an agreement in privately held views among these members than the efforts of a competent and a less competent member (or of two less competent members). As a result, deliberation patterns allow one to revise one's belief about somebody's level of competence. Larger committees allow for sharper comparisons. It is in this sense that committees are like audiences: the larger they are, the more prepared one wishes to be. External or market reputations, on the other hand, are based on the decision that the committee as a whole takes. In a large committee, the chance that a member's signal is pivotal in the decision tends to zero. As a result, markets loose their motivating power in large committees.

Traditionally, the literature on information acquisition in groups has focused on groups that are exclusively motivated by a state-dependent payoff net of the cost of information acquisition. Decision-relevant information is a public good. It is underprovided as individual members don't care about the positive externality of their information acquisition. To counter the underprovision, researchers have studied the role played by features of the decision-making process, including the voting rule, whether information is collected simultaneously or sequentially and the efficiency or inefficiency of the decision conditional on the information collected. Others have investigated how conflict or preference heterogeneity among members about the desirable outcome provides incentives to produce decision-relevant information.[1]

Given the underprovision, the additional investment in information acquisition thanks to reputation concerns is welcomed by a social planner who cares about the state-dependent decision and the costs of members' effort. But the presence of reputation concerns may also induce an individual member to actually participate in the meeting and invest in information collection rather than to leave the decision to a fellow member. This is true, even though investing in information will, in expected terms, leave one's reputation – internal or external – unaffected. After all, in expected terms, Bayesian evaluators cannot be fooled.

If members are only interested in the state-dependent decision, the public good nature of decision-relevant information has another consequence. If one member is anticipated to invest less to become informed, the other member compensates by investing more. Reputation concerns create a different relationship between members. Consider a member who is concerned with internal reputations. The more a member invests in becoming informed, the more likely it becomes that his signal corresponds with the (unobserved) state. As a result, the reputation from agreeing with him

[1] Gersbach (1995) is among the first to study underprovision of information in committees. Kartik et al. (2017) is a recent study. Mukhopadhaya (2003) shows numerically that majority voting may induce large groups to take worse decisions than small groups. Persico (2004) studies for which group size the optimal voting rule induces members to acquire information. Dewatripont and Tirole (1999) compare the efficiency of information acquisition by advocates and a nonpartisan advisor. See Li and Suen (2009) for a lucid survey of the literature.

goes up, and the reputation from disagreeing with him goes down. The increase in the difference in the possible internal reputation outcomes induces a fellow member to also invest more to become informed. In other words, a concern with how one is viewed by one's peers creates strategic complementarity between members' information acquisition decisions. It is in this sense that audiences are active, rather than passive: they also exert effort, and it is their effort that stimulates an individual member to exert effort.

A concern with reputations may thus also create an indeterminacy in investment levels. If it is anticipated that a member comes badly prepared to the meeting, rather than compensating for the expected lack of decision-relevant information, fellow members will come badly prepared, too; if, on the other hand, one believes that the meeting is going to be productive as others are thought to come well-prepared, one comes well-prepared oneself to avoid embarassment and feel galvanized by agreeing with expert peers instead.

We are, to the best of our knowledge, the first to formally study a concern with internal reputation for being well-informed and its interaction with external repuations. However, the presence of both concerns already plays a key role in the informal argument of Fama (1980) as to why corporations can bring about efficient outcomes even though they are characterized by a separation of ownership and control. He views managers as decision makers who are deeply concerned with the information that is generated about their decision-making ability in the internal and external labor market, not unlike our committees of experts.

There is a growing literature on committees of experts. Visser and Swank (2007) characterize the quality of deliberation as a function of the voting rule and differences among members in the degree to which they trade off project value and external reputations. In the current paper, we show that, even if the interests of members are perfectly aligned among members, a focus on the internal labor market may hamper deliberation in the meeting. This happens when, *ex ante*, one state is considerably more likely than the other. Internal reputation concerns then dictate to say what is commonly expected, rather than to share one's view.

Models of committees of experts are often used to analyze the behavior of monetary policy committees, especially to study the effect of a change in the 'transparency regime' – the information that becomes public about the way the final decision was reached – on observed behavior.[2] In line with empirical evidence, transparency leads to more frequent united fronts or conformity and tends to discipline members. Models of committees of experts have also been used to understand the behavior of judges and company boards[3]. The environments in which these decision makers operate seem to be characterized best as inconclusive. The lack of counterfactual information means that the quality of the decision taken is hard to assess. Moreover, the consequences of the decisions taken by monetary policy committees, senior management teams or corporate boards are often only fully experienced in the long run. Career-related decisions (retention, promotion etc.) are then taken before that information becomes available and thus cannot be based on a comparison of decision and state. Other papers that explore the effects of reputation concerns on information acquisition and project choice are Milbourn, Shockley and Thakor (2001), Suurmond, Swank and Visser (2004) and Bar-Isaac (2012). Unlike us, they study single-agent settings. As a result, attention is limited to external reputations.

More generally, our paper contributes to the literature on reputation or career concerns. The seminal paper is Holmström (1999), originally published in 1982. It formally showed for the first time that if a principal rationally bases an agent's wage on observable outcomes generated by the agent, then the agent acts with a view to influencing the principal's inferences. Such behavior may well be in conflict with maximizing value for the principal.[4] Scharfstein and Stein (1990) is probably the first paper in which agents care about a reputation for being well-informed about the state. They show how such a concern may lead to herding when decisions are taken sequentially.[5]

[2] Levy (2007) and Gersbach and Hahn (2008, 2012) study the effects of transparency in situations in which committee members care about their reputation for expertise. Swank and Visser (2013) study how imposing transparency leads to a change in the locus of decision making through the emergence of pre-meetings. Meade and Stasavage (2005), Swank, Swank and Visser (2008) and Hansen, McMahon and Prat (2018) test implications of models of reputation-concerned committees using data about behavior at the U.S. Federal Open Market Committee. Fehrler and Hughes (2018) and Mattozzi and Nakaguma (2017) are the first lab experiments of the effects of transparency regimes on committee behavior. Gersbach and Hahn (2004), Sibert (2003) and Stasavage (2007) study the effects of transparency on the behavior of group members if there is uncertainty about interest alignment with the principal. For general discussions about transparency and decision making by monetary policy committees, see Blinder (2007), Geraats (2002) and Reis (2013).

[3] See Iaryczower, Lewis and Shum (2013) for judges and Malenko (2014) for company boards.

[4] Incidentally, Holmström's paper was written in an attempt to understand Fama's claim about career concerns.

[5] Kandel and Lazear (1992) study various forms of peer pressure as a means to counter the un-

The rest of the paper is organized as follows. The next section presents the model. Section 3 analyses the equilibria of this model. Section 4 illustrates these equilibria with a numerical example. Various extensions are discussed in section 5. Section 6 concludes.

2 A model of committee decision making with internal and external reputation concerns

The decision problem. A committee of two members, $i \in \{1, 2\}$, has to decide whether to maintain the status quo, $X = 0$, or to implement a project, $X = 1$. By normalization, status quo delivers a project payoff equal to zero. Project payoff in case of implementation is uncertain and state dependent. It equals $k + \mu$, where $\mu \in \{-h, h\}$ with $\Pr(\mu = h) = \alpha$.[6] In section 3, we assume that the initial uncertainty about the state is maximal, $\alpha = 1/2$. In sections 5.1–5.2 we relax this assumption. We assume throughout the paper that (i) $k < 0$, i.e., the unconditional expected value of an implemented project is negative, implying that the committee has a bias against project implementation; (ii) $k + h > 0$, implying that the optimal decision depends on the state.

The decision-making process. The decision-making process starts with an *information collection stage* in which each member exerts effort $e_i \geq 0$ to receive a signal $s_i \in \left\{s^b, s^g\right\}$ about the state μ. A signal refers to a member's assessment, forecast or view of μ (b is bad and g is good). The quality of this signal depends on i's effort and on his ability $a_i \in \{L, H\}$. The prior likelihood that member i is of high ability is $\Pr(a_i = H) = \pi$.[7] The likelihood that a member's signal is "correct", given effort e_i and ability level a_i equals

$$p^{a_i}(e_i) = \Pr\left(s_i^g | \mu = h, a_i, e_i\right) = \Pr\left(s_i^b | \mu = -h, a_i, e_i\right),$$

derprovision of effort in large groups – shame, guilt, norms, mutual monitoring and empathy. With the exception of guilt, for peer pressure to work, effort should be observable. In our model, effort is unobservable. Peer reputations nevertheless provide strong incentives to acquire information.

[6] Thus, μ represents both the state and the state-dependent value.

[7] The absence of private information on a decision-maker's ability is a common assumption in the literature on career concerns, see e.g. Holmström (1999) and Scharfstein and Stein (1990).

for $a_i \in \{L, H\}$. Moreover, for $a_i \in \{L, H\}$, $p^{a_i}(\cdot)$ an increasing, strictly concave function with $p^{a_i}(0) > 1/2$, $p^{a_i\prime}(0) = \infty$, $\lim_{e_i \to \infty} p^{a_i\prime}(e_i) = 0$. Define the *ex ante* likelihood that a signal is correct as

$$p^M(e_i) = \Pr(s_i^g | \mu = h, e_i) = \pi p^H(e_i) + (1 - \pi) p^L(e_i).$$

Throughout the paper, we assume that higher ability means a higher likelihood of receiving the right signal.

Assumption 1 *For all e_i, $p^H(e_i) > p^L(e_i)$.*

Sometimes, we make an additional assumption.

Assumption 2 *For all e_i, $\frac{\partial p^H(e_i)}{\partial e_i} / p^H(e_i) \geq \frac{\partial p^L(e_i)}{\partial e_i} / p^L(e_i)$.*

The costs of exerting effort are increasing and strictly convex, with $c(e_i) > 0$, $c(0) = c'(0) = 0$ and $\lim_{e_i \to \infty} c'(e_i) = \infty$. The other member (call her j) does not observe i's effort choice.

