

# Consensus building: How to persuade a group\*

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## Abstract

Many decisions in private and public organizations are made by groups. The paper explores strategies that the sponsor of a proposal may employ to convince a qualified majority of group members to approve the proposal. Adopting a mechanism design approach to communication, it emphasizes the need to distill information selectively to key members of the group and to engineer persuasion cascades in which members who are brought on board sway the opinion of others. The paper unveils the factors, such as the extent of congruence among group members and between them and the sponsor, and the size and governance of the group, that condition the sponsor's ability to maneuver and get his project approved.

*Keywords* Group decision-making, selective communication, persuasion cascade, internal and external congruence.

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# 1 Introduction

Many decisions in private and public organizations are made by groups. For example, in western democracies Congressional committees command substantial influence on legislative outcomes through their superior information and their gatekeeping power. Academic appointments are made by committees or departments; corporate governance is run by boards of directors; firms' strategic choices are often made internally by groups of managers; and decisions within families or groups of friends usually require consensus-building.

“Group decision-making” is also relevant in situations in which an economic agent's project requires adhesion by several parties as in joint ventures, standard setting organizations, coalition governments, or complementary investments by several other agents. For example, an entrepreneur may need to convince a financier to fund his project and a supplier to make a specific investment. Similarly, for its wide-body aircraft A380, Airbus had to convince its board and relevant governments, and must now convince airlines to buy the planes and airports to make investments in order to accommodate the new plane. Finally, a summer school organizer may need to convince both a theorist and an empiricist to accept teaching.

While the economic literature has studied in detail whether the sponsor of an idea or a project can persuade a single decision-maker to endorse his proposal, surprisingly little has been written on group persuasion. Yet group decision-making provides for a rich layer of additional persuasion strategies, including “selective communication” and “persuasion cascades”. Sponsors can distill information selectively; they can further try to “lever support”, namely to approach group members sequentially and build on one's gained adhesion to the project to convince another to either take a careful look or to rubberstamp altogether.

Persuasion cascades are relied upon early in life as when a child tries to strategically convince one of his parents with the hope that this will then trigger acceptance by the other. Lobbyists in Congress engage in so-called “legislator targeting”; and organizations

such as the Democracy Center provide them with advice on how to proceed.<sup>1</sup> Supporters of an academic appointment trying to convince the department to vote for an offer to the candidate, or corporate executives hoping to get a merger or an investment project approved by the board, know that the success of their endeavor depends on convincing key players (whose identity depends on the particular decision), who are then likely to win the adhesion of others.

The paper builds a sender/multi-receiver model of persuasion. The receivers (group members) adopt the sender's (sponsor's) project if all or a qualified majority of them are in favor at the end of the communication process. Unlike existing models of communication with multiple receivers, which focus on soft information ("recommendations"), the sender can transmit hard information (evidence, reports, material proofs) to a receiver, who can then use it to assess her payoff from the project. [While the sender has information that bears on the receivers' payoffs, we assume for simplicity that he does not know the latter.] Communication is costly in that receivers who are selected to receive this hard information must incur a private cost in order to assimilate it. Thus, convincing a group member to "take a serious look at the evidence" may be part of the challenge faced by the sponsor.

The introduction of hard information in sender/multi-receiver modeling underlies the possibility of persuasion cascade, in which one member is persuaded to endorse the project or at least to take a serious look at it when she is aware that some other member with at least some alignment in objectives has already investigated the matter and came out supportive of the project. Hard information also provides a foundation for strategies involving selective communication. We for example give formal content to the notion of "key member" or "member with string pulling ability" as one of "informational pivot", namely a member who has enough credibility within the group to sway the vote of (a qualified majority of) other members.

Another departure from the communication literature is that we adopt a mechanism

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<sup>1</sup>The reader interested in a pragmatic approach to these questions in the political context is invited to refer to the Democracy Center's website at <http://www.democracyctr.org/>.

design approach: The sender builds a mechanism (à la Myerson 1982) involving a sequential disclosure of hard and soft information between the various parties as well as receivers' investigation of hard information. This approach can be motivated in two ways. First, it yields an upper bound on what the sponsor can achieve. Second, and more descriptively, it gives content to the pro-active role played by sponsors in group decision-making. Indeed, we show how both selective communication and persuasion cascades are in equilibrium engineered by the sponsor.

The sponsor's optimal strategy is shown to depend on the congruence between individual group members and the sponsor (a factor that we label "external congruence" and that has received much attention in the single-receiver literature), on the congruence among group members ("internal congruence"), and on the size of the group and its decision-rule. Interestingly, increasing group size and thereby the number of veto powers may make it easier for the sponsor to have his project adopted even when all members are a priori reluctant to adopt it. Surprisingly also, an increase in external congruence may actually hurt the sponsor; by contrast, an increase in internal congruence always benefits the sponsor. Finally, it may be optimal for the sponsor to create some ambiguity for each member as to whether other members are already on board.

The paper is organized as follows: Section 2 sets up the sender/multi-receiver model. Section 3, in the context of a two-member group, develops a mechanism-design approach. Section 4 derives the optimal deterministic mechanism, and Section 5 studies its properties and demonstrates its robustness to the sender's inability to control communication channels among members. Section 6 extends the analysis to  $N$  members. Section 7 allows stochastic mechanisms and shows that ambiguity may benefit the sender. Finally, Section 8 summarizes the main insights and discusses alleys for future research.

#### *Relationship to the literature.*

Our paper is related to and borrows from a number of literatures. Of obvious relevance is the large single-sender/single-receiver literature initiated by Crawford and So-

bel (1982)'s seminal paper on the transmission of soft information,<sup>2</sup> and by the work of Grossman (1980), Grossman-Hart (1980), and Milgrom (1981) on the disclosure of hard information. Much of this work has assumed that communication is costless. One recent exception to this is Dewatripont-Tirole (2005), which emphasizes sender and receiver moral hazard in communication as well as the various modes (issue-relevant and issue-irrelevant) of communication.

This literature has been extended to analyze the aggregation of dispersed information within a group through debate (Spector 2000, Li-Rosen-Suen 2001).<sup>3</sup> Like ours, these papers analyze collective decision making processes, but they assume that group members have exogenous information, and they do not tackle the questions of whether and how a sponsor can maneuver to get his project adopted.<sup>4</sup>

A large body of literature covers receiver/multi-sender situations, where the receiver is an uninformed decision-maker and senders are experts with biased preferences or reputational concerns, as in Ottaviani-Sorensen (2001). Milgrom and Roberts (1986) pioneered this literature in the context of disclosure of hard information, while most later papers (e.g. Glazer-Rubinstein 1998, Krishna-Morgan 2001, Battaglini 2002, Battaglini-Bénabou 2003) focused on experts endowed with (or able to gather) soft private information. The multi-sender literature offers for example insights on the impact of the decision rules in committees (Austen-Smith 1993a and 1993b, Gilligan-Krehbiel 1989, Glazer-Rubinstein 2001), or of their composition (Dewatripont-Tirole 1999, Beniers-Swank 2004, and the empirical work of Krehbiel 1990). By contrast, we focus on sender / multi-receiver en-

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<sup>2</sup>Dessein (2002) extends the Crawford-Sobel model by allowing delegation of the decisions to the informed sender. The receiver optimally delegates when the divergence of preferences is small relative to her uncertainty about the environment. In an extension, Dessein also shows that it may be optimal for the receiver to delegate the decision to an intermediary with intermediate preferences.

<sup>3</sup>For early applications to Congressional committees, see Austen-Smith (1990) or Austen-Smith - Riker (1987).

<sup>4</sup>These two papers further assume heterogenous priors while our framework falls in the Bayesian tradition.

vironments, and the concomitant phenomena of selective communication and persuasion cascades.

Closer to our contribution, the Farrell-Gibbons (1989) model of cheap talk with multiple audiences addresses the problem of selective communication. Besides the sole focus on cheap talk, which precludes persuasion cascades in our model, a key difference with our framework is that the members of the audience do not form a single decision-making body and so no group persuasion strategies emerge in their paper.

Finally, our ruling out the possibility of targeting resources or paying bribes to committee members distinguishes our work from some of the literature on lobbying (e.g., Groseclose-Snyder 1996 or Lindbeck-Weibull 1987).

## 2 Model

We consider a sender ( $S$ ) / multi-receiver ( $R_i$ ) communication game. An  $N$ -member committee ( $R_1, R_2, \dots, R_N$ ) must decide on whether to endorse a project submitted by a sponsor  $S$ . Each committee member can individually support or oppose the project and the decision rule defines an aggregation procedure. Under the unanimity rule, all committee members must approve the project and so the sponsor needs to build a consensus. Under the more general  $K$ -majority rule, no abstention is allowed and the project is adopted whenever at least  $K$  members approve it.

The project yields benefits  $s > 0$  to  $S$  and  $r_i$  to committee member  $R_i$ . The status quo yields 0 to all parties. The sponsor's benefit  $s$  is common knowledge and his objective is to maximize the expected probability that the project is approved.

$R_i$ 's benefit  $r_i$  is a priori unknown to anyone<sup>5</sup> and the question for  $R_i$  is whether her benefit from the project is positive or negative. A simple binary model captures this

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<sup>5</sup>This assumption implies that  $S$ 's choice of strategy per se does not convey any information to the receivers. See Dewatripont-Tirole (2005) for a comparison, in the single-receiver case, of equilibrium behaviors when the sender knows and does not know the receiver's payoff.

dilemma;  $r_i$  can a priori take two values,  $r_i \in \{-L, G\}$ , with  $0 < L, G$ . The realization of  $r_i$  in case the project is implemented is not verifiable. Committee member  $R_i$  can simply accept or reject the project on the basis of her prior  $p_i \equiv \Pr\{r_i = G\}$ . She can also learn the exact value of her individual benefit  $r_i$  by spending time and effort investigating a detailed report about the project if provided by the sponsor: the sponsor is an information gatekeeper. Investigation is not verifiable, and so is subject to moral hazard. The personal cost of investigation is denoted  $c$  and is identical across committee members. There are several possible interpretations for the “report”. It can be a written document handed over by the sponsor. Alternatively, it could be a “tutorial” (face-to-face communication) supplied by the sponsor. Its content could be “issue-relevant” (examine the characteristics of the project) or “issue-irrelevant” (provide the member with track-record information about the sponsor concerning his competency or trustworthiness). Committee member  $R_i$  can also try to infer information from the opinion of another member who has investigated. That is, committee member  $R_i$  may use the correlation structure of benefits  $\{r_i\}_{i=1}^N$  to extract information from  $R_j$ 's investigating and deciding to approve the project.

*The dictator case.*

Let  $u^I(p) \equiv pG - c$  denote the expected benefit from investigation for a single decision-maker (a “dictator”), when her prior is  $\Pr\{r = G\} = p$ , and let  $u^R(p) \equiv pG - (1 - p)L$  denote her expected benefit when granting approval without investigation, i.e. when rubberstamping  $S$ 's proposal.

The dictator prefers rubberstamping to rejecting the project without investigation if<sup>6</sup>

$$u^R(p) \geq 0 \iff p \geq p_0 \equiv \frac{L}{G + L}.$$

Similarly, when asked to investigate, she prefers investigating and approving whenever  $r = G$  to rejecting without investigation if

$$u^I(p) \geq 0 \iff p \geq p_- \equiv \frac{c}{G}.$$

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<sup>6</sup>In the analysis, we neglect boundary cases and always assume that when indifferent, a committee member decides in the sponsor's best interest.

And she prefers rubberstamping to investigating and approving whenever  $r = G$  if

$$u^R(p) \geq u^I(p) \iff p \geq p_+ \equiv 1 - \frac{c}{L}.$$

These thresholds play a central role in the analysis.

