Decision making in committees : transparency, reputation and voting rules

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Decision Making in Committees: Transparency, Reputation and Voting Rules

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Abstract

In this paper I analyze the effect of the transparency of the decision making process in committees on the decisions that are eventually taken. I focus on committees whose members are motivated by career concerns, so that each member tries to enhance his own reputation. When the decision making process is secretive, the individual votes of the committee members are not exposed to the public but only the final decision. Thus, individuals are evaluated according to the group's decision. I find that in such a case, group members are induced to comply with preexisting biases. For example, if the voting rule demands a supermajority to accept a reform, individuals vote more often against reforms and exacerbate the conservatism of the voting rule. When the decision making process becomes transparent and individual votes are observed, this effect disappears and such committees are then more likely to accept reforms. I also find that coupled with the right voting rule, a secretive procedure may induce better decisions than a transparent one.

1 Introduction

Many economic and political decisions are taken by groups of decision makers, i.e., by committees. Company boards, governments and monetary policy committees are some notable examples. Such decision making bodies, however, seem to be going through a process of becoming more transparent. In particular, it is only a recent phenomenon that the Federal Reserve Open Market Committee's minutes or the deliberations of the US Supreme Court Justices are published. Although the views of individuals members of the European Central Bank and the EU Court of Justice are still hidden from the public eye, the trend is undoubtedly in the direction of more transparency. This trend is casually connected with more openness and more 'democratization'. In this paper I investigate the effect of transparency on the behaviour of committee members, and hence, on decision making in committees.

My analysis focuses on committees whose members are motivated by career concerns. Committee members such as members of governments, monetary committees or multi-judicial courts, are indeed likely to be concerned about their own promotion, re-election or prestige. Although by now we have a relatively good understanding of how individual decision makers behave when they are motivated by career concerns,[1] we are still lacking an analysis of group decision making when the individuals members of the group have career concerns. I therefore study the interaction of these reputation concerns with the decision process - be it transparent or secretive.

In the model, I assume that to advance his career, each committee member wishes to accumulate reputation for being a high ability decision maker. Namely, that he has accurate private information about the matter to be decided. Obviously then, in a transparent procedure, when votes of the individual members of the committee can be observed, they can be used strategically by the committee members to affect their reputation and career path. I show how reputation concerns induce committee members to vote strategically even when the procedure is secretive, i.e., when their individual votes are not observed by those they wish to impress.

The main result is that when the decision process in a committee is secretive, then committee members conform to preexisting biases in the decision making process. In particular,

[1] The large literature following Holmström (1982) spans many types of decision makers (such as managers, financial advisers, politicians etc.) in a plethora of environments.

when the voting rule is biased against some decision so that it demands a supermajority in order to accept it, then individual votes are biased against this decision as well. Similarly, if the voting rule is unbiased but the prior expectation is, committee members tend to vote for the action that is favored by the prior. This implies that when a committee becomes transparent, it is more likely to accept reforms or radical decisions. I also show that transparency is not always optimal, and that in some environments, a secretive committee that uses a particular voting rule makes better decisions on average.

To understand the intuition for the above findings, consider a secretive committee, so that outside evaluators can observe only the final decision. Suppose that the voting rule demands unanimity to change the status quo. If the committee does accept a reform, then these outsiders can perfectly learn that all individuals supported the reform. It therefore becomes analogous to a transparent procedure.

On the other hand, if the status quo is maintained, it is harder to extract information about individual votes. Maintaining the status quo is therefore a "noisier" decision. In the presence of such uncertainty about individual votes, two conflicting effects arise compared with a transparent mechanism. If the committee's decision is wrong, an individual expert can gain utility by shedding the blame on others and "claiming" that his vote was correct. On the other hand, an expert can also lose utility since he forgoes being recognized as the one who made the right recommendation, as evaluators may suspect that he voted in the wrong way. I show that for the marginal types (who are the less able types) the utility gain is larger; this arises since on average, experts are perceived to vote in the right way and are then more likely to be able to shed the blame than to be losing recognition. Thus, compared with a transparent mechanism, more types of experts would vote for the status quo (i.e., experts would align their vote with the inherent bias of the voting rule).

To see why transparency is not always optimal, note that careerist experts have a tendency to vote too much against the decision that the prior beliefs indicates to be the right one. This proves that their own information is more accurate than that represented by the prior. In fact, when the prior is very strong, such a distortion arises in all decision making procedures. But among the procedures considered, a secretive committee coupled with a voting rule that is biased in favor of the prior has a two-fold advantage. First, for any behavior of the experts, the decision favored by the prior is most likely to be accepted with this voting rule. Second, in the secretive mechanism, individual votes conform to the bias in the voting rule and thus experts least distort their votes in this case.

My paper identifies therefore a "conformity" effect which is completely different from what previous literature on group decision making has found. In papers by Feddersen and Pesendorfer (1997), Austen-Smith and Banks (1996), Persico (2004) and Austen-Smith and Feddersen (2003), the assumption is that agents only care about the decision and not about their career. These papers find then the opposite effect, that agents actually vote more often for the decision that the voting rule is biased against.

Other papers do assume that committee members care about their career but none identifies the "conformity" effect. Ottaviani and Sørensen (2000) model a transparent voting processes. Since it is transparent, their model is strategically equivalent to an individual decision making process and no strategic group effects arise. Visser and Swank (2005) model a secretive voting process and assume that talented experts receive the same perfect signals, and thus, as in Scharfstein and Stein (1990), experts wish to convince the evaluator that they have voted in the same way.

More closely related are Gersbach and Hahn (2001), Fingleton and Raith (2005), Stasavage (2004) and Sibert (2003), who focus directly on the comparison between secretive and transparent mechanisms. They all show that secrecy may induce better decisions because it reduces the incentives of an individual to distort her actions in order to signal her type.[2] I show however that there are still strong incentives for signalling even in the secretive case, and that these incentives depend on the voting rule. In particular, secretive procedures can be better when coupled with the right voting rule and otherwise, they can be worse.

More specifically, Gersbach and Hahn (2001) analyse a two-period model in which all or some committee members can be replaced after the first period. In the equilibrium they discuss, uninformed types mimic informed types when the process is transparent but abstain when the process is secretive. They therefore isolate an inter-temporal trade-off between transparency (which allows for better selection of committee members after the first period) and secrecy (which allows for better decisions in the first period). In the context of bargaining, Fingleton and Raith (2005) show that while open door negotiations can allow employers to learn more information about their agents, such practice is also inefficient

[2] The same intuition arises in papers by Prat (2004) and Avery and Meyer (2003) for the case of individual decision makers.

since agents bid more aggressively (relative to closed-door negotiations). Stasavage (2004) assumes that agents care about acquiring a reputation for having some particular ideology (in my analysis, agents acquire reputation for being able experts) and that agents also care directly about the decision of the committee.[3] He concludes that secrecy is sometimes better; what drives this result is the interplay between career concerns and decision concerns (see Section 6.2). In my analysis, secretive procedures may be better even when agents do not care about the decision itself.

The rest of the paper is organized as follows. In the next section I describe the model. Section 3 presents the equilibrium for the transparent case and section 4 analyses the equilibrium for the secretive case. In section 5, I present the main result which compares decision making in committees under the different procedures. I analyse some extensions and conclude in Section 6. The appendix has all proofs that are not in the text.

2 The Model

I describe now the decision making process in a committee. I make some simplifying assumptions to facilitate the analysis. First, I analyse the smallest size of a committee which can yield interesting results in terms of different voting rules, that is, a three member committee (the results, as can be seen from the proofs and the general intuition, can be extended to larger committees). Second, I focus the analysis on agents with career concerns only. The results are robust when we assume that experts are also genuinely interested in the committee's decision on top of their career concerns (see section 6.2).

Consider therefore a three-member committee that needs to decide between two alternatives, A and B. Each member i, $i \in \{1, 2, 3\}$, receives information on a random variable $w_i \in \{a_i, b_i\}$. Each of these random variables could be interpreted as determining a dimension of the problem, for example, a different criterion according to which A and B are evaluated.

I assume first that these dimensions are not correlated, i.e., that the $w_i's$ are independently distributed. I do so for exposition purposes since it allows me to isolate the different effects arising due to career concerns (the results are robust when we introduce correlation, see section 6.1). It is also a reasonable assumption in the context of committees. Committees (compared with individuals) allow for division of labor, so that each expert can

[3] These are also the assumptions in Sibert (2003).

focus on a different aspect of the problem. This is the case for example in committees in which members represent different business units in the same company, or in governments in which each minister holds a different portfolio. Thus, although extreme, the assumption of no correlation captures the environments in which there is a relatively low level of correlation between the different dimensions.

I assume therefore that the prior probability is $\Pr(w_i = b_i) = q_i$. To make the model tractable, let $q_i = q > \frac{1}{2}$ for all i. Also, each expert i receives a signal $s_i \in \{a_i, b_i\}$, such that $\Pr(s_i = w_i | w_i) = t_i$. Each expert i knows t_i, whereas all others know that t_i is uniformly distributed on $[.5, 1]$. The talent of an expert is therefore measured by t_i; the more talented is expert i, the more accurate is his information. Thus, given the prior and his private signal, each expert can update his posterior probability about his state of the world:

$$\Pr(w_i = a | q, s_i, t_i) = \begin{cases} \frac{(1-q)(1-t_i)}{qt_i + (1-q)(1-t_i)} & \text{if } s_i = b; \\ \frac{(1-q)t_i}{q(1-t_i) + (1-q)t_i} & \text{if } s_i = a. \end{cases} \tag{1}$$

where $\Pr(w_i = b | q, s_i, t_i) = 1 - \Pr(w_i = a | q, s_i, t_i)$.