The information collection stage is followed by a *deliberation stage* in which members simultaneously send a message to the other member. We assume that private information is truthfully revealed.[8] In section 5.1, we show that members do not have incentives to misrepresent private information and discuss an extension of the model in which incentives to misrepresent information do exist.

In the *voting stage*, members simultaneously cast their votes on the project, $v_i \in \{v^0, v^1\}$, where $v_i = v^0$ ($v_i = v^1$) denotes that i votes against (in favour of) the project. The voting strategy $v_i(s_i, s_j, e_i) = \Pr(v_i = v^1 | s_i, s_j, e_i)$ of i is a function that maps the signal that i received, the signal of j that he learned in the deliberation stage and the effort he exerted to a probability that i votes v^1. We assume that implementation requires unanimity, a natural assumption given that the expected project payoff is negative.

[8]The assumption that private information is truthfully revealed may be realistic if other committee members have time to ask probing questions to verify claims made in the meeting. A second reason why making this assumption the point of departure of the analysis is that the analysis that results suggests which member has an incentive to misrepresent his private information and in what situation. See also Visser and Swank (2007).

Objectives of committee members. Each member cares about the value of the project and his reputation for being well-informed. The reputation concerns component consists of two parts. First, a member cares about his ability level as perceived by an evaluator outside the committee, his *external reputation.* Such an evaluator observes the decision X taken by the committee, but does not observe deliberations, voting, nor the state of the world. Let $\hat{\pi}_i^E(X) = \Pr(a_i = H|X)$ denote i's external reputation if the committee takes decision X. The prior belief of the external evaluator about member i's competence equals π. Second, a member cares about his ability as perceived by the other member in the committee, his *internal reputation.* The internal reputation is based on the signal pair that members receive, $\hat{\pi}_i^I(s_i, s_j) = \Pr(a_i = H|s_i, s_j)$. Again, this reputation is not based on a comparison with the state of the world.[9] The payoff member i obtains from exerting effort e_i, with decision X in state μ and with signal pair (s_i, s_j) equals

$$X(k + \mu) + \gamma\hat{\pi}_i^I(s_i, s_j) + \lambda\hat{\pi}_i^E(X) - c(e_i).$$

The parameters γ and λ are the weights both members attach to their internal and external reputations, respectively. We make the usual assumption that both members and the market have common knowledge of the above.

An equilibrium consists of an effort level and a voting strategy for each member, and reputations, both internal and external. In equilibrium,

1. for given e_i, given (s_i, s_j), given internal and external reputations and given v_j, v_i is a best reply;

2. for given voting strategies of i and j, given internal and external reputations and given e_j, e_i is a best reply;

3. internal and external reputations are updated beliefs about a member's ability level that are obtained from prior beliefs and members' voting strategies and effort levels, using Bayes' rule whenever possible.

[9] In other words, the external and internal reputations are determined before the state of the world becomes known. In some sense, we are dealing here with decisions that take a long time before it becomes known whether they were good or bad.

4. in the voting stage each member behaves as if his vote is pivotal.

Requirement 4 rules out the uninteresting equilibrium in which each member always votes against implementation. It is tantamount to assuming that a member votes v^1 if he prefers $X = 1$ over $X = 0$ and v^0 in the opposite case.

Let $\mathbf{e}^* = \left(e_i^*, e_j^*\right)$ denote the pair of equilibrium effort levels and $\mathbf{v}^* = \left(v_i^*\left(\cdot\right), v_j^*\left(\cdot\right)\right)$ the pair of equilibrium voting strategies. In models like ours typically two kinds of equilibria exist. In a symmetric equilibrium, both members exert the same level of effort, $e_i^* = e_j^*$, and the signal of each member may be decisive for the decision on X. This equilibrium describes a *joint decision-making process.* In an asymmetric equilibrium, the signal of only one member is decisive for the decision on X. In this equilibrium, the decision on X is made by one member. It describes *delegated decision making.* In our model, a similar type of distinction can be made. In what follows we will distinguish between a joint decision-making process, $p = J$, and delegated decision making, $p = D$, on the basis of the votes on the equilibrium path, $v_i^*\left(s_i, s_j, e_{ip}^*\right)$ for the four pairs $\left(s_i, s_j\right)$ and for e_{ip}^*, the equilibrium effort level of i in process p, $i = 1, 2$. We denote by $\hat{\pi}_i^I\left(s_i, s_j; \mathbf{e}_p^*\right)$ and $\hat{\pi}_i^E\left(X; \mathbf{e}_p^*\right)$ the internal and external reputations, respectively, consistent with equilibrium behaviour in p.

Note that the information collecting stage is not preceded by a participation stage in which a member considers whether to join the committee or not. In practice, participation in meetings often cannot be avoided. We start the analysis by assuming that members have to participate in the meetings. In section 3.3, we study how reputation concerns affect members' participation constraints.

3 Analysis of the decision-making process

In the last stage of the decision-making process, the voting stage, each committee member votes for the decision that maximizes his expected utility. That vote depends on his level of effort, the pair of signals exchanged in the deliberation stage and the reputations. As internal reputations are determined after signals have been exchanged in the deliberation stage, only a member's external reputation matters in the voting stage. Let $\Delta\hat{\pi}_i^E\left(X; \mathbf{e}_p^*\right)$ denote the (equilibrium) *external reputation gap*,

$$\Delta\hat{\pi}_i^E\left(X; \mathbf{e}_p^*\right) = \hat{\pi}_i^E\left(1; \mathbf{e}_p^*\right) - \hat{\pi}_i^E\left(0; \mathbf{e}_p^*\right), \tag{1}$$

i.e., the difference in external reputation from implementation and maintaining the status quo. From the point of view of a committee member, $\Delta\hat{\pi}_i^E\left(X;\mathbf{e}_p^*\right)$ is given. Let $\Delta U_i\left(s_i,s_j,e_i\right)$ denote the difference in expected payoffs from implementing the project and rejecting it, given a pair of signals (s_i,s_j). That is,[10]

$$\Delta U_i\left(s_i,s_j,e_i\right)=k+E\left[\mu|s_i,s_j;\mathbf{e}\right]+\lambda\Delta\hat{\pi}_i^E\left(X;\mathbf{e}_p^*\right). \tag{2}$$

Member i's voting strategy satisfies for all (s_i,s_j,e_i)

$$v_i^*\left(s_i,s_j,e_i\right)=\begin{cases}1 & \text{if } \Delta U_i\left(s_i,s_j,e_i\right)>0\\ \beta_i & \text{if } \Delta U_i\left(s_i,s_j,e_i\right)=0\\ 0 & \text{if } \Delta U_i\left(s_i,s_j,e_i\right)<0,\end{cases} \tag{3}$$

with $\beta_i\in[0,1]$.

At the end of the deliberation stage, members internal reputations are determined. In equilibrium, they are obtained using Bayes' rule and are thus consistent with equilibrium effort levels $\mathbf{e}_p^*$. The following Lemma presents members' internal reputations for all signal pairs (s_i,s_j).

Lemma 1 *In any decision-making process p, internal reputations consistent with $\mathbf{e}_p^*$ satisfy*

$$\begin{aligned}\hat{\pi}_i^I\left(s_i^g,s_j^g;\mathbf{e}_p^*\right) &= \hat{\pi}_i^I\left(s_i^b,s_j^b;\mathbf{e}_p^*\right)>\pi \\ &> \hat{\pi}_i^I\left(s_i^g,s_j^b;\mathbf{e}_p^*\right)=\hat{\pi}_i^I\left(s_i^b,s_j^g;\mathbf{e}_p^*\right)\ \textit{for } i\in\{1,2\}.\end{aligned} \tag{4}$$

An increase in e_{jp}^* increases $\hat{\pi}_i^I\left(s_i^g,s_j^g;\mathbf{e}_p^*\right)$ and $\hat{\pi}_i^I\left(s_i^b,s_j^b;\mathbf{e}_p^*\right)$ and decreases $\hat{\pi}_i^I\left(s_i^g,s_j^b;\mathbf{e}_p^*\right)$ and $\hat{\pi}_i^I\left(s_i^b,s_j^g;\mathbf{e}_p^*\right)$. Under Assumption 2, $\hat{\pi}_i^I\left(s_i^g,s_j^g;\mathbf{e}_p^*\right)$ and $\hat{\pi}_i^I\left(s_i^b,s_j^b;\mathbf{e}_p^*\right)$ are increasing in e_{ip}^* and $\hat{\pi}_i^I\left(s_i^g,s_j^b;\mathbf{e}_p^*\right)$ and $\hat{\pi}_i^I\left(s_i^b,s_j^g;\mathbf{e}_p^*\right)$ are decreasing in e_{ip}^*.

If members receive the same signals, a member's internal reputation improves, whereas conflicting signals hurt a member's internal reputation. This stems from the fact that high ability members are more likely to receive informative signals – and thus equal signals – than low ability members. In other words, the signals of high ability members are correlated more strongly than those of low ability members.

[10] To be precise, $E\left[\mu|s_i,s_j;\mathbf{e}\right]$ is based on e_i and i's conjecture about e_j.

Let $\Delta\hat{\pi}_i^I\left(s_i, s_j; \mathbf{e}_p^*\right) = \hat{\pi}_i^I\left(s, s; \mathbf{e}_p^*\right) - \hat{\pi}_i^I\left(s', s; \mathbf{e}_p^*\right)$ denote the *internal reputation gap*, where $s, s' \in \left\{s^g, s^b\right\}$ and $s \neq s'$. It denotes the difference in i's perceived ability between him having received the same signal as j or a signal different from j's. The lemma says that this gap exists and is positive. Also, the reputation gap of member i is increasing in e_j and, under Assumption 2, e_i.

In the subsections that follow, we determine the equilibrium levels of effort, the signal pairs that lead to v^1 or v^0 on the equilibrium path, and the external reputation consistent with such behaviour for a joint decision making process and a delegated decision making process.

