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On the Composition of Committees*

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Abstract

This paper is concerned with the role of committees in collective decision-making processes in a world where agents must be motivated to collect information. Committees improve the quality of decision-making by providing information and by coordinating the collection of information. We address two types of questions. First, how does the composition of a committee affect final decisions? Second, what is the optimal composition of a committee from the decision maker's point of view? As to the latter question, we show that the cost of information collection plays an important role. If this cost is low, then the preferences of the committee members should be aligned to those of the decision maker. Members with similar preferences as the decision maker collect the proper pieces of information. Moreover, manipulation of information does not occur if the preferences of the decision maker and the members are consonant. If the cost of searching is high, then the committee should be composed of members with polarized preferences. Outliers have a strong incentive to search for information.

Key words: committees, information collection, preference outliers, moderates.

JEL codes: D81, D83.

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1 Introduction

The consequences of many decisions are complicated and difficult to foresee. Often small groups - committees - assist decision makers with collecting information. Committees are used in all types of organizations. In U.S. Congress committees prepare and propose bills; in firms committees rather than single persons prepare major investment decisions; in universities committees have much say in appointment decisions.

A common rationale for the existence of committees is that they lead to decisions which are based on more and/or better information. However, it is also well-known that committees may raise an agency problem. When the interests of committee members on the one hand and the interests of the decision maker or organization on the other hand do not perfectly align, committee members may have an incentive to manipulate or conceal information.

We argue that apart from manipulation and concealment of information committees may raise two other agency problems. First, committee members may lack incentives to collect information. Information is usually not for free. In most studies on committees, it is assumed rather than explained that committees are informed. Second, committee members must be motivated to collect the proper pieces of information. The reason for this agency problem is that the consequences of many decisions are multi-dimensional. For instance, the construction of a new railroad has economic consequences, consequences for the environment and social consequences. A committee thus faces the problem of determining which pieces of information to collect. Concerning this choice, the desires of the principal may deviate from those of the committee members.

This paper is concerned with the role of committees in collective decision making processes in a world where agents must be motivated to collect information. We analyze a simple model in which a decision maker has to make a binary decision under uncertainty. The decision maker misses three pieces of information. A committee consisting of two members is tasked with the provision of information. Each member can collect at most one piece of information. An important aspect of our model is that the nature of the three pieces of information differs. One piece of information is soft and can be manipulated if it is found. The other two pieces are hard information. If hard information is found, it can costlessly be verified. Another important aspect of our model is that the decision maker cannot guide the behavior of committee members through monetary rewards. The reason why in our model committee members may collect and supply information is that they have an interest in the outcomes. These interests may differ from those of the decision maker. Our setting enables us to address two types of questions: First, how does the composition of a committee affect final decisions? Second, what is the optimal composition of a committee from the decision maker's point of view?

As to the question of the optimal composition of the committee, we show that the cost of information collection plays an important role. If this cost is low, then the preferences of the committee members should be aligned to those of the decision maker. The committee should be composed of members with polarized preferences if the cost is high. The intuition behind this result is as follows. From the decision maker's point of view, there are two benefits of committee members with preferences similar to those of himself. First, recommendations based on soft information are most informative when the preferences of the members and the principal are consonant.[1] Second, if the preferences of the committee members and the principal are consonant, then the committee members will collect the pieces of information the principal wants them to collect. The benefit of appointing preference outliers is that preference outliers have stronger incentives to collect information. For example, a member who is strongly biased against a project has strong incentives to search for information that may convince the decision maker that the project should not be implemented.[2] If the cost of acquiring information is high, then members with moderate preferences will not collect information. A related result is that if the costs of collecting information is high, only hard information will be collected. The reason is that preference outliers have incentives to manipulate soft information. Manipulation precludes communication between the principal and the members. Consequently, outliers do not collect soft information. Hard information cannot be manipulated by definition.

We believe that our results improve our understanding of the role of commit-

[1] This result is well-known from the cheap talk literature. In the context of the literature on committees, Krehbiel (1991) speaks about the outlier principle.

[2] Interest groups can be seen as preference outliers. Interest groups provide information through, for example, lobbying, see among others Potters and van Winden (1992).

tees in decision- making processes. On the basis of our results we can categorize alternative types of committees. At one extreme, we have the advocacy committee. An advocacy committee consists of a strong proponent and a fierce opponent of the project. The former will try to find hard evidence supporting the project, while the latter will try to find hard evidence against the project. As a rule, advocacy committees do not speak with one voice. At the other extreme, we have the moderate committee. The members of a moderate committee have preferences which are approximately congruent with those of the principal. Transmission of soft information between committee members and the decision maker is possible. Moderates may also search for hard information. Unlike in advocacy committees, in moderate committees there is not a natural division of tasks. Tasks have to be coordinated.

Both archetypes of committees, as well as mixed forms, can be found in organizations. Krehbiel (1990) finds that most legislative committees in U.S. Congress consist of members with moderate preferences. He finds preference outliers in some committees, however. We identify the conditions under which the various types of committees are desirable from the point of view of the median floor member.

This paper is organized as follows. The next section discusses the literature related to this paper. Section 3 describes the model. Section 4 presents equilibria of our game first under the assumption that information is hard, and next under the assumption that information is soft. Section 5 examines what kind of information is provided if members can decide to search for either hard or soft information. In Section 6 we extend the basic model by allowing the principal to appoint committee members. Section 7 concludes.

2 Related literature

Our paper makes use of several elements employed in other papers. The collection of information is delegated to committees.[3] The principal retains the formal authority to make the decision. However, by providing information committee members essentially control the decision (Aghion and Tirole, 1997). Taking this into account, the principal wants to guide the actions of the committee members.

[3] See for an excellent overview of theories of delegation Bendor, Glazer and Hammond (2001).

In our paper, we consider the collection of several pieces of information, verifiable as well as non-verifiable. As far as the latter is concerned, communication between the members and the principal plays an important role. Crawford and Sobel (1982) show that perfect communication of non-verifiable information requires that the preferences of the players are congruent. Using a model of soft information, Krishna and Morgan (2001) study information transmission between a principal and two perfectly and identically informed experts. They focus on the aggregation and extraction of soft information rather than on the collection of information. In the same spirit, Ottaviani and Sorensen (2001) examine how the order of speech affects the extraction of information within committees. Li, Rosen and Suen (2001) show that voting procedures may improve the extraction of information when committee members have conflicting preferences.[4]

Dur and Swank (2002) study the selection of an advisor in a situation in which the collection of information is costly. As in our paper, the collection of soft information requires that the preferences of the advisor and the principal are congruent. An unbiased advisor, however, has strong incentives to collect soft information since information often affects his recommendation. Our paper focuses on the collection of information through the use of committees. Committees may also facilitate the coordination of information collection if the consequences of the decision are multi-dimensional.

A paper closely related to ours is Dewatripont and Tirole (1999). They show that using two competing agents defending their own special interest improves the quality of decision-making compared to using a single information-collecting agent. They thus provide a rationale for advocacy. Our paper deviates from the paper by Dewatripont and Tirole in two respects. First, Dewatripont and Tirole assume that agents are ideologically neutral and can be induced to search through monetary decision-based rewards. We focus on situations in which committee members collect information solely because they have a non-monetary interest in the outcomes. Second, in Dewatripont and Tirole agents can only collect hard information, while in our model agents may also collect soft information.

Furthermore, our paper is related to the literature on the composition of com-

[4]Piketty (1999) provides an overview of the information-aggregation literature.

mittees in U.S. Congress. There are two strands in this literature. First, the informational theory argues that preferences of committee members should be close to the preferences of the median floor member.[5] The principal (e.g. Congress) can prevent manipulation of information by appointing members with moderate preferences.[6] Second, the distributive theory argues that committees are composed of preference outliers.[7] Committees are presumed to have strong proposal power and agenda-setting control. This allows committee members to enforce bills that are beneficial for a small group but are inefficient for the society as a whole. Each representative then applies for a committee that potentially benefits his constituency most. Hence, as claimed by Shepsle and Weingast (1987), committees consist of "homogeneous high demanders".

Empirical research shows that in most committees in U.S. Congress moderates are found while sometimes preference outliers are found.[8] Our paper provides the conditions under which different types of committee members are optimal. As in the informational theory, there is a clear incentive for the principal to use like-minded committee members if the costs of searching are low. However, members with moderate preferences have no incentive to collect information if the costs of searching are high. Then it is optimal to make use of preference outliers.