All members vote simultaneously and their vote/message is denoted by $m_i \in \{a, b\}$, which therefore indicates whether they support A or B. A *voting rule* is denoted by $x \in \{1, 2, 3\}$. A voting rule x implies that if $\{\sharp i | m_i = a\} \geq x$, then the committee decides for A. When $x = 3$, the voting rule is A-*unanimity*, i.e., all need to approve A for it to be accepted. When $x = 2$, the voting rule is *majority* and when $x = 1$, the voting rule is *B-unanimity.* Denote the decision of the committee by $d \in \{A, B\}$.

An additional agent is the evaluator, denoted by E. If the committee is formed of politicians, the evaluator can represent the public who assesses how competent is each politician. If the committee is composed of different unit managers in the firm, the evaluator can represent the shareholders, who decide whom to promote.

The evaluator updates his beliefs about t_i for each expert i, given the uniform prior on each. To simplify the analysis, I assume that E observes w_i, after the decision had been taken, for all i (the results hold also when E observes each state only with some probability). In addition, E observes the decision d and knows the voting rule x. Finally, if the committee's meeting is transparent, he also observes the votes m_i for $i \in \{1, 2, 3\}$. If the committee's decision making process is secretive, then E does not observe m_i.[4]

[4] The effects described in my analysis also arise if in the secretive case E observes with some probability the vote configuration, that is, how many experts vote for A or for B.

As usual in career concerns models, I don't attribute any utility function to the evaluator but simply assume that he rationally updates his beliefs. This can be derived from a motivation to promote the most able experts. Denote the posterior expectations that the evaluator has on the type t_i of expert i by τ_i. I assume that each expert's objective is to maximize $E(\tau_i)$.

In equilibrium, the evaluator's beliefs about the experts' strategies are correct and his updating process relies on Bayes rule whenever possible. Also, each experts chooses the vote which maximizes $E(\tau_i)$, given his own information, E's beliefs, and the strategies of other experts. I focus on informative equilibria, i.e., equilibria in which each expert's votes are sometimes responsive to their signals, and ignore 'mirror' equilibria in which the meaning of the signals is reversed.

To summarize, the timing of the game is as follows:

1. The states w_i for $i \in \{1,2,3\}$ are realized and each expert i learns $s_i \in \{a,b\}$.

2. Each expert sends $m_i \in \{a,b\}$, given $\{q, s_i, t_i\}$.

3. The decision of the committee is $d = A$ if $\{\sharp i | m_i = a\} \geq x$ and $d = B$ otherwise.

4. E updates beliefs on t_i for all i, given the decision of the committee d, w_i for all i, and if the mechanism is transparent, also m_i for all i.

3 Transparent committees

Suppose first that the evaluator observes the personal recommendation of each expert, i.e., the voting mechanism is transparent. In that case, the evaluator would only assess the talent of expert i based on m_i - the recommendation of expert i, and w_i - the relevant state of the world for expert i. In particular, the committee's decision d, the voting rule x, and the behaviour of other experts are of no consequence for the assessment of the evaluator and hence do not affect the equilibrium behaviour of expert i. Thus, each expert accumulates *individual reputation* in the transparent mechanism. To solve for the equilibrium, we can then focus on a generic expert and follow previous literature on individual career concerns (thus, for the remainder of this section, I drop the index i).[5]

It is easy to establish that in any informative equilibrium, an expert uses a cutoff point strategy. Let $v(q,s,t) \equiv \Pr(w = a|q,s,t)$ where $\Pr(w = a|q,s,t)$ is defined in (1). Thus, in equilibrium, an expert recommends a if and only if $v(q,s,t) \geq v(q,s^*,t^*)$. This cutoff does

[5] See for example Levy (2004), Trueman (1994).

not depend on x and is denoted in short by $v^*(q)$.

The evaluator E, using Bayesian updating, forms his expectations $\tau_v(m, w)$ about the ability of the expert, given some conjecture of the expert's strategy of a cutoff point v, and the observations of m and w. Thus, for example, $\tau_v(a, a)$ denotes the posterior expectations over the type t of the agent when $m = a$ and $w = a$ and E conjectures the cutoff v, $\tau_v(b, a)$ is the reputation of the expert when $m = b$ and $w = a$, and so on. In equilibrium, the conjecture of E about v has to be correct.

We now have all the ingredients necessary for solving for the equilibrium cutoff. In equilibrium, the type $v^*(q)$, that is, the type (s^*, t^*) for which $\Pr(w = a|q, s^*, t^*) = v^*(q)$, must be indifferent between recommending b or a. The following equation has therefore to hold:

$$v^*(q)\tau_{v^*}(a, a) + (1 - v^*(q))\tau_{v^*}(a, b) = v^*(q)\tau_{v^*}(b, a) + (1 - v^*(q))\tau_{v^*}(b, b) \Leftrightarrow$$

$$v^*(q)(\tau_{v^*}(a, a) - \tau_{v^*}(b, a)) = (1 - v^*(q))(\tau_{v^*}(b, b) - \tau_{v^*}(a, b)) \tag{2}$$

The equilibrium is characterized in the following Proposition:

Proposition 1 *There is a unique informative equilibrium in which: (i) each expert i recommends $m_i = b$ if $v(q, s_i, t_i) \leq v^*(q) < \frac{1}{2}$, and recommends $m_i = a$ otherwise; (ii) for each expert, $\tau_{v^*}(a, a) \geq \tau_{v^*}(b, b) > \tau_{v^*}(a, b) \geq \tau_{v^*}(b, a)$; (iii) for all q, each expert votes for each decision, A or B, with an ex ante probability that is bounded away from zero.*

The first observation is that an informative equilibrium exists even though the expert only cares for his reputation and does not have a genuine interest in the decision itself. The reason is that in an informative equilibrium, an expert is indeed rewarded with higher reputation for making the correct recommendation. Thus, he has an interest to make a good use of his private signal.

A second observation is that $v^*(q) < \frac{1}{2}$ which implies that each expert would sometimes vote for A although he believes that B is the right decision. The reason is, as stated in part (ii) of the Proposition, that the expert is rewarded - in reputation terms - when he contradicts the prior and recommends for A. This increases reputation since it 'proves' that the expert's own private information is rather accurate, or at least, more accurate than the prior.

Moreover, as shown in Levy (2004), this incentive to go against the prior implies that the interval of types who vote for A does not shrink to zero measure with q (i.e., even if the prior is heavily biased towards B). In other words, it is not only the extremely able who vote for A. Such a strategy cannot be sustained in equilibrium since in that case, the reputation from voting for A would exceed that from voting for B even if the vote for A turns out to be the wrong vote. But this would provide an incentive for types of lesser ability to deviate and vote for A, a contradiction.

Finally, note that since all experts behave in the same way in equilibrium, a transparent process implies that the committee accepts A more often when x is smaller, and that each decision, A or B, is accepted by the committee with an ex ante probability that is bounded away from zero.

4 Secretive committees

We now consider the case in which the decision making process in the committee is non-transparent, that is, E does not observe the individual votes. But note that the evaluator does observe the decision of the committee, d, which allows him to extract some information about individual votes. Thus, each expert becomes now - indirectly - interested in the decision d. This also implies that each expert's equilibrium behaviour would depend on the voting rule x and on other experts' behaviour. As opposed to the transparent case, the committee's decision making process creates therefore a strategic interaction between its members.

To further the analysis, I impose the following. First, as usual in strategic voting games, I focus only on the interesting equilibria in which experts do not use weakly dominated strategies. In other words, they vote as if they are pivotal. Second, since the experts are ex ante symmetric, I analyse the symmetric equilibrium in which all experts use the same strategy.

We can now analyse the equilibrium. As in the transparent case, each expert would use a unique cutoff point. Denote the cutoff point as a function of the voting rule by $v^x(q)$. Recall that we have defined $\tau_v(m_i, w_i)$; this is the reputation of expert i given a message m_i, the state w_i, and the conjecture of the evaluator about some cutoff v. This was a useful tool in the analysis of the transparent case, in which the evaluator observes m_i. But it is still useful: In the secretive case, the evaluator would simply form some beliefs regarding what expert i had recommended. In other words, given some group decision d, an expert knows that he is perceived to have voted a with some probability (and hence have reputation of

$\tau_v(a, w_i)$), and to have voted b in the remaining probability (and hence have reputation of $\tau_v(b, w_i)$).