**Assumption 1.**  $c < \frac{GL}{G+L}$ .

If  $c$  were too large, i.e. violated Assumption 1, a committee member would never investigate as a dictator, and a fortiori as a member of a multi-member committee. The dictator's behavior is summarized in Lemma 1 and depicted in Figure 1.

**Lemma 1.** *In the absence of a report, the dictator rubberstamps whenever  $p \geq p_0$ . When provided with a report, she rubberstamps the project whenever  $p \geq p_+$ , investigates whenever  $p_- \leq p < p_+$ , and turns down the project whenever  $p < p_-$ . Under Assumption 1,  $p_- < p_0 < p_+$ .*

The following terminology, borrowed and adapted from the one used on the Democracy Center website,<sup>7</sup> may help grasp the meaning of the three thresholds. Based on her prior, a committee member is said to be a *hard-core opponent* if  $p < p_-$ , a *mellow opponent* if  $p_- \leq p < p_0$ , an *ally* if  $p_0 \leq p$ ; an ally is a *champion* for the project if  $p \geq p_+$ . The lemma simply says that only a *moderate*  $p_- \leq p < p_+$  investigates when she has the opportunity to do so, while an *extremist*, i.e. either a hard-core opponent or a champion, does not bother to gather further information by investigating.

### FIGURE 1 HERE

Faced with a dictator, the sponsor has two options: present a detailed report to the dictator and thereby allow her to investigate, or ask her to rubberstamp the project (these two strategies are equivalent when  $p \geq p_+$  since the dictator rubberstamps anyway, and when  $p < p_-$ , as the dictator always rejects the project).

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<sup>7</sup>See <http://www.democracyctr.org/resources/lobbying.html> for details.

**Proposition 1. (The dictator case)** *When  $p \geq p_0$ , the sponsor asks for rubberstamping and thereby obtains approval with probability 1; when  $p_- \leq p < p_0$ , the sponsor lets the dictator investigate and obtains approval whenever  $r = G$ , that is with probability  $p$ .*

It is optimal for  $S$  to let the dictator investigate only when the latter is a mellow opponent; in all other instances, the decision is taken without any information exchange. A moderate ally, in particular, would prefer to investigate if she had the chance to, but she feels confident enough not to oppose the project in the absence of investigation;  $S$  therefore has real authority<sup>8</sup> in this situation.

### 3 Mechanism design with $N = 2$

For a two-member committee, let  $P \equiv \Pr\{r_1 = r_2 = G\}$  denote the joint probability that both benefit from the project. The Bayesian update of the prior on  $r_i$  conditional on the other member's benefiting from the project is:  $\hat{p}_i \equiv \Pr\{r_i = G \mid r_j = G\} = P/p_j$ . We assume that committee members' benefits are affiliated for  $i = 1, 2$ ,  $\hat{p}_i \geq p_i$ .<sup>9</sup> We assume that this stochastic structure is common knowledge and we label committee members so that  $R_1$  is a priori more favorable to the project than  $R_2$ ; that is,  $p_1 \geq p_2$ . Finally, we focus on the unanimity rule.<sup>10</sup>

We characterize the sponsor's optimal strategy to obtain approval from the committee:  $S$  chooses which committee members to provide the report to, in which order, and what information he should disclose in the process. The specification of the game form to be played by  $S$  and committee members is part of  $S$ 's optimization problem, and so it is not possible to specify a priori the timing of the game to be analyzed. Therefore we follow a mechanism design approach (see Myerson 1982), where  $S$  is the mechanism designer, to

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<sup>8</sup>Here, we follow the terminology in Aghion-Tirole (1997).

<sup>9</sup>See Proposition 6 for the case of negative correlation in two-member committees.

<sup>10</sup>We do not consider governance mechanisms in which e.g. voting ties are broken by a randomizing device (for example the project is adopted with probability 1/2 if it receives only one vote).

obtain an upper bound on  $S$ 's payoff without specifying a game form; we will later show that this upper bound can be attained through a simple implementation procedure.

The formal mechanism design analysis is relegated to the appendix; this section provides only an intuitive description of the approach and a presentation of the simplified mechanism design problem. Regardless of the game form, a payoff-relevant outcome consists, for each state of nature, of the list of members who actually incur the cost of investigating and of the final decision, that is whether the project is implemented. The set of states of nature  $\Omega$  is characterized by the possible values of  $r_1$  and  $r_2$ . A (stochastic) direct mechanism is a mapping from the set of states of nature  $\Omega$  to the set of probability distributions over the set of possible outcomes. From the Revelation Principle, we know that we can restrict attention to obedient and truthful mechanisms, i.e. mechanisms that satisfy incentive compatibility: when given information and asked to investigate by  $S$ , a member must have an incentive to comply with the recommendation and then to report truthfully to  $S$  whether she benefits from the project. The optimal obedient and truthful mechanism maximizes  $Q$ , the expected probability that the project is implemented, under incentive constraints, individual rationality constraints, feasibility constraints (probabilities are positive and sum to one in each state of nature), and measurability constraints.

Measurability constraints refer to the fact that the outcome cannot depend upon information that is unknown to all players. The probability that no one investigates and that the project is implemented (or rejected) cannot depend upon the state of nature, since no committee member knows her benefit  $r_i$  in this outcome. Similarly, the probability that only  $R_i$  investigates and that the project is implemented (or rejected) cannot depend upon the value of  $r_j$ .

Individual rationality constraints reflect the fact that under unanimity the project cannot be implemented when  $R_i$  investigates and  $r_i = -L$ . Incentive constraints dictate that, when committee member  $R_i$  learns through investigation the true value of her benefit  $r_i$ , she must prefer reporting it truthfully to  $S$  to lying; and that a committee member must get higher expected utility by complying with  $S$ 's request to investigate than by not

investigating.

The appendix simplifies  $S$ 's program drastically. Intuitively, the optimal mechanism should not involve wasteful investigation. When committee member  $R_i$  investigates and  $r_i = G$ , it should implement the project unless  $R_j$  investigates and  $r_j = -L$ . This property helps restrict attention to a simple class of mechanisms, the class of *no-wasteful-investigation mechanisms*.

**Lemma 2. (No wasteful investigation)** *There is no loss of generality in looking for the optimal mechanism within the class of no-wasteful-investigation mechanisms, that is the class of mechanisms described by an element of the 5-simplex  $(\gamma, \theta_1, \theta_2, \lambda_1, \lambda_2)$  such that:*

- *with probability  $\gamma$ , both  $R_1$  and  $R_2$  rubberstamp the project, i.e. approve it without any investigation;*
- *with probability  $\theta_i$ ,  $R_i$  investigates, and  $R_j$  rubberstamps;*
- *with probability  $\lambda_i$ ,  $R_i$  investigates;  $R_j$  investigates if  $R_i$  benefits from the project;*
- *with probability  $1 - \gamma - \sum_i \theta_i - \sum_i \lambda_i$ , there is no investigation and the status quo prevails.*

A further simplification results from the fact that we do not need to consider truthful revelation constraints. When  $R_i$  has investigated and  $r_i = -L$ , she will veto the project and so her utility is not affected by her report of  $r_i$  to  $S$ . And when  $r_i = G$ , lying can only hurt  $R_i$  when the mechanism belongs to the class defined by Lemma 2.

A no-wasteful-investigation mechanism, henceforth a “mechanism”, is thus a commitment by  $S$  to a lottery  $(\gamma, \theta_1, \theta_2, \lambda_1, \lambda_2)$ . With probability  $\gamma$ , he asks members to vote on the project without letting them investigate.<sup>11</sup> With probability  $\theta_i$ ,  $S$  presents only

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<sup>11</sup>All implementation games we consider involve voting subgames in which multiple Nash equilibria can arise, e.g. everyone vetoes. So, throughout the paper, we assume that committee members never play weakly dominated strategies in voting subgames.

$R_i$  with a report and asks her to approve or veto the project;  $S$  asks  $R_j$  to rubberstamp (given unanimity, this is equivalent to asking  $R_j$  to rubberstamp if  $R_i$  has approved the project). With probability  $\lambda_i$ ,  $S$  presents  $R_i$  with a report and asks her whether she will vote for the project; then conditional on  $R_i$ 's approval of the project,  $S$  presents  $R_j$  with a report.

The sponsor maximizes  $Q$ , the overall probability of approval:

$$Q = \gamma + \theta_1 p_1 + \theta_2 p_2 + (\lambda_1 + \lambda_2)P,$$

with respect to  $(\gamma, \theta_1, \theta_2, \lambda_1, \lambda_2)$  in the 5-simplex, subject to incentive constraints, which we now describe.

First, when  $R_i$  is asked to investigate, there is a probability  $(\frac{p_j \lambda_j}{\theta_i + \lambda_i + p_j \lambda_j})$  that the other committee member has investigated and approved the project; from this, she infers that  $r_j = G$  and so, that the project will be implemented if and only if she finds out that  $r_i = G$ , i.e. with probability  $\hat{p}_i$ . Or,  $R_i$  is the first member to investigate (probability  $\frac{\lambda_i}{\theta_i + \lambda_i + p_j \lambda_j}$ ) and she expects the project to be implemented if and only if both members benefit from the project, i.e. with probability  $P$ ; or else,  $R_i$  is the only member who will be asked to investigate (probability  $\frac{\theta_i}{\theta_i + \lambda_i + p_j \lambda_j}$ ) and the project is implemented if and only if she benefits, i.e. with probability  $p_i$ . If she instead rubberstamps the project, with probability  $\frac{\theta_i}{\theta_i + \lambda_i + p_j \lambda_j}$  the project is implemented and she benefits from the project with probability  $p_i$ , and with probability  $\frac{(\lambda_i + \lambda_j) p_j}{\theta_i + \lambda_i + p_j \lambda_j}$ , the project is implemented because the other member finds out that  $r_j = G$ , in which case  $R_i$  benefits from the project with probability  $\hat{p}_i$ . This yields the constraint:  $\forall i, j, i \neq j$ ,

$$\theta_i u^I(p_i) + \lambda_i u^I(P) + \lambda_j p_j u^I(\hat{p}_i) \geq \theta_i u^R(p_i) + (\lambda_i + \lambda_j) p_j u^R(\hat{p}_i). \quad (1)$$

Second, in the same situation,  $R_i$  must not prefer to simply veto the project:  $\forall i, j, i \neq j$ ,

$$\theta_i u^I(p_i) + \lambda_i u^I(P) + \lambda_j p_j u^I(\hat{p}_i) \geq 0. \quad (2)$$

Third, when  $R_i$  is asked to rubberstamp, and hence is not provided with any report, she must not prefer to simply veto the project, which would yield zero benefit. She may

be asked to rubberstamp just like the other member (with probability  $\frac{\gamma}{\gamma+\theta_j p_j}$ ) or after the other member's investigation and approval (with probability  $\frac{\theta_j p_j}{\gamma+\theta_j p_j}$ ) in which case she benefits from the project with probability  $\hat{p}_i$ :  $\forall i, j, i \neq j$ ,

$$\gamma u^R(p_i) + \theta_j p_j u^R(\hat{p}_i) \geq 0. \quad (3)$$

To sum up, the problem to be solved is:

$$\begin{aligned} & \max Q \\ & \text{s.t. (1), (2), and (3).} \end{aligned}$$

## 4 Optimal deterministic mechanism

This section focuses on “deterministic mechanisms” that is, on mechanisms in which the outcome (who investigates and whether the project is adopted) is deterministic in each state of nature. This implies that  $\gamma, \theta_i$  and  $\lambda_i$  all belong to  $\{0, 1\}$ . While focusing on deterministic mechanisms is restrictive, the analysis is simple and allows us to obtain a complete characterization of the optimum and to provide intuition for our main results.