3 The Model

3.1 Policies

A decision maker, for example the median voter of Congress, has to make a decision about a project, X. There are two alternatives: implementation ($X = 1$) and status quo ($X = 0$). The consequences of the project are surrounded by uncertainty. The

[5] See the papers by Gilligan and Krehbiel (1987, 1989, 1990, 1997).

[6] In their 1990 paper, Gilligan and Krehbiel argue that preference outliers may have lower costs of collecting information. This provides a rationale for using members with polarized preferences. In our paper, the cost of searching is equal for all agents. However, biased agents have a stronger interest in the decision to be made. Hence, rather than the costs the benefits of searching differ among agents.

[7] The major references are Shepsle and Weingast (1987) and Weingast and Marshall (1988).

[8] See for example Krehbiel (1990). Groseclose (1992) provides an overview of the empirical literature on the composition of committees in U.S. Congress.

decision maker prefers $X = 1$ to $X = 0$ if

$$p + \theta_A + \theta_B + \mu > 0. \quad (1)$$

The parameter θ_A is equal to $-z$ with probability $\frac{1}{2}$ and 0 with probability $\frac{1}{2}$. The parameter θ_B equals z with probability $\frac{1}{2}$ and 0 with probability $\frac{1}{2}$. The parameter μ is uniformly distributed over the interval $[-h, h]$. The reason for the asymmetry among the parameters is as follows. As we will see below, information about μ cannot be verified (it captures soft information). Communication about μ occurs through recommendations. By assuming that μ is distributed according to a continuous function, we allow for the possibility of imperfect communication. Information about θ_A and θ_B cannot be manipulated by assumption (it captures hard information). We assume for simplicity that both are binary parameters. The three parameters are independently distributed. The parameter p denotes the expected benefit of the project from the decision maker's point of view. It is meant to capture the decision maker's political attitude towards the project. We assume that $p < 0$.[9] The implication is that without information about the stochastic terms the decision maker would choose $X = 0$.

3.2 Information Collection

The decision maker constitutes a committee of two agents to learn the consequences of the project. Each agent can learn the value of at most one stochastic term. Formally, agent i, $i \in \{1, 2\}$, selects $L_i \in \{\theta_A, \theta_B, \mu, 0\}$, where $L_i = 0$ denotes that agent i chooses to learn nothing. To learn the value of a stochastic term, an agent must incur disutility of effort K. When agent i selects $L_i = \theta_A$ or $L_i = \theta_B$, he learns its value with certainty. We assume that θ_A and θ_B contain hard information, in the sense that if agent i finds that $\theta_A = -z$ or $\theta_B = z$, he can credibly communicate this information to anybody. Discovering $\theta_A = -z$ can be interpreted as finding an argument for maintaining the status quo. Likewise, discovering $\theta_B = z$ can be interpreted as finding an argument for implementation. Though information about θ_A and θ_B cannot be forged, it can be concealed.

[9] The analysis of the case that $p > 0$ is analogous to the case analyzed below.

When agent i selects $L_i = \mu$ and incurs K, he receives a private signal s_i about μ with probability π and learns nothing with probability $1 - \pi$. The signal s_i is fully informative: $s_i = \mu$. For simplicity, we assume that whether or not an agent has received a signal is common knowledge.[10] However, the content of the signal is only known to the agent. The signal contains soft information, that is information that cannot be verified. If the agent has received a signal about μ, then he makes a recommendation about the project. We allow for two recommendations: Y_i (agent i recommends $X = 1$) and N_i (agent i recommends $X = 0$). Formally, the message space of agent i is $m_i \in \{0, -z, z, Y_i, N_i\}$.

3.3 The Committee

Like the decision maker, the agents are concerned with policy outcomes. Agent i prefers $X = 1$ to $X = 0$ if

$$a_i + \theta_A + \theta_B + \mu > 0, \tag{2}$$

where $a_i \in (-\infty, \infty)$ denotes agent i's political attitude towards the project. Without loss of generality, we assume that $a_2 \geq a_1$. As to the nature of the a_i's, we make two alternating assumptions. In the next two sections, the a_i's are exogenous. In Section 6, the decision maker appoints members of the committee. We model this by allowing the decision maker to determine the political attitude of each agent. Throughout, we assume that agents' decisions are voluntary. They cannot be forced to collect information. Nor can they be forced to collect information about a specific stochastic term.

3.4 The Timing

First, nature chooses θ_A, θ_B and μ. Next, the decision maker appoints two agents: a_1 and a_2. Once appointed, each agent decides whether or not to examine an aspect of the project or to do nothing $L_i \in \{\theta_A, \theta_B, \mu, 0\}$. The two agents examine the project simultaneously.[11] When the process of information collection has been completed,

[10] This assumption does not affect the results qualitatively.

[11] This assumption is not innocuous. For example, in our model we allow for the possibility that $L_1 = L_2 = \mu$. If there were no time constraint, it would be always better to let agent i to examine

communication may take place between the agents on the one hand and the decision maker on the other hand. If found, hard information may be transmitted. In addition, agents who have received a signal about μ may make a recommendation. We assume that if agent i looks for hard information while agent j looks for soft information, agent j speaks after agent i.[12] Finally, the decision maker chooses $X = 1$ or $X = 0$.

We have a game with asymmetric information. To solve the game we identify equilibria in which (1) players' strategies are optimal responses to each other given the players' beliefs about the stochastic terms, and (2) given this set of strategies, the beliefs about the stochastic terms are updated according to Bayes' Rule.

For reasons of brevity, we confine ourselves to analyzing two equilibria of the game. First, we identify the conditions under which a committee searches only for hard information. Second, we identify the conditions under which a committee only searches for soft information. We are aware of the existence of other equilibria. Appendix A discusses one of them. We believe that analyzing the conditions of the existence for the two prototypes suffices for understanding the main mechanism at work. The results of Appendix A confirm this belief.

4 Hard and soft information

This section consists of two parts. In the first part we examine the model of Section 3 under the assumption that $h = 0$. Thus each agent looks for hard information or does not look for information, $L_i \in \{\theta_A, \theta_B, 0\}$. In the second part, we assume that $z = 0$, so that the model revolves around soft information.

4.1 Hard Information ($h = 0$)

The following Proposition identifies the conditions for an equilibrium in which both pieces of hard information are collected.

μ first, and to let agent j to select L_j conditional on the findings of agent i.

[12] This assumption seems plausible. As it turns out later, a recommendation may depend on the realization of θ_A or θ_B. As a consequence, an agent may change his recommendation when new information becomes available. This assumption makes this possible. It should be emphasized that this assumption does not affect our results qualitatively.

Proposition 1 *Suppose $p > -z$, $a_1 \leq -4K$ and $a_2 > 4K - z$. Then an equilibrium exists in which the strategies are defined as follows: (i) agent 1 examines θ_A and reports information, if found; (ii) agent 2 examines θ_B and reports information, if found; (iii) the DM chooses $X = 1$ if and only if he learns $\theta_B = z$ and infers that $\theta_A = 0$. The posterior probabilities are given by $\Pr(\theta_A = 0\,|\text{no report } \theta_A = -z) = 1$ and $\Pr(\theta_B = 0\,|\text{no report } \theta_B = z) = 1$.*

Proof. To prove Proposition 1, we have to show that no player has an incentive to deviate from his strategy, and that priors are updated according to Bayes' Rule. The proof consists of four steps.

1. If $\theta_A = -z$ $(\theta_B = z)$, then agent 1 (2) reports this to the DM. Consequently, the DM can infer that $\theta_A = 0$ $(\theta_B = 0)$ if agent 1 (2) does not report evidence.

2. When the DM makes his decision about X, he has learned or has inferred the values of θ_A and θ_B. Since $-z < p < 0$, $X = 1$ yields a higher payoff than $X = 0$ if and only if $\theta_A = 0$ and $\theta_B = z$.