I now define these probabilities. Let $\alpha_v(d, w_i, x)$ denote the expected probability, from the point of view of expert i, that the evaluator would believe that $m_i = a$ for expert i, given the decision d, his state w_i, the voting rule x and some conjecture of a cutoff strategy v for all members. This expected probability also depends on the beliefs of i on the other agents' states, i.e., w_j and w_h for $j, h \neq i$. For clarity of exposition, I suppress these indices which are not important for the main argument.[6]

Thus, $\alpha_v(A, a, x)$ is the probability with which expert i is perceived to have recommended a, given the decision $d = A$ and $w_i = a$. Similarly, $\alpha_v(B, a, x)$ is the probability with which expert i is perceived to have recommended a, given the decision $d = B$ and $w_i = a$, and so on. For example, it is easy to see that for the unanimity rules $x = 3$ and $x = 1$ respectively, $\alpha_v(A, w_i, 3) = 1$ and $\alpha_v(B, w_i, 1) = 0$.

In equilibrium, an expert votes as if he is pivotal. The equilibrium condition, given some voting rule x, has to equate the expected utility of expert i from $d = A$ and from $d = B$ precisely at the cutoff point $v^x(q)$. Recall that $v^x(q)$ denotes the belief of the expert that the state is a. The equilibrium condition is therefore:

$$
\begin{aligned}
&v^x(q)(\alpha_{v^x}(A,a,x)\tau_{v^x}(a,a) + (1-\alpha_{v^x}(A,a,x))\tau_{v^x}(b,a)) \\
&+(1-v^x(q))(\alpha_{v^x}(A,b,x)\tau_{v^x}(a,b) + (1-\alpha_{v^x}(A,b,x))\tau_{v^x}(b,b)) \\
=&\, v^x(q)(\alpha_{v^x}(B,a,x)\tau_{v^x}(a,a) + (1-\alpha_{v^x}(B,a,x))\tau_{v^x}(b,a)) \\
&+(1-v^x(q))(\alpha_{v^x}(B,b,x)\tau_{v^x}(a,b) + (1-\alpha_{v^x}(B,b,x))\tau_{v^x}(b,b))
\end{aligned} \tag{3}
$$

The next result characterizes the equilibrium in the secretive mechanism:

Proposition 2 *For any voting rule $x \in \{1, 2, 3\}$, there exists a unique symmetric equilibrium with a cutoff $v^x(q)$ such that each expert i votes $m_i = a$ if $v(q, s_i, t_i) \geq v^x(q)$ and $m_i = b$ otherwise. For all q and x, the ex ante probability that any action A or B is taken, is bounded away from zero.*

The equilibrium in the secretive mechanism maintains the same features of that in the transparent mechanism. For example, as in the transparent case, it cannot an equilibrium phenomenon that only the extremely able vote for A and thus also types of mediocre ability

[6] See the proof of Lemma 1.

vote for A (even if the prior is heavily biased towards B). We are now ready to compare between the different decision making procedures.

5 Transparency and Reputation

In this section I show how secretive and transparent committees tend to make different decisions. I show that a secretive procedure exacerbates preexisting biases. If the voting rule is biased against an action, committee members tend to vote more often against this action. Similarly, if the voting rule is unbiased but the prior expectation is, committee members tend to vote for the action that is favored by the prior. I also show that this "conforming" behavior is sometimes more efficient than the behaviour in the transparent procedure. To proceed, I first prove a simple but a useful Lemma.

5.1 A useful lemma

Bayesian updating implies that in any equilibrium, given any state w_i, expert i is perceived as more likely to have recommended a when the decision of the committee is A, and that given any decision of the committee, expert i is perceived as more likely to have recommend a when his state is a:

Lemma 1 *For any cutoff point v and voting rule x: (i) $\alpha_v(A,a,x) \geq \alpha_v(B,a,x)$ and $\alpha_v(A,b,x) \geq \alpha_v(B,b,x)$; (ii) $\alpha_v(A,a,x) \geq \alpha_v(A,b,x)$ and $\alpha_v(B,a,x) \geq \alpha_v(B,b,x)$.*

Proof of Lemma 1: Consider an expert i and let $w_{jh} = \{w_j, w_h\}$ for $j,h \neq i$ denote the vector of states of the world for the other experts. The expert knows that E would know w_{jh} and hence for each state w_{jh}, can construct $\alpha_v^{w_{jh}}(d, w_i, x)$. When i is pivotal, he knows that there must be $x-1$ votes of a, and $2-(x-1)$ votes of b, for $x \in \{1,2,3\}$. This allows him to update his beliefs about w_{jh}, so that (where piv stands for pivotal):

$$\alpha_v(d, w_i, x) = \sum_{w_{jh} \in \{a,b\}^2} \Pr(w_{jh}|piv, x, v)\alpha_v^{w_{jh}}(d, w_i, x).$$

Note however that $\Pr(w_{jh}|piv, x, v)$ does not depend neither on d nor on w_i. Thus, to prove the Lemma, it is sufficient to prove that for any w_{jh}, $\alpha_v^{w_{jh}}(A,a,x) \geq \alpha_v^{w_{jh}}(B,a,x)$, $\alpha_v^{w_{jh}}(A,b,x) \geq \alpha_v^{w_{jh}}(B,b,x)$, $\alpha_v^{w_{jh}}(A,a,x) \geq \alpha_v^{w_{jh}}(A,b,x)$ and $\alpha_v^{w_{jh}}(B,a,x) \geq \alpha_v^{w_{jh}}(B,b,x)$.

When the voting rule is x, the probability that the group makes the decision A given that expert i recommends a or b is:

$$d_a \equiv \Pr(d = A | m_i = a, x, w_{jh}, v) = \sum_{l=x-1}^{2} \Pr(\text{exactly } l \text{ experts recommend } a | w_{jh}, v) \quad (4)$$

$$d_b \equiv \Pr(d = A | m_i = b, x, w_{jh}, v) = \sum_{l=x}^{2} \Pr(\text{exactly } l \text{ experts recommend } a | w_{jh}, v) \quad (5)$$

By Bayesian updating:

$$\alpha_v^{w_{jh}}(A, w_i, x) = \frac{m_{w_i} d_a}{m_{w_i} d_a + (1 - m_{w_i}) d_b} \quad (6)$$
$$\alpha_v^{w_{jh}}(B, w_i, x) = \frac{m_{w_i}(1 - d_a)}{m_{w_i}(1 - d_a) + (1 - m_{w_i})(1 - d_b)}.$$

where $m_{w_i} = \Pr(m_i = a | w_i, v)$. However, it is easy to see from (4) and (5) that $d_a > d_b$ for any w_{jh}. This, with (6), implies that $\alpha_v^{w_{jh}}(A, a, x) \geq \alpha_v^{w_{jh}}(B, a, x)$ and that $\alpha_v^{w_{jh}}(A, b, x) \geq \alpha_v^{w_{jh}}(B, b, x)$. Moreover, since the equilibrium is informative, then $m_a > m_b$. From (6), it then follows that $\alpha_v^{w_{jh}}(B, a, x) \geq \alpha_v^{w_{jh}}(B, b, x)$ and $\alpha_v^{w_{jh}}(A, a, x) \geq \alpha_v^{w_{jh}}(A, b, x)$.□

5.2 The "conformity" effect

Using Lemma 1, I now analyse how the decisions of the committee differ when the procedure is transparent and when it is secretive. To compare between these procedures, consider the equilibrium cutoff point of the transparent case, $v^*(q)$. Let us now conjecture that in the secretive case, this cutoff point $v^*(q)$ is the equilibrium cutoff point as well. And to start, suppose that the voting rule is $A-$unanimity ($x = 3$).

When $x = 3$, if the committee's decision is A, it allows the evaluator to perfectly learn that each expert voted A. Thus, given our equilibrium conjecture $v^*(q)$, the expected utility from voting for A, for an expert of any talent, is equal in the transparent procedure and in the secretive procedure. On the other hand, if the committee decides for B, there is some uncertainty regarding individual votes in the secretive procedure. In that case, given the equilibrium conjecture, the expected utility from voting for B differs in the transparent and in the secretive procedures. Specifically, consider the expert at the cutoff point (who believes that his state is a with probability $v^*(q)$). In the transparent mechanism, his expected utility from voting b is:

$$v^*(q)\tau_{v^*}(b, a)) + (1 - v^*(q))\tau_{v^*}(b, b), \quad (7)$$

whereas at the secretive mechanism, the expected utility from voting b is:

$$v^*(q)(\alpha_{v^*}(B,a,3)\tau_{v^*}(a,a) + (1-\alpha_{v^*}(B,a,3))\tau_{v^*}(b,a)) \\ +(1-v^*(q))(\alpha_{v^*}(B,b,3)\tau_{v^*}(a,b) + (1-\alpha_{v^*}(B,b,3))\tau_{v^*}(b,b)). \tag{8}$$

Subtract (7) from (8), to get:

$$\alpha_{v^*}(B,a,x)[v^*(q)(\tau_{v^*}(a,a)-\tau_{v^*}(b,a))] - \alpha_{v^*}(B,b,x)[(1-v^*(q))(\tau_{v^*}(b,b)-\tau_{v^*}(a,b))]. \tag{9}$$

Thus, for the expert at $v^*(q)$, the expression in (9) describes how his utility changes when he votes for B and the procedure switches from transparent to secretive. To find the sign of (9), let us ignore the α terms for a moment. The first term of (9), $[v^*(q)(\tau_{v^*}(a,a) - \tau_{v^*}(b,a))]$, represents a gain in utility terms when the mechanism becomes secretive. In that case, when the committee decides B, but when the correct state of the expert is actually a (which happens with probability $v^*(q)$), the expert is not to be fully blamed for this wrong decision, since the evaluator may think that he have voted for A.

