DISCUSSION PAPER SERIES

No. 6677

INFORMATION ACQUISITION AND TRANSPARENCY IN COMMITTEES

Hans Gersbach and Volker Hahn

PUBLIC POLICY

Centre for Economic Policy Research

www.cepr.org

Available online at: **www.cepr.org/pubs/dps/DP6677.asp**

ISSN 0265-8003

INFORMATION ACQUISITION AND TRANSPARENCY IN COMMITTEES

Hans Gersbach, Center of Economic Research at ETH Zurich and CEPR
Volker Hahn, Center of Economic Research at ETH Zurich

Discussion Paper No. 6677
February 2008

Centre for Economic Policy Research
90–98 Goswell Rd, London EC1V 7RR, UK
Tel: (44 20) 7878 2900, Fax: (44 20) 7878 2999
Email: cepr@cepr.org, Website: www.cepr.org

CEPR Discussion Paper No. 6677

February 2008

ABSTRACT

Information Acquisition and Transparency in Committees*

We study a two-period model of committee decision-making where members differ in their levels of efficiency. They may acquire costly information that enhances their ability to make a correct decision. We focus on the impact of transparency. We show that the principal's initial utility is higher under transparency, because members exert more effort, which makes correct decisions more likely. The principal also benefits from transparency later, unless transparency leads to an alignment of the signal qualities of highly efficient and less efficient committee members. In general, committee members are harmed by transparency.

JEL Classification: D70
Keywords: career concerns, committees, experts, information acquisition and transparency

Hans Gersbach
Centre for Economic Research
at ETH Zurich
Zürichbergstrasse 18
8092 Zürich
SWITZERLAND
Email: hgersbach@ethz.ch

For further Discussion Papers by this author see:
www.cepr.org/pubs/new-dps/dplist.asp?authorid=119061

Volker Hahn
Centre for Economic Research
at ETH Zurich
Zürichbergstrasse 18
8092 Zürich
SWITZERLAND
Email: vhahn@ethz.ch

For further Discussion Papers by this author see:
www.cepr.org/pubs/new-dps/dplist.asp?authorid=159938

* We would like to thank Johannes Becker, Thomas Lanz, Bernhard Pachl, and Bauke Visser for valuable comments.

Submitted 21 January 2008

1 Introduction

Many important economic and political issues are decided by committees whose individuals have particular expertise. Company boards or monetary policy committees are examples in the economic realm. Parliamentary committees, the Council of Ministers in the European Union, or constitutional courts are examples in the political area.

Arguably, many of the decisions taken in these examples are complex, and members of the committee have to exert effort prior to meetings in order to thoroughly understand and evaluate the issues at hand. Hence the amount of information acquired by members is crucial for the quality of the committee's decision.

One recent phenomenon is that a variety of committee decision-making bodies are becoming more transparent by publishing deliberations and individual votes.[1] In this paper we examine how transparency about the behavior of committee members impacts on the amount of information acquired by them and, accordingly, on the quality of decision-making in committees.

Our analysis focuses on committees whose members are motivated by career concerns. It is plausible that members are concerned about their prestige and the satisfaction gained by working on the committee and thus, in turn, about their re-appointment prospects. The desire to be re-appointed creates incentives to acquire information, as the principal (such as the parliament, shareholders, ministers, etc.) will tend to re-appoint only those members who display higher quality in decision-making than the average in the pool of potential experts.

When the principal opts for transparency, he can evaluate the quality of a member by observing the individual's decisions. This will determine that member's re-appointment chances. The amount of information acquired by an individual member is independent of the behavior of other committee members. When the principal decides to have an opaque committee, the fact that he observes the collective decision alone means that he can either re-appoint all the members or none of them.

[1] Examples are the Federal Open Market Committee, the U.S. Supreme Court, or the Monetary Policy Committee of the Bank of England.

We use a simple two-period model to examine information acquisition, the probability of correct decisions, and the re-appointment decisions of a principal. The main results are as follows. We show that under transparency the principal is always better off in the first period, because transparency induces higher effort on behalf of committee members and thus improves decision-making in the first period. In the second period, it is not clear a priori whether transparency enables the principal to improve the quality of the committee more efficiently. While under transparency the principal can observe individual behavior, which tends to improve his ability to increase the competency of members by his re-appointment decisions, transparency may lead to a convergence of the quality of the members' signals, which makes identifying the individual ability of members difficult. We identify a critical property guaranteeing that the principal profits from transparency in the second period if experts know their own abilities. If experts do not know their own abilities, transparency is always beneficial to the principal in the second period.

Transparency makes committee members worse off, because they have to invest more in effort and their re-appointment chances are lower. This might explain a certain initial reluctance on the part of various committees to make their decision-making transparent. For example, the FOMC did not adopt transparent decision-making voluntarily.

In the concluding section, taking the findings of this paper and the existing literature into account, we will draw a more general conclusion. We elaborate on the circumstances under which transparency is beneficial to committee designers and those under which it is not.

Our paper combines two strands of literature. The first is concerned with the impact of transparency requirements on the quality of committee decision-making if the abilities of members are exogenously given.[2] This literature has shown that transparency may distort the behavior of individual committee members, because they are not only interested in the impact of their vote on the outcome of decision-making but

[2]Holmström (1982) is a seminal contribution to the literature on experts motivated by career concerns. Other important contributions include Scharfstein and Stein (1990), Trueman (1994), and Ottaviani and Sørensen (2001).

attempt to use their vote as a signal of a particular type. This effect is taken into account in Fingleton and Raith (2005), Gersbach and Hahn (2004), Gersbach and Hahn (2007), Levy (2007), Sibert (2003), and Stasavage (2006).[3] Sibert (2003) analyzes the impact of transparent decision-making on reputation-building if central bankers may have an incentive to increase output above the natural rate. Levy (2007) shows that opaque decision-making induces members to comply with pre-existing biases, as the signaling incentives in such cases are not eliminated. The disadvantage of secrecy can be obviated if appropriate voting rules are used. Gersbach and Hahn (2007) identify an intertemporal trade-off between transparency and opacity. While secrecy initially makes for better decisions because uninformed committee members have no incentive to mimic informed members, it hampers the principal's ability to dismiss manifestly less well-informed members.