The sponsor's preferences over deterministic mechanisms are immediate. There are four possible deterministic mechanisms that yield a positive probability of implementing the project, provided they are incentive compatible. Ignoring incentive compatibility,  $S$  has a clear *pecking order* over these mechanisms. He prefers a mechanism that asks both committee members to rubberstamp the project since the project is then implemented with probability  $Q = 1$ . His next best choice is to have only  $R_1$  investigate and decide while  $R_2$  rubberstamps, yielding  $Q = p_1$ . His third best choice is to have  $R_2$  investigate and  $R_1$  rubberstamp, yielding  $Q = p_2$ . Finally, his last choice is to have both committee members investigate, since this implies  $Q = P$  irrespective of the member who investigates first. The optimal deterministic mechanism maximizes  $S$ 's payoff within the set of incentive compatible deterministic mechanisms. We therefore simply follow down  $S$ 's pecking

order and characterize when a mechanism is incentive compatible while all preferred ones are not.<sup>12</sup>

The committee rubberstamps ( $Q = 1$ ) if and only if  $u^R(p_i) \geq 0$  for each committee member, that is if and only  $p_2 \geq p_0$  (since  $p_1 \geq p_2$  by assumption).

**Proposition 2.** *If both committee members are allies of the sponsor, i.e. if  $p_1 \geq p_2 \geq p_0$ , members rubberstamp without investigation and so the project is implemented with probability  $Q = 1$ .*

This outcome is similar to the one obtained in the dictator case. The committee is reduced to a mere rubberstamping function even though moderate allies ( $p_0 \leq p_i < p_+$ ) would prefer to have a closer look at the project if given the chance to. But  $S$  does not give them the option since this could only trigger some opposition to the project.

Another simple case arises when the committee consists of two hard-core opponents, that is when  $p_2 \leq p_1 < p_-$ . In this case,  $u^R(P) \leq u^R(p_i) < u^I(p_i) < 0$  for  $i = 1, 2$ . A hard-core opponent neither approves nor investigates based on her prior, and so the project is turned down.

**Proposition 3.** *If both committee members are hard-core opponents to the project, i.e. if  $p_2 \leq p_1 < p_-$ , the project is never implemented.*

We therefore restrict attention to the constellation of parameters such that at least one member is not an ally ( $p_2 \leq p_0$ ), and at least one member is not a hard-core opponent ( $p_1 \geq p_-$ ).

We focus first on the case where  $R_1$  is a champion for the project ( $p_1 > p_+$ ), while  $R_2$  is an opponent ( $p_2 < p_0$ ). From the definition of  $p_+$ ,  $u^R(p_1) > u^I(p_1)$ . So there is no

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<sup>12</sup>Given this pecking order,  $S$ 's optimal mechanism never implies too much investigation from the members' point of view. More precisely, consider the incentive compatible mechanism that would be chosen by the members to maximize the sum of their expected utilities. Then, the sponsor's optimal mechanism cannot involve (strictly) more member investigation than the members' optimal mechanism (which, for example in the symmetric-payoff case, maximizes the members' average expected utility under the same constraints (1)-(2)- (3)).

way to induce the champion to investigate; she always prefers to rubberstamp and avoid paying the cost of examining the report. Referring to  $S$ 's pecking order, the only possible way to get the project approved is to let  $R_2$  investigate and decide.

**Proposition 4.** *If  $R_1$  is a champion ( $p_1 > p_+$ ), while  $R_2$  is a mellow opponent ( $p_- \leq p_2 < p_0$ ), the project is implemented with ex ante probability  $Q = p_2$ ; the sponsor lets the mellow opponent investigate and decide according to the value of  $r_2$ , while the champion rubberstamps. If however  $R_1$  is a champion while  $R_2$  is a hard-core opponent, there is no way to have the project approved ( $Q = 0$ )*

The proposition formalizes the idea that *too strong a support is no useful support*.  $S$ 's problem here is to convince the opponent  $R_2$ . Without any further information, this opponent will simply reject the proposal. To get  $R_2$ 's approval, it is therefore necessary to gather good news about the project. Investigation by  $R_1$  is likely to deliver such good news, but committee member  $R_1$  is so enthusiastic about the project that she will never bother to investigate. The sponsor has no choice but to let the opponent investigate herself.  $R_2$  de facto is a dictator and  $R_1$  is of no use for the sponsor's cause.

We complete our analysis by focusing on the region of parameters such that  $p_- \leq p_1 \leq p_+$  and  $p_2 < p_0$ . In this region, we move down  $S$ 's pecking order, given that having both members rubberstamp cannot be incentive compatible. The following proposition characterizes the optimal scheme.

**Proposition 5.** *Suppose the committee consists of a moderate and an opponent, i.e.  $R_1$  is a moderate with  $p_- \leq p_1 \leq p_+$  and  $R_2$  is an opponent with  $p_2 < p_0$ ;*

- *if  $\hat{p}_2 \geq p_0$  ( $R_2$  is willing to rubberstamp if she knows that  $R_1$  benefits from the project), the optimal mechanism is to let the most favorable member  $R_1$  investigate and decide: the project is implemented with probability  $Q = p_1$ ;*
- *if  $\hat{p}_2 < p_0$  and  $\hat{p}_1 \geq p_0$ , the optimal mechanism is to let  $R_2$  investigate and decide (in which case the project is implemented with probability  $Q = p_2$ ) if  $p_2 \geq p_-$ ; the project cannot be implemented if  $p_2 < p_-$ ;*

- if  $\hat{p}_i < p_0$  for  $i = 1, 2$ , the optimal mechanism is to let both members investigate provided  $P \geq p_-$ , in which case  $Q = P$ ; the status quo must prevail if  $P < p_-$ .

**Proof.** The proof simply follows  $S$ 's pecking order.  $\theta_1 = 1$  is incentive compatible if and only if:

$$\begin{aligned} u^I(p_1) &\geq \max\{u^R(p_1); 0\} \\ u^R(\hat{p}_2) &\geq 0. \end{aligned}$$

The first condition is equivalent to  $p_- \leq p_1 < p_+$ , and hence is satisfied; the last condition is equivalent to  $\hat{p}_2 \geq p_0$ .

If  $\hat{p}_2 < p_0$ ,  $\theta_1 = 1$  violates incentive compatibility and the next best choice is  $\theta_2 = 1$ . The latter is incentive compatible if and only if:

$$\begin{aligned} u^I(p_2) &\geq \max\{u^R(p_2); 0\} \\ u^R(\hat{p}_1) &\geq 0. \end{aligned}$$

In the sub-region  $\hat{p}_2 < p_0$ , the first condition is equivalent to  $p_2 \geq p_-$ , and the last one is equivalent to  $\hat{p}_1 \geq p_0$ .

Finally, the next best choice would be to have  $\lambda_i = 1$  for some  $i$ . Equation (2) then imposes that  $u^I(P) \geq 0$ , i.e. that  $P \geq p_-$ . So, if  $p_2 < p_-$ ,  $\lambda_i = 1$  cannot be implementable since  $P \leq p_2$ . Therefore  $\lambda_i = 1$  can only be optimal within the region such that  $p_- \leq p_2$ ,  $\hat{p}_2 < p_0$  and  $\hat{p}_1 < p_0$ . There, the incentive compatibility constraints for  $\lambda_i = 1$  are:

$$\begin{aligned} u^I(P) &\geq \max\{p_j u^R(\hat{p}_i); 0\} \\ u^I(\hat{p}_j) &\geq \max\{u^R(\hat{p}_j); 0\}. \end{aligned}$$

$\hat{p}_i < p_0$  implies  $u^R(\hat{p}_i) < 0$  so that the first constraint is implied by the third; similarly, the second and the fourth constraint are satisfied since  $\hat{p}_j \geq p_2 \geq p_-$ . So,  $\lambda_i = 1$  is optimal whenever  $\hat{p}_2 < p_0$ ,  $\hat{p}_1 < p_0$  and  $P \geq p_-$ . ■

Proposition 5 shows that for committees that consist of a moderate and an opponent, communication is required to get the project adopted. More importantly, Proposition 5

relies on the existence of *persuasion cascades*. Although a committee member  $R_i$  is a priori an opponent to the project ( $p_i < p_0$ ), she may be induced to give her approval without investigation if she can trust her fellow committee member  $R_j$ 's informed decision. In some sense,  $R_i$  is willing to delegate authority about the decision to  $R_j$ , knowing that  $R_j$  will endorse the project only after investigating and learning that her benefit is positive ( $r_j = G$ ).  $R_j$  is reliable for  $R_i$  because the information that  $r_j = G$  is sufficiently *good news* about  $r_i$  so that the updated beliefs  $\Pr\{r_i = G \mid r_j = G\}$  turn  $R_i$  into an ex post ally. That is,  $\hat{p}_i \geq p_0$  and  $R_i$  is now willing to rubberstamp  $R_j$ 's decision without further investigation.

Of course, the sponsor prefers to rely on a persuasion cascade triggered by the most favorable committee member  $R_1$ , since the probability that this member benefits from the project is larger than the corresponding probability for the other member. But this strategy is optimal only if  $R_1$  is reliable for  $R_2$ , that is if news about  $r_1 > 0$  carries enough information to induce  $R_2$  to rubberstamp. If  $R_1$  is not reliable for  $R_2$ , then the next best strategy is to rely on a persuasion cascade triggered by the less favorable committee member  $R_2$ . Even though this implies a smaller probability of having the project adopted, this strategy is still better than having both members investigate, which leads to approval with probability  $P$ .

It is worth noting that the choice of the optimal persuasion strategy by the sponsor does not depend only on the *external congruence* of the committee, that is on the prior probabilities  $p_i$  that the members' benefits are aligned with the sponsor's benefit; this choice also depends on the degree of *internal congruence* among committee members, that is on the posteriors  $\hat{p}_i$ . The sponsor will find it optimal to trigger a targeted persuasion cascade when facing a committee with high internal congruence, while he must convince both members of a committee with poor internal congruence.

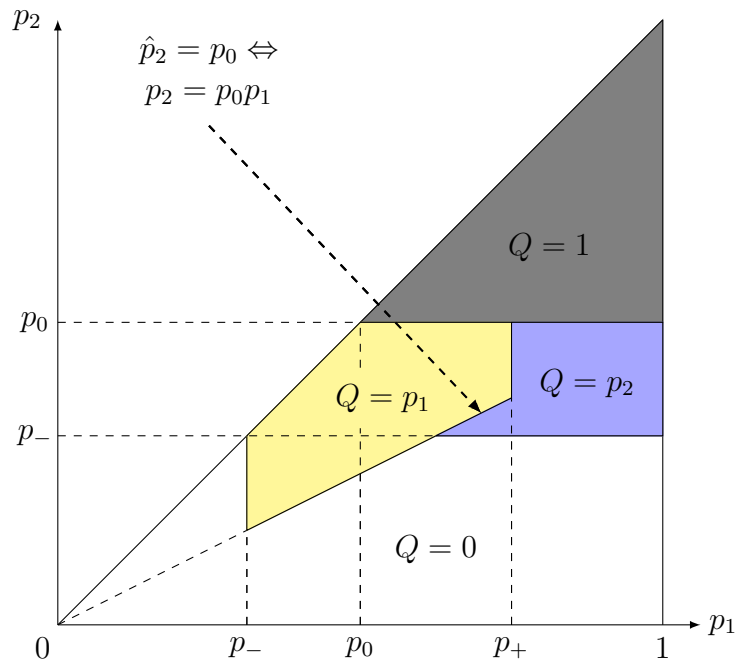
It is straightforward to find implementation procedures for the optimal mechanism. Persuasion cascades amount to presenting the project to one committee member through private communication, letting her endorse or reject the project, and asking the other

member to rubberstamp. When both committee members need be convinced, one of them is asked to investigate, followed by the other if the first investigator endorses the project.