On the other hand, the second term in (9), $-[(1-v^*(q))(\tau_{v^*}(b,b)-\tau_{v^*}(a,b))]$, represents a utility loss when the mechanism becomes secretive. If the decision B of the committee is actually correct (which happens with probability $1-v^*(q)$), the expert is not fully rewarded from voting for the correct decision, since the evaluator believes that he might have actually voted for A.

However, recall that $v^*(q)$ is the equilibrium cutoff point in the transparent case. Therefore, by (2), these two terms - the reputational gain of not being fully blamed and the reputational loss from not being fully rewarded - are equal. To find the sign of (9) we therefore have to consider the *probabilities* with which the expert will get the reputational gain or the reputational loss, and in fact, these are different. The expert gets the reputational gain, compared with the transparent case, when the decision is B, his state is a, and he is perceived as voting for A. On the other hand, he incurs a reputational loss compared with the transparent case when the decision is B, his state is b, but he is perceived as voting for A. By Lemma 1,

$$\alpha_v(B,a,x) > \alpha_v(B,b,x)$$

which implies that the expert is more likely to incur a reputational gain than a loss when the mechanism becomes secretive. Thus, for all q, the expression in (9) is positive.

We have therefore established that given the equilibrium conjecture $v^*(q)$, the expected utility of the expert at the cutoff $v^*(q)$ from voting for A is the same in both procedures whereas that from voting for B is higher in the secretive case compared with the transparent case. Moreover, in the transparent case, the expected utility of the expert at $v^*(q)$ from voting for A and from voting for B must be equal, since $v^*(q)$ is indeed the equilibrium cutoff point. These two observations imply that in the secretive mechanism, the expert at $v^*(q)$ would rather vote for B than vote for A. Along with equilibrium uniqueness, we can then conclude that $v^*(q) < v^3(q)$.[7] Thus, when $x = 3$, experts vote more often for B in the secretive procedure than in the transparent procedure.

At a more basic level, the intuition for the above result is as follows. Since the voting rule is biased against A, a decision of A reveals relatively precise information to the evaluator about an individual's vote. A decision of B on the other hand reveals little information and hence allows individuals to garble their recommendations. The able types wish that their type is revealed and hence would like to provide as much information as possible to the evaluator about their vote. However, when we compare between procedures, it is the marginal types - the less able ones - who make the difference. These types actually prefer as little information as possible to be revealed about their type and hence about their vote, and thus rather vote for the "noisier" decision.

When the voting rule is $x = 1$, we therefore get a similar result. This voting rule is also biased, this time towards A, and hence experts are induced to vote more often for A, so that $v^1(q) < v^*(q)$. More generally, and according with the intuition described above, the more a voting rule is biased against an action, the more often an individual votes against this action in the secretive process, i.e., $v^1(q) < v^2(q) < v^3(q)$ for any q.

It remains to compare the behaviour of experts in the secretive and in the transparent mechanism when the voting rule is the unbiased simple majority rule. Let $x = 2$, and think first of $q = \frac{1}{2}$. In this case, given the fully symmetric model, the evaluator's possible assessments are the same when $d = A$ and when $d = B$. Since there is no differential learning from the group's decision, the model becomes analogous to the transparent one and hence when $q = \frac{1}{2}$, $v^*(q) = v^2(q)$.

[7] This result depends not only on equilibrium uniqueness but also on the fact that the expected utility of an expert at the cutoff point from voting for $A(B)$ increases(decreases) when the cutoff point increases, as I show in the proofs.

However, when the prior points towards to B as the likely state, this 'breaks' the symmetry. In particular, it is ex ante more likely that experts vote for B (since their signals are informative and their strategies are responsive to the signals). But then if a group decision of B proved to be the wrong decision from the point of view of some expert i, this expert can "blame" others for voting for B. As above, he is more likely to gain utility by shedding the blame on others than to lose utility from not being fully recognized as the one who made the correct recommendation. This induces agents to recommend for B more often in the secretive mechanism, so that $v^*(q) < v^2(q)$. We therefore establish that:

Proposition 3 *(i)* $v^1(q) < v^2(q) < v^3(q)$; *(ii)* $v^1(q) < v^*(q) < v^3(q)$, *and for high enough values of* q, *also* $v^*(q) < v^2(q)$.[8]

Both the prior q and the voting rule x serve as sources of *bias* in the secretive case and individual votes conform to these biases. The voting rule is a procedural bias, such as a constitutional law which requires that any change to an existing law can be approved by a supermajority of the votes. This "status quo bias" is diminished once votes are observed. The prior creates another bias, of beliefs. When votes are observed however, experts would vote more often against the popular views or public opinions. Corollary 1 summarizes the implications of Proposition 3 for decision making in committees:

Corollary 1 *(Reputation, voting rules and transparency):*

(i) When the mechanism changes from secretive to transparent, the committee accepts more often the decision that the voting rule is biased against.

(ii) When the voting rule is majority rule, and the mechanism changes from secretive to transparent, the committee accepts more often the decision that goes against the initial prior belief when the prior is sufficiently high.

(iii) When the committee changes its voting rule to a higher x, *the probability that B is accepted increases more in the secretive than in the transparent mechanism.*

5.3 Optimal decision making procedures

I have described several decision making procedures which differ on two aspects, the voting rule and the level of transparency. I now use the results of the previous sections to shed some light on the question of which procedure induces committees to make decisions in the

[8] Analytically I can show that $v^*(q) < v^2(q)$ only for high values of q but I have also checked numerically that $v^*(q) < v^2(q)$ for all other values of q.

most efficient manner.

A natural criterion for efficiency is the (aggregate) probability that the decision is correct on all dimensions. Since all dimensions are ex ante symmetric, it is enough though to look at one dimension only. We therefore search for the procedure that maximizes $q\Pr(d = B|v, x) + (1 - q)\Pr(d = A|v, x)$ where $v \in \{v^*(q), v^x(q)\}$, i.e., v depends on the voting rule and on the level of transparency.

To gain some intuition about which procedure allows for more efficient decision making, recall that it cannot be an equilibrium phenomenon that only the extremely able vote for A. If this would arise in equilibrium, then voting for A would be a very precise and favourable signal about talent which would create an incentive for all other types to vote for A as well, a contradiction. Thus, both in the transparent and in the secretive mechanism and for all levels of q and for all x, also experts of mediocre talent vote for A. But when q is high (so that B is probably the right action), this means that experts vote inefficiently too often for A, in all procedures. To find the best (constrained) optimal mechanism, we therefore have to identify the one which induces the smallest such distortion.[9]

There are two possible tools that can somewhat mitigate this distortion. First, for a fixed cutoff point, it is best to choose the voting rule which reduces the probability that the committee decides for A (that is, $x = 3$). Similarly, for some fixed voting rule, it is best to choose the transparency level which allows for the highest cutoff point (i.e., the one associated with an equilibrium in which experts vote more often for B). We have to be cautious since the voting rule also affects the cutoff point so these two tools might create conflicting effects. By Proposition 3 however, in the secretive case, these two effects go in the same direction; the $A-$unanimity voting rule indeed induces the highest cutoff point among all possible procedures. We therefore have:

Proposition 4 *There exists q', such that for all $q > q'$, the optimal committee decision making procedure is secretive and has $x = 3$.*

Note that even when q is high, it is still optimal, depending on its members' information, that the committee sometimes decides for A. However, since all procedures induce

[9] In the transparent case, experts always behave inefficiently by voting too often for A (as $v^*(q) < \frac{1}{2}$). In the secretive case, when $x = 2$ or when $x = 3$, and the prior q is low, this might be reversed; it is still the case that mediocre types vote for A but it is not necessarily inefficient. Assessing which procedure is the most efficient is therefore not as clear cut as in the case of high levels of q.

the committee to decide for A too often, the secretive $A-unanimity$ procedure is (constrained) optimal as, relative to other procedures, it induces the highest probability that the committee decides for B.

Given the discussion above, it is easy to see that the secretive procedure with $x = 1$ is actually the worst mechanism for sufficiently high q. Thus, we cannot simply conclude that "secretive procedures" or "transparent procedures" are better, but we have to take into consideration the voting rule as well.

The normative analysis is somewhat restrictive; I have focused only on the efficiency of current decisions while different procedures also allow evaluators to learn differently about the ability of the committee members, which may have implications for promotion of committee members and hence the efficiency of future decisions. Moreover, I discuss below some extensions of the model, in which I allow for experts to care directly about the decision, and for correlation in the private information of the experts. These two possibilities can also be taken into account in a richer mechanism design analysis. For example, one can consider what should be the division of labor in the committee, or whether to provide direct incentives for committee members to take the right decision. Thus, in future research, it might be fruitful to investigate all these possibilities in a more nuanced welfare analysis.

6 Discussion

I conclude by discussing some extensions of the model, which illustrate the robustness of the results as well as introduce some possibilities for future research.