3. Consider agent 1's strategy. Reporting $\theta_A = -z$ induces the DM to choose $X = 0$. Not reporting $\theta_A = -z$ induces the DM to choose $X = 1$ if $\theta_B = z$. Reporting thus yields a higher payoff than not reporting if $a_1 < 0$. It is easy to verify that in equilibrium, the expected payoff to agent 1 equals $\frac{1}{4}(a_1 + z) - K$. If $L_1 = 0$ agent 1 would not incur K and, obviously, would never report evidence. His expected payoff would become $\frac{1}{2}\left(a_1 + \frac{1}{2}z\right)$. Agent 1 thus selects $L_1 = \theta_A$ if $a_1 \leq -4K$. Note that if this restriction is satisfied, then agent 1 reports evidence, if found.

4. Now consider agent 2's strategy. Reporting $\theta_B = z$ induces the DM to choose $X = 1$ if $\theta_A = 0$. Not reporting $\theta_B = z$ induces the DM to choose $X = 0$. Reporting thus yields a higher payoff than not reporting if $a_2 > -z$. It is easy to verify that in equilibrium, the expected payoff to agent 2 equals $\frac{1}{4}(a_2 + z) - K$. If $L_2 = 0$ agent 2 would not incur K and, obviously, would never report evidence. His expected payoff would be equal to zero. Agent 2 thus selects $L_2 = \theta_B$ if $a_2 > 4K - z$. Note that if this restriction is satisfied, then agent 2 reports evidence, if found.

■

Proposition 1 shows the conditions under which both pieces of hard information are collected. A necessary condition for committee members to collect information is that the principal responds to information. This requires that the principal is not too strongly opposed towards implementation, $p > -z$.

The second condition states that agent 1 has an incentive to search for the disadvantages of the project if he is sufficiently biased against the project. To understand why, first recall that the DM implements the project only if an argument in favor and no argument against the project is found. Consequently, finding evidence against the project only affects the decision if an argument in favor of the project is found. A committee member who is biased towards implementation is in favor of implementation if an argument in favor of the project is found. Hence, searching for arguments against the project requires a bias against the project. The agent has to be *sufficiently* biased, because investigation is costly.

The third condition shows that agent 2 has an incentive to search for the advantages of the project if he is sufficiently biased towards the project. However, if the costs are low then agent 2 may also have an incentive to select $L_2 = \theta_B$ if he is slightly opposed towards the project. The reason is simple. Suppose $K = 0$. Finding an argument in favor of the project convinces the DM to select $X = 1$ only if no argument against the project is found. An agent opposed to implementation also prefers $X = 1$ if an argument in favor is found an no argument against is found. Hence, without costs of searching also agents biased against the project want to search for the advantages of the project. For high costs of searching, the benefits of searching exceed the costs of searching only for agents who are biased towards implementation.

There is thus a natural division of tasks if the committee is composed of a strong opponent and a strong proponent of the project.[13] The former tries to find evidence against the project, while the latter tries to find evidence in favor of the project. Communication between the members to divide tasks is not necessary. Note that members with moderate preferences do not collect hard information if the costs of searching are high. Moderates do have an incentive to collect hard information if

[13]Krehbiel (1990) calls these agents "bipolar outliers", on each side of the political spectrum there is an outlier.

the costs of searching are low. Coordination of tasks is necessary, however, when the committee is composed of two members with moderate preferences.

4.2 Soft Information ($z = 0$)

Now the model revolves around soft information. The following proposition shows the conditions for the existence of an equilibrium in which both agents collect soft information.[14]

Proposition 2 *Suppose* $a_i \in [-h, h]$, $p \in \left(\frac{1}{2}(a_2 - h), 0\right)$, $p \leq \frac{1}{2}(a_1 + a_2)$, $\frac{1}{4h}\pi(1-\pi)(h + a_1)^2 + \frac{1}{4h}\pi^2(a_2 - a_1)^2 \geq K$ *and* $\frac{1}{4h}\pi(1-\pi)(h + a_2)^2 \geq K$ *. Then, an equilibrium exists in which the strategies are: (i) agent* i *examines* μ*; he sends* $m_i = 0$ *if he has not received a signal; he sends* $m_i = Y_i$ *if he has found* $s_i > -a_i$*; he sends* $m_i = N_i$ *if he has found* $s_i \leq -a_i$*; (ii) the DM chooses* $X = 1$ *if he has received* (Y_1, Y_2), $(Y_1, 0)$, $(0, Y_2)$, *and chooses* $X = 0$ *otherwise. The posterior beliefs are given by:* $E(\mu \mid Y_1, Y_2) = E(\mu \mid Y_1, 0) = \frac{1}{2}(h - a_1)$*;* $E(\mu \mid N_1, N_2) = E(\mu \mid 0, N_2) = -\frac{1}{2}(h + a_2)$*;* $E(\mu \mid N_1, Y_2) = -\frac{1}{2}(a_1 + a_2)$*;* $E(\mu \mid 0, Y_2) = \frac{1}{2}(h - a_2)$*;* $E(\mu \mid N_1, 0) = -\frac{1}{2}(h + a_1)$ *and* $E(\mu \mid 0, 0) = 0$*.*

Proof. To prove Proposition 2, we have to show that no player has an incentive to deviate from his strategy, and that priors are updated according to Bayes' Rule. The proof consists of four steps.

1. The posterior beliefs directly follow from the agents' strategies and the assumption that $a_2 \geq a_1$.

2. Consider agent 1's strategy. The DM's strategy implies that if agent 1 has received a signal, agent 1's recommendation is decisive: Y_1 (N_1) implies $X = 1$ ($X = 0$). Since agent 1 prefers $X = 1$ to $X = 0$ if $\mu > -a_1$, he sends Y_1 if $s_1 > -a_1$ and N_1 if $s_1 \leq -a_1$. Agent 1 selects $L_1 = \mu$, if $L_1 = \mu$ yields a

[14] An equilibrium in which one agent collects soft information while the other agent refrains from searching may exist. This equilibrium, however, requires coordination. In addition, there exists an equilibrium in which the DM ignores all recommendations and neither of the agents examine μ. In this equilibrium, posterior beliefs are equal to the prior beliefs.

higher expected payoff than $L_1 = 0$:

$$\pi \left(\frac{h+a_1}{2h}\right)\left(a_1 + \frac{1}{2}(h-a_1)\right) + (1-\pi)\pi\left(\frac{h+a_2}{2h}\right)\left(a_1 + \frac{1}{2}(h-a_2)\right) - K$$
$$\geq \pi\left(\frac{h+a_2}{2h}\right)\left(a_1 + \frac{1}{2}(h-a_2)\right),$$

implying $\frac{1}{4h}\pi(1-\pi)(h+a_1)^2 + \frac{1}{4h}\pi^2(a_2-a_1)^2 \geq K$.

3. Consider agent 2's strategy. The DM's strategy implies that agent 2's message is only decisive if agent 1 has not received a signal. Agent 2 prefers $X = 1$ to $X = 0$ if $\mu > -a_2$. Since the DM may follow his recommendation, it is optimal for agent 2 to send Y_2 if $s_2 > -a_2$ and N_2 if $s_2 \leq -a_2$. It is easy to verify that $L_2 = \mu$ yields a higher expected payoff than $L_2 = 0$ if $(1-\pi)\pi\frac{1}{4h}(h+a_2)^2 \geq K$.

4. Using the posterior beliefs, it is easy to verify that, given $p \in (\frac{1}{2}(a_2-h), 0)$ and $p \leq \frac{1}{2}(a_1+a_2)$, the DM prefers $X = 1$ to $X = 0$ if he has received (Y_1, Y_2), $(Y_1, 0)$, $(0, Y_2)$, and prefers $X = 0$ to $X = 1$ otherwise.

■

To understand Proposition 2 let us explain the conditions in it in detail. The condition $p \in (\frac{1}{2}(a_2-h), 0)$ shows the combination of parameters for which the DM has an incentive to follow a recommendation for $X = 1$ made by agent 2. We refer to this condition as the condition for communication. If $a_2 \geq 2p + h$ then this condition is violated. The reason is that if a_2 deviates from p, then agent 2's recommendation does not accord with the DM's interest for a range of μ. By following agent 2's recommendation, the DM runs the risk of making a wrong decision. If a_2 is too large, then the probability of making a wrong decision is so large that the DM prefers not to follow the recommendation. Notice that the condition for communication is always satisfied if $a_2 = p$, as $h > |p|$. If $a_2 = p$, then agent 2's recommendation is always in line with the DM's interest. If the DM follows the recommendation made by agent 2, he will certainly follow the recommendation made by agent 1. The inequality $p < 0$ implies that the DM has to be convinced to choose $X = 1$. Since $a_2 \geq a_1$, agent 1 is less inclined than agent 2 to recommend implementation. Hence, if the DM chooses $X = 1$ in case the message set is $(0, Y_2)$, then the DM also selects $X = 1$ in case the message set is $(Y_1, 0)$ or (Y_1, Y_2).