Finally persuasion cascades may be viewed as “top-down” or “bottom-up”, depending upon whether  $S$  convinces first the committee member with interests closer to his (the more externally congruent) or the committee member with interests that are the more in conflict with his (the less externally congruent member).

*An illustrative example: the case of nested preferences.*

Assume that a project that benefits committee member  $R_2$  necessarily also benefits  $R_1$ :  $P = p_2$ . Committee members are then ranked ex post as well as ex ante in terms of how aligned their objectives are with the sponsor’s. Internal congruence within the committee is captured by the updated beliefs:  $\hat{p}_1 = 1$  and  $\hat{p}_2 = p_2/p_1$ .



**FIGURE 2**

Note that  $R_1$  will always rubberstamp  $R_2$ 's informed decision and so persuasion cascades triggered by  $R_2$  are possible provided  $p_2 \geq p_-$ . Persuasion cascades triggered by  $R_1$  if feasible are preferred by  $S$  since  $R_1$  has more external congruence with him. But  $R_1$ 's external congruence with  $S$  comes in direct conflict with internal congruence within the committee: indeed, keeping  $p_2$  fixed, the larger  $p_1$ , the less reliable  $R_1$  is as a sole investigator for  $R_2$  and the less  $R_2$  is willing to follow a persuasion cascade triggered by  $R_1$ .

The optimal mechanism in this nested case can be straightforwardly computed from previous propositions using the fact that  $\hat{p}_2 \geq p_0 \Leftrightarrow p_2 \geq p_0 p_1$ . It is depicted in Figure 2.

*Internal dissonance.*

Persuasion cascades rely on the fact that it is good news for one committee member to learn that the other benefits from the project. If committee members' benefits are stochastically independent, then  $\hat{p}_i = p_i$  for each  $i$ : No bandwagon effect can be generated and no persuasion cascade can exist. Each committee member is de facto a dictator and the sponsor has no sophisticated persuasion strategy relying on group effects.

When the members' benefits are negatively correlated,  $r_i = G$  is bad news for  $R_j$  and therefore  $\hat{p}_i < p_i$ : there is internal *dissonance* within this committee. In this case, Propositions 2 and 3 continue to hold. Focusing on the non-trivial case in which  $p_2 < p_0$ ,  $\hat{p}_2 < p_2 < p_0$  implies that no persuasion cascade can be initiated with  $R_1$  investigating and  $R_2$  rubberstamping. So, whenever  $p_2 < p_0$ ,  $R_2$  must investigate for the project to have a chance of being approved. Then,  $R_1$  knows that the project can be adopted only if  $r_2 = G$ . In the optimal mechanism,  $R_1$  acts as a dictator conditional on  $r_2 = G$  and decides to rubberstamp, investigate or reject the project based on the posterior  $\hat{p}_1$ . Since  $\hat{p}_1 < p_1$ , it is more difficult to get  $R_1$ 's approval when she is part of a committee with internal *dissonance*. Following similar steps as in the proof of Proposition 5, it is easy to characterize the optimal mechanism under internal dissonance; the results are summarized in the following proposition.

**Proposition 6. (Internal dissonance)** *Assume the committee is characterized by internal dissonance, i.e.  $\hat{p}_i \leq p_i$  for  $i = 1, 2$ , and that  $p_2 < p_0$  and  $p_1 > p_-$ :*

- *if  $p_2 < p_-$ , the project cannot be implemented;*
- *if  $p_2 \geq p_-$  and  $\hat{p}_1 \geq p_0$ , the optimal mechanism is to let  $R_2$  investigate and  $R_1$  rubberstamp:  $Q = p_2$ ;*
- *if  $p_2 \geq p_-$  and  $\hat{p}_1 < p_0$ , the optimal mechanism is to let both members investigate whenever  $P \geq p_-$ , in which case the project is implemented with probability  $Q = P$ ; if  $P < p_-$  however, the status quo prevails.*

Note that the second bullet point in this proposition does not describe a persuasion cascade:  $R_1$  would be willing to rubberstamp based on her prior and the mechanism exploits the fact that she is still willing to rubberstamp *despite* the bad news  $r_2 = G$ .

## 5 Comparative statics and robustness

This section discusses the properties of the optimal deterministic mechanism.

*Stochastic structure.*

The comparative statics analysis with respect to priors in the general model is slightly more delicate than in the nested example since the following equality must always hold:  $\hat{p}_2 p_1 = \hat{p}_1 p_2 = P$ . Several types of analysis can be considered: increasing  $\hat{p}_i$  while keeping  $p_i$  fixed (hence increasing  $P$ ), increasing  $p_i$  while keeping  $P$  fixed (hence decreasing  $\hat{p}_j$ ), increasing  $p_i$  while keeping  $\hat{p}_j$  and  $p_j$  fixed (hence increasing  $P$  and  $\hat{p}_i$ ).

The first type of analysis is straightforward and a mere examination of Proposition 5 delivers the following corollary.

**Corollary 1. (Benefits from internal congruence)** *Fixing priors  $p_i$ , the probability of having the project implemented is (weakly) increasing in  $\hat{p}_1$  and  $\hat{p}_2$ .*

The sponsor unambiguously benefits from higher internal congruence within the committee. It should be noted that this holds even when only one member investigates (when both members investigate, an increase in internal congruence mechanically raises the probability  $P$  that both favor the project). Note further that Proposition 6 implies that less internal dissonance also benefits the sponsor under negative correlation.

The next corollary shows that an increase in member  $i$ 's external congruence with  $S$  may hurt  $S$  for two reasons: First, if  $R_i$  investigates, her endorsement may no longer be credible enough for  $R_j$  ( $\hat{p}_j$  falls below  $p_0$ ); second she may even no longer investigate ( $p_1$  becomes greater than  $p_+$ ). In either case, an increase in  $R_i$ 's congruence with  $S$  prevents a persuasion cascade.

**Corollary 2. (Potential costs of external congruence)** *(i) Fixing  $P$ , an increase in either  $p_1$  or  $p_2$  may lead to a smaller probability of having the project approved.*

*(ii) Fixing  $p_2$  and  $\hat{p}_2$ , an increase in  $p_1$  (and therefore also in  $\hat{p}_1$ ) may lead to a smaller probability of having the project approved.<sup>13</sup>*

*Payoffs.*

First, although  $R_1$ 's prior payoff distribution first-order stochastically dominates  $R_2$ 's,  $R_1$ 's expected benefit may be smaller than  $R_2$ 's. The reason is that  $R_1$ , but not  $R_2$ , may incur the investigation cost.<sup>14</sup> The sponsor's reliance on the member with highest external congruence to win the committee's adhesion imposes an additional burden on this member and she may be worse off than her fellow committee member.<sup>15</sup>

Second, suppose that the sponsor can modify project characteristics so as to raise the

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<sup>13</sup>By contrast, fixing  $p_1$  and  $\hat{p}_1$ , an increase in  $p_2$  unambiguously increases  $Q$ .

<sup>14</sup>In particular, when  $p_1$  is slightly above  $p_-$  (while  $\hat{p}_2 \geq p_0$ ),  $R_1$ 's expected benefit is almost null.

<sup>15</sup>This point is to be contrasted with one in Dewatripont-Tirole (2005), according to which a dictator may be made worse off by an increase in her congruence with the sponsor because she is no longer given the opportunity to investigate (see also Proposition 1). It also suggests that if the a priori support of committee members were unknown to the sponsor, the latter could not rely on voluntary revelation of priors by committee members (the same point also applies to the dictator case).

members' benefits or reduce their losses. Such manipulations do not necessarily make it easier to get the project adopted, as the next result shows.<sup>16</sup>

**Corollary 3.** *If  $G_1 = G_2 = G$  and  $L_1 < L_2 = L$ , the probability of having the project approved may be smaller than when  $L_1 = L$ .*<sup>17</sup>

As in Corollary 2, too strong an ally is useless, and so raising an ally's external congruence may decrease the chances of the project being approved.

*Do more veto powers jeopardize project adoption?*

Intuition suggests that under the unanimity rule, the larger the committee the stronger the status-quo bias. Although our model so far deals only with one- and two-member committees, it may shed a new light on this idea and enrich our understanding of bureaucracies. The conjecture that larger communities are less likely to vote against change misses the main point about the use of persuasion cascades to persuade a group. When internal congruence within the committee is high enough so that  $\hat{p}_2 \geq p_0$ , it is possible to win  $R_2$ 's adhesion to the project even though she started as a hard-core opponent ( $p_2 < p_-$ ). Adoption would not be possible with a hard-core opponent dictator.

Suppose that committees are formed by randomly selecting members within a given population of potential members with ex ante unknown support for  $S$ 's project. For a one-member committee (a dictator) the probability of implementing the project is based merely on external congruence with  $S$ ; two-member committees may compensate poor external congruence of some of its members by high internal congruence among its members

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<sup>16</sup>More generally, the sponsor could raise  $G_i$  and lower  $L_i$ . Corollary 3 focuses on the interesting case. For completeness, let us state the other results:

(i) If  $G_1 > G_2 = G$  and  $L_1 = L_2 = L$ , the probability of having the project approved unambiguously increases compared with the case where  $G_1 = G$ . (ii) If  $G_1 = G_2 = G$  and  $L_2 < L_1 = L$ , the probability of having the project approved unambiguously increases compared with the case where  $L_2 = L$ .

<sup>17</sup>If  $L_1 < L$ , the thresholds  $p_{0,1} = \frac{L_1}{G+L_1}$  and  $p_{+,1} = 1 - \frac{c}{L_1}$  become member-specific and smaller than their counterparts  $p_0$  and  $p_+$ . A decrease in  $L_1$  below  $L$  may then turn  $R_1$  into a champion, which prevents a persuasion cascade initiated by  $R_1$ .

and therefore lead, ex ante, to a higher probability of implementing  $S$ 's project.

**Proposition 7.** *A randomly drawn two-member committee may implement projects more often than a randomly drawn dictator: a two-member committee is not necessarily more prone to the status-quo bias than a one-member committee.*

**Proof.** The proof is by way of an example. A randomly-drawn member is a mellow opponent with probability  $\beta$  (has congruence  $p = p_H$ , where  $p_- < p_H < p_0$ ), and a hardcore opponent with probability  $1 - \beta$  (has congruence  $p_L < p_-$ ). Assume that the hardcore opponent rubberstamps if the mellow opponent investigates and favors the project. The optimal organization of a two-member committee that turns out to be composed of at least one mellow opponent is to let a mellow opponent investigate and the other rubberstamp. The ex ante probability that a randomly drawn two-member committee approves the project is larger than for a random dictator:

$$\mathbf{E}[Q] = \beta^2 p_H + 2\beta(1 - \beta)p_H = \beta(2 - \beta)p_H > \beta p_H. \quad \blacksquare$$

*Side communication.*

We have assumed that communication can only take place between the sponsor and committee members. There may be uncontrolled channels of communication among members, though. First, members may exchange soft information about their preferences and about whether they have been asked to investigate. Second, an investigator may, in the absence of a confidentiality requirement imposed by the sponsor, forward the file to the other committee member. It is therefore interesting to question the robustness of our results to the possibility of side communication between committee members. To this purpose, we exhibit implementation procedures in which the equilibrium that delivers the optimal outcome is robust to the possibility of side communication, whether the latter involves cheap talk or file transfer among members.<sup>18</sup>

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<sup>18</sup>So, we focus on a weak form of robustness; there exist other equilibria that do not implement the optimal outcome, if only because of the voting procedure.