6.1 Correlated information

In the model, committee members have private information on aspects of the decision which are assumed to be independently distributed. This assumption allows me to distinguish the "conformity" effect, i.e., that experts exacerbate existing procedural biases in the secretive mechanism. When the states are correlated however, another effect arises. Consider the *A-unanimity* rule ($x = 3$). When an expert is pivotal, he realizes that the state a is more likely since the two other experts have voted for A. Since correct recommendations enhance reputation, the expert is encouraged, under this voting rule, to vote a. Thus, this effect works in the opposite direction compared with the "conformity" effect.[10]

[10] In related models, this effect arises when agents care for the decision per se (see Austen-Smith and Banks (1996) or Federssen and Pesendorfer (1997)). In my model it arises because career concerns also

I now analyse the case of correlation to consider this additional "pivotal" effect. Assume that with probability λ, $w_i = w$ for all i. The common state w can take the two values a or b where $\Pr(w = b) = q$, and experts receive conditionally independent signals about w according to their talent, as above. With probability $1 - \lambda$, each state w_i is drawn independently as in the original model. Note then that for all λ, nothing changes in the transparent procedure and all experts use the cutoff point $v^*(q)$. I can then show:

Proposition 5 *There exists $\underline{\lambda}, \bar{\lambda} \in (0,1)$ with $\underline{\lambda} \leq \bar{\lambda}$, such that the results of Proposition 3 hold for all $\lambda \leq \underline{\lambda}$ whereas for all $\lambda > \bar{\lambda}$, $v^3(q) < v^2(q) \leq v^*(q) < v^1(q)$.*

To see the intuition, note first that for all λ, the "conformity" still exists. It is also the dominant effect for low levels of λ, insuring the robustness of the previous results. However, when λ increases, this effect becomes weaker; experts are expected to vote in a similar way when their information is correlated. It therefore becomes harder to "claim" that others are to blame for a wrong decision. Moreover, the "pivotal" effect becomes stronger with a higher degree of correlation and thus becomes dominant for a high enough λ. In these cases, secretive committees are more likely to actually accept than to reject reforms.

The behavior of committee members may depend therefore on the interaction between voting procedures and the degree of correlation between their private information. In some environments it might be possible to control this degree of correlation. As illustrated above, this can therefore be another tool in the design of optimal committee procedures.

6.2 Decision concerns

In this section I show how the results are robust to the introduction of an assumption that experts are genuinely concerned for the committee to take the 'right' decision. Specifically, assume that each expert gains utility when the decision of the committee accords with his state of the world and to fix ideas, let expert i maximize $\tau_i + \theta I_i$, where $\theta > 0$ and $I_i = 1$ if $d = w_i$ and $I_i = 0$ otherwise.

Note that decisions concerns are manifested differently in the secretive and in the transparent case. In the secretive mechanism, an expert assesses the effect of his recommendation on both his reputation and the committee's decision, only in the event in which he is pivotal. In the transparent case, the expert's recommendation still matters for the decision only when he is pivotal but matters for his reputation in any event. This implies

induce agents to try and make the correct decision since this results in higher reputation.

that decision concerns are relatively weaker when the procedure is transparent.[11] As I show, this additional consideration does not affect the results when θ is sufficiently low.

Recall that in the transparent case experts bias their vote against the prior; they vote for A even when they believe that the state of the world is more likely to be b. This distortion remains however for all (finite) values of θ. Thus, for all voting rules, the marginal expert at the transparent cutoff point believes that the state b is more likely. Therefore, upon a switch to a secretive mechanism, stronger decision concerns induce this marginal expert to vote for B. But in the cases of $x = 3$ and $x = 2$ such expert is induced to vote for B even in the absence of decision concerns. Decision concerns can only strengthen the result in these cases. When $x = 1$ on the other hand, a switch to a secretive procedure in the absence of decision concerns induced experts to vote more often for A and hence too strong decision concerns, which create the opposite incentive, might offset this. We therefore have the following robustness result (note that the transparent cutoff points are sensitive now to the voting rule x and are thereby denoted by v_x^*)):

Proposition 6 *For all θ, $v^1(q,\theta) < v^2(q,\theta) < v^3(q,\theta)$ in secretive committees, where $v_3^*(q,\theta) < v^3(q,\theta)$, and for high enough q also $v_2^*(q,\theta) < v^2(q,\theta)$. When θ is sufficiently low, $v^1(q,\theta) < v_1^*(q,\theta)$.*

6.3 Discussion of other assumptions

In the model I have made several simplifying assumptions, most of which are not important. I have assumed that committee members vote simultaneously. A sequential process however would yield the same results. To see that, note that either the procedure is transparent in which case others' vote is meaningless (and hence also the order of the vote), or the procedure is secretive in which case one's vote only matters when he is pivotal and an expert's strategy in this case is the same when the vote is sequential or simultaneous.

The assumptions about binary states, binary signals about the states, or continuous signals about the experts' talents all do not matter for the results and the analysis carries through with alternative assumptions. The assumption that the prior distribution over each expert's types is uniform is also not crucial as Proposition 1 and Lemma 1 hold for any prior distribution function. The uniform assumption simplifies the analysis when we

[11] This intuition drives the result in Stasavage (2004) who shows that a secretive mechanism may be more efficient.

consider equilibrium uniqueness in the secretive case.

I have considered a symmetric case in which experts are ex ante homogenous. This assumption is not important in terms of the qualitative results. If for example one agent is known to have better talent ex ante (for example, the prior distribution over his types first order stochastically dominates that of the others), then in equilibrium he will use a different cutoff point than others. Still, the cutoff points will change between the secretive and the transparent case in the same manner as in the model since Lemma 1 holds for any prior distribution.

Another symmetry assumption, about the prior being the same on all dimensions, was made for tractability. This assumption does not matter when we consider the unanimity rules. When we consider the unbiased majority rule, the results can be easily modified when the priors differ. For example, experts would tend to vote more often for B under majority rule in the secretive mechanism, as derived here, if the joint prior distribution over other experts' states places a high enough probability on both states being b.

Finally, there are two possible alternative assumptions regarding the preferences of the experts. I have assumed that experts are risk neutral. All the results would hold if the experts maximize instead some function $V(\tau)$ for $V(\cdot)$ which is either concave or not too convex. In the case of an extremely convex utility function (an extreme risk-loving agent), however, the results may be reversed. For example, when $x = 3$, an expert in the secretive mechanism would have incentives to vote for A, relative to the transparent case. Voting for A allows him to receive the highest possible reputation (that of voting correctly against the prior) whereas voting for B can never result in such reputation since the evaluator cannot assert for sure that the expert voted A.[12]

I have also assumed that experts are interested in proving their ability. In some contexts, committee members might want to create a reputation for having some particular preferences (for example, preferences which accord with the ideology of the evaluator). A reasonable conjecture is that under this alternative assumption, agents in secretive committees would tend to vote more with their own true preferences and cater less to the evaluator's preferences. In future research, it might therefore be interesting to combine both types of reputation concerns, for expertise and for ideology.

[12] I thank a referee for pointing this out.

6.4 Concluding remarks

I have shown that the transparency of the decision making process has important consequences when committee members have career concerns. In particular, transparent committees tend to vote more often for the decision that is disadvantaged by institutional biases, such as the voting rule, or by public opinion biases, such as the prior. Moreover, the analysis illustrates that optimal committee design needs to take into account not only the transparency of the process but also the voting rule. That is, secretive procedures may be better than transparent ones when coupled with the right voting rule, and otherwise they may be worse.

I have abstracted in the model from the possibility that committee members exchange their views prior to placing their votes. Attempting to influence the votes of other agents is clearly an important feature of group decision making.[13] Specifically, when such internal deliberation is unobserved by the evaluator, this may result in interesting interaction between information aggregation and voting procedures. For example, if the actual vote is also secretive, the less able experts may want to insure that the committee's decision is the one that reveals the least information about their type (for example, the decision that the voting rule is biased in favour). The more able types might have the opposite incentive. This internal conflict will constrain the possibility for truthful information exchange. If the actual vote is transparent on the other hand, committee members may have a greater incentive to transmit truthful information to one another, since no such endogenous conflict is created regarding the committee's decision. It might therefore be fruitful to explore in future research the interaction between career concerns, transparency, and information aggregation, in group decision making.

[13] For recent contributions, see Austen-Smith and Feddersen (2003) and Visser and Swank (2005).

Appendix

Definitions and notation: For any x and a cutoff point v, we have:

$$\frac{\alpha_v(A,b,x)-\alpha_v(B,b,x)}{\alpha_v(A,a,x)-\alpha_v(B,a,x)}=\frac{\sum_{w_{jh}\in\{a,b\}^2}\Pr(w_{jh})\Pr(piv|w_{jh},x,v)(\alpha_v^{w_{jh}}(A,b,x)-\alpha_v^{w_{jh}}(B,b,x))}{\sum_{w_{jh}\in\{a,b\}^2}\Pr(w_{jh})\Pr(piv|w_{jh},x,v)(\alpha_v^{w_{jh}}(A,a,x)-\alpha_v^{w_{jh}}(B,a,x))}, \tag{10}$$

where $\Pr(w_{bb})=q^2$, $\Pr(w_{ab})=\Pr(w_{ba})=q(1-q)$ and $\Pr(w_{aa})=(1-q)^2$. Since w_{ab} and w_{ba} are strategically equivalent, I therefore treat them as one state, w_{ab}, and assume that this state occurs with probability $2q(1-q)$. By Lemma 1, each element in the nominator and the denominator is positive.