It is easy to verify that the condition $p \leq \frac{1}{2}(a_1 + a_2)$ implies that if the DM observes the message set (N_1, Y_2), he prefers $X = 0$ to $X = 1$. As discussed above, the more the preferences of the DM and an information provider deviate, the higher is the probability that by following the recommendation the DM makes a wrong decision. For this reason, in case two agents make conflicting recommendations, the DM will follow the agent whose preferences are closest to his own preferences.

Finally, consider the last two conditions in Proposition 2. These conditions give the incentive constraint to examine μ for agent 1 and agent 2, respectively. Three features of these constraints are worth emphasizing. First, the higher is h, the less restrictive are the incentive constraints. Of course, the reason is that more uncertainty, that is an increase in h, increases the value of information. Second, the higher is a_i, the less restrictive are the incentive constraints. Agents who are more biased towards the project have an stronger incentive to collect information to convince the DM to implement the project. Recall, however, that soft information is only provided if the condition for communication is satisfied. This requires that the committee is composed of moderates. As a result, there exists no equilibrium in which soft information is provided if the costs of searching are high.[15] The reason is as follows. On the one hand, a committee composed of preference outliers does not collect soft information since they can not communicate with the DM.[16] On the other hand, although moderates can communicate with the DM, they are not sufficiently interested in the outcome to incur a high cost. Third, the benefits of examining μ depend on the value of π. Proposition 2 shows under what conditions *both* agents examine μ. Clearly, duplication of effort only makes sense if the chances of success are not too high. In case $\pi = 1$, an equilibrium in which both agents always examine μ does not exist.[17] One solution to this problem is a committee of one agent. Alternatively, the agents could agree that only one of them examine μ. The latter solution requires coordination.

[15]Formally, if $K \geq \pi(1-\pi)\left[\frac{(p+h)^2}{h}\right]$, then agents satisfying the condition for communication have no incentive to search for soft information.

[16]In contrast, as seen section 4.1, preference outliers are willing to incur a high costs to collect hard information. The reason is that communication is not required for collecting hard information.

[17]If $\pi\left[\frac{(h+a_1)^2}{4h}\right] \geq K$, then also an equilibrium in which both agents select $L_i = 0$ with probability one does not exist. Without coordination, then only an equilibrium in mixed strategies may exist.

5 Who Collects What?

In this section, we relax the assumption that either $h = 0$ or $z = 0$. This extension increases the action space of each agent. Obviously, it also increases the number of equilibria of the game. However, as in the previous section, we do not identify all equilibria but restrict attention to two equilibria: The equilibrium in which each agent collects hard information, and the equilibrium in which each agent collects soft information.[18]

5.1 Hard information

This subsection examines under what circumstances an equilibrium can occur in which agent 1 selects $L_1 = \theta_A$ and agent 2 selects $L_2 = \theta_B$. To this end, we identify the conditions under which neither agent has an incentive to deviate from his strategy given the other agent's strategy and the posterior beliefs. Proposition 1 gives the conditions for the same equilibrium when $h = 0$. Therefore, if the conditions in Proposition 1 are satisfied, then neither agent 1 nor agent 2 has an incentive to select $L_i = 0$. As this section allows for the possibility that an agent collects soft information, there remains to show under what conditions neither agent has an incentive to select $L_i = \mu$.

In subsection 4.2, we have argued that an agent is only willing to collect soft information if communication is possible. Of course, this is also the case in the present model. The implication is that if the conditions for communication are violated, then neither agent will deviate from his strategy by collecting soft information. Lemma 1 gives the conditions under which no communication about μ is possible when one agent collects hard information and the other agent deviates by collecting soft information.

Lemma 1 *Suppose agent i has selected $L_i = \theta_A$ ($L_i = \theta_B$), agent j has selected $L_j = \mu$, $a_j \in \left[-h - \frac{1}{2}z, h + \frac{1}{2}z\right]$, $h > \frac{1}{2}z$, and agent j has received a signal. Then*

1. *in case $m_i = -z$ ($m_i = 0$), then the DM ignores the recommendation of agent j if $p \notin (\frac{1}{2}(a_j - h) + \frac{1}{4}z, 0)$.*

[18] Appendix A discusses an equilibrium of the game in which one agent collects hard information and one agent collects soft information.

2. *in case* $m_i = 0$ $(m_i = z)$*, then the DM ignores the recommendation of agent* j *if* $p \notin (\frac{1}{2}(a_j - h) - \frac{1}{4}z, \frac{1}{2}(a_j + h) - \frac{1}{4}z]$.

Proof. The proofs of this lemma and the propositions in this section can be found in the Appendix. ■

Lemma 2 shows that the conditions for communication depend on whether or not hard evidence has been found. In case hard evidence has been found against implementation (or no evidence has been found in favor of implementation) the condition for communication is more restrictive than when both agents collect soft information (see Proposition 2). In case hard evidence has been found in favor of implementation (or no evidence has been found against implementation) the condition for communication becomes less restrictive than in Section 4.2. To understand these results first recall that the reason why the DM may follow advice is that advice may reduce the risk of making a wrong decision. The probability that, without advice, the DM makes a wrong decision depends on his predisposition (p). The higher is the absolute value of p, the lower is the probability that information about the stochastic terms affects his decision. For example, when the DM is strongly opposed against the project, it is unlikely that information about μ should affect his decision. The effect of hard information on the benefits of advice is similar to the effect of a change in the DM's predisposition. Hard evidence against implementation makes the DM more biased against the project (recall $p < 0$). A direct implication is that the benefits of soft information reduce. Hard evidence in favor of the project decreases the DM's bias against the project. Consequently, the probability that soft information affects the decision about the project rises. Hence, hard evidence against the project reduces the benefits of advice, whereas hard evidence in favor of the project increases the benefits of advice.

On the basis of Lemma 2 three situations can be distinguished. First, if both conditions hold, then neither agent can affect the DM's decision about the project by making a recommendation on the basis of μ. Then, together Proposition 1 and Lemma 1 give the conditions for an equilibrium in which both agents collect hard information. Loosely speaking, these conditions say that if a committee consists of outliers (with opposite preferences), so that communication about μ is not possible, then the two members of a committee will collect hard information. Secondly, if one of the two conditions is violated, then whether or not the DM follows an agent's recommendation depends on whether or not the other agent presents hard evidence. In this situation, an agent may prefer collecting soft information to collecting hard information. Finally, if both conditions in Lemma 2 are violated, then the DM will follow an agent's recommendation about the project irrespective of the evidence presented by the other agent. Clearly, the incentive to collect soft information is stronger in the third situation than in the second situation. Proposition 3 gives the conditions under which each agent prefers collecting hard information to soft information in the third situation.[19]

Proposition 3 *Suppose that the conditions presented in Proposition 1 hold and that both conditions in Lemma 1 are violated. Suppose furthermore that:*

i) $(a_1 + z) \geq \frac{\pi}{h}\left[(h + a_1)^2 + \frac{1}{4}z^2\right] + 2(1 - \pi)(a_1 + \frac{1}{2}z)$ *and*

ii) $(a_2 + z) \geq \frac{\pi}{h}\left[(h + a_2)^2 + \frac{1}{4}z^2\right]$.

Then an equilibrium exists in which the strategies and the posterior probabilities are as described in Proposition 1.

It is easy to verify that the constraints presented in the above Proposition become more restrictive if h increases. Furthermore, provided that $h > \frac{1}{4}$, the constraints become less restrictive, if z increases.[20] The intuition is straightforward. If h increases, the value of soft information increases. Consequently, a rise in h leads to stronger incentives to collect soft information. Likewise, an increase in z leads usually to stronger incentives to collect hard information.

5.2 Soft information

Proposition 2 shows under what conditions an equilibrium exists in which each agent collects soft information when $z = 0$. When $z > 0$, it is no longer obvious that an agent prefers collecting soft information to collecting hard information. Therefore, there remains to show under what conditions each agent has no incentive to collect

[19] The conditions for an equilibrium in which each agent collects hard information are weaker in the second situation (see Appendix B).