Obviously, side communication has no impact when both members rubberstamp, as they then have no information. Intuitively, it also does not matter under sequential investigation, because the sponsor both reveals the first investigator's preferences and hands over the file to the second investigator. Under a single investigation and rubberstamping, the member who rubberstamps can as well presume that the investigator liked the project (otherwise her vote is irrelevant); furthermore, conditional on liking the project, the investigator is perfectly congruent with the sponsor and has no more interest than the sponsor in having the second member investigate rather than rubberstamp. Appendix 2 makes this reasoning more rigorous and also looks at side communication following out-of-equilibrium moves.

**Proposition 8. (Robustness to side communication)** *The sponsor can obtain the same expected utility even when he does not control communication channels among members.*

## 6 Informational and voting pivots in $N$ -member committees

We now turn to  $N$ -member committees. In this richer framework, we discuss selective communication (who should be presented with a report) and the role of the committee's decision rule. To present the main intuition, we focus on a case that generalizes the example provided at the end of section 4: committee members' preferences are nested. Moreover, we restrict the analysis to deterministic sequential mechanisms, defined below.

Let  $R_i$ ,  $i = 1, 2, \dots, N$  denote the members of the committee, with benefits  $r_i \in \{-L, G\}$  and  $p_i = \Pr\{r_i = G\}$ . Committee members are ranked with respect to their degree of external congruence with the sponsor,  $R_1$  being the most supportive and  $R_N$  the most radical opponent:

$$p_{N+1} \equiv 0 \leq p_N \leq p_{N-1} \leq \dots \leq p_2 \leq p_1 \leq 1.$$

We assume the following nested stochastic structure: projects that benefit a given member also benefit all members who are a priori more supportive of (or less opposed to) the project. That is, for any  $j, k$  such that  $j > k$ ,

$$r_j = G \implies r_k = G.$$

The committee makes its decision according to a  $K$ -majority rule, with  $K \leq N$  ( $K = N$  corresponds to the unanimity rule). So,  $S$  needs to build a consensus among (at least)  $K$  members of the committee to get the project approved. If  $p_K \geq p_0$ , then for all  $j \in \{1, 2, \dots, K\}$ ,  $p_j \geq p_0$ , and the  $K$  members who are the most externally congruent with the sponsor are willing to approve the project without investigation. From now on, we focus on the more interesting case in which general rubberstamping is not feasible ( $p_K < p_0$ ).

If the *voting pivot*  $R_K$  is not a priori willing to rubberstamp ( $p_K < p_0$ ), some information must be passed on inside the committee to obtain approval. Let us define the *informational pivot*  $R_{i^*}$  as the member who is the most externally congruent member within the set of committee members  $R_j$  who are not champion and whose internal congruence with  $R_K$  is sufficiently high to sway the voting pivot's opinion:  $\Pr\{r_K = G \mid r_j = G\} \geq p_0$ . Formally, in the nested structure:

$$i^* = \min\{j \mid p_0 p_j \leq p_K \text{ and } p_j \leq p_+\}.$$

Clearly,  $i^*$  exists and  $i^* \leq K$ .

A deterministic mechanism is a mapping  $(I(\cdot), d(\cdot))$  from the set of states of nature to  $2^{\{1, 2, \dots, N\}} \times \{0, 1\}$ , where  $I(\omega)$  denotes the set of committee members who investigate and  $d(\omega)$  denotes the final decision in state of nature  $\omega$ . In the rest of this section, we discuss the optimal deterministic mechanism in the nested case, first under the unanimity rule, and then under a more general  $K$ -majority rule.

*Unanimity rule ( $K = N$ )*

When general rubberstamping is infeasible, the sponsor has to let at least one committee member investigate. The sponsor has an obvious pecking order if he chooses to let exactly one member investigate: he prefers to approach the most favorable member among those who have the right incentives to investigate and whose endorsement convinces all other members (and in particular the voting pivot  $R_N$ ) to rubberstamp. The informational pivot is then a natural target for selective communication of the report by  $S$ . The next proposition formalizes this intuition and shows that selective communication with the informational pivot is optimal within the set of all deterministic mechanisms, even those involving multiple investigations.<sup>19</sup>

**Proposition 9. (Informational pivot under unanimity)** *Suppose that  $K = N$  and that  $p_N < p_0$ ;*

- *if  $p_- \leq p_{i^*}$ , the optimal deterministic mechanism consists in letting  $R_{i^*}$  investigate and all other members rubberstamp; the project is then approved with probability  $Q = p_{i^*}$ ;*
- *if  $p_{i^*} < p_-$ , the project cannot be approved using a deterministic mechanism.*

The proposition characterizes which committee member the sponsor should try to convince. Investigation revealing that  $r_{i^*} = G$  can generate a strong enough persuasion cascade that member  $R_N$ , and a fortiori all others, approve the project without further investigation. In general, the informational pivot differs from the voting pivot ( $R_N$  here). That is, the best strategy of persuasion is usually not to convince the least enthusiastic member. A better approach is to generate a persuasion cascade that reaches  $R_N$ . With nested preferences and the unanimity rule, this persuasion cascade involves at most a single investigation: member  $R_i$  is better off not investigating and pretending she favors the project when she knows that member  $R_j$  for  $j > i$  has or will investigate. The choice of the informational pivot reflects the trade-off between internal congruence with  $R_N$  and external congruence with  $S$ .

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<sup>19</sup>Both propositions in this section are proved in Appendix 3.

*Majority rule ( $K < N$ )*

Since  $p_K < p_0$ , the sponsor again must let at least one member investigate. If he chooses to let exactly one member investigate, he should target a member  $j$  who has an incentive to investigate and whose endorsement induces at least  $K - 1$  members to rubberstamp. Given the nested structure, the latter property amounts to convincing  $R_K$  to rubberstamp.

Proving that this one-investigation mechanism is optimal among all deterministic mechanisms is however more difficult than under the unanimity rule, because an investigation revealing that  $r_j = -L$  is still compatible with the project being approved. We were able to obtain this result only under the additional assumption of *vote transparency*: under vote transparency, before being asked to vote, all committee members observe which members have investigated and the results of their investigation. Although it is restrictive, this assumption may be motivated as follows. If all members know who has investigated but not necessarily the results of their investigation, it would be a dominant strategy for informed members to publicly and truthfully disclose the value of their benefits if a stage of public communication were introduced before the final vote. So, the important assumption is that investigation by a member who is presented with a report is observable by other members, or else that it is costless. Finally, note that it might be difficult for the sponsor to secretly approach a committee member without the others noticing.

**Proposition 10.** *Suppose that  $p_K < p_0 p_+$ ,  $K < N$ , and vote transparency holds; if  $p_- \leq p_{i^*}$ , the optimal deterministic mechanism consists in letting  $R_{i^*}$  investigate and all other members rubberstamp; the project is approved with probability  $Q = p_{i^*}$ .*

Note that the larger the required majority ( $K$  grows), the less sympathetic to the sponsor's cause the informational pivot is, and the lower the probability of adoption. Unlike an increase in the committee size under a given voting rule, an increase in the required majority for a given committee size can never benefit the sponsor under the conditions of Proposition 10.

Both propositions prove that selective communication is a key dimension in the sponsor’s optimal strategy; irrespective of the rules governing decision-making in the committee, it leads to a strong distinction between the voting and the informational pivot.<sup>20</sup>

## 7 Stochastic mechanisms

The restriction to deterministic mechanisms involves some loss of generality, as we now show. In this section, we consider a symmetric two-member committee ( $p_1 = p_2 = p$ ,  $\hat{p}_1 = \hat{p}_2 = \hat{p}$ ), and we investigate whether  $S$  can increase the probability of project approval by using (symmetric) stochastic mechanisms.

Assume that  $p_- < p < p_0 < \hat{p}$ , so that the optimal deterministic mechanism consists in a persuasion cascade where  $R_1$ , say, investigates and  $R_2$  rubberstamps. In this deterministic mechanism,  $R_2$  knows that  $R_1$  investigates and, given this, she has strict incentives to rubberstamp rather than to reject the project:  $u^R(\hat{p}) > 0 = u^R(p_0)$ . If  $R_2$  knew that  $R_1$  does not investigate, however, she would not rubberstamp since  $u^R(p) < 0$ . Suppose now that  $R_1$  may or may not investigate;  $R_2$  is then willing to rubberstamp provided she is confident enough that  $R_1$  investigates. So, when  $p < p_0 < \hat{p}$ , it is not necessary to have  $R_1$  investigate with probability 1 to get  $R_2$ ’s approval.

Intuitively, the incentive constraint corresponding to rubberstamping is slack in the deterministic mechanism. Stochastic mechanisms may be designed so as to induce appropriate beliefs from the committee members: we say that stochastic mechanisms exhibit *constructive ambiguity*. Constructive ambiguity enables  $S$  to reduce the risk that one member gets evidence that she would lose from the project, and thereby increases the overall probability of having the project adopted.

To make this intuition more precise, suppose  $S$  mixes among three deterministic mechanisms and committee members do not directly observe the realization of this lottery: with

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<sup>20</sup>Interestingly, the Democracy Center’s website makes a similar distinction between “decision-influencer” and “decision-maker”.

probability  $\theta \in (0, \frac{1}{2})$ ,  $S$  asks  $R_1$  to investigate and  $R_2$  to rubberstamp, with probability  $\theta$ ,  $S$  asks  $R_2$  to investigate and  $R_1$  to rubberstamp, and with probability  $\gamma = 1 - 2\theta$ ,  $S$  asks both committee members to rubberstamp. When asked to rubberstamp,  $R_i$  does not know whether  $R_j$  is asked to investigate.  $R_i$  rubberstamps whenever (3) holds, that is whenever:

$$(1 - 2\theta)u^R(p) + \theta pu^R(\hat{p}) \geq 0 \iff \theta \geq \frac{u^R(p)}{2u^R(p) - pu^R(\hat{p})}.$$

Note that  $\frac{u^R(p)}{2u^R(p) - pu^R(\hat{p})} \in (0, \frac{1}{2})$  because  $u^R(p) < 0$ , so that it is possible to find appropriate values of  $\theta$ . Moreover, when being asked to investigate, a committee member perfectly knows the realization of the mechanism lottery and she has incentives to comply, just like in a deterministic mechanism (since  $p > p_-$ ). This stochastic mechanism is therefore implementable and it leads to an overall probability of implementing the project equal to  $Q = (1 - 2\theta) + 2\theta p > p$ , hence higher than for the optimal deterministic mechanism.

We summarize this discussion as follows.