Recall that $m_{w_i}\equiv\Pr(m_i=a|w_i,t)$. For the different voting rules, we can now derive the expressions in (10) by using Bayesian updating:

$$\Pr(piv|w_{jh},3,v)(\alpha_v^{w_{jh}}(A,w_i,3)-\alpha^{w_{jh}}(B,w_i,3))=$$
$$\left\{\begin{array}{c} m_b^2[1-\frac{m_{w_i}(1-m_b^2)}{m_{w_i}(1-m_b^2)+(1-m_{w_i})}]\text{ for }w_{jh}=w_{bb}\\ m_am_b[1-\frac{m_{w_i}(1-m_bm_a)}{m_{w_i}(1-m_bm_a)+(1-m_{w_i})}]\text{ for }w_{jh}=w_{ab}\\ m_a^2[1-\frac{m_{w_i}(1-m_a^2)}{m_{w_i}(1-m_a^2)+(1-m_{w_i})}]\text{ for }w_{jh}=w_{aa}\end{array}\right\},$$

$$\Pr(piv|w_{jh},2,v)(\alpha_v^{w_{jh}}(A,w_i,2)-\alpha^{w_{jh}}(B,w_i,2))=$$
$$\left\{\begin{array}{c} 2m_b(1-m_b)[\frac{m_{w_i}(1-(1-m_b)^2)}{m_{w_i}(1-(1-m_b)^2)+(1-m_{w_i})m_b^2}-\frac{m_{w_i}(1-m_b)^2}{m_{w_i}(1-m_b)^2+(1-m_{w_i})(1-m_b^2)}]\text{ for }w_{jh}=w_{bb}\\ K[\frac{m_{w_i}(1-(1-m_b)(1-m_a))}{m_{w_i}(1-(1-m_b)(1-m_a))+(1-m_{w_i})m_bm_a}-\frac{m_{w_i}(1-m_b)(1-m_a)}{m_{w_i}(1-m_b)(1-m_a)+(1-m_{w_i})(1-m_bm_a)}]\text{ for }w_{jh}=w_{ab}\\ 2m_a(1-m_a)[\frac{m_{w_i}(1-(1-m_a)^2)}{m_{w_i}(1-(1-m_a)^2)+(1-m_{w_i})m_a^2}-\frac{m_{w_i}(1-m_a)^2}{m_{w_i}(1-m_a)^2+(1-m_{w_i})(1-m_a^2)}]\text{ for }w_{jh}=w_{aa}\end{array}\right\},$$

for $K=m_a(1-m_b)+m_b(1-m_a)$, and:

$$\Pr(piv|w_{jh},1,v)(\alpha_v^{w_{jh}}(A,w_i,1)-\alpha^{w_{jh}}(B,w_i,1))=$$
$$\left\{\begin{array}{c} (1-m_b)^2[\frac{m_{w_i}}{m_{w_i}+(1-m_{w_i})(1-(1-m_b)^2)}]\text{ for }w_{jh}=w_{bb}\\ (1-m_a)(1-m_b)[\frac{m_{w_i}}{m_{w_i}+(1-m_{w_i})(1-(1-m_b)(1-m_a))}]\text{ for }w_{jh}=w_{ab}\\ (1-m_a)^2[\frac{m_{w_i}}{m_{w_i}+(1-m_{w_i})(1-(1-m_a)^2)}]\text{ for }w_{jh}=w_{aa}\end{array}\right\}.$$

Recall also that $v(q)$ is shorthand for $v(q,s,t)$, where $v(q,a,t)=\frac{(1-q)t}{(1-q)t+q(1-t)}$ and $v(q,b,t)=\frac{(1-q)(1-t)}{(1-q)(1-t)+qt}$. I sometimes refer to v as the generic cutoff point and sometimes to t (and then specify whether $s=a$ or $s=b$). Note that when the cutoff point has $s=a$, then $m_a=\int_t^1 2zdz=1-t^2$ and $m_b=\int_t^1 2(1-z)dz=(1-t)^2$ for some cutoff point t, with $m_a>m_b$. Finally, let $\Gamma(s,t;q,x)\equiv\frac{\alpha_v(A,b,x)-\alpha_v(B,b,x)}{\alpha_v(A,a,x)-\alpha_v(B,a,x)}$.

I now prove three technical Lemmas.

Lemma A1: For any x and v :

$$\frac{\alpha_v^{w_{bb}}(A,b,x)-\alpha_v^{w_{bb}}(B,b,x)}{\alpha_v^{w_{bb}}(A,a,x)-\alpha_v^{w_{bb}}(B,a,x)} > \frac{\alpha_v^{w_{ab}}(A,b,x)-\alpha_v^{w_{ab}}(B,b,x)}{\alpha_v^{w_{ab}}(A,a,x)-\alpha_v^{w_{ab}}(B,a,x)} > \frac{\alpha_v^{w_{aa}}(A,b,x)-\alpha_v^{w_{aa}}(B,b,x)}{\alpha_v^{w_{aa}}(A,a,x)-\alpha_v^{w_{aa}}(B,a,x)} \tag{11}$$

Proof: These inequalities hold since $m_a > m_b$. For example, consider $x = 1$ and the inequality on the left:

$$\frac{\frac{m_b}{m_b+(1-m_b)(1-(1-m_b)^2)}}{\frac{m_a}{m_a+(1-m_a)(1-(1-m_b)^2)}} > \frac{\frac{m_b}{m_b+(1-m_b)(1-(1-m_b)(1-m_a))}}{\frac{m_a}{m_a+(1-m_a)(1-(1-m_b)(1-m_a))}} \Leftrightarrow$$
$$\frac{m_a+(1-m_a)(1-(1-m_b)^2)}{m_b+(1-m_b)(1-(1-m_b)^2)} > \frac{m_a+(1-m_a)(1-(1-m_b)(1-m_a))}{m_b+(1-m_b)(1-(1-m_b)(1-m_a))} \Leftrightarrow$$
$$m_a > m_b.$$

All the other inequalities are similarly derived.□

Lemma A2: For all x, $\Gamma(s,t;q,x)$ increases in q.

Proof: The derivative of $\Gamma(s,t;q,x)$ w.r.t. q has a positive sign if:

$$2q^2\left(\frac{\alpha_v^{w_{bb}}(A,b,x)-\alpha_v^{w_{bb}}(B,b,x)}{\alpha_v^{w_{bb}}(A,a,x)-\alpha_v^{w_{bb}}(B,a,x)} - \frac{\alpha_v^{w_{aa}}(A,b,x)-\alpha_v^{w_{aa}}(B,b,x)}{\alpha_v^{w_{aa}}(A,a,x)-\alpha_v^{w_{aa}}(B,a,x)}\right) > 0;$$
$$2q(1-q)\left(\frac{\alpha_v^{w_{bb}}(A,b,x)-\alpha_v^{w_{bb}}(B,b,x)}{\alpha_v^{w_{bb}}(A,a,x)-\alpha_v^{w_{bb}}(B,a,x)} - \frac{\alpha_v^{w_{ab}}(A,b,x)-\alpha_v^{w_{ab}}(B,b,x)}{\alpha_v^{w_{ab}}(A,a,x)-\alpha_v^{w_{ab}}(B,a,x)}\right) > 0; \text{ and}$$
$$2(1-q)^2\left(\frac{\alpha_v^{w_{ab}}(A,b,x)-\alpha_v^{w_{ab}}(B,b,x)}{\alpha_v^{w_{ab}}(A,a,x)-\alpha_v^{w_{ab}}(B,a,x)} - \frac{\alpha_v^{w_{aa}}(A,b,x)-\alpha_v^{w_{aa}}(B,b,x)}{\alpha_v^{w_{aa}}(A,a,x)-\alpha_v^{w_{aa}}(B,a,x)}\right) > 0.$$

But all these hold by Lemma A1 and thus $\Gamma(s,t;q,x)$ increases in q.□

Lemma A3: $\Gamma(a,t;q,x)$ decreases in t and $\Gamma(b,t;q,x)$ increases in t.