3.1 Joint Decision-Making Process

In a joint decision-making process, $p = J$, equilibrium effort levels and external reputations are such that members vote for implementation if signals are positive and vote for the status quo for the other three signal pairs. That is,

$$(v_1, v_2) = \begin{cases} (1,1) & \text{for } \left(s_i, s_j\right) = \left(s^g, s^g\right) \\ (0,0) & \text{otherwise.} \end{cases} \tag{5}$$

As in a J process implementation only takes place after two positive, and thus equal signals, while maintaining the status quo can also result from two conflicting signals, $X = 1$ commands a higher external reputation than $X = 0$. Let the external reputation gap $\Delta\hat{\pi}_i^E\left(X; \mathbf{e}_J^*\right)$ consistent with the pair of effort levels $\mathbf{e}_J^*$ be defined as $\Delta\hat{\pi}_i^E\left(X; \mathbf{e}_J^*\right) = \hat{\pi}_i^E\left(1; \mathbf{e}_J^*\right) - \hat{\pi}_i^E\left(0; \mathbf{e}_J^*\right)$.

Lemma 2 *External reputations that are consistent with a $p = J$ process satisfy*

$$\hat{\pi}_i^E\left(1; \mathbf{e}_J^*\right) > \pi > \hat{\pi}_i^E\left(0; \mathbf{e}_J^*\right). \tag{6}$$

An increase in e_{jJ}^* increases $\hat{\pi}_i^E\left(1; \mathbf{e}_J^*\right)$ and decreases $\hat{\pi}_i^E\left(0; \mathbf{e}_J^*\right)$. Under Assumption 2, the external reputation gap $\Delta\hat{\pi}_i^E\left(X; \mathbf{e}_J^*\right)$ increases in e_{iJ}^*.

A comparison between lemmas 1 and 2 shows that in a J process members may end up in a situation in which their internal reputations get a boost, while at the same time their external reputations are hurt. This is the case for $\left(s_i, s_j\right) = \left(s^b, s^b\right)$.

In a J process, the expected payoff to member i when choosing effort equals

$$\Pr\left(s_i^g, s_j^g; \mathbf{e}\right)\left(k + E\left[\mu | s_i^g, s_j^g; \mathbf{e}\right]\right) + \gamma E\left[\hat{\pi}_i^I\left(s_i, s_j; \mathbf{e}_J^*\right)\right] + \lambda E\left[\hat{\pi}_i^E\left(X; \mathbf{e}_J^*\right)\right] - c\left(e_i\right). \tag{7}$$

When determining how much effort to exert, a member can only influence the *likelihood* of commanding a certain reputation, not the reputation itself.[11] How do reputation concerns affect effort? The marginal benefits from exerting effort equal

$$\begin{aligned} MB_i\left(e_i, e_j, \mathbf{e}_J^*\right) &= \frac{\partial p_i^M}{\partial e_i}\left(\left(p_j^M\left(e_j\right) - \frac{1}{2}\right)k + \frac{h}{2}\right) \\ &\quad + 2\gamma \frac{\partial p_i^M}{\partial e_i}\left(p_j^M\left(e_j\right) - \frac{1}{2}\right)\Delta\hat{\pi}_i^I\left(s_i, s_j; \mathbf{e}_J^*\right) \\ &\quad + \lambda \frac{\partial p_i^M}{\partial e_i}\left(p_j^M\left(e_j\right) - \frac{1}{2}\right)\Delta\hat{\pi}_i^E\left(X; \mathbf{e}_J^*\right). \end{aligned} \tag{8}$$

Both forms of reputation concerns add incentives to exert effort, as both reputation gaps are positive, see Lemmas 1 and 2. If a member cares to the same degree about either reputation, $\lambda = \gamma$, a concern with internal reputations create stronger incentives to become informed than a concern with external reputations. The reason is twofold. First, the internal reputation gap is larger than the external reputation gap thanks to the fact that a fellow committee member obtains finer information than the market about a member. Moreover, it is more damaging to a member's internal reputation to be found out to have a signal that is different from that of his peer than it is to his external reputation to maintain the status quo, $\hat{\pi}_i^I\left(s_i^g, s_j^g; \mathbf{e}_J^*\right) = \hat{\pi}_i^E\left(1; \mathbf{e}_J^*\right) > \hat{\pi}_i^E\left(0; \mathbf{e}_J^*\right) > \hat{\pi}_i^I\left(s_i^g, s_j^b; \mathbf{e}_J^*\right)$. Second, exerting more effort helps in attaining a strong internal reputation irrespective of the signal of the other member, whereas effort improves a member's external reputation only if the other member has a positive signal.

Committees, then, create audiences to members, and thereby make concerns with internal reputations possible. Such concerns give incentives to members to exert effort.

[11] To be sure, $E\left[\hat{\pi}_i^I\left(s_i, s_j; \mathbf{e}_J^*\right)\right] = \sum_{(s_i, s_j)} \Pr\left(s_i, s_j; \mathbf{e}\right)\hat{\pi}_i^I\left(s_i, s_j; \mathbf{e}_J^*\right)$ and $E\left[\hat{\pi}_i^E\left(X; \mathbf{e}_J^*\right)\right] = \sum_X \Pr\left(X; \mathbf{e}\right)\hat{\pi}_i^I\left(X; \mathbf{e}_J^*\right)$.

It follows from (8) and Lemmas 1 and 2 that both forms of reputation concerns create strategic complementarity between effort levels. Two things happen if j acquires more information. First, it makes it more likey that additional effort of i prevents conflicting signals and the status quo. This is beneficial from an internal and external reputation point of view, respectively. Second, both reputation gaps grow in size. This further amplifies the marginal reputation benefits. Of course, if members were only to care about project value, their effort levels would be strategic substitutes as decision-relevant information is a public good. The net effect of these three components will depend on parameter values. Proposition 1 summarizes the discussion above.

Proposition 1 *In a joint decision-making process,*
(1) the concern with project value creates strategic substitutability among members' effort levels;
(2) the concern with reputations, internal or external, creates strategic complementarity among members' effort levels;
(3) for $\lambda = \gamma$, a concern with internal reputations creates stronger incentives to exert effort than a concern with external reputations;
(4) if $(s_i, s_j) = \left(s^b, s^b\right)$, then a member's internal reputation is strengthened whereas his external reputation is hurt.

Characterizing the equilibrium levels of effort in this game requires some care. There are potentially multiple equilibria due to the fact that the internal and external reputations of member i enter i's marginal benefits from effort and are based on conjectured effort levels. Nevertheless, for *given* ex post reputations based on $\hat{\mathbf{e}}$ and *given* (conjectured) effort level e_j^+, member i's payoff is strictly concave in e_i, and the optimal effort level is unique, interior and satisfies $MB_i\left(e_i, e_j^+, \hat{\mathbf{e}}\right) = C'\left(e_i\right)$. An equilibrium pair of effort levels (e_{1J}^*, e_{2J}^*) in a J process should satisfy

$$MB_i\left(e_{iJ}^*, e_{jJ}^*, \mathbf{e}_J^*\right) = C'\left(e_{iJ}^*\right) \tag{9}$$

for $i = 1, 2$.

Propostition 2 provides the conditions that should hold for $p = J$ process to exist in equilibrium.

Proposition 2 *For a joint decision-making process to exist, the following conditions must hold for a pair of effort levels* $\mathbf{e}_J^*$ *that satisfies (9):*

$$
\begin{aligned}
k + \lambda \Delta \hat{\pi}^E \left(X; \mathbf{e}_J^*\right) &< 0 & (10)\\
k + E\left[\mu | s^g, s^g; \mathbf{e}_J^*\right] + \lambda \Delta \hat{\pi}^E \left(X; \mathbf{e}_J^*\right) &> 0 & (11)
\end{aligned}
$$

$$
\begin{aligned}
&\Pr\left(s_1^g, s_2^g; \mathbf{e}_J^*\right)\left(k + E\left[\mu | s^g, s^g; \mathbf{e}_J^*\right]\right) + \gamma\pi + \lambda\pi - c\left(e_2^*\right) > \\
&\frac{1}{2}\left(k + E\left[\mu | s^g; e_{J1}^*\right]\right) + \gamma\pi + \lambda\frac{1}{2}\left[\hat{\pi}^E\left(1; \mathbf{e}_J^*\right) + \hat{\pi}^E\left(0; \mathbf{e}_J^*\right)\right]. \qquad (12)
\end{aligned}
$$

Condition (10) captures that each member must withstand the temptation to vote for implementation in case of $\left(s_1^g, s_2^b\right)$ or $\left(s_1^b, s_2^g\right)$ when the conditionally expected project payoff equals k. This temptation exists because $X = 1$ yields a better external reputation than $X = 0$. If (10) is violated, an equilibrium in mixed strategies exists. With some probability the project is implemented when members' signals disagree. In Section 4, where we present a numerical analysis, we show the consequences of mixing in the voting stage for members' choices of effort. It is worth emphasizing that indirectly, through $\mathbf{e}_J^*$, (10) depends on members' concerns with their internal reputations. A higher weight γ on internal reputations increases equilibrium effort levels, and thereby widens the external reputation gap. Of course, the same indirect effect exists for λ, the weight put on the external reputation.[12]

Equation (11) states that two positive signals are sufficient to warrant implementation. Essentially, this condition means that in equilibrium members must exert sufficient effort. A higher weight on external reputation concerns directly relax (11) by making $X = 1$ more attractive. Indirectly, through encouraging effort, both external and internal reputations make (11) less tight.