**Proposition 11.** *In the symmetric two-member committee, when  $p_- < p < p_0 < \hat{p}$ , stochastic mechanisms strictly dominate the optimal deterministic (persuasion cascade) mechanism; constructive ambiguity allows the sponsor to reduce investigation and to elicit rubberstamping more often.*

Stochastic mechanisms and the role of constructive ambiguity may also help  $S$  get a project approved even when facing two hard-core opponents. The intuition for this particularly striking result is quite similar to that for the previous result. Suppose the committee consists of two hard-core opponents ( $p < p_-$ ) whose distributions of payoffs are highly correlated:  $\hat{p} > p_0$ , i.e. there is strong internal congruence within this committee.  $S$ 's problem is to induce one member to investigate. If a committee member thought with sufficiently high probability that she is asked to investigate after her fellow committee member has investigated and discovered that her own benefits are positive, she would be willing to investigate herself, and even to rubberstamp. Hence, there is room again for constructive ambiguity:  $S$  can simply randomize the order in which he asks members to

investigate, without revealing the order that is actually followed.<sup>21</sup>

**Proposition 12.** *When  $p_0 > \frac{1+p_-}{2}$ , there exists a subset of parameter values  $(p, \hat{p})$  under which the sponsor can get approval from a committee consisting of two hard-core opponents as an equilibrium of a stochastic mechanism.*

The previous two propositions demonstrate the power of constructive ambiguity. Stochastic mechanisms enable  $S$  to manipulate committee members' information when they decide upon their action, thereby enlarging the set of available persuasion strategies. This approach is very similar to the practice that consists in getting two major speakers interested in attending a conference by mentioning the fact that the other speaker will likely attend the conference herself. If each is sufficiently confident that the other one is seriously considering to attend, she might indeed be induced to look closely at the program of the conference and investigate whether she can move her other commitments.

The one-investigation stochastic mechanism discussed in Proposition 11 can be easily implemented; the sponsor simply commits to secretly approach one of the members before the final vote. Implementing the random sequential investigation mechanism discussed in Proposition 12 may however be rather involved if  $S$  can approach only one committee member at a time and communication requires time. To illustrate the difficulty, suppose that with probability  $\frac{1}{2}$  the sponsor presents  $R_1$  with a detailed report at time  $t = 1$  and, if  $r_1 = G$ , he transfers the report to  $R_2$  at time  $t = 2$ ; with probability  $\frac{1}{2}$  the order is reversed. When being approached at  $t = 1$ ,  $R_i$  then knows for sure that she is the first to investigate and constructive ambiguity collapses. Implementing constructive ambiguity requires a more elaborate type of commitment.<sup>22</sup> Note also that Proposition 12 only yields a weak

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<sup>21</sup>The proof of Proposition 12 can be found in Appendix 4.

<sup>22</sup>Suppose there is a date  $t = 1$  at which the committee must vote. In addition to randomizing the order, the project sponsor must also commit to draw a random time  $t \in (0, 1)$ , according to some probability distribution, at which he will present the first member with a report; if presenting the report lasts  $\Delta$ , at  $t + \Delta$  he should (conditionally) present the other member with the report. The distribution of  $t$  must be fixed so that when being approached, a committee member draws an asymptotically zero-power test on the hypothesis that she is the first to be approached, when  $\Delta$  goes to 0.

implementation result: the stochastic mechanism admits another equilibrium where both members simply refuse to investigate and reject the project. Stochastic mechanisms may therefore come at a cost in terms of realism.

Finally, let us discuss the robustness of stochastic mechanisms to side communication. While the mechanism exhibited in Proposition 11 is robust to file transfers (for the now-usual reason that a member who knows she will benefit from the project does not want to jeopardize the other member's assent), it is not robust to soft communication before voting. Indeed it is Pareto optimal and incentive compatible for the members to communicate to each other when they have been asked to rubberstamp. This prevents them from foolishly engaging in collective rubberstamping.

By contrast, it can be argued that the random sequential investigation mechanism in Proposition 12 is robust to side communication. It is obviously robust to soft communication before voting as both know that they benefit from the project when they actually end up adopting it. Similarly, file transfers are irrelevant. Furthermore the equilibrium outcome is under some conditions Pareto optimal for the members and remains an equilibrium under soft communication as to the order of investigation (see footnote 22 for an example of implementation).

## 8 Conclusion

Many decisions in private and public organizations are made by groups. The economic literature on organizations has devoted surprisingly little attention to how sponsors of ideas or projects should design their strategies to obtain favorable group decisions. This paper has attempted to start filling this gap. Taking a mechanism design approach to communication, it shows that the sponsor should distill information selectively to key members of the group and engineer persuasion cascades in which members who are brought on board sway the opinion of others. The paper unveils the factors, such as the extent of congruence among group members (“internal congruence”) and between them and the

sponsor (“external congruence”), and the size and governance of the group, that condition the sponsor’s ability to maneuver and get his project approved. While external congruence has received much attention in the literature on a single decision-maker, the key role of internal congruence and its beneficial effect for the sponsor (for a given external congruence) is novel.

This work gives content not only to the pro-active role played by sponsors in group decision-making, but also to the notion of “key member”, whose endorsement is look after. A key member turns out to be an “informational pivot”, namely the member who is most aligned with the sponsor while having enough credibility within the group to sway the vote of (a qualified majority of) other members; a key member in general is not voting-pivotal and may initially oppose the project.

Even in the bare-bones model of this paper, the study of group persuasion unveils a rich set of insights, confirming some intuitions and invalidating others. On the latter front, we showed that adding veto powers may actually help the sponsor while an increase in external congruence may hurt him; that a more congruent group member may be worse off than an a priori more dissonant member; and that, provided that he can control channels of communication, the sponsor may gain from creating ambiguity as to whether other members really are on board. Finally, an increase in internal congruence always benefits the sponsor.

Needless to say, our work leaves many questions open. Let us just mention three obvious ones:

*Multiple sponsors:* Sponsors of alternative projects or mere opponents of the existing one may also be endowed with information, and themselves engage in targeted lobbying and the building of persuasion cascades. Developing such a theory of competing advocates faces the serious challenge of building an equilibrium mechanism design methodology for studying the pro-active role of the sponsors.

*Size and composition of groups:* We have taken group composition and size as given (although we performed comparative static exercises on these variables). Although this is

perhaps a fine assumption in groups like families or departments, the size and composition of committees, boards and most other groups in work environments are primarily driven by the executive function that they exert. As committees and boards are meant to serve organizational goals rather than lobbyists' interests, it would thus make sense to move one step back and use the results of analyses such as the one proposed here to answer the more normative question of group size and composition.<sup>23</sup>

*Two-tier persuasion cascades:* even though their informational superiority and gate-keeping privileges endow them with substantial influence on the final decision, committees in departments, Congress or boards must still defer to a “higher principal” or “ultimate decision-maker” (department; full House or, because of pandering concerns, the public at large; general assembly). Sponsors must then use selective communication and persuasion building at two levels. For example, lobbying manuals discuss both “inside lobbying” and “outside lobbying” (meetings with and provision of analysis to legislators, selective media and grassroot activities).

We leave these and many other fascinating questions related to group persuasion for future research.

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<sup>23</sup>In the context of a committee model with exogenous signals and no communication among members, Bond-Eraslan (2006) makes substantial progress in characterizing the optimal majority rule for members (taken behind the veil of ignorance).

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## Appendix 1: Proof of Lemma 2.

A payoff-relevant outcome consists of the list of members who investigate and whether the project is implemented or not. The set of states of nature is characterized by the possible values of  $r_1$  and  $r_2$ ; let  $\omega_0$  correspond to  $r_1 = r_2 = -L$ ,  $\omega_i$  to  $r_i = G$  and  $r_j = -L$ , and  $\omega_3$  to  $r_1 = r_2 = G$ . A (stochastic) direct mechanism is a mapping from the set of states of nature  $\Omega$  to the set of probability distributions over the set of possible outcomes.

For each  $\omega \in \Omega$ , let us introduce the following notation:

- $\gamma(\omega) \geq 0$ , the probability that no-one investigates and that the project is implemented in state  $\omega$ ;
- $\eta(\omega) \geq 0$ , the probability that no-one investigates and that the project is NOT implemented in state  $\omega$ ;
- $\theta_i(\omega) \geq 0$ , the probability that only  $R_i$  investigates and the project is implemented;
- $\mu_i(\omega) \geq 0$ , the probability that only  $R_i$  investigates and the project is NOT implemented;
- $\lambda(\omega) \geq 0$ , the probability that both investigate and the project is implemented;
- $\nu(\omega) \geq 0$ , the probability that both investigate and the project is NOT implemented.

When no one investigates, the mechanism cannot depend upon  $\omega$ ; when only  $R_i$  investigates, the mechanism cannot depend upon the value of  $r_j$ . From this, the following measurability conditions must hold:  $\gamma(\omega)$  and  $\eta(\omega)$  are constant across  $\omega$ , equal to  $\gamma$  and  $\eta$ ; moreover,  $\theta_i(\omega)$  and  $\mu_i(\omega)$  can only depend on  $r_i$  and, using the restriction presented above, we define:  $\theta_i(\omega_i) = \theta_i(\omega_3) \equiv \theta_i$ ,  $\mu_i(\omega_i) = \mu_i(\omega_3) \equiv \mu_i^+$  and  $\mu_i(\omega_j) = \mu_i(\omega_0) \equiv \mu_i^-$ .

Under the unanimity rule, a member can veto the project when knowing that she loses from the project. Interim incentive compatibility then requires:  $\theta_i(\omega_j) = \theta_i(\omega_0) = 0$ ,  $\lambda(\omega_0) = \lambda(\omega_1) = \lambda(\omega_2) = 0$ . We let now  $\lambda$  denote  $\lambda(\omega_3)$  and  $\nu_h$  denote  $\nu(\omega_h)$ .

The feasibility constraints impose that probabilities add up to 1 in each state of nature: for respectively  $\omega = \omega_3, \omega_1, \omega_2$  and  $\omega_0$

$$\begin{aligned}\gamma + \eta + \theta_1 + \theta_2 + \mu_1^+ + \mu_2^+ + \lambda + \nu_3 &= 1, \\ \gamma + \eta + \theta_1 + \mu_1^+ + \mu_2^- + \nu_1 &= 1, \\ \gamma + \eta + \theta_2 + \mu_1^- + \mu_2^+ + \nu_2 &= 1, \\ \gamma + \eta + \mu_1^- + \mu_2^- + \nu_0 &= 1,\end{aligned}$$

Alternatively, a mechanism is given by  $(\gamma, \theta_i, \mu_i^+, \mu_i^-, \nu_0, \nu_3)$  and:

$$\lambda = \nu_0 - \theta_1 - \theta_2 - \mu_1^+ - \mu_2^+ + \mu_1^- + \mu_2^- - \nu_3 \geq 0, \quad (4)$$

$$\nu_1 = \nu_0 - \theta_1 - \mu_1^+ + \mu_1^- \geq 0, \quad (5)$$

$$\nu_2 = \nu_0 - \theta_2 - \mu_2^+ + \mu_2^- \geq 0, \quad (6)$$

$$\eta = 1 - \gamma - \mu_1^- - \mu_2^- - \nu_0 \geq 0. \quad (7)$$

The expected probability that the project is implemented is given by:

$$Q = \gamma + p_1\theta_1 + p_2\theta_2 + P\lambda.$$

Plugging in the value of  $\lambda$  from (4), we find:

$$Q = \gamma + (p_1 - P)\theta_1 + (p_2 - P)\theta_2 + P\nu_0 - P\mu_1^+ - P\mu_2^+ + P\mu_1^- + P\mu_2^- - P\nu_3. \quad (8)$$

Let us now write the incentive constraints. When  $R_i$  is supposed to investigate, not investigating and playing as if  $r_i = G$  must be an unprofitable deviation. Given previous results and using the expressions for  $\lambda$  and  $\nu_i$ , this constraint can be written as:

$$\begin{aligned}& \theta_1(1 - p_1)L + (\nu_0 - \theta_1 - \theta_2 - \mu_1^+ - \mu_2^+ + \mu_1^- + \mu_2^- - \nu_3) (p_2 - P)L \\ & \geq c[\nu_0 + \mu_1^- + p_2(\mu_2^- - \theta_2 - \mu_2^+)],\end{aligned} \quad (9)$$

$$\begin{aligned}& \theta_2(1 - p_2)L + (\nu_0 - \theta_1 - \theta_2 - \mu_1^+ - \mu_2^+ + \mu_1^- + \mu_2^- - \nu_3) (p_1 - P)L \\ & \geq c[\nu_0 + \mu_2^- + p_1(\mu_1^- - \theta_1 - \mu_1^+)].\end{aligned} \quad (10)$$