[20] To understand why an increase in z weakens the incentive to collect soft information only if h is sufficiently large, recall that the value of soft information depends on the availability of hard evidence (see Lemma 1).

hard information, given that he prefers collecting soft information to collecting no information. As in Subsection 5.1, deviating may imply a situation where one agent collects hard information and one agent collects soft information. We have already argued that in such a situation the possibility of communication about μ depends on the availability of hard information.[21] Here we focus on the case that hard information does not affect the possibility of communication. This is implied by condition *i)* in Proposition 4.[22]

Proposition 4 *Suppose that the conditions in Proposition 2 hold. Suppose furthermore that:*

i) $p \in \left(\frac{1}{2}(a_2 - h) + \frac{1}{4}z, -\frac{1}{2}z\right]$,

ii) $(1-\pi)(h+a_1)^2 + \pi(a_2-a_1)^2 \geq \frac{1}{2}z\left(a_2 - a_1 + \frac{1}{4}z\right)$, *and*

iii) $(1-\pi)(h+a_2)^2 \geq \frac{1}{2}z\left(a_2 - a_1 + \frac{1}{4}z\right)$.

Then an equilibrium exists in which the strategies and the posterior probabilities are as described in Proposition 2.

From Section 4 we know that communication requires that the agents' predispositions towards the project do not deviate too much from the DM's predisposition. This is a necessary condition for an equilibrium in which both agents select $L_i = \mu$. In addition, agents must prefer collecting soft information to collecting hard information. In Proposition 4, these conditions are given by *ii)* and *iii).* It is easy to show that both conditions become more restrictive if z increases and/or h decreases. Hence, an equilibrium in which each agent collects soft information is more likely to occur when h is large and z is small. The intuition behind this result is as in the previous subsection. The value of soft information increases with h, while the value of hard information increases with z.

[21] Of course there is one difference. In this subsection, point of departure is a situation where both agents collect soft information. When one agent deviates by searching for hard evidence, but does not find evidence, the DM will believe that the agent has tried to find soft information. In the previous subsection, point of departure was a situation where agents collect hard information.

[22] Thus, as in Subsection 5.1 several cases can be distinguished, depending on the possibility of communication and the effect of hard information on the decision about the project. The main text discusses the case that communication is possible whether or not hard evidence has been found. In addition, when no recommendation is made, hard information does not affect the decision about the project. See Appendix C for a description of all cases.

One can also verify that the conditions in Proposition 4 become more restrictive if a_1 and a_2 diverge. To understand why, suppose that agent 1 collects soft information. If $a_2 > a_1$, then agent 1 recommends $X = 0$ too often from agent's 2 point of view. From Lemma 1 we know that agent 2 can influence agent 1's recommendation by providing hard evidence. Hard evidence in favor of the project increases the probability that agent 1 recommends $X = 1$. Hence, by searching for the advantages of the project agent 2 may affect agent 1's recommendation in a favorable way.

6 Explaining the Composition of Committees

So far, we have analyzed how the composition of a committee affects the decision whether or not to collect information, and the decision which pieces of information to collect. In this section, we grant the DM with the power to appoint the committee members. More formally, we allow the DM to determine $a_i \in (-\infty, \infty)$. We intend to shed light on the empirical literature on the composition of committees in U.S. Congress. In particular, Krehbiel (1990) finds that most committees are composed of members alike the median floor member (moderates). Only occasionally, committee members are outliers. In this section, we try to identify the conditions under which the two alternative types of committees exist. We will argue that the cost of collecting information plays an essential role.

When appointing committee members, the DM anticipates their behavior. The previous section describes this behavior. Loosely speaking, the results of Section 5 give the DM's opportunity set. To examine who the DM will appoint, it is worth to recall one result of Section 4 and two results of Section 5. First, in Section 4 we have shown that when K is sufficiently high, only agents who are sufficiently biased towards or against the project are willing to incur the cost of collecting information. We have argued that the implication of this result is that a very high cost of collecting information excludes the possibility that soft information is collected. Second, when z is large, and h and K are small, moderate committee members collect soft information. Finally, when h is large, and z and K are small, moderate committee members collect hard information.

From these results it is only a small step towards the determination of the DM's appointment decision. Recall that not all pieces of information can be collected.

When $a = p$, the committee member and the DM will agree on which pieces of information should be collected. In our model, the main difference between a committee member and the DM is that a member incurs the cost of information collection, while the DM does not. Hence, if the cost of information collection is low, then the DM will appoint members who have the same preferences as himself. The following Proposition summarizes this discussion.

Proposition 5 *Suppose i) $K < \frac{1}{8}z$, ii) $p \in (4K - z, -4K]$, and iii) $K \leq \frac{1}{4h}\pi(1-\pi)(h+p)^2$. Then, $a_i = p$ yields at least the same payoff to the DM as $a_i \neq p$.*

Proof. The proofs of the propositions in this section can be found in the appendix. ■

The conditions in Proposition 5 ensure that two committee members with $a_i = p$ would be willing to incur the cost of collecting both pieces of hard information (condition i and ii) or would be willing to incur the cost of collecting soft information twice (condition iii). When z is large relative to h, each committee member, like the DM, prefers collecting hard information to collecting soft information. In this case, the DM only weakly prefers $a_i = p$ to $a_i \neq p$. Weakly, because a committee with (opposite) outliers would yield the same outcomes. When h is large relative to z, each committee member, like the DM, prefers collecting soft information to collecting hard information. In this case, the DM strictly prefers $a_i = p$ to $a_i \neq p$. Strictly, because in case of soft information, $a_i \neq p$ distorts communication.

Now suppose the cost of collecting information is that high that a committee member with $a_i = p$ is neither willing to collect hard information nor willing to collect soft information. The DM is thus forced to appoint outliers. In Section 4 we have argued that preference outliers have an incentive to manipulate information. As a consequence, the collection of soft information becomes less attractive from the DM's point of view. Of course, when h is very large relative to z, the DM may prefer the collection of soft information to the collection of hard information in spite of the danger of manipulation of information. In this case, the DM appoints committee members whose preferences are exactly extreme enough to induce them to collect soft information. In case z is large relative to h, and K is high, the DM will appoint preference outliers. Since outliers are willing to incur high cost of collecting information, the DM will get the information he wants. Proposition 6 summarizes the above discussion about the case in which the cost of information collection is high.

Proposition 6 *Suppose* $K \geq \frac{1}{8}z$, *and* $K > \frac{1}{4h}\pi(1-\pi)(h+p)^2$. *Then*

i) if K rises, the range of parameters for which the DM prefers both committee members to collect soft information shrinks;

ii) if the DM prefers the committee members collecting soft information to collecting hard information, he selects $\min a_i \in (p, 2p+h)$, *such that the conditions in Proposition 2 and 4 are satisfied;*

iii) if the DM prefers the committee members collecting hard information to collecting soft information, he selects a_i *such that the conditions in Proposition 1 and 3 are satisfied.*

In the introduction, we have discussed three agency problems. First, committee members should put effort in information collection. Second, committee members should try to find the proper pieces of information. Third, committee members may manipulate certain pieces of information. In this section, we have shown that when the cost of information collection is low the second and the third agency problem can be solved by appointing members whose preferences are identical to those of the DM. When the cost are high, solving the first agency problem requires that preferences outliers are appointed. Clearly this may endanger the solution of the second and the third agency problem.

7 Conclusions

In this paper we have analyzed a model to gain insight into the role of committees in collective decision-making processes in a world where agents must be motivated to collect the proper pieces of information. We have addressed two types of questions: First, how does the composition of a committee affect final decisions? Second, what is the optimal composition of a committee from the decision maker's point of view? We have shown that the answer to the second question depends to a large extent on the cost of information collection. If this cost is low, then it is likely that a committee will consist of members whose preferences are closely aligned to those of the decision maker. The advantage of members with similar preferences is that they collect the pieces of information the decision maker wants them to collect. Moreover, with similar preferences information will not be manipulated. If the cost of searching is high, then the committee is composed of members with polarized preferences. The reason is that outliers have strong incentives to search for information.