The last condition for a joint decision-making process states that neither employee has an incentive to significantly reduce effort. Equation (12) is formulated under the assumption that at the beginning of the deliberation stage, that is before signals are exchanged, a member can make claims about the level of effort he has exerted. Such claims about sunk effort are credible, as the interests of the members, one the sender, the other the receiver, are perfectly aligned at this stage. The

[12] Given our focus on symmetric equilibria, this should be understood to mean that γ or λ increases for both members.

deviation considered in the bottom line of Equation (12) assumes that the implementation decision will be based on the other member's signal only. The benefit of this deviation for a member is twofold. First, it avoids costly effort. Second, it maximizes the likelihood of $X = 1$, and thereby increases the probability of a boost of a member's external reputation. Note that the external reputation is based on $\mathbf{e}_J^*$ as the external market does not observe the deviation. The cost of foregoing effort is a lower project value.[13]

Overall, Proposition 2 shows that when members are not overly interested in project value, reputation concerns may make a joint decision-making process viable by relaxing (11). Strong external reputation concerns may backfire, however. They may make members too interested in $X = 1$. Internal reputation concerns, by raising effort, may jeopardize a $p = J$ process through widening the external reputation gap.

3.2 Delegated Decision Making Process

In case of delegated decision making, $p = D$, equilibrium effort levels and external reputations are such that members vote for implementation if member 1's signal is positive and vote for the status quo if member 1's signal is negative. That is,

$$(v_1, v_2) = \begin{cases} (1,1) & \text{for } \left(s_1^g, s_2^g\right) \text{ and } \left(s_1^g, s_2^b\right) \\ (0,0) & \text{for } \left(s_1^b, s_2^g\right) \text{ and } \left(s_1^b, s_2^b\right). \end{cases} \tag{13}$$

In a D process, the decision on the project reveals member 1's signal, but does not reveal anything about member 2's signal. This makes external reputations independent of the decision and equal to the prior belief, π. They lose their power to motivate members to exert effort to become informed. With his signal having no value in the voting stage and external reputations independent of the decision taken, the only reason for member 2 to exert effort is his internal reputation.

In a D process, the expected payoff to members 1 and 2 when choosing effort

[13] Whether member 2 sticks to equilibrium play or deviates, his expected internal reputation equals $\gamma\pi$.

equals

$$\Pr\left(s_1^g; e_{1D}\right)\left(k + E\left[\mu | s_1^g; e_1\right]\right) + \gamma E\left[\hat{\pi}^I\left(s_i, s_j; \mathbf{e}_D^*\right)\right] + \lambda\pi - c\left(e_1\right) \tag{14}$$

$$\gamma E\left[\hat{\pi}^I\left(s_i, s_j; \mathbf{e}_D^*\right)\right] + \lambda\pi - c\left(e_2\right) \tag{15}$$

respectively. The derivatives of these expressions with respect to e_1 and e_2 are

$$h\frac{\partial p_1^M}{\partial e_1} + 2\gamma\frac{\partial p_1^M}{\partial e_1}\left(p_2^M\left(e_2\right) - \frac{1}{2}\right)\Delta\hat{\pi}_1^I\left(s_1, s_2; \mathbf{e}_D^*\right) = c'\left(e_1\right) \tag{16}$$

$$2\gamma\frac{\partial p_2^M}{\partial e_2}\left(p_1^M\left(e_1\right) - \frac{1}{2}\right)\Delta\hat{\pi}_2^I\left(s_2, s_1; \mathbf{e}_D^*\right) = c'\left(e_2\right) \tag{17}$$

respectively. Compared with a J process, member 1's signal now matters for the decision on the project *irrespective* of the signal of member 2, strengthening 1's incentives to exert effort. On the other hand, member 2's incentives to become informed become weaker as they now only stem from a desire to improve the chance of a good internal reputation. Because the cross-partial derivatives of the objective functions are positive, members effort levels are strategic complements. The fact that member 2 now exerts less effort than in a J equilibrium means that the pressure to become informed for internal reputation reasons becomes weaker for member 1. The net effect on member 1's incentives is ambiguous.

Proposition 3 *In case of delegated decision making,*
(1) a concern with project value gives incentives to member 1 to exert effort, but not to member 2;
(2) external reputations do not provide incentives to become informed, whereas internal reputations do;
(3) a concern with internal reputations creates strategic complementarity among members' effort levels;
(4) member 2's incentives to become informed are weaker than in a J equilibrium;
(5) member 1's incentives to become informed may be weaker or stronger than in a J equilibrium.

We noted earlier that committees create audiences to members, and that the resulting concern with internal reputations gives incentives to become informed. This mechanism even works when the audience itself, here member 2, is not directly relevant for the final decision.

The next proposition describes the conditions for the existence of a $J = D$ process.

Proposition 4 *For delegated decision making to exist, the following conditions must hold for effort levels* $\mathbf{e}_D^*$ *that jointly satisfy the first-order conditions (16) and (17):*

$$\begin{aligned} k + E\left[\mu | s_1^g, s_2^b; \mathbf{e}_D^*\right] &\geq 0 & (18) \\ k + E\left[\mu | s_1^b, s_2^g; \mathbf{e}_D^*\right] &< 0 & (19) \\ \frac{1}{2}\left(k + E\left[\mu | s_1^g, s_2; \mathbf{e}_D^*\right]\right) + \gamma\pi - c\left(e_{1D}^*\right) &> \gamma\pi & (20) \end{aligned}$$

$$\frac{1}{2}\left(k + E\left[\mu | s^g, s_2; \mathbf{e}_D^*\right]\right) + \gamma\pi - c\left(e_{2D}^*\right) >$$
$$\Pr\left(s_1^g, s_2^g; e_{1D}^*, e^{BR}\right)\left(k + E\left[\mu | s^g, s^g; e_{1D}^*, e^{BR}\right]\right) + \gamma\pi - c\left(e^{BR}\right), \qquad (21)$$

where e^{BR} *equals*

$$\arg\max_e \Pr\left(s_1^g, s_2^g; e_{1D}^*, e\right)\left(k + E\left[\mu | s_1^g, s_2^g; e_{1D}^*, e\right]\right) + \gamma E\left[\hat{\pi}^I\left(s_1, s_2; e_{1D}^*, e^{BR}\right)\right] - c\left(e\right).$$

Equations (18) and (19) capture that a positive signal of member 1 warrants implementation, while a positive signal of 2 does not, respectively. Equation (20) guarantees that 1 does not want to deviate to zero effort (and credibly announce so at the beginning of the deliberation stage). Inequality (21) ensures that member 2 has no incentive to deviate by exerting a level of effort such that his signal is relevant for the final decision.

Evidently, concerns with external reputations do not affect the conditions for the existence of $j = D$. Those concerns do not play a role if the signal of one member is decisive. Concerns with internal reputations[14], by stimulating information acquisition, relax the first condition, while the second becomes more difficult to satisfy. They also make the third condition more restrictive. The reason is that internal reputation concerns increase members' efforts but, in expected terms, the extra efforts do not improve reputations.

[14]This should be interpreted as an increase in the weight for both members.

3.3 How do reputation concerns affect a member's decision to participate in a joint decision-making process?

So far, we have taken the participation constraints of the committee members for granted. Our motivation was that in many situations members' attendance is unavoidable. Thus, we have studied behavior within the committee, including whether members merely attend, with $e = 0$, or actively participate, with $e > 0$. In this section, we investigate the related question of members' willingness to participate in a joint decision-making meeting. Throughout, we assume that a member's decision to withdraw from the committee is publicly observed before effort levels are chosen.

Consider a situation without reputation concerns. Assume that both members participate. Denote by $\mathbf{e}_0^*$ the resulting equilibrium effort levels. These levels satisfy (9) for $i = 1, 2$ with $\gamma = \lambda = 0$. Now suppose that a member, say member 1, decides not to participate. Assume that the other member implements the project only if $s_2 = s^g$. His optimal effort level, $\bar{e}_2$, satisfies

$$\bar{e}_2 = \arg\max_e \Pr\left(s_2^g; e\right)\left(k + E\left[\mu | s_2^g; e\right]\right) - c\left(e\right).$$

In the absence of reputation concerns, each member wants to participate if

$$\Pr\left(s^g, s^g; \mathbf{e}_0^*\right)\left(k + E\left[\mu | s^g, s^g; \mathbf{e}_0^*\right]\right) - c\left(e_0^*\right) > \Pr\left(s_2^g; \bar{e}_2\right)\left(k + E\left[\mu | s_2^g; \bar{e}_2\right]\right). \tag{22}$$

Note that a member's choice of effort level e_0^* doesn't take into account the positive externality of effort on the other member's utility. It therefore falls short of the first-best levels $\mathbf{e}^{FB} = \left(e_1^{FB}, e_2^{FB}\right)$ that maximize the sum of project value to each member net of total costs of effort.

How do reputation concerns affect member 1's incentive to participate in the committee? Whether member 1 participates or not, the ex ante expected ex post reputations equal $(\gamma + \lambda)\pi$ as Bayesian beliefs form a martingale. Reputation concerns induce extra effort, but do not affect members' expected reputations.

Thus, sufficiently weak reputation concerns relax members' participation constraints. As long as the equilibrium effort levels, $\mathbf{e}_J^*$, move closer to the first-best effort levels, $\mathbf{e}^{FB}$, the expected payoff of participation increases. If reputation concerns are strong, such that $\mathbf{e}_J^* > \mathbf{e}^{FB}$, stronger concerns tighten members' participation constraints. As a result, members may opt out of the meeting.