$R_i$  must also not prefer to reject the project (an ex ante individual rationality constraint). Using the same manipulations as above, the latter inequality becomes:

$$\begin{aligned} & \theta_1 p_1 G + (\nu_0 - \theta_1 - \theta_2 - \mu_1^+ - \mu_2^+ + \mu_1^- + \mu_2^- - \nu_3) PG \\ \geq & c[\nu_0 + \mu_1^- + p_2 (\mu_2^- - \theta_2 - \mu_2^+)], \end{aligned} \quad (11)$$

$$\begin{aligned} & \theta_2 p_2 G + (\nu_0 - \theta_1 - \theta_2 - \mu_1^+ - \mu_2^+ + \mu_1^- + \mu_2^- - \nu_3) PG \\ \geq & c[\nu_0 + \mu_2^- + p_1 (\mu_1^- - \theta_1 - \mu_1^+)]. \end{aligned} \quad (12)$$

Finally, when the project is supposed to be implemented without  $R_i$ 's investigation,  $R_i$  must not prefer vetoing the project (another ex ante individual rationality constraint):

$$\gamma u^R(p_1) + \theta_2 p_2 u^R(\hat{p}_1) \geq 0, \quad (13)$$

$$\gamma u^R(p_2) + \theta_1 p_1 u^R(\hat{p}_2) \geq 0. \quad (14)$$

The program is to maximize (8) under the feasibility and incentive constraints. It is first immediate that  $\nu_3 = 0$  at the optimum. With  $(A_1, A_2, B_1, B_2, C_1, C_2)$  the multipliers associated with constraints (9)-(10)-(11)-(12)-(13)-(14), and  $D, E_1, E_2$  and  $F$  the multipliers associated with (4)-(5)-(6)-(7), one can compute the derivatives of the Lagrangian with respect to  $(\mu_1^+, \mu_2^+, \mu_1^-, \mu_2^-, \nu_0)$  (omitting the constraints that each of these must lie within  $[0, 1]$ ):<sup>24</sup>

$$\begin{aligned} \frac{\partial \mathcal{L}}{\partial \mu_i^+} &= -P - A_i(p_j - P)L - A_j(p_i - P)L + A_j c p_i \\ &\quad - B_i PG - B_j PG + B_j c p_i - (D + E_i) \end{aligned}$$

$$\begin{aligned} \frac{\partial \mathcal{L}}{\partial \mu_i^-} &= P + A_i(p_j - P)L + A_j(p_i - P)L - A_j c p_i \\ &\quad + B_i PG + B_j PG - B_j c p_i - c(A_i + B_i) + (D + E_i) - F \end{aligned}$$

$$\begin{aligned} \frac{\partial \mathcal{L}}{\partial \nu_0} &= P + A_1(p_2 - P)L - cA_1 + A_2(p_1 - P)L - cA_2 \\ &\quad + B_1 PG - cB_1 + B_2 PG - cB_2 + (D + E_1 + E_2) - F \end{aligned}$$

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<sup>24</sup>We do not need to write the other derivatives to obtain Lemma 2.

Note that if  $(A_j + B_j) = 0$ , then  $\frac{\partial \mathcal{L}}{\partial \mu_i^+} < 0$  and so,  $\mu_i^+ = 0$ .

From the derivatives of the Lagrangian, one can derive useful relationships:

$$\frac{\partial \mathcal{L}}{\partial \mu_i^+} + \frac{\partial \mathcal{L}}{\partial \mu_i^-} = -F - c(A_i + B_i) \leq 0, \quad (15)$$

$$\frac{\partial \mathcal{L}}{\partial \mu_i^-} + E_j = \frac{\partial \mathcal{L}}{\partial \nu_0} + c(1 - p_i)(A_j + B_j). \quad (16)$$

**Claim 1.** *The optimum cannot be such that  $\nu_0 > 0$ ,  $\mu_i^+ > 0$  and  $\mu_2^+ > 0$ .*

**Proof.** If  $\nu_0 > 0$ ,  $\mu_i^+ > 0$  for  $i = 1, 2$ , it follows that  $\frac{\partial \mathcal{L}}{\partial \nu_0} \geq 0$ ,  $\frac{\partial \mathcal{L}}{\partial \mu_i^+} \geq 0$ .  $A_1, A_2, B_1$  and  $B_2$  must be strictly positive so that  $\frac{\partial \mathcal{L}}{\partial \mu_i^+} + \frac{\partial \mathcal{L}}{\partial \mu_i^-} < 0$ . Hence,  $\frac{\partial \mathcal{L}}{\partial \mu_i^-} < 0$  and  $\mu_i^- = 0$  from (15).

Moreover, (16) implies that  $E_j > 0$ , which implies  $\nu_j = 0$  and so, summing (5) and (6),  $\lambda = -\nu_0 < 0$ , a contradiction. ■

**Claim 2.** *The optimum is without loss of generality such that for  $i = 1, 2$ ,  $\mu_i^+ \mu_i^- = 0$ .*

**Proof.** Fix  $\mu_i^- - \mu_i^+$ . A simple examination of  $Q$  and of all the constraints reveals that decreasing  $\mu_i^-$  only relaxes (7) and (9)-(11) or (10)-(12). Therefore, if  $\mu_i^- - \mu_i^+ \geq 0$ , the optimum can be chosen so that  $\mu_i^+ = 0$  and if  $\mu_i^- - \mu_i^+ \leq 0$ , the optimum can be chosen so that  $\mu_i^- = 0$ . ■

Therefore, we will now focus on optima that satisfy Claim 2.

**Claim 3.** *An optimum satisfying Claim 2 cannot be such that  $\nu_0 = 0$  and  $\mu_i^+ > 0$  for some  $i$ .*

**Proof.** Suppose that  $\nu_0 = 0$  and there exists  $i$  such that  $\mu_i^+ > 0$ . From Claim 2, the optimum is such that  $\mu_i^- = 0$ . Then, the constraint that  $\nu_i \geq 0$  is violated. ■

**Claim 4.** *An optimum satisfying Claim 2 cannot be such that  $\nu_0 > 0$ ,  $\mu_1^+ > 0$  and  $\mu_2^+ = 0$ .*

**Proof.** Suppose  $\nu_0 > 0$  and  $\mu_1^+ > 0 = \mu_2^+ = \mu_1^-$ . It must be that  $\frac{\partial \mathcal{L}}{\partial \nu_0} \geq 0$ ,  $\frac{\partial \mathcal{L}}{\partial \mu_1^+} \geq 0$ ,  $\frac{\partial \mathcal{L}}{\partial \mu_1^-} \leq 0$  and  $A_2 + B_2 > 0$ . As in the proof of Claim 1, it follows that  $E_2 > 0$ , which implies that  $\nu_2 = 0$ . So, we have:

$$\begin{aligned} 0 &\leq \lambda = \nu_0 - \theta_1 - \theta_2 - \mu_1^+ - \mu_2^+ + \mu_1^- + \mu_2^- \\ &= \nu_2 - \theta_1 - \mu_1^+ + \mu_1^- = -\theta_1 - \mu_1^+ < 0, \end{aligned}$$

a contradiction. ■

**Claim 5.** : If  $\mu_1^+ = \mu_2^+ = 0$ , the optimum is without loss of generality such that  $\nu_0 = 0$ .

**Proof.** Suppose  $\mu_1^+ = \mu_2^+ = 0 < \nu_0$ , then  $\frac{\partial \mathcal{L}}{\partial \nu_0} \geq 0$ .

Note first that if there exists  $i$  such that  $\frac{\partial \mathcal{L}}{\partial \mu_i^-} > 0$ , then  $\mu_i^- = 1$  and then  $\eta < 0$ , a contradiction. So, for  $i = 1, 2$ ,  $\frac{\partial \mathcal{L}}{\partial \mu_i^-} \leq 0$ .

Note also that if  $E_i > 0$ , then  $\nu_i = 0$  so that  $\nu_j = \lambda + \nu_0 > 0$  and therefore  $E_i = 0$ . With the previous remark, using (16), this implies that  $\frac{\partial \mathcal{L}}{\partial \nu_0} = 0$  and for some  $i$ ,  $A_i = B_i = 0$ .

Suppose  $A_1 = B_1 = 0 < A_2 + B_2$  and  $E_2 > 0 = E_1$ . Consider the simplified program where the constraints corresponding to  $A_1$ ,  $B_1$  and  $E_1$  are omitted. In this program,  $\nu_0$  and  $\mu_2^-$  enter only through  $(\nu_0 + \mu_2^-)$  within  $(0, 1]$ ; and so, there is no loss of generality in looking for the optimum with  $\nu_0 = 0$ .

The last possibility is such that  $A_i = B_i = E_i = 0$  for  $i = 1, 2$ . Then, the simplified program where all corresponding constraints are omitted only depends upon  $\nu_0 + \mu_1^- + \mu_2^-$ , and again, one can set  $\nu_0 = 0$  without loss of generality. ■

To summarize, the optimal mechanism is without loss of generality such that  $\nu_0 = \mu_1^+ = \mu_2^+ = 0$ . It belongs to the class of no-wasteful-investigation mechanisms. In this class, a mechanism is characterized by  $(\gamma, \theta_1, \theta_2, \mu_1^-, \mu_2^-)$ . Defining  $\lambda_i = \mu_i^- - \theta_i$ , yields the final result of Lemma 2.

## Appendix 2: Proof of Proposition 8.

Assume first, that  $p_2 < p_0$ ,  $p_- \leq p_1 \leq p_+$  and  $\hat{p}_2 \geq p_0$ , so that the optimal mechanism is to let  $R_1$  investigate and  $R_2$  rubberstamp.<sup>25</sup> Consider the following game form  $\Gamma$ :

- $S$  presents  $R_1$  with a report;  $R_1$  investigates (or not) and reports  $r_1$  publicly;

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<sup>25</sup>The case where  $R_2$  investigates and  $R_1$  rubberstamps is similar.

- $R_1$  may communicate with  $R_2$ , that is, she may send  $R_2$  a message or transfer her the file, in which case  $R_2$  may investigate;
- $R_1$  and  $R_2$  can exchange information;
- finally members vote on the project.

Game form  $\Gamma$  has an equilibrium that implements the optimal mechanism and in which no side communication takes place on the equilibrium path:  $R_1$  investigates in the first stage, does not transfer the file, and reports truthfully;  $R_2$  approves the project,  $R_2$  always believes that  $R_1$  has investigated, regardless of whether  $R_1$  hands over the file, and  $R_2$  never investigates in case  $R_1$  transfers the file ( $R_2$ 's beliefs over the value of  $r_1$  in case of file transfer are irrelevant).  $R_1$  is a de facto dictator.

Let us now assume that  $p_- \leq P < p_1 \leq p_+$  and for all  $i = 1, 2$ ,  $\hat{p}_i < p_0$ , in which case the optimal mechanism is to have both members investigate, with say  $R_2$  investigating conditionally on  $r_1 = G$ . Consider the following game form  $\Gamma'$ :

- $S$  presents  $R_1$  with a report;  $R_1$  investigates (or not), and reports  $r_1$  publicly;
- $R_1$  may send  $R_2$  a message or transfer her the file;
- $S$  presents  $R_2$  with a report if  $R_1$  has announced that  $r_1 = G$ ;
- $R_2$  and  $R_1$  may exchange information;
- finally members vote on the project.