Admittedly, our results have been derived from a rather specific model. Some of the assumptions underlying our model are restrictive but innocuous. Other assumptions call for relaxation. Let us first briefly discuss two examples of restrictive, but rather unimportant assumptions. To reduce straightforward algebra, we have assumed that the decision maker observes whether or not committee members receive a signal. Relaxing this assumption does not affect our results qualitatively. The main implication would be that the conditions for communication become more restrictive. Uncertainty about whether or not an information provider is informed jeopardizes communication. Another illustration of the fact that our model is specific is the way we have specified the two types of uncertainty. Soft information has been represented by a stochastic term being continuously distributed, while hard information has been represented by a discrete distribution function. Again our excuse is simplicity. On the one hand, to address the problem of communication a discrete distribution function would not suffice. On the other hand, discrete distribution functions facilitate the illumination of the agency problems in a situation where agents should collect hard information.

In spite of several restrictive assumptions, our model is still complicated in the sense that a full description of the equilibria is cumbersome. For this reason, we have analyzed the conditions for the existence of two prototypes of committees: a committee consisting of only outliers and a committee consisting of only moderates. We believe that by focusing on the two prototypes of committees, we have highlighted the features that make some types of committees more likely than others. Of course we are aware that mixed committees, for example a committee composed of one moderate and one outlier, may exist. Such a case is discussed in Appendix A. The analysis of that case confirms our conjecture that analyzing all cases would not yield new insights.

Less innocent are our assumptions about the institutional setting and the size of the committee. Our model revolves around one decision maker who can appoint committee members. Although one could think of this decision maker as the median floor member in Congress, it is important to realize that political institutions are more complex. We have ignored the role political parties and the president play in the composition of committees. Concerning the size of the committee, we have simply assumed that a committee consists of two members even though it may be optimal to create a committee consisting of more members. We leave the question on the optimal size of the committee for future research. However, whatever the size of the committee, the mechanism illuminated by this paper will also be relevant when the size of the committee is endogenous. As members must be motivated to collect the proper pieces of information, the cost of collecting information, the magnitudes of the various types of uncertainty, and the members' preferences will remain important.

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Appendix

Appendix A: Hard and soft information

In this appendix, we show the conditions for an equilibrium in which agent 1 selects $L_1 = \mu$ and agent 2 selects $L_2 = \theta_B$.

Proposition 7 *Suppose* $p \in (\frac{1}{2}(a_1 - h) + \frac{1}{4}z, \frac{1}{2}(a_1 + h) - \frac{1}{4}z]$, $p \leq \frac{1}{2}(a_1 + a_2)$, $h > \frac{1}{2}z$ *and* $p \leq -\frac{1}{2}z$. *Furthermore, suppose* $\frac{\pi}{4h}\left[(h + a_1)^2 + \frac{1}{4}z\right] \geq K$, $\frac{\pi}{2h}\left[\frac{1}{4}z^2 + a_2\right] \geq K$ *and* $\frac{1}{4}z^2 \geq (1 - \pi)(h + a_2)$. *Then an equilibrium exists in which the strategies are defined as follows: (i) agent 1 examines* μ*; he sends* $m_1 = 0$ *if he has not received a signal; he sends* $m_1 = Y_1$ *if he has inferred that* $\theta_B = 0$ *and has found* $s_i > -a_i + \frac{1}{2}z$*; he sends* $m_1 = Y_1$ *if he has observed that* $\theta_B = z$ *and has found* $s_i > -a_i - \frac{1}{2}z$*; he sends* $m_i = N_i$ *in all other cases; (ii) agent 2 examines* θ_B *and reports information, if found (iii) the DM chooses* $X = 1$ *if he has received* $(Y_1, 0)$, (Y_1, z) *and chooses* $X = 0$ *otherwise. The posterior beliefs are given by:* $E(\mu \mid Y_1, 0) = \frac{1}{2}(h - a_1 + \frac{1}{2}z)$; $E(\mu \mid Y_1, z) = \frac{1}{2}(h - a_1 - \frac{1}{2}z)$; $E(\mu \mid N_1, 0) = -\frac{1}{2}(h + a_1 - \frac{1}{2}z)$; $E(\mu \mid N_1, z) = -\frac{1}{2}\left(h + a_1 + \frac{1}{2}z\right)$; $E(\mu \mid 0, 0) = E(\mu \mid 0, z) = 0$ *and* $\Pr(\theta_B = 0 \mid \text{not report } \theta_B = z) = 1$.

Proof. The proof is given in four steps.

1. The posterior beliefs follow directly from the strategies of the agents.

2. Consider agent 1's strategy. The DM's strategy implies that if agent 1 has received a signal, his recommendation is decisive. Before a recommendation is made, agent 1 observes the message of agent 2 and infers the value of θ_B. If $m_2 = 0$ then agent 1 recommends Y_1 if $s_i > -a_i + \frac{1}{2}z$ and N_1 if $s_i \leq -a_i + \frac{1}{2}z$. If $m_2 = z$ then agent 1 recommends Y_1 if $s_i > -a_i - \frac{1}{2}z$ and N_1 if $s_i \leq -a_i - \frac{1}{2}z$. Agent 1 selects $L_1 = \mu$ if he prefers $L_1 = \mu$ to $L_1 = 0$, to $L_1 = \theta_A$, and to $L_1 = \theta_B$. Agent 1 prefers selecting $L_1 = \mu$ to selecting $L_1 = 0$ if:

$$\frac{1}{2}\pi\left(\frac{h + a_1 - \frac{1}{2}z}{2h}\right)\left(a_1 + \frac{1}{2}(h - a_1) - \frac{1}{4}z\right) + \frac{1}{2}\pi\left(\frac{h + a_1 + \frac{1}{2}z}{2h}\right)\left(a_1 + \frac{1}{2}(h - a_1) + \frac{1}{4}z\right) - K \geq 0, \qquad \text{(A1)}$$

   which reduces to $\frac{\pi}{4h}\left[(h + a_1)^2 + \frac{1}{4}z\right] \geq K$. Note that since $p \leq -\frac{1}{2}z$ and $h > \frac{1}{2}z$, the DM never selects $X = 1$ if no recommendation is made. Consequently, agent 1 has no incentive to select $L_1 = \theta_A$ or to select $L_1 = \theta_B$ if (A1) is satisfied.

3. Consider agent 2's strategy. Although the DM always follows the recommendation of agent 1, there is an incentive for agent 2 to search. This is because agent 2 can affect the recommendation of agent 1 by searching for hard evidence. Agent 2 selects $L_2 = \theta_B$ if he prefers $L_2 = \theta_B$ to $L_2 = 0$, to $L_2 = \mu$ and to $L_2 = \theta_A$. Agent 2 prefers selecting $L_2 = \theta_B$ to selecting $L_2 = 0$ if:

$$\begin{aligned} &\frac{1}{2}\pi\left(\frac{h + a_1 - \frac{1}{2}z}{2h}\right)\left(a_2 + \frac{1}{2}(h - a_1) - \frac{1}{4}z\right) \\ &+\frac{1}{2}\pi\left(\frac{h + a_1 + \frac{1}{2}z}{2h}\right)\left(a_2 + \frac{1}{2}(h - a_1) + \frac{1}{4}z\right) - K \\ &\geq \pi\left(\frac{h + a_1 - \frac{1}{2}z}{2h}\right)\left(a_2 + \frac{1}{2}(h - a_1) + \frac{1}{4}z\right), \end{aligned}$$

   which reduces to $\frac{\pi}{2h}\left[\frac{1}{4}z^2 + a_2\right] \geq K$. After some straightforward algebra, we can show that agent 2 prefers $L_2 = \theta_B$ to $L_2 = \mu$ if $\frac{1}{4}z^2 \geq (1 - \pi)(h + a_2)^2$. Note that this condition is always satisfied if $\pi = 1$. If agent 1 receives a informative signal $s_1 = \mu$ with certainty then there is no use for agent 2 to select $L_2 = \mu$. Agent 2 prefers $L_2 = \theta_B$ to $L_2 = \theta_A$ if $2(a_2 - a_1) + z \geq 0$. Using $a_2 \geq a_1$ this condition is always satisfied. Note that if the incentive constraints are satisfied, then agent 2 reports information if found.

4. Using the posterior beliefs, it is easy to verify that, given $p \in (\frac{1}{2}(a_1 - h) + \frac{1}{4}z, \frac{1}{2}(a_1 + h) - \frac{1}{4}z]$ and $p \leq -\frac{1}{2}z$, the DM prefers $X = 1$ if he has received $(Y_1, 0)$, (Y_1, z) and chooses $X = 0$ otherwise.