I show here one of the cases, when $x = 3$ and $s = a$. The other cases are proved in the same way. To construct the derivative of $\Gamma(a,t;q,3)$, we need the following (note that $m_a = 1-t^2$, $m_b = (1-t)^2$, $\frac{\partial m_b}{\partial t} = -2(1-t)$ and $\frac{\partial m_a}{\partial t} = -2t$):

$$\frac{\partial \Pr(piv|w_{bb},3,v)(1-\alpha_v^{w_{bb}}(B,b,3))}{\partial t} = \frac{\partial m_b}{\partial t}\frac{m_b(m_b+2)}{(m_b+m_b^2+1)^2};$$
$$\frac{\partial \Pr(piv|w_{bb},3,v)(1-\alpha_v^{w_{bb}}(B,a,3))}{\partial t} = \frac{\partial m_b}{\partial t}\frac{2m_b(1-m_a)}{(1-m_b^2 m_a)^2} + \frac{\partial m_a}{\partial t}\frac{m_b^2(m_b^2-1)}{(1-m_b^2 m_a)^2};$$
$$\frac{\partial \Pr(piv|w_{ab},3,v)(1-\alpha_v^{w_{ab}}(B,b,3))}{\partial t} = \frac{\partial m_b}{\partial t}\frac{m_a(m_a m_b^2-2m_b+1)}{(1-m_b^2 m_a)^2} + \frac{\partial m_a}{\partial t}\frac{m_b(1-m_b)}{(1-m_b^2 m_a)^2};$$
$$\frac{\partial \Pr(piv|w_{ab},3,v)(1-\alpha_v^{w_{ab}}(B,a,3))}{\partial t} = \frac{\partial m_b}{\partial t}\frac{m_a(1-m_a)}{(1-m_b m_a^2)^2} + \frac{\partial m_a}{\partial t}\frac{m_b(m_a^2 m_b-2m_a+1)}{1-m_b m_a^2};$$
$$\frac{\partial \Pr(piv|w_{aa},3,v)(1-\alpha_v^{w_{aa}}(B,b,3))}{\partial t} = \frac{\partial m_b}{\partial t}\frac{m_a^2(m_a^2-1)}{(1-m_b m_a^2)^2} + \frac{\partial m_a}{\partial t}\frac{2m_a(1-m_b)}{(1-m_b m_a^2)^2};$$
$$\frac{\partial \Pr(piv|w_{aa},3,v)(1-\alpha_v^{w_{aa}}(B,a,3))}{\partial t} = \frac{\partial m_a}{\partial t}\frac{m_a(m_a+2)}{(m_a+m_a^2+1)^2}.$$

In fact, for any w_{jh} and $w_i \in \{a,b\}$, $\frac{\partial \Pr(piv|w_{jh},3,v)(1-\alpha_v^{w_{jh}}(B,w_i,3))}{\partial t} < 0$. Thus, the derivative of (10) w.r.t. t, at $x = 3$ and $s = a$, is negative if:

$$\frac{\sum_{w_{jh}\in\{a,b\}^2} \Pr(w_{jh})|\frac{\partial}{\partial t}\Pr(piv|w_{jh},x,v)(1-\alpha_v^{w_{jh}}(B,b,3))|}{\sum_{w_{jh}\in\{a,b\}^2} \Pr(w_{jh})|\frac{\partial}{\partial t}\Pr(piv|w_{jh},x,v)(1-\alpha_v^{w_{jh}}(B,a,3))|} > \frac{1-\alpha_v(B,b,3)}{1-\alpha_v(B,a,3)},$$

but by Lemma A1, $\frac{1-\alpha_v^{w_{bb}}(B,b,3)}{1-\alpha_v^{w_{bb}}(B,a,3)} > \frac{1-\alpha_v(B,b,3)}{1-\alpha_v(B,a,3)}$ and thus it is sufficient to show that

$$\frac{|\frac{\partial}{\partial t}\Pr(piv|w_{jh},x,v)(1-\alpha_v^{w_{jh}}(B,b,3))|}{|\frac{\partial}{\partial t}\Pr(piv|w_{jh},x,v)(1-\alpha_v^{w_{jh}}(B,a,3))|} > \frac{1-\alpha_v^{w_{bb}}(B,b,3)}{1-\alpha_v^{w_{bb}}(B,a,3)},$$

for any w_{jh}. Using the expressions derived above (which are functions of t only), a routine calculation establishes these three inequalities for any $t \in [.5, 1]$.□

Proof of Proposition 1: See Levy (2004). The main argument involves the following: (i) when the cutoff point has $s = b(a)$, then $\tau_v(a,a) \leq (\geq)\tau_v(b,b)$ and $\tau_v(a,b) \leq (\geq)\tau_v(b,a)$ and therefore for (2) to hold, the cutoff point must admit $s = a$; (ii) If we conjecture that in equilibrium $s = a$ and $t = q$, then for this type, the expected utility from voting a is higher than that from voting b and thus by continuity an equilibrium exists; (iii) for any conjecture of a cutoff point that has $s = a(b)$, the expected utility of an expert at the cutoff point from voting a increases(decreases) with t and from voting b decreases(increases) with t. The equilibrium cutoff is therefore unique and has $s = a$ and $t < q$; (iv) the cutoff point t is bounded by some $\hat{t} < 1$ for all q. Otherwise, if only the extremely able vote for a, we would have that $\tau_v(b,a) \leq \tau_v(b,b) \leq \tau_v(a,b) \leq \tau_v(a,a)$ and thus (2) cannot hold. The bound $\hat{t}$ is easily computed by finding the value of t which satisfies $\tau_v(b,b) = \tau_v(a,b)$.■

Proof of Proposition 2: Re-arranging (3), the equilibrium condition becomes:

$$\begin{aligned} &v^x(q)(\alpha_{v^x}(A,a,x) - \alpha_{v^x}(B,a,x))(\tau_{v^x}(a,a) - \tau_{v^x}(b,a)) \\ &= (1 - v^x(q))(\alpha_{v^x}(A,b,x) - \alpha_{v^x}(B,b,x))(\tau_{v^x}(b,b) - \tau_{v^x}(a,b)). \end{aligned} \tag{12}$$

By Lemma 1, $\alpha_{v^x}(A,a,x) - \alpha_{v^x}(B,a,x) > 0$ and $\alpha_{v^x}(A,b,x) - \alpha_{v^x}(B,b,x) > 0$ for all q, x and some v^x. Existence and the fact that the equilibrium cutoff point t^x is bounded by $\hat{t} < 1$ follows then from the same arguments as in the transparent case. To see that the equilibrium cutoff point is unique, note that in the transparent case the expected utility from voting $a(b)$ increases (decreases) in t for $s = a$ and the other way around for $s = b$. By Lemma A3 this holds in the secretive case as well and thus the cutoff is unique.

Finally, note that when $x = 2$ and when $x = 3$, the cutoff point must admit $s^x = a$. For $x = 3$, note that otherwise, by Proposition 1 and Lemma 1, the utility from voting b would exceed that from voting a for all types with $s = b$, a contradiction. For $x = 2$, note first that $\Gamma(s, \frac{1}{2}; \frac{1}{2}, 2) = 1$.[14] But then $\Gamma(b, \frac{1}{2}; q, 2) > 1$ by Lemma A2 and $\Gamma(b, t; q, 2) > 1$ by Lemma A3. Now divide both sides of (12) by $\alpha_{v^x}(A, a, x) - \alpha_{v^x}(B, a, x)$. In the transparent case, the left-hand-side is smaller than the right-hand-side when $s = b$. Since $\Gamma(b, t; q, 2) > 1$, this moreover holds in the secretive case and hence $s^x = b$ cannot be an equilibrium.■

Proof of Proposition 3: I first show part (ii). The case of $v^*(q) < v^3(q)$ is in the text. To show that $v^1(q) < v^*(q)$, I have to show that when the equilibrium conjecture is $v^*(q)$, then the expert at $v^*(q)$ prefers to vote for A, i.e., that:

$$v^*(q)\alpha_{v^*}(A, a, 1)(\tau_{v^*}(a, a) - \tau_{v^*}(b, a)) > (1 - v^*(q))\alpha_{v^*}(A, b, 1)(\tau_{v^*}(b, b) - \tau_{v^*}(a, b)).$$

This holds by (2) and by Lemma 1. Similarly, to show that $v^*(q) < v^2(q)$ for high enough q, and given (2), it is enough to show that $\Gamma(s^*, t^*; q, 2) > 1$ when q is high enough. By Proposition 1, the transparent cutoff point has $s = a$ and $t < \hat{t}$. By Lemma A3, $\Gamma(a, t; q, x)$ decreases in t. Moreover, by Lemma A2, $\Gamma(s, t; q, x)$ is monotone in q. Thus, using continuity, it is enough to establish that $\Gamma(a, \hat{t}; 1, 2) > 1$ which indeed holds.

To prove part (i) of the Proposition I use the same methodology. For that purpose, I first check that $\Gamma(a, \frac{1}{2}; 1, 1) < \Gamma(a, \hat{t}; \frac{1}{2}, 2)$ and $\Gamma(a, \frac{1}{2}; 1, 2) < \Gamma(a, \hat{t}; \frac{1}{2}, 3)$. By Lemma A2 and Lemma A3, this implies that $\Gamma(a, t; q, 1) < \Gamma(a, t; q, 2) < \Gamma(a, t; q, 3)$ for $t \leq \hat{t}$. Note now that for $x = 2$ and $x = 3$, as established in Proposition 2, the cutoff point is at $s^x = a$. Thus $v^2 < v^3$. If $s^x = a$ also for $x = 1$ then by the same reasoning we have $v^1 < v^2$. If for $x = 1$ we have the cutoff point at $s^x = b$, then moreover $v^1 < v^2$.■

Proof of proposition 4: Let $\lambda = qm_b + (1 - q)m_a$ be the ex ante probability that some expert votes for a. The probability that the committee's decision is correct is therefore $q(1 - m_b\lambda^2) + (1 - q)(m_a\lambda^2)$ if $x = 3$, $q((1 - \lambda)^2 m_b + (1 - m_b)(1 - \lambda^2)) + (1 - q)(m_a(1 - (1 - \lambda)^2) + (1 - m_a)\lambda^2)$ if $x = 2$ and $q((1 - m_b)(1 - \lambda)^2) + (1 - q)(m_a + (1 - m_a)(1 - (1 - \lambda)^2))$ if $x = 1$.