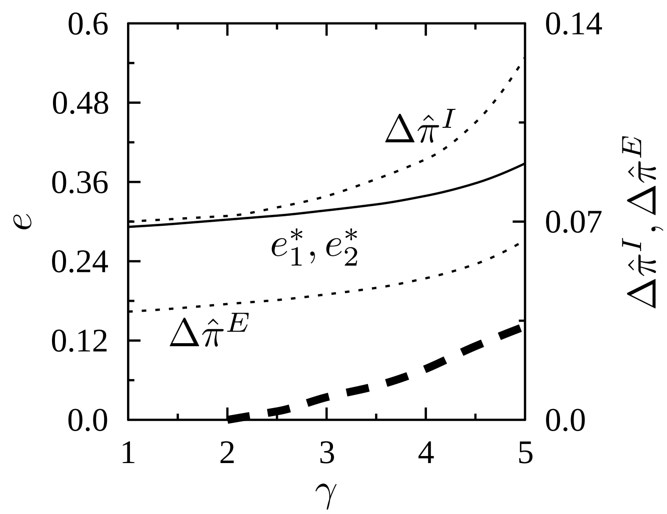
4 A Numerical Illustration

This section presents a numerical analysis of our model to illustrate the effects of reputation concerns on (1) members' willingness to participate in the committee, (2) members' effort decisions, and (3) members' incentives to distort the decision on the project. For the numerical analysis we have made some specific assumptions. The probablity with which a high ability member receives a correct signal is $p^H(e) = \frac{1}{2} + e$, while the probability that a low ability member receives a correct signal is $p^L(e) = \frac{1}{2} + \frac{1}{2}e$. The cost of effort function is quadratic, $c(e) = \frac{9}{8}e^2$. The ex ante probability that a member is smart equals $\pi = \frac{1}{2}$. The ex ante expected value of the project is $k = -\frac{3}{4}$. Finally, the state dependent value equals $h = 2$. The last two assumptions imply that the value of the project is either $-2\frac{3}{4}$ or $1\frac{1}{4}$.

In the assumed environment, the first-best effort levels equal 0.365. In the absence of reputation concerns, and assuming that both members participate, each member would choose an effort level equal to 0.28. A member acquires "too little" information as he ignores the positive externality this activity has. In the assumed setting in the absence of reputation concerns, a $p = J$ process is not an equilibrium outcome, because members' participation constraints are violated. We deliberately choose an evironment for which members are not willing to participate in the absence of reputation concerns to highlight that reputation concerns may relax participation constraints (see Proposition 2).

Figure 1 depicts a number of key variables for various weights γ that a member attaches to his internal reputation. We assume a fixed weight on the external reputation equal to $\lambda = \frac{3}{2}$. The drawn line shows the (common) equilibrium effort level. Its value can be read on the y-axis on the left. The dotted lines show the size of the two reputation gaps. The thick dashed line shows the difference in expected utility between participating in the meeting and not participating. The values of the reputation gaps and of the gain in expected utility from participating can be read on the y-axis on the right. This graph thus shows that if a member cares too little about his internal reputation, a two-member committee in which participation

Figure 1: Key variables as a function of the weight γ that committee members attach to their internal reputations.



is a choice cannot exist. Reputation concerns, if sufficiently strong, make committee decision-making possible. It also shows that higher values of γ increase effort and both reputation gaps. Clearly, the internal reputation gap is larger than the external reputation gap.

In Figure 2, we illustrate the effect of varying the weight λ on external reputations, while keeping the weight γ on internal reputation fixed at $\gamma = \frac{3}{2}$. The figure illustrates again that, if members can choose to participate or not, reputation concerns are needed to make committee decision-making viable. The more members care about their external reputation, the more effort they exert, and the larger are the internal and the external reputation gaps.

The figure also illustrates a point raised in section 3.1, namely that the external reputation gap may grow so large that the committee wants to implement the project even if they have received conflicting signals. This would be a violation of condition (10) in Proposition 1. In this numerical example, this happens for $\lambda > 13$. This has a number of consequences for equilibrium behavior. First, as shown in Visser and Swank (2007), the committee decides to implement the project with a probability

$\beta^* < 1/2$ in case of conflicting signals.[15] The larger is λ, the larger β^* becomes. We have added a thin, dashed line in Figure 2 that represents this probability. Its value can be read on the y-axis on the left.

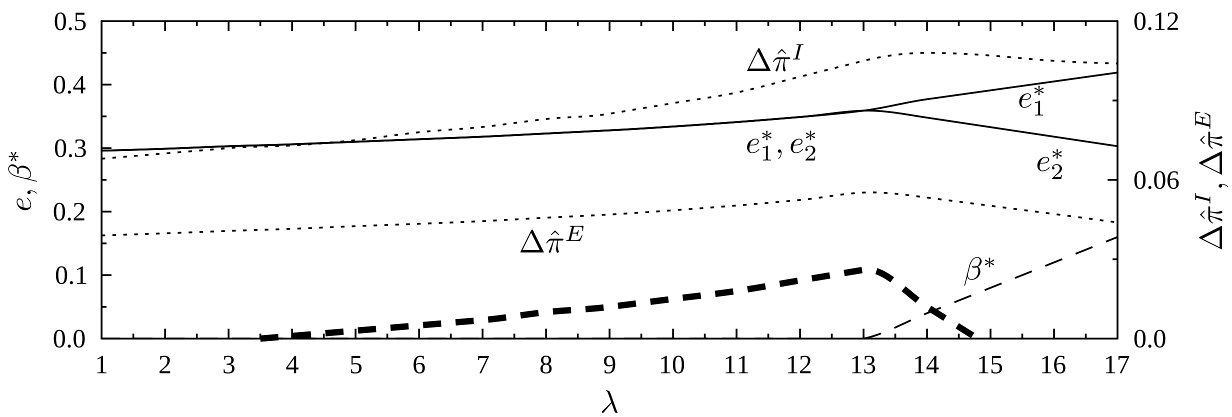
A direct effect of the distortion is that the external reputation gap shrinks, as can be seen in the figure. After all, the decision to implement may now result from two conflicting signals, while the decision to maintain the status quo becomes less likely to result from conflicting signals. This lowers the external reputation in case of implementation and raises the reputation in case of maintaining the status quo. The second consequence is that, if conflicting signals may lead to implementation, then this generically means that implementation happens with some probability for one of the two pairs of conflictions signals, say $\left(s_1^g, s_2^b\right)$, and with zero probability for $\left(s_1^b, s_2^g\right)$.[16] This implies that the signal that member 1 obtains as an outcome of his effort determines the decision not only when member 2's signal is positive, but also, with some probability, when the latter's information is negative. The resulting increase in the marginal benefits from information acquisition leads to an increase in e_1, as illustrated in the figure. On the other hand, member 2's information becomes less relevant, as implementation no longer requires his signal to be positive. As a result, e_2^* goes down. The increase in e_1^* relative to e_2^* means that the participation constraint of 1 becomes the relevant constraint. As the figure illustrates, member 1's net benefit from participation declines steeply once his signal becomes the more important of the two.

Other numerical results, not reported here, illustrate that for $\lambda > 0$, an increase in γ can end the existence of a $p = J$ process (for example if $\lambda = 13$, an increase of γ from 1 to 2). The reason is a spill over between internal and external reputation concerns. An increase in γ leads to higher effort levels, which in turn widens the external reputation gap. This provides incentives to the members to choose $X = 1$

[15] For the committee to implement the project with some probability in case of conflicting signals, the expected loss on the project should be exactly offset by a rise in reputation, $\Delta\hat{\pi}^E\left(X; \mathbf{e}^*, \beta^*\right) > 0$. This requires in turn that $\beta^* < 1/2$.

[16] By generically, we mean that if members were only slightly heterogenous this would be the relevant situation to analyse. With heterogenous members, $E\left[\mu | s_1^g, s_2^b; \mathbf{e}^*\right] > E\left[\mu | s_1^b, s_2^g; \mathbf{e}^*\right]$. Thus, implementing the project for $\left(s_1^g, s_2^b\right)$ costs less in terms of expected project payoff than for $\left(s_1^b, s_2^g\right)$, and the committee would implement the project with a positive probability for the former pair of signals and with zero probability for the latter pair.

Figure 2: Key variables as a function of the weight λ that committee members attach to their external reputations.



when signals are conflicting.

5 Further analysis

In this section, we extend the analysis in two directions. In section 5.1, we study the conditions under which information sharing is incentive compatible. Section 5.2 explores the effects of group size on the marginal benefits from exerting effort to improve reputations and on the willingness to share information.

5.1 When is information sharing incentive compatible?

So far we have assumed that members cannot misrepresent their private information in the deliberation stage. This is of course best from a project-value perspective. For the analysis above this assumption is relatively innocuous for two reasons. First, once members have collected information, their preferences are perfectly alligned. If members were to differ in the way they trade off project value and external reputations, they would have incentives to misrepresent their private information in the deliberation stage. These incentives are not discussed in the present paper, as they are studied in detail in Visser and Swank (2007). Second, misrepresentation of private information would hurt a member's expected internal reputation. We now show that a concern with internal reputations may make misrepresenting one's private information attractive if one state is more likely to occur than another.

We replace the assumption that the prior probability that the state $\mu = h$ equals $\frac{1}{2}$ with the assumption that this probability equals $\alpha \in (0,1)$. To isolate information-manipulation incentives arising from internal reputations, we assume that members exert effort and care exclusively about internal reputations.

Suppose members have exerted effort and have received their signals. Consider the deliberation stage. For truth telling by member i to be incentive compatible, the following conditions must hold for s_i^g and s_i^b,

$$\begin{aligned}
\Pr\left(s_j^g|s_i^g\right)\left[\hat{\pi}_i^I\left(s_i^g,s_j^g\right)-\hat{\pi}_i^I\left(s_i^b,s_j^g\right)\right] &\geq \Pr\left(s_j^b|s_i^g\right)\left[\hat{\pi}_i^I\left(s_i^b,s_j^b\right)-\hat{\pi}_i^I\left(s_i^g,s_j^b\right)\right] &(23)\\
\Pr\left(s_j^b|s_i^b\right)\left[\hat{\pi}_i^I\left(s_i^b,s_j^b\right)-\hat{\pi}_i^I\left(s_i^g,s_j^b\right)\right] &\geq \Pr\left(s_j^g|s_i^b\right)\left[\hat{\pi}_i^I\left(s_i^g,s_j^g\right)-\hat{\pi}_i^I\left(s_i^b,s_j^g\right)\right], &(24)
\end{aligned}$$

respectively.[17]

Member i's signal improves his *ex post* internal reputation if his signal becomes more likely to be correct in the perception of member j. Two forces are at work. First, the more likely it is that member j has received a correct signal (the higher is p_j^M), the more important it is for member i's reputation that his signal concurs with that of member j. Second, the more likely is one of the states *ex ante* (α deviating from $\frac{1}{2}$), the more important it is for member i's reputation that his signal concurs with the more likely state. If $\frac{1}{2} < \alpha < p_j^M$ or $\frac{1}{2} < 1-\alpha < p_j^M$, the first force dominates. Otherwise, the second force dominates.