■

Proof of Lemma 1.

Proof. We have to derive the conditions for communication if an agent deviates from an equilibrium in which $L_1 = \theta_A$ and $L_2 = \theta_B$ by collecting soft information. First note that agent j speaks after agent i if $L_j = \mu$ and $L_i = \theta_A$ ($L_i = \theta_B$).

Suppose $m_i = -z$ ($m_i = 0$). Then agent j recommends $X = 1$ if $s_j > \frac{1}{2}z - a_j$. Given $h > \frac{1}{2}z$, the posterior beliefs are given by $E(\mu \mid m_j = Y, m_i = -z \ (m_i = 0)) = \frac{1}{2}(h + \frac{1}{2}z - a_j)$ and $E(\mu \mid m_j = N, m_i = -z \ (m_i = 0)) = -\frac{1}{2}(h - \frac{1}{2}z + a_j)$. The DM follows agent j's recommendation if $p - \frac{1}{2}z + \frac{1}{2}(h + \frac{1}{2}z - a_j) > 0$ and $p - \frac{1}{2}z - \frac{1}{2}(h - \frac{1}{2}z + a_j) \leq 0$. The latter condition is always satisfied since $p < 0$. Hence, in case $m_i = -z$ ($m_i = 0$), the DM ignores agent j's advice if $p \notin (\frac{1}{2}(a_j - h) + \frac{1}{4}z, 0)$.

Suppose $m_i = 0$ ($m_i = z$). Then agent j recommends $X = 1$ if $s_j > -\frac{1}{2}z - a_j$. Given $h > \frac{1}{2}z$, the posterior beliefs are given by $E(\mu \mid m_j = Y, m_i = 0 \ (m_i = z)) = \frac{1}{2}(h - \frac{1}{2}z - a_j)$ and $E(\mu \mid m_j = N, m_i = 0 \ (m_i = z)) = -\frac{1}{2}(h + \frac{1}{2}z + a_j)$. The DM follows agent j's recommendation if $p + \frac{1}{2}z + \frac{1}{2}(h - \frac{1}{2}z - a_j) > 0$ and $p + \frac{1}{2}z - \frac{1}{2}(h + \frac{1}{2}z + a_j) \leq 0$. Hence, in case $m_i = 0$ ($m_i = z$), the DM ignores agent j's advice if $p \notin (\frac{1}{2}(a_j - h) - \frac{1}{4}z, \frac{1}{2}(a_j + h) - \frac{1}{4}z]$. ■

Appendix B: Hard information

In this Appendix, we show under what conditions $L_1 = \theta_A$ and $L_2 = \theta_B$ are selected rather than $L_j = \mu$. From Lemma 1 we know that the conditions for communication depend on the availability of hard evidence. As a consequence, the incentive to deviate by collecting soft information depends on the conditions in

Lemma 1. Four cases can be distinguished. In each case, agent j refers to the agent who considers to collect soft information and agent i refers to the agent who collects hard information. The second case is described in Proposition 3.

i) No communication is possible, $p \notin (\frac{1}{2}(a_j - h) + \frac{1}{4}z, 0)$ and $p \notin (\frac{1}{2}(a_j - h) - \frac{1}{4}z, \frac{1}{2}(a_j + h) - \frac{1}{4}z]$. Then neither agent has an incentive to collect soft information.

ii) Full communication, $p \in (\frac{1}{2}(a_j - h) + \frac{1}{4}z, 0)$ and $p \in (\frac{1}{2}(a_j - h) - \frac{1}{4}z, \frac{1}{2}(a_j + h) - \frac{1}{4}z]$. Hence, $p \in (\frac{1}{2}(a_j - h) + \frac{1}{4}z, \frac{1}{2}(a_j + h) - \frac{1}{4}z]$. The implication is that the DM follows a recommendation of agent j irrespective of the hard evidence presented by agent i. The following condition shows when agent 1 prefers selecting $L_1 = \theta_A$ to selecting $L_1 = \mu$, given that $L_2 = \theta_B$,

$$\frac{1}{4}(a_1 + z) - K \geq \frac{1}{2}\pi\left(\frac{h - \frac{1}{2}z + a_1}{2h}\right)\left(\frac{1}{2}(h + a_1) - \frac{1}{4}z\right) + \frac{1}{2}\pi\left(\frac{h + \frac{1}{2}z + a_1}{2h}\right)\left(\frac{1}{2}(h + a_1) + \frac{1}{4}z\right) + \frac{1}{2}(1 - \pi)\left(a_1 + \frac{1}{2}z\right) - K, \quad \text{(A2)}$$

implying $(a_1 + z) \geq \frac{\pi}{h}\left[(h + a_1)^2 + \frac{1}{4}z^2\right] + 2(1 - \pi)(a_1 + \frac{1}{2}z)$. Similarly, we can show that agent 2 has no incentive to select $L_2 = \mu$ if $(a_2 + z) \geq \frac{\pi}{h}\left[(h + a_2)^2 + \frac{1}{4}z^2\right]$.

iii) Partial communication, $p \notin (\frac{1}{2}(a_j - h) + \frac{1}{4}z, 0)$ and $p \in (\frac{1}{2}(a_j - h) - \frac{1}{4}z, \frac{1}{2}(a_j + h) - \frac{1}{4}z]$. Hence, $p \in (\frac{1}{2}(a_j - h) - \frac{1}{4}z, \frac{1}{2}(a_j - h) + \frac{1}{4}z]$ which implies that the DM follows Y_1 only if $m_2 = z$. The following condition shows when agent 1 prefers selecting $L_1 = \theta_A$ to selecting $L_1 = \mu$, given that $L_2 = \theta_B$,

$$\frac{1}{4}(a_1 + z) - K \geq \frac{1}{2}\pi\left(\frac{h + \frac{1}{2}z + a_1}{2h}\right)\left(\frac{1}{2}(h + a_1) + \frac{1}{4}z\right) + \frac{1}{2}(1 - \pi)\left(a_1 + \frac{1}{2}z\right) - K, \quad \text{(A3)}$$

implying $(a_1 + z) \geq \frac{1}{2}\frac{\pi}{h}\left(h + a_1 + \frac{1}{2}z\right)^2 + 2(1 - \pi)(a_1 + \frac{1}{2}z)$. Note that $X = 1$ is selected if $m_2 = z$ and agent 1 has received no signal since the DM infers from $m_1 = 0$ that $\theta_A = 0$. It is easy to show that (A3) is less restrictive than (A2). This is because the DM does not always follow the recommendation of agent 1 and therefore the benefits of collecting soft information are lower. Along the same line, we can show that agent 2 has no incentive to select $L_2 = \mu$ if $(a_2 + z) \geq \frac{1}{2}\frac{\pi}{h}(h + a_2 + \frac{1}{2}z)^2$.

iv) Partial communication, $p \in (\frac{1}{2}(a_j - h) + \frac{1}{4}z, 0)$ and $p \notin (\frac{1}{2}(a_j - h) - \frac{1}{4}z, \frac{1}{2}(a_j + h) - \frac{1}{4}z]$. Hence, $p \in (\frac{1}{2}(a_j + h) - \frac{1}{4}z, 0)$ which implies that the DM follows N_1 only if $m_2 = 0$. Condition (A4) shows when agent 1 prefers selecting $L_1 = \theta_A$ to selecting $L_1 = \mu$, given that $L_2 = \theta_B$,

$$\frac{1}{4}(a_1 + z) - K \geq \frac{1}{2}\pi\left(\frac{h - \frac{1}{2}z + a_1}{2h}\right)\left(\frac{1}{2}(h + a_1) - \frac{1}{4}z\right) + \frac{1}{2}\left(a_1 + \frac{1}{2}z\right) - K, \tag{A4}$$

implying $(a_1 + z) \geq \frac{1}{2}\frac{\pi}{h}\left(h + a_1 - \frac{1}{2}z\right)^2 + 2(a_1 + \frac{1}{2}z)$. For the same reason as in *iii*), condition (A4) is less restrictive than condition (A2). Along the same line, we can show that agent 2 has no incentive to select $L_2 = \mu$ if $(a_2 + z) \geq \frac{1}{2}\frac{\pi}{h}(h + a_2 - \frac{1}{2}z)^2 + 2\pi(a_2 + \frac{1}{2}z)$.