Note that by Propositions 1 and 2, for all q, m_a, m_b and λ are bounded from below by

[14] This is established by noting that $m_a = \frac{3}{4} = 1 - m_b$ and substituting in (10). Moreover, this is intuitive since in the fully symmetric case ($q = .5$, $x = 2$ and $t = .5$), the evaluator does not learn different information from a decision for A or a decision for B.

some positive number. Given this observation, it is easy to see from the above expressions that: (i) Fixing m_a, m_b and λ, then when q is high enough, $x = 3$ induces a higher probability of a correct decision relative to $x = 1$ and $x = 2$; (ii) For a high enough q, for any x, the probability that the decision is correct decreases in (the bounded) m_a, m_b and λ. Finally, note that m_a, m_b and λ depend only on v and thus Proposition 3 implies the result.■

Proof of proposition 5 In the general case, the equilibrium condition can be simply constructed in the following way:

$$\begin{aligned}
&(1-\lambda)[v^x(q)(\alpha_{v^x}(A,a,x)-\alpha_{v^x}(B,a,x))(\tau_{v^x}(a,a)-\tau_{v^x}(b,a))] \\
&+\lambda[V(q)\cdot(\alpha_{v^x}^{w_{aa}}(A,a,x)-\alpha_{v^x}^{w_{aa}}(B,a,x))(\tau_{v^x}(a,a)-\tau_{v^x}(b,a))] \\
=&(1-\lambda)[(1-v^x(q))(\alpha_{v^x}(A,b,x)-\alpha_{v^x}(B,b,x))(\tau_{v^x}(b,b)-\tau_{v^x}(a,b))] \\
&+\lambda[(1-V(q))(\alpha_{v^x}^{w_{bb}}(A,b,x)-\alpha_{v^x}^{w_{bb}}(B,b,x))(\tau_{v^x}(b,b)-\tau_{v^x}(a,b))]
\end{aligned} \tag{13}$$

where $V(q) = \dfrac{v^x(q)\Pr(piv|w=a,x,v^x(q))}{v^x(q)\Pr(piv|w=a,x,v^x(q))+(1-v^x(q))\Pr(piv|w=b,x,v^x(q))}$.

Since the differences in the α probabilities do not vanish and do not depend on λ, the results for $\lambda = 0$ hold for small values of λ and the results for $\lambda = 1$ hold for large values of λ. I now show that when $\lambda = 1$, $v^3(q) < v^2(q) < v^*(q) < v^1(q)$.

In the transparent case, in fact, the cutoff point does not depend on λ and is the same $v^*(q)$ as described in Proposition 1. In the secretive case, the equilibrium condition is as in (13), when we set $\lambda = 1$. As in the method of the proof of Proposition 3, to show that $v^1(q) > v^*(q)$, given the equilibrium condition (2), I have to show that:

$$\begin{aligned}
&\Pr(piv|w=a,1,v^*(q))\alpha_{v^*}^{w_{aa}}(A,a,1) < \Pr(piv|w=b,1,v^*(q))\alpha_{v^*}^{w_{bb}}(A,b,1) \\
&\Leftrightarrow \tfrac{m_a(1-m_a)^2}{m_a+(1-m_a)(1-(1-m_a)^2)} < \tfrac{m_b(1-m_b)^2}{m_b+(1-m_b)(1-(1-m_b)^2)}
\end{aligned}$$

at v^*. This holds since $m_a > m_b$. Similarly, to show that $v^3(q) < v^2(q)$, I have to show that

$$\begin{aligned}
&\tfrac{\Pr(piv|w=a,3,v^2(q))(1-\alpha_{v^*}^{w_{aa}}(B,a,3))}{\Pr(piv|w=b,3,v^2(q))(1-\alpha_{v^*}^{w_{bb}}(B,b,3))} > \tfrac{\Pr(piv|w=a,2,v^2(q))(\alpha_{v^*}^{w_{aa}}(A,a,2)-\alpha_{v^*}^{w_{aa}}(B,a,2))}{\Pr(piv|w=b,2,v^2(q))(\alpha_{v^*}^{w_{bb}}(A,b,2)-\alpha_{v^*}^{w_{bb}}(B,b,2))} \Leftrightarrow \\
&\tfrac{(1-m_b^3)}{m_b}(\tfrac{2-m_b}{3-2m_b}-\tfrac{m_b}{1+2m_b}) > \tfrac{(1-m_a^3)}{m_a}(\tfrac{2-m_a}{3-2m_a}-\tfrac{m_a}{1+2m_a})
\end{aligned}$$

at v^*. This also holds whenever $m_a > m_b$ and thus holds for any v. Finally, I have to show that $v^2(q) < v^*(q)$, or that

$$\begin{aligned}
&\Pr(piv|w=a,1,v^*(q))(\alpha_{v^*}^{w_{aa}}(A,a,2)-\alpha_{v^*}^{w_{aa}}(B,a,2)) \\
&\quad > \Pr(piv|w=b,1,v^*(q))(\alpha_{v^*}^{w_{bb}}(A,b,2)-\alpha_{v^*}^{w_{bb}}(B,b,2)) \\
&\quad \Leftrightarrow 2m_a(1-m_a)(\tfrac{2-m_a}{3-2m_a}-\tfrac{m_a}{1+2m_a}) > 2m_b(1-m_b)(\tfrac{2-m_b}{3-2m_b}-\tfrac{m_b}{1+2m_b}).
\end{aligned}$$

Substituting for $m_a = 1 - t^2$ and $m_b = (1-t)^2$ (since $s = a$ at $v^*(q)$), I find that it holds for all $t \in [.5, 1]$. This establishes that $v^3(q) < v^2(q) < v^*(q) < v^1(q)$ when $\lambda = 1$.■

Proof of Proposition 6 With decision concerns, in the case of a transparent process, the equilibrium condition is:

$$\begin{aligned} & v_x^*(q,\theta)(\tau_{v^*}(a,a) - \tau_{v^*}(b,a) + \Pr(piv|x, v^*)\theta) \\ = & (1 - v_x^*(q,\theta))(\tau_{v^*}(b,b) - \tau_{v^*}(a,b) + \Pr(piv|x, v^*)\theta) \end{aligned} \tag{14}$$

It is then easy to see that the cutoff points obey $\frac{1}{2} > v_1^*(q,\theta) > v_2^*(q,\theta) > v_3^*(q,\theta) > v^*(q,0)$, since: (i) For all q, a cutoff point of $\frac{1}{2}$ is the limit equilibrium when $\theta \to \infty$; (ii) Relative to the case of $\theta = 0$, a positive value of θ implies that experts tend to make the correct recommendation more often. Since $v_x^*(q,\theta) < \frac{1}{2}$, the correct decision is b. Thus, $v_x^*(q,\theta) > v^*(q,0)$;(iii) The greatest effect of θ is when the expert is more likely to be pivotal. Even though $v_x^*(q,\theta) < \frac{1}{2}$, it is still ex ante more likely that any other expert votes for B; an expert is therefore more likely to be pivotal the lower is x. Thus, $v_x^*(q,\theta)$ decreases in x.

In the case of a secretive process, the equilibrium condition is:

$$\begin{aligned} & v^x(q,\theta)[(\alpha_{v^x}(A,a,x) - \alpha_{v^x}(B,a,x))(\tau_{v^x}(a,a) - \tau_{v^x}(b,a)) + \theta] \\ = & (1 - v^x(q,\theta))[(\alpha_{v^x}(A,b,x) - \alpha_{v^x}(B,b,x))(\tau_{v^x}(b,b) - \tau_{v^x}(a,b)) + \theta] \end{aligned}$$

The result that in secretive committees that $v^1(q,\theta) < v^2(q,\theta) < v^3(q,\theta)$ is maintained here since the decision concerns play the same role in all voting rules and are not affected by the voting rule.

Fix x and consider the transparent cutoff point $v_x^*(q,\theta)$. At this cutoff point, in the secretive process, an expert prefers to vote for B if (where I use the equality in (14)):

$$\begin{aligned} & (\alpha_{v^x}(A,b,x) - \alpha_{v^x}(B,b,x) - (\alpha_{v^x}(A,a,x) - \alpha_{v^x}(B,a,x)))[(1 - v_x^*(q,\theta)(\tau_{v^*}(b,b) - \tau_{v^*}(a,b))] \\ & +(1 - 2v_x^*(q,\theta))[1 - \Pr(piv|x, v^*)(\alpha_{v^x}(A,a,x) - \alpha_{v^x}(B,a,x))]\theta > 0 \end{aligned}$$

Note that from Proposition 3 we know that the first term is positive for $x = 3$, and for $x = 2$ and high q. The second term is on the other hand positive for all x. Thus, the results are maintained for all θ for $x = 3$, and for $x = 2$ and high q. For $x = 1$, we have to show the reverse inequality. We know by Proposition 3 that the first term is strictly negative for all q. Thus, for a low enough θ the whole expression remains negative and the results hold for $x = 1$ as well.■

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