Lemma 3 *Suppose $\alpha \in (0,1)$ and write p_j^M instead of $p_j^M(e_j)$, which is set in the information collection stage. In any decision-making process, internal reputations consistent with members who truthfully reveal their private signals satisfy*

$$\begin{aligned}
\hat{\pi}_i^I\left(s_i^g,s_j^g\right) &\gtreqless \hat{\pi}_i^I\left(s_i^b,s_j^b\right) \Leftrightarrow \alpha \gtreqless 1/2\\
\hat{\pi}_i^I\left(s_i^g,s_j^b\right) &\gtreqless \hat{\pi}_i^I\left(s_i^b,s_j^g\right) \Leftrightarrow \alpha \gtreqless 1/2\\
\hat{\pi}_i^I\left(s_i^b,s_j^b\right) &\gtreqless \hat{\pi}_i^I\left(s_i^g,s_j^b\right) \Leftrightarrow p_j^M \gtreqless \alpha &(25)\\
\hat{\pi}_i^I\left(s_i^g,s_j^g\right) &\gtreqless \hat{\pi}_i^I\left(s_i^b,s_j^g\right) \Leftrightarrow p_j^M \gtreqless 1-\alpha.
\end{aligned}$$

[17] For notational simplicity we have suppressed the chosen effort levels in the conditional probabilities and the conjectured effort levels in the ex post internal reputation terms.

Note that $\alpha \neq 1/2$ may make that conflicting signals command a higher reputation than concurring signals.

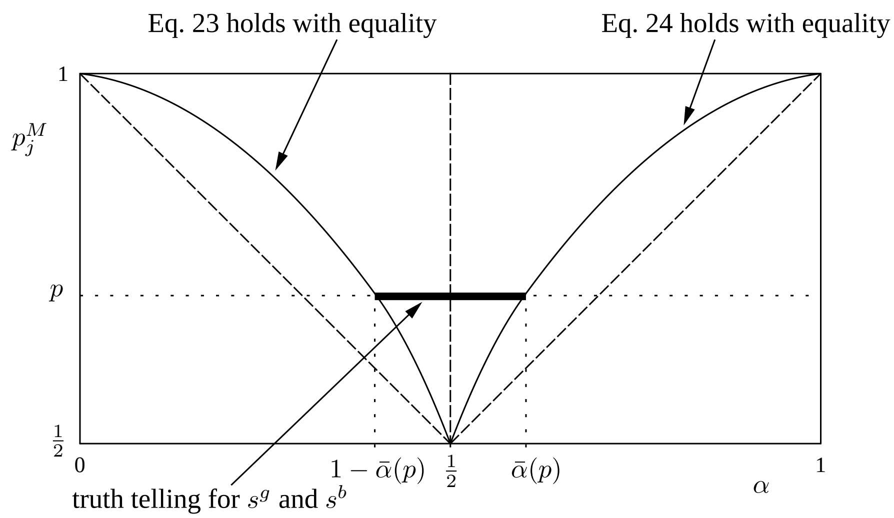
Figure 3 illustrates the truth-telling conditions. The parameter α varies along the horizontal axis, while p_j^M, which is determined in the information collection stage, is depicted on the vertical axis. The three dashed lines indicate the three inequalities derived in Lemma 3. For $\alpha = 1/2$, as in section 3, the only force at work is that member i's message should concur with j's signal. This gives an unambiguous incentive to tell the truth. For a given value of p_j^M, say p, an increase in α improves i's reputation whenever he holds the view that points towards the positive state, while it is hurt if he holds the view that points towards the negative state. Moreover, it increases both $\Pr\left(s_j^g|s_i^g\right)$ and $\Pr\left(s_j^g|s_i^b\right)$, while it reduces $\Pr\left(s_j^b|s_i^b\right)$ and $\Pr\left(s_j^b|s_i^g\right)$. The net effect on the truth telling conditions is clear: compared with $\alpha = 1/2$, the slack in (23) increases, while the slack in (24) goes down. Thus, for a given value p of p_j^M, there is an $\bar{\alpha}(p) \in \left(\frac{1}{2}, p\right)$, such that for $\alpha > \bar{\alpha}(p)$, the truth telling condition for s_i^b fails to hold. Vice versa, for $\alpha < 1 - \bar{\alpha}(p)$, the truth telling condition for s_i^g fails to hold. In other words, the $\left(\alpha, p_j^M\right)$-pairs consistent with truth telling for $p_j^M = p$ are indicated by the thick line. If instead α is held constant, but p_j^M increases, it becomes more important that i's message concurs with j's signal. As a result, such an increase creates slack in the truth telling condition for s_i^b, meaning that for a higher value of p_j^M, condition (24) holds for larger values of α. The next proposition summarizes the above discussion.

Proposition 5 *Suppose that both members have exerted effort and only care about their internal reputations. A sufficient condition for member i to truthfully reveal his information is that $\alpha \in \left[1 - \bar{\alpha}\left(p_j^M\right), \bar{\alpha}\left(p_j^M\right)\right]$, with $\bar{\alpha}\left(p_j^M\right) \in \left(\frac{1}{2}, p_j^M\right)$. $\bar{\alpha}\left(p_j^M\right)$ is increasing in p_j^M.*

5.2 Committee size

The size of a committee is an important design variable. If a member only cares about project value, a member's choice of effort depends on the probability that his

Figure 3: The truth telling conditions Eqs 23 and 24 for given values of α and p_j^M.



signal affects the final decision on the project. If an agent were to decide on his own, his signal, if sufficiently informative, would always be decisive. In a two-member committee with joint decision-making, member i's signal is only decisive if member j's signal is positive. As a result, the marginal benefits from exerting effort are lower. Thus, if members care exclusively about project value, a growing group size weakens incentives to become informed as the probability that a member's signal is decisive goes down. Once effort has been exerted, though, the committee works smoothly: private information is revealed and votes are cast to maximize expected project value (Coughlan, 2000). In the next two subsections we discuss how committee size influences the effects of reputation concerns on members' incentives to share information and to exert effort. We do so by comparing a two-member committee with a single agent and with a large committee consisting of an infinite number of members. We allow for $\alpha \in (0, 1)$.

5.2.1 Committee size and internal reputation concerns

By definition, internal reputation concerns are eliminated when the decision on the project is made by a single agent. Also, sharing information is not an issue. We can thus confine ourselves to analyzing a large committee. We focus again on the internal reputation component in members' objective function.

Suppose a committee is large ($n \to \infty$). Then we can invoke the Condorcet Jury Theorem. In our context, this Theorem says that if all committee members truthfully reveal their signals, then the likelihood that the majority of signals correctly points to the true state goes to one if the size of the committee goes to infinity. Thus, if members share their views, a comparison of the view that member i expressed with those of the other members amounts to a comparison between i's view and the true state. We therefore write $\hat{\pi}_i(s_i, \mu)$, where

$$\hat{\pi}_i^I(s_i^g, h) = \hat{\pi}_i^I(s_i^b, -h) = \frac{p_i^H}{p_i^M}\pi > \hat{\pi}_i^I(s_i^g, -h) = \hat{\pi}_i^I(s_i^b, h) = \frac{1-p_i^H}{1-p_i^M}\pi. \tag{26}$$

In large committees, a member's optimal level of effort is determined independently of the level of effort of other members and thus does not exhibit strategic complementarity.

For truth telling to be incentive compatible for member i, the following two conditions must hold for s_i^g and s_i^b

$$\begin{aligned}
\Pr(h|s_i^g)\left[\hat{\pi}_i^I(s_i^g, h) - \hat{\pi}_i^I(s_i^b, h)\right] &\geq \Pr(-h|s_i^g)\left[\hat{\pi}_i^I(s_i^b, -h) - \hat{\pi}_i^I(s_i^g, -h)\right] \\
\Pr(-h|s_i^b)\left[\hat{\pi}_i^I(s_i^b, -h) - \hat{\pi}_i^I(s_i^g, -h)\right] &\geq \Pr(h|s_i^b)\left[\hat{\pi}_i^I(s_i^g, h) - \hat{\pi}_i^I(s_i^b, h)\right].
\end{aligned}$$

respectively. This reduces to $1-\alpha \leq p_i^M$ and $\alpha \leq p_i^M$, respectively. A comparison with the findings in section 5.1 shows that, for the same parameter values and levels of effort e_J, truthtelling in a large committee is incentive compatible for a superset of parameters for which it is compatible in a two-member committee: the two diagonally sloped, dashed lines in Figure 3 are precisely $p_i^M = \alpha$ and $p_i^M = 1-\alpha$.

The effect of group size on the marginal incentives to exert effort is also clear. Intuitively, as observing μ is the best evidence available to establish member i's reputation, the difference in reputation between member i being right and wrong is larger than the difference in reputation between member i agreeing and disagreeing with member j. Besides, the change in probability of commanding the better reputation thanks to an increase in effort is larger for a large committee than for a two-person committee. As a result, a member's marginal benefits of exerting effort to improve his internal reputation become larger.

Proposition 6 *Regarding internal reputations, a large committee instead of a two-*

member committee enlarges the set of parameters for which members are willing to share their private information and strengthens their marginal incentives to exert effort to become informed.

Remark about μ observable. If conclusive evidence about the correctness of the decision were available, a member's internal reputation would be determined by a comparison between the state and the signal he revealed in the deliberation stage, as if the committee were large. Internal reputations would no longer gain strength with any increase in committee size. Instead, internal reputation concerns would provide relatively strong incentives to exert effort for any size of the committee.