Game form  $\Gamma'$  has an equilibrium that implements the optimal mechanism and in which no side communication takes place on the equilibrium path:  $R_1$  investigates and reports truthfully; if  $R_1$  reports she favors the project,  $R_2$  investigates; if  $R_1$  reports that  $r_1 = -L$ ,  $R_2$  does not investigate even if  $R_1$  hands over the file; at the voting stage, both vote according to their benefit.

## Appendix 3: Proof of Propositions 9 and 10.

### *Preliminaries: consequences of measurability*

In this framework, there are  $N + 1$  states of nature:  $\omega = 0$  by convention denotes the state in which no-one benefits from the project and, for  $i \in \{1, 2, \dots, N\}$ ,  $\omega = i$  denotes the state in which all  $j \leq i$  benefit from the project and all  $j > i$  suffer from it. The probability of state  $\omega_i$  for  $i \in \{1, 2, \dots, N\}$  is equal to  $\pi(i) = p_i - p_{i+1}$ , and the probability of state  $\omega_0$  is equal to  $\pi(0) = 1 - p_1$ .

Any deterministic mechanism must meet *measurability conditions* that generalize the idea that the mechanism cannot depend upon information that is unknown to everyone. More precisely, the probability of a given outcome must be measurable with respect to the benefits of members who end up investigating in this outcome. Consider two different states  $\omega = i$  and  $\omega = i'$ ; if they give rise to different deterministic outcome,  $(I(i), d(i)) \neq (I(i'), d(i'))$ , the outcome  $(I(i), d(i))$  has probability 1 in state of nature  $\omega = i$  and 0 in state of nature  $\omega = i'$ . If all investigating members in  $I(i)$  have identical benefits in  $\omega = i$  and in  $\omega = i'$ , the probability of this outcome would depend upon unknown information, hence would violate measurability. So, measurability implies that there exists  $j \in I(i)$  such that  $r_j(i) \neq r_j(i')$ .

This property has several important implications in the unanimity case.

First, suppose that  $I(i) \neq I(i')$  and  $d(i) = d(i') = 1$ . There must exist a member  $j \in I(i)$  such that  $r_j(i) = G \neq r_j(i') = -L$ , which implies that  $d(i') = 0$ , a contradiction. Therefore, if  $d(i) = d(i') = 1$ , then the set of members who investigate must be the same in both states:  $I(i) = I(i')$ . So there exists a set  $I$  and  $m = \max\{j \in I\}$ , such that:  $d(i) = 1 \implies I(i) = I$  and  $i \geq m$ .

As a second consequence of the above property, if  $i' = i + 1$  and  $d(i)$  and  $d(i + 1)$  are different, then necessarily  $j = i + 1$  must belong to  $I(i) \cap I(i + 1)$ . This has two consequences:

- Let  $k = \min\{j \mid j \geq m, d(j) = 1\}$ . Suppose  $k > m$ . Then  $d(k) = 1 \neq d(k - 1) = 0$

and  $k - 1 \geq m$ . It follows that  $k \in I(k) = I$  a contradiction with  $m = \max\{j \in I\}$ .

Therefore,  $d(m) = 1$ .

- Suppose there exists  $j \geq m$  such that  $d(j) = 1$  and  $d(j + 1) = 0$ . Then again,  $(j + 1) \in I$  and  $j + 1 > m$ ; a contradiction.

One can then conclude that  $d(i) = 1 \iff i \geq m$ .

As a third consequence of the previous property, suppose  $i = m$  and  $i' < m$  so that  $d(i') = 0$ . There exists  $j \in I$  such that  $r_j(m) \neq r_j(i')$ ; given the nested structure, this is possible only if  $i' < j \leq m$ . Since  $m$  is extremal in  $I$ , necessarily  $j = m$ . Therefore, for any  $i$ ,  $m \in I(i)$ , provided  $m < N + 1$ .

*Proof of Proposition 9*

From the property that  $d(i) = 1 \iff i \geq m$ , it follows that  $Q = \sum_{i=0}^N \pi(i)d(i) = p_m$ . If  $N \in I$ , then  $Q = p_N \leq p_{i^*}$ . If  $N \notin I$ ,  $R_N$  never investigates in any state of nature where the project is implemented and  $R_N$  rubberstamps in states  $\omega \in I$  if:

$$\sum_{i=0}^N \pi(i)d(i)r_N(i) \geq 0 \iff d(N) = 1 \text{ and } p_N \geq p_0 \sum_{i=m}^N \pi(i)d(i) = p_0 p_m.$$

The probability of the project being adopted then satisfies:  $Q = p_m \leq \frac{p_N}{p_0}$ .

Since  $m \in I(i)$  for all  $i$ , let us analyze  $R_m$ 's incentive constraint.  $R_m$ 's expected payoff from investigating when being asked equals:

$$\sum_{i=0}^N \pi(i)d(i)r_m(i) - \sum_{\{i|m \in I(i)\}} \pi(i)c = p_m G - c,$$

since for any  $i$ ,  $m \in I(i)$ . If she deviates and rubberstamps, she obtains:

$$\begin{aligned} \sum_i \pi(i)d(\alpha(i))r_m(i) &= \sum_{i \geq m} \pi(i)G - \sum_{\{i|i < m, d(\alpha(i))=1\}} \pi(i)L \\ &\geq p_m G - (1 - p_m)L, \end{aligned}$$

where  $\alpha(i)$  is the state of nature obtained by substituting  $G$  in place of the true value of  $r_m$ ; note that this may lead to a different decision  $d(\alpha(i)) \neq d(i)$  only if no other

investigation reveals a loss for another member.  $R_m$ 's incentive constraint then implies  $p_m \leq p_+$ .

Similarly,  $R_m$ 's incentives to investigate instead of simply vetoing the project implies  $p_m \geq p_-$ .

Therefore, suppose the project can be implemented with positive probability using a deterministic mechanism, i.e. there exists  $m < N + 1$ . An overall upper bound on the probability that the project be implemented is therefore  $p_{i^*}$ . If  $p_- \leq p_{i^*}$ , this upper bound can be reached with the mechanism described in the text since then  $R_{i^*}$  is willing to act as sole investigator. If  $p_{i^*} < p_-$ ,  $Q = p_m < p_-$  would lead to a contradiction; so, in this case, the project cannot be implemented using a deterministic mechanism.

*Proof of Proposition 10*

We assume vote transparency that is, when deciding to vote on the project proposal, all members know who has investigated in the mechanism that is being implemented and what are their benefits.

Under a  $K$ -majority rule, let  $m(i) = \max\{j \in I(i), \text{ such that } r_j(i) = G\}$ . Member  $R_{m(i)}$  is the least externally congruent investigator in state of nature  $\omega = i$  that finds out she benefits from the project. Obviously,  $m(i) \leq i$ .

Suppose that  $m(i) < i^*$ . For  $j \geq K$ , let us analyze  $R_j$ 's incentive constraints to vote in favor of the proposal. If  $j \in I(i)$ , since  $j \geq K \geq i^* > m(i)$ , then  $r_j(i) = -L$  and  $j$  will vote against the project. If  $j \notin I(i)$ , she rubberstamps if all information  $\mathcal{J}$  she acquires enables her to update her beliefs so that  $\Pr\{r_j = G \mid \mathcal{J}\} \geq p_0$ . By vote transparency, Information  $\mathcal{J}$  consists of the list  $I = I(i)$  of members who have investigated and the values  $r_k(i)$  for  $k \in I(i)$  and  $m(i)$ . Given affiliation and the nested information structure, the best news  $R_j$  can obtain is that there does not exist  $k \in I$  such that  $r_k(i) = -L$ , that is  $\mathcal{J} = \{i \geq m(i)\}$  since  $m(i)$  is the largest of  $k$  such that  $r_k(i) = G$ . Then  $\Pr\{r_j = G \mid \mathcal{J}\} = \frac{p_j}{p_{m(i)}}$ .

$m(i) < i^*$  implies that  $p_{m(i)} > \frac{p_K}{p_0}$  since  $p_K \leq p_+ p_0$ . Then

$$\Pr\{r_j = G \mid \mathcal{J}\} = \frac{p_j}{p_{m(i)}} \leq \frac{p_K}{p_{m(i)}} < p_0.$$

That is, even with the best possible news, all  $j \geq K$  vote against the project. Therefore, the project gets less than  $K$  favorable votes in every state of nature  $i$  such that  $m(i) < i^*$ . And so, the project is turned down if  $i < i^*$ . It follows that  $Q \leq p_{i^*}$ .

Under the assumption that  $p_{i^*} \geq p_-$ , the mechanism described in the proposition meets all incentive constraints and achieves this upper bound; it is therefore optimal.

## Appendix 4: Proof of Proposition 12.

Suppose  $p < p_-$ . Consider the following symmetric stochastic mechanism.  $S$  commits to draw randomly between two deterministic mechanisms with equal probabilities, without revealing the realization of this lottery to committee members: with probability  $\frac{1}{2}$ , he asks  $R_1$  to investigate and then, if  $r_1 = G$ , he asks  $R_2$  to investigate, and with probability  $\frac{1}{2}$ , she follows the symmetric scheme.

This mechanism is incentive compatible if there exists an equilibrium in which  $R_i$  is induced to investigate given that she expects  $R_j$  to investigate, that is if (2) and (1) hold:

$$u^I(P) + pu^I(\hat{p}) \geq 0, \tag{17}$$

$$\frac{u^I(P) + pu^I(\hat{p})}{2} \geq pu^R(\hat{p}). \tag{18}$$

If  $\hat{p} > p_0$ ,  $u^R(\hat{p}) > 0$  and (17) can be omitted. (18) is equivalent to:

$$PG - c + p(\hat{p}G - c) \geq 2p(\hat{p}G - (1 - \hat{p})L),$$

and, using  $\frac{c}{G} = p_-$  and  $\frac{c}{L} = \frac{c}{G} \frac{G}{L} = p_- \frac{1-p_0}{p_0}$ , this can be written as:

$$1 - \hat{p} \geq p_- \frac{1 - p_0}{p_0} \frac{1 + p}{2p}. \tag{19}$$

For  $p \in (0, p_-)$ , there exists  $\hat{p} \in (p_0, 1)$  satisfying the above inequality if and only if:

$$p_0 < 1 - p_- \frac{1 - p_0}{p_0} \frac{1 + p}{2p}.$$

The RHS being increasing in  $p$ , one can conclude that if this inequality holds for  $p = p_-$ , then for  $p$  in a left neighborhood of  $p_-$ , there exists  $\hat{p} \in (p_0, 1)$  satisfying the incentive constraints. Finally, the above inequality holding for  $p = p_-$  is equivalent to:

$$p_0 > \frac{1 + p_-}{2}.$$

If  $\hat{p} < p_0$ , (18) can be omitted and (17) can be written as:

$$\hat{p} \geq p_- \frac{1 + p}{2p}. \quad (20)$$

For  $p \in (0, p_-)$ , there exists  $\hat{p} \in (0, p_0)$  satisfying this inequality if and only if:  $p_0 > p_- \frac{1+p}{2p}$ . Therefore, if  $p_0 > \frac{1+p_-}{2}$ , (20) holds for  $p$  close enough to  $p_-$  and  $\hat{p}$  in a left neighborhood of  $p_0$ .

So, if  $p_0 > \frac{1+p_-}{2}$  and  $p$  is smaller but close to  $p_-$ , there exists an interval of values of  $\hat{p}$  around  $p_0$  such that the symmetric stochastic mechanism that we have analyzed is incentive compatible and yields a strictly positive probability of having the project approved.