Appendix C: Soft information.

In this appendix, we show under what conditions both agents select $L_i = \mu$ rather than $L_i = \theta_A$ or $L_i = \theta_B$. As in Appendix B, the incentive to deviate depends on the possibility of communication. However, now we consider an equilibrium in which both agents select $L_i = \mu$. Now, the DM infers from $m_i = 0$ that agent i received no signal. This implies that the DM selects $X = 0$ if $p \leq -\frac{1}{2}z$ and selects $X = 1$ if $p > -\frac{1}{2}z$ when $m_i = 0$ and $m_j = z$. In the remaining part of this appendix, we show the conditions for which agents prefer collecting soft information to collecting hard information. On the basis of the conditions in Lemma 1, we can distinguish three cases. In each case we show four incentive constraints; 1) when agent 1 prefers selecting $L_1 = \mu$ to $L_1 = \theta_A$, 2) when agent 1 prefers selecting $L_1 = \mu$ to $L_1 = \theta_B$, 3) when agent 2 prefers selecting $L_2 = \mu$ to $L_2 = \theta_A$, and 4) when agent 2 prefers selecting $L_2 = \mu$ to $L_2 = \theta_B$.

i) Suppose $p \in (\frac{1}{2}(a_j - h) + \frac{1}{4}z, -\frac{1}{2}z]$. The incentive constraints are:

1. $(1 - \pi)(h + a_1)^2 + \pi(a_2 - a_1)^2 \geq \frac{1}{2}z\left(a_2 - a_1 + \frac{1}{4}z\right)$

2. $(1-\pi)(h+a_1)^2 + \pi(a_2-a_1)^2 \geq \frac{1}{2}z\left[-(a_2-a_1)+\frac{1}{4}z\right]$

3. $(1-\pi)(h+a_2)^2 \geq \frac{1}{2}z\left[-(a_2-a_1)+\frac{1}{4}z\right]$

4. $(1-\pi)(h+a_2)^2 \geq \frac{1}{2}z\left(a_2-a_1+\frac{1}{4}z\right)$.

Clearly, the second and the third constraint are redundant. The first and the fourth constraint are mentioned in Proposition 4. Now suppose $p > -\frac{1}{2}z$. The implication is that $X = 1$ is selected if $m_i = z$ and $m_j = 0$. As a consequence, the RHS of constraint 2 increases with $2h\left(\frac{1-\pi}{\pi}\right)(a_1+\frac{1}{2}z)$ and the RHS of constraint 4 increases with $2h\left(\frac{1-\pi}{\pi}\right)(a_2+\frac{1}{2}z)$.

ii) Suppose $p \in (\frac{1}{2}(a_j-h)-\frac{1}{4}z, \frac{1}{2}(a_j-h)+\frac{1}{4}z]$ and $p \leq -\frac{1}{2}z$. The incentive constraints are:

1. $(h+a_1)^2 + (1-2\pi)(h+a_2)\left[a_1+\frac{1}{2}(h-a_2)\right] \geq (h+a_2)\frac{1}{2}z$

2. $(h+a_1)^2 + \frac{1}{2}z(a_2-a_1+\frac{1}{4}z) \geq 2\pi(h+a_2)\left[a_1+\frac{1}{2}(h-a_2)\right]$

3. $(h+a_1)\left[a_2+\frac{1}{2}(h-a_1)-\frac{1}{2}z\right] + (1-\pi)(h+a_2)^2 \geq 0$

4. $(1-\pi)(h+a_2)^2 \geq \frac{1}{2}z(a_2-a_1+\frac{1}{4}z)$.

Now, suppose $p > -\frac{1}{2}z$. As in i), the RHS of constraint 2 increases with $2h\left(\frac{1-\pi}{\pi}\right)(a_1+\frac{1}{2}z)$ and the RHS of constraint 4 with $2h\left(\frac{1-\pi}{\pi}\right)(a_2+\frac{1}{2}z)$.

iii) Suppose $p \in (\frac{1}{2}(a_j+h)-\frac{1}{4}z, 0)$. As a consequence, $p > -\frac{1}{2}z$. The incentive constraints are:

1. $(h+a_1)^2 - 2\pi(h+a_2)\left[a_1+\frac{1}{2}(h-a_2)\right] \geq \frac{1}{2}z(a_2-a_1+\frac{1}{4}z)$

2. $\pi(h+a_1)^2 - (1-\pi)\pi(h+a_2)\left[a_1+\frac{1}{2}(h-a_2)\right] \geq -\frac{1}{2}z(h+a_2) + h(a_1+\frac{1}{2}z)$

3. $(h+a_1)\left[a_2+\frac{1}{2}(h-a_1)-\frac{1}{2}z\right] + (1-\pi)\pi(h+a_2)^2 \geq 0$

4. $\pi(h+a_1)\left[a_2+\frac{1}{2}(h-a_1)+\frac{1}{2}z\right] + (1-\pi)\pi(h+a_2)^2 \geq 2h(a_2+\frac{1}{2}z)$.

Proof of Proposition 5

Proof. We have to proof that $a_i = p$ yields at least the same payoff for the DM as $a_i \neq p$ if $K < \frac{1}{8}z$, $p \in (4K - z, -4K]$ and $K \leq \frac{1}{4h}\pi(1-\pi)(h+p)^2$. First, note that if $a = p$, then members collect the pieces of information the DM wants to be collected. We focus on two cases; i) the DM wants both pieces of hard information to be collected, and ii) the DM wants both members to collect soft information.

i) The DM yields an expected payoff of $\frac{1}{4}(z+p)$ in case $L_1 = \theta_A$ and $L_2 = \theta_B$. This payoff is independent of a_1 and a_2. Two members with predisposition $a_i = p$ have an incentive to collect both pieces of hard information if $a_i \leq -4K$ and if $a_i > 4K - z$. This requires that $K < \frac{1}{8}z$ and $p \in (4K - z, -4K]$.

ii) The DM yields an expected payoff of

$$\pi\left(\frac{h+a_i}{2h}\right)\left(p+\frac{1}{2}(h-a_i)\right)+(1-\pi)\,\pi\left(\frac{h+a_j}{2h}\right)\left(p+\frac{1}{2}(h-a_j)\right). \qquad \text{(A5)}$$

in case $L_i = \mu$ and $L_j = \mu$. Maximizing (A5) towards a_i and a_j gives $\frac{\partial}{\partial a_i} = \frac{\pi}{2h}(p - a_i) = 0$ and $\frac{\partial}{\partial a_j} = \frac{\pi(1-\pi)}{2h}(p - a_j) = 0$. Hence, the expected payoff for the DM in case soft information is collected is maximized if $p = a_i = a_j$. Remains to show when members alike the DM have an incentive to collect soft information. Proposition 2 shows the incentive constraints for which both agents select $L_i = \mu$ rather than $L_i = 0$. Inserting $a = p$ gives that $K \leq \frac{1}{4h}\pi(1-\pi)(h+p)^2$.

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Proof of Proposition 6

Proof. From the proof of Proposition 5 we know that if $K \geq \frac{1}{8}z$ and $K > \frac{1}{4h}\pi(1-\pi)(h+p)^2$ then agents with $a = p$ do not collect information. Hence, the DM has to appoint two agents with $a_i \neq p$. The remaining part of the proof is divided into three parts, as in Proposition 6.

i) The DM prefers both members to collect soft information if the expression in (A5) is higher than $\frac{1}{4}(z+p)$. If the DM prefers the collection of soft information, then he should appoint two members with $a > p$ since the costs are high. It is easy to show that the expected payoff for the DM decreases with $\frac{1}{4h}(a-p)^2$ if $a > p$ rather than if $a = p$. An increase in a decreases the expected payoff for the DM. From the incentive constraints in Proposition 2, we know that a should rise if K increases. Hence, the DM prefers both members to collect soft information for a smaller range of parameters if K increases.

ii) In i) we have seen that the DM prefers selecting a_i as close as possible to p to maximize the expected payoff in case soft information is collected. The conditions in Proposition 2 and 4 show when both members select $L_i = \mu$ given that $h > 0$ and $z > 0$. The condition for communication requires that $a_i < 2p + h$.

iii) This follows simply from the fact that the conditions in Proposition 1 and 3 show when $L_1 = \theta_A$ and $L_2 = \theta_B$ are selected given that $h > 0$ and $z > 0$.

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