5.2.2 Committee size and external reputation concerns

How does committee size affect members' effort levels through a concern with external reputations? We compare a single agent, a two-member committee and a committee consisting of an infinite number of members. The question we address is whether external reputation concerns *add* marginal incentives to exert effort.[18]

Consider a single member deciding on the project. If he follows his signal to maximize project value, then $\hat{\pi}_i^E(1) > \hat{\pi}_i^E(0) \Leftrightarrow \alpha > 1/2$. In other words, if $\alpha \neq \frac{1}{2}$, a single member's external reputation improves if the decision on X corresponds with the more likely state. The marginal benefits from exerting effort that stem from a concern with external reputations equal

$$\lambda \frac{\partial p_i^M}{\partial e_i} (2\alpha - 1) \Delta \hat{\pi}^E (X; e^*, n = 1),$$

where we include reference to the size of the committee in the expression of the reputation gap. Irrespective of α, reputation concerns create (positive) marginal benefits. These marginal benefits should be compared with those stemming from reputation concerns in a committee of two members,

$$\lambda \frac{\partial p_i^M}{\partial e_i} \left(p_j^M + \alpha - 1\right) \Delta \hat{\pi} (X; \mathbf{e}^*, n = 2).$$

For α close to $\frac{1}{2}$, having two members rather than one member strengthens the effect of external reputation concerns on effort. For small values of p_j^M and values of α

[18] On their own, external reputations do not provide incentives.

deviating from $\frac{1}{2}$, the opposite holds.

In large committees, with $n \to \infty$, in any equilibrium in which members follow the same strategies, the effect of a member's signal on the final decision goes to zero. This means that the final decision does not contain information about an individual member's signal. Hence, for very large committees, external reputation concerns do not give members any incentives to exert effort.

There is thus a fundamental difference between internal and external reputation concerns. In case of internal reputation concerns, a member's signal is compared to the signals of the other members. The more comparisons can be made, the better one can assess the ability of a member. An increase in the number of members widens a member's internal reputation gap. Larger audiences create larger incentives and facilitate truth telling. In case of external reputation concerns, the market assesses the influence of a member's signal on the project decision. This influence declines when more members are involved. With $n \to \infty$, the effect of higher effort of one member on the project decision goes to zero.

Remark about μ observable. If the market learns the state μ before determining members' reputations, then members who care about those reputations would be encouraged to acquire information especially in small committees. When one person makes a decision on the project, the market can compare the decision with the state, giving strong incentives to this person to exert effort in order to make the correct decision. When the committee is large, generally, the decision on X does not contain much information about the signal of an individual member. The effects of external reputation concerns are weak.

6 Conclusion

In this paper, we introduce reputations concerns within a committee context and study the resulting incentives to acquire decision-relevant information. As the state remains unobserved, there is neither conclusive evidence about the quality of a member's contribution to the deliberation preceding the voting, nor about the quality of the decision taken by the committee as a whole. Nevertheless, reputation concerns – both internal and external – motivate to exert effort. As a result, they counteract the underprovision of effort stemming from the public good nature of information.

The absence of conclusive evidence means that a member's internal reputation is based on deliberation patterns, in particular on a comparison between the member's signal with all the other signals; members' external reputation is based on what outside observers infer from the observed decision about the degree of congruence among individual signals. As a result, reputation concerns create strategic complementarity among individual effort levels. This also implies that even if a member's assessment of the state is irrelevant for the decision, his presence in the meeting may be useful to make the *other* member exert more effort to assess the state. Internal reputations provide more incentives to become informed, rather than less, with any increase in the size of the committee. In marked contrast, external reputations vanish as a motivator in large committees.

We noticed in the introduction that various papers have studied how the transparency regime shapes the behavior of reputation-concerned committee members and determines the resulting decision. Transparency regimes differ in terms of the information that becomes available to an evaluator about the decision process. Typically, the literature compares opaque or secretive regimes with transparent regimes. In an opaque regime, no information about the decision process becomes available apart from the final decision. In a transparent regime, information about how this decision was reached also becomes available. As a result, the information base of internal reputations in our paper is similar to that of reputations in a transparent regime, while the information base of external reputations is similar to that of reputations in an opaque regime. Obviously, a major difference between our paper and those on transparency regimes is that only one regime can apply at any given moment to a given committee, whereas members care about their internal and external reputations at the same time.

7 Appendix

Proof of Lemma 1: Consider the general case $\Pr(\mu = h) = \alpha \in (0,1)$. In what follows we suppress the effort pair $\mathbf{e}_p^*$ in the expressions and write $p_i^{a_i}$ instead of

$p^{a_i}\left(e^*_{ip}\right)$ etc. Use Bayes rule to obtain

$$\begin{aligned}
\hat{\pi}^I_i\left(s^g_i, s^g_j\right) &= \Pr\left(a_i = H | s^g_i, s^g_j\right) = \frac{\Pr\left(s^g_i, s^g_j | H\right)}{\Pr\left(s^g_i, s^g_j\right)} \Pr\left(a_i = H\right) \\
&= \frac{\Pr\left(s^g_i, s^g_j | H, \mu = h\right) \Pr\left(\mu = h\right) + \Pr\left(s^g_i, s^g_j | H, \mu = -h\right) \Pr\left(\mu = -h\right)}{\Pr\left(s^g_i, s^g_j | \mu = h\right) \Pr\left(\mu = h\right) + \Pr\left(s^g_i, s^g_j | \mu = -h\right) \Pr\left(\mu = -h\right)} \pi \\
&= \frac{p^H_i p^M_j \alpha + \left(1 - p^H_i\right)\left(1 - p^M_j\right)\left(1 - \alpha\right)}{p^M_i p^M_j \alpha + \left(1 - p^M_i\right)\left(1 - p^M_j\right)\left(1 - \alpha\right)} \pi.
\end{aligned}$$

Similarly,

$$\begin{aligned}
\hat{\pi}^I_i\left(s^b_i, s^b_j\right) &= \frac{p^H_i p^M_j \left(1 - \alpha\right) + \left(1 - p^H_i\right)\left(1 - p^M_j\right)\alpha}{p^M_i p^M_j \left(1 - \alpha\right) + \left(1 - p^M_i\right)\left(1 - p^M_j\right)\alpha} \pi \\
\hat{\pi}^I_i\left(s^g_i, s^b_j\right) &= \frac{p^H_i \left(1 - p^M_j\right)\alpha + \left(1 - p^H_i\right) p^M_j \left(1 - \alpha\right)}{p^M_i \left(1 - p^M_j\right)\alpha + \left(1 - p^M_i\right) p^M_j \left(1 - \alpha\right)} \pi \\
\hat{\pi}^I_i\left(s^b_i, s^g_j\right) &= \frac{p^H_i \left(1 - p^M_j\right)\left(1 - \alpha\right) + \left(1 - p^H_i\right) p^M_j \alpha}{p^M_i \left(1 - p^M_j\right)\left(1 - \alpha\right) + \left(1 - p^M_i\right) p^M_j \alpha} \pi.
\end{aligned}$$

It follows that

$$\begin{aligned}
\hat{\pi}^I_i\left(s^g_i, s^g_j\right) &\gtreqless \hat{\pi}^I_i\left(s^b_i, s^b_j\right) \Leftrightarrow \alpha \gtreqless 1/2 \\
\hat{\pi}^I_i\left(s^g_i, s^b_j\right) &\gtreqless \hat{\pi}^I_i\left(s^b_i, s^g_j\right) \Leftrightarrow \alpha \gtreqless 1/2 \\
\hat{\pi}^I_i\left(s^b_i, s^b_j\right) &\gtreqless \hat{\pi}^I_i\left(s^g_i, s^b_j\right) \Leftrightarrow p^M_j \gtreqless \alpha \\
\hat{\pi}^I_i\left(s^g_i, s^g_j\right) &\gtreqless \hat{\pi}^I_i\left(s^b_i, s^g_j\right) \Leftrightarrow p^M_j \gtreqless 1 - \alpha.
\end{aligned} \tag{27}$$

For $\alpha = 1/2$, the equalities and inequalities in (4) follow.

Concerning $\partial\hat{\pi}^I_i\left(\cdot\right)/\partial e^*_{jp}$, note that $\partial\hat{\pi}^I_i\left(\cdot\right)/\partial e^*_{jp} = \left(\partial\hat{\pi}^I_i\left(\cdot\right)/\partial p^M_j\right)\left(\partial p^M_j\left(\cdot\right)/\partial e^*_{jp}\right)$ and $\partial p^M_j/\partial e^*_{jp} > 0$. Thus, $sign\left(\partial\hat{\pi}^I_i\left(\cdot\right)/\partial e^*_{jp}\right) = sign\left(\partial\hat{\pi}^I_i\left(\cdot\right)/\partial p^M_j\right)$. Straigthforward derivations show that for $s, s' \in \left\{s^g, s^b\right\}$,

$$\begin{aligned}
\frac{\partial\hat{\pi}^I_i\left(s, s\right)}{\partial p^M_j} &= \pi\alpha\left(1 - \alpha\right)\frac{p^H_i - p^M_i}{\Pr\left(s, s\right)^2} > 0 \\
\frac{\partial\hat{\pi}^I_i\left(s', s\right)}{\partial p^M_j} &= \pi\alpha\left(\alpha - 1\right)\frac{p^H_i - p^M_i}{\Pr\left(s', s\right)^2} < 0
\end{aligned}$$

for any α. This implies that the internal reputation gap $\Delta\hat{\pi}^I_i\left(s_i, s_j\right)$ is increasing in e^*_{jp}.

Finally, we prove the signs of $\partial\hat{\pi}_i^I(\cdot)/\partial e_{ip}^*$. Define $D(e_i) = \left(\frac{\partial p_i^H(e_i)}{\partial e_i} - \frac{\partial p_i^M(e_i)}{\partial e_i}\right)$ and $d(e_i) = \left(\frac{\partial p_i^H(e_i)}{\partial e_i} p_i^M(e_i) - \frac{\partial p_i^M(e_i)}{\partial e_i} p_i^H(e_i)\right)$. In what follows, we suppress the dependence of $D(\cdot)$ and $d(\cdot)$ on e_i. Then,

$$
\begin{aligned}
\frac{\partial\hat{\pi}_i^I\left(s_i^g, s_j^g\right)}{\partial e_{ip}^*} &= \frac{\left(p_j^M + \alpha - 1\right)\left(D(1-\alpha)\left(1-p_j^M\right) + d\left(p_j^M + \alpha - 1\right)\right)}{\Pr\left(s_i^g, s_j^g\right)^2} \\
\frac{\partial\hat{\pi}_i^I\left(s_i^b, s_j^b\right)}{\partial e_{ip}^*} &= \frac{\left(p_j^M - \alpha\right)\left(D\alpha\left(1-p_j^M\right) + d\left(p_j^M - \alpha\right)\right)}{\Pr\left(s_i^b, s_j^b\right)^2} \\
\frac{\partial\hat{\pi}_i^I\left(s_i^g, s_j^b\right)}{\partial e_{ip}^*} &= \frac{\left(\alpha - p_j^M\right)\left(D(1-\alpha)p_j^M + d\left(\alpha - p_j^M\right)\right)}{\Pr\left(s_i^g, s_j^b\right)^2} \\
\frac{\partial\hat{\pi}_i^I\left(s_i^b, s_j^g\right)}{\partial e_{ip}^*} &= \frac{\left(1 - \alpha - p_j^M\right)\left(D\alpha p_j^M + d\left(1-\alpha-p_j^M\right)\right)}{\Pr\left(s_i^b, s_j^g\right)^2}.
\end{aligned}
$$

As $p_i^H > p_i^M$ for any e_i by construction of p_i^M, $D > d$ holds for any e_i. Moreover, it follows from Assumption 2 that $d \geq 0$ for any e_i. It can then be shown that

$$
\begin{aligned}
\text{if } p_j^M &> 1-\alpha, \text{ then } \frac{\partial\hat{\pi}_i^I\left(s_i^g, s_j^g\right)}{\partial e_{ip}^*} > 0 \text{ and } \frac{\partial\hat{\pi}_i^I\left(s_i^b, s_j^g\right)}{\partial e_{ip}^*} < 0; \\
\text{if } p_j^M &> \alpha, \text{ then } \frac{\partial\hat{\pi}_i^I\left(s_i^b, s_j^b\right)}{\partial e_{ip}^*} > 0 \text{ and } \frac{\partial\hat{\pi}_i^I\left(s_i^g, s_j^b\right)}{\partial e_{ip}^*} < 0.
\end{aligned}
$$

Clearly, for $\alpha = 1/2$ both if-clauses hold, implying that $\Delta\hat{\pi}_i^I(s_i, s_j)$ is increasing in e_{ip}^*.■

Proof of Lemma 2: For $p = J$,

$$\hat{\pi}_i^E(1) = \frac{\Pr\left(s_i^g, s_j^g|H\right)}{\Pr\left(s_i^g, s_j^g\right)}\pi \text{ and } \hat{\pi}_i^E(0) = \frac{1 - \Pr\left(s_i^g, s_j^g|H\right)}{1 - \Pr\left(s_i^g, s_j^g\right)}\pi,$$

where we have suppressed reference to $\mathbf{e}_J^*$. $\hat{\pi}_i^E(1) > \hat{\pi}_i^E(0) \Leftrightarrow \Pr\left(s_i^g, s_j^g|H\right) > \Pr\left(s_i^g, s_j^g\right) \Leftrightarrow \left(p_j^M + \alpha - 1\right)\left(p_i^H - p_i^M\right) > 0$. For $\alpha = 1/2$, $\hat{\pi}_i^E(1) > \hat{\pi}_i^E(0)$ holds.

Concerning $\partial\hat{\pi}_i^E(\cdot)/\partial e_{jJ}^*$, note that $\partial\hat{\pi}_i^E(\cdot)/\partial e_{jJ}^* = \left(\partial\hat{\pi}_i^E(\cdot)/\partial p_j^M\right)\left(\partial p_j^M(\cdot)/\partial e_{jJ}^*\right)$ and $\partial p_j^M/\partial e_j > 0$. Thus, $sign\left(\partial\hat{\pi}_i^E(\cdot)/\partial e_{jJ}^*\right) = sign\left(\partial\hat{\pi}_i^E(\cdot)/\partial p_j^M\right)$. Note that in $p = J$, $\partial\hat{\pi}_i^E(1)/\partial p_j^M = \partial\hat{\pi}_i^I\left(s_i^g, s_j^g\right)/\partial p_j^M$. It follows from Lemma 1 that if $p_j^M > 1-\alpha$, then $\partial\hat{\pi}_i^E(1)/\partial e_{jp}^* > 0$. This condition is satisfied for $\alpha = 1/2$. Moreover,

$$\frac{\partial \hat{\pi}_i^E(0)}{\partial p_j^M} = \left(-\alpha^2 + \alpha - 1\right) \frac{\left(p_i^H - p_i^M\right)}{\left(1 - \Pr\left(s_i^g, s_j^g\right)\right)^2} \pi < 0.$$

for all α and in particular for $\alpha = 1/2$. It follows that the external reputation gap of member i increases in e_{jJ}^* if $p_j^M > 1 - \alpha$.

Finally, note that

$$\frac{\partial \hat{\pi}_i^E(1)}{\partial e_{iJ}^*} = \frac{\partial \hat{\pi}_i^I\left(s_i^g, s_j^g\right)}{\partial e_{iJ}^*}$$

which is positive if $p_j^M > 1 - \alpha$, see Lemma 1 and so in particular for $\alpha = 1/2$. Furtermore,

$$\frac{\partial \hat{\pi}_i^E(0)}{\partial e_{iJ}^*} = \frac{\left(1 - \alpha - p_j^M\right)\left(D\left(p_j^M + \alpha - p_j^M \alpha\right) - d\left(p_j^M + \alpha - 1\right)\right)}{\left(1 - \Pr\left(s_i^g, s_j^g\right)\right)^2}.$$

Using again that $D > d \geq 0$, it follows that the derivative is negative for $p_j^M > 1 - \alpha$. This inequality holds for $\alpha = 1/2$. It follows that the external reputation gap of member i increases in e_{iJ}^* if $p_j^M > 1 - \alpha$.■

Proof of Lemma 3: This was shown in the proof of Lemma 1.■

Proof of Proposition 6: What remains to be shown is that the marginal benefits of exerting effort are higher in a large committee than in a two-person committee. Assume a given effort level, the same for the $n = 2$-case and $n \to \infty$-case. We suppress reference to this level in the expressions that follow. For $n = 2$, the marginal benefits of e_i are

$$\frac{\partial \Pr\left(s_i^g, s_j^g\right)}{\partial e_i}\left[\hat{\pi}_i^I\left(s_i^g, s_j^g\right) - \hat{\pi}_i^I\left(s_i^b, s_j^g\right)\right] + \frac{\partial \Pr\left(s_i^b, s_j^b\right)}{\partial e_i}\left[\hat{\pi}_i^I\left(s_i^b, s_j^b\right) - \hat{\pi}_i^I\left(s_i^g, s_j^b\right)\right].$$

For $n \to \infty$, the marginal benefits of e_i equal

$$\begin{aligned} & \frac{\partial \Pr\left(s_i^g, h\right)}{\partial e_i} \hat{\pi}_i^I\left(s_i^g, h\right) + \frac{\partial \Pr\left(s_i^g, -h\right)}{\partial e_i} \hat{\pi}_i^I\left(s_i^g, -h\right) + \\ & \frac{\partial \Pr\left(s_i^b, h; e\right)}{\partial e_i} \hat{\pi}_i^I\left(s_i^b, h\right) + \frac{\partial \Pr\left(s_i^b, -h; e\right)}{\partial e_i} \hat{\pi}_i^I\left(s_i^b, -h\right) \\ = & \left(\frac{\partial \Pr\left(s_i^g, h\right)}{\partial e_i} + \frac{\partial \Pr\left(s_i^b, -h\right)}{\partial e_i}\right)\left[\hat{\pi}_i^I\left(s_i^g, h\right) - \hat{\pi}_i^I\left(s_i^b, h\right)\right]. \end{aligned}$$

It can be checked using Eq. (26) and the expressions in the proof of Lemma 1 that

$\hat{\pi}_i^I\left(s_i^g, h\right) > \max\left\{\hat{\pi}_i^I\left(s_i^g, s_j^g\right), \hat{\pi}_i^I\left(s_i^b, s_j^b\right)\right\}$ and $\hat{\pi}_i^I\left(s_i^b, h\right) < \min\left\{\hat{\pi}_i^I\left(s_i^b, s_j^g\right), \hat{\pi}_i^I\left(s_i^g, s_j^b\right)\right\}$. This implies that, for the same effort levels, the internal reputation gaps are larger in the larger committee than in the 2-person committee. Furthermore,

$$\begin{aligned}
\frac{\partial \Pr\left(s_i^g, h\right)}{\partial e_i} &= \frac{\partial p_i^M}{\partial e_i}\alpha > \frac{\partial p_i^M}{\partial e_i}\left(p_j^M + \alpha - 1\right) = \frac{\partial \Pr\left(s_i^g, s_j^g\right)}{\partial e_i} \\
\frac{\partial \Pr\left(s_i^b, -h\right)}{\partial e_i} &= \frac{\partial p_i^M}{\partial e_i}\left(1-\alpha\right) > \frac{\partial p_i^M}{\partial e_i}\left(p_j^M - \alpha\right) = \frac{\partial \Pr\left(s_i^b, s_j^b\right)}{\partial e_i}.
\end{aligned}$$

As a result, the marginal benefits are larger in a large committee for the same level of effort. ■

8 References

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