The second strand of literature is concerned with information acquisition and voting in committees.[4] Gersbach (1995) studies agents' incentives to acquire information if decisions are made by majority rule. He characterizes situations where the committee acts as if it were fully informed and where this is preferred to ignorance by a majority of members or the whole committee. Mukhopadhaya (2003) and Persico (2004) examine the role of committee size for incentives to acquire information. Both find that large committees lead to a severe underprovision of information.[5] Gerardi and Yariv (2007) study the optimal committee size and decision rule. We examine here how the incentives to acquire information interact with the transparency regime when members have career concerns.

This paper is organized as follows: In Section 2 we outline our model. We analyze the equilibrium in the second period for transparency and opacity in Section 3. Subsequently, in Sections 4 and 5, we derive the equilibria under transparency and opacity. We compare the utility under transparency and under opacity for the principal and the

[3]Visser and Swank (2007) present another interesting model where experts derive utility from being perceived as competent. Prat (2005) examines transparency for a career concern model with one individual expert.

[4]For a survey of this literature see Gerling et al. (2005).

[5]As a member benefits from information acquisition by others, this is a classical team-work problem of the kind discussed by Marschak and Radner (1972).

committee members in Section 6. In Section 7, we analyze our model for the alternative assumption that experts do not know their own abilities. Section 8 concludes.

2 Model

We consider a two-period model of a committee comprising N experts ($N \geq 1$). For simplicity of exposition we assume that N is odd. Committee members make a decision $d_t \in \{-1; +1\}$ by majority rule in each period $t = 1, 2$. We use $d_t^i \in \{-1; +1\}$ to denote the individual vote of member i ($i = 1, \ldots, N$).

Committee members are appointed by a principal who benefits if the committee reaches a decision that corresponds to the state of the world, which is given by $s_t \in \{-1; +1\}$. The principal has the following utility function in each period $t = 1, 2$:

$$u_t^P = \begin{cases} 1 & \text{if } d_t = s_t \\ 0 & \text{if } d_t \neq s_t. \end{cases} \tag{1}$$

Without loss of generality, we have normalized the principal's benefits from a correct decision to 1. We assume that nature chooses $s_t = -1$ and $s_t = 1$ with equal probability. The state of the world is unknown to the principal at the beginning of period t. However, it becomes common knowledge after the committee has made its decision. There is a common discount factor δ for the principal and experts.

There are two types of experts, highly efficient experts and less efficient experts. We assume that the level of efficiency is private information. The prior probability of an expert being highly efficient amounts to q^H ($0 < q^H < 1$). The probability for the less efficient type is denoted by $q^L = 1 - q^H$. Each expert may invest effort $e_t^i \in [0; E]$ ($E > 0$) into information acquisition about the state of the world. The effort of experts is unobservable to the principal. A highly efficient expert i then receives a signal $\sigma_t^i \in \{-1, +1\}$ about the state of the world. The signal is correct with probability $p^H(e_t^i)$; with probability $1 - p^H(e_t^i)$ the signal is incorrect. A less efficient expert has a probability $p^L(e_t^i)$ of receiving a correct signal. Thus the effort in period t only affects the quality of the signal in the same period.

We make the following assumptions about $p^H : [0; E] \rightarrow]1/2; 1]$ and $p^L : [0; E] \rightarrow]1/2; 1]$:

$$
\begin{aligned}
& p^H(e_t^i) > p^L(e_t^i) && \frac{\partial p^H}{\partial e_t^i}(e_t^i) \geq \frac{\partial p^L}{\partial e_t^i}(e_t^i) && \forall e_t^i \in [0; E[, \\
& \frac{\partial p^X}{\partial e_t^i}(e_t^i) > 0 && \frac{\partial^2 p^X}{\partial (e_t^i)^2}(e_t^i) < 0 && \forall e_t^i \in [0; E[, \forall X \in \{H, L\}, \\
& \lim_{e_t^i \rightarrow E} \frac{\partial p^X}{\partial e_t^i}(e_t^i) < \frac{1}{\delta B} && \lim_{e_t^i \rightarrow 0} \frac{\partial p^X}{\partial e_t^i}(e_t^i) = \infty && \forall X \in \{H, L\}.
\end{aligned}
$$

In particular, we assume that experts with high efficiency have a higher probability of obtaining a correct signal for a given level of effort. Moreover, a marginal increase in effort results in a weakly higher increase in the precision of the signal for highly efficient members over and against less efficient members. The assumptions on $\lim_{e_t^i \rightarrow E} \frac{\partial p^X}{\partial e_t^i}(e_t^i)$ $\lim_{e_t^i \rightarrow 0} \frac{\partial p^X}{\partial e_t^i}(e_t^i)$ are made for analytical convenience and guarantee the existence of interior solutions.

We assume that experts obtain utility from being on the committee. These benefits amount to $B > 0$ in each period. Benefits B may comprise wages. They may also be affected by the prestige and satisfaction involved in working on the committee. Moreover, experts incur costs from exerting effort. If they do not hold office, utility is normalized to 0. The utility of an expert in period t is given by

$$
u_t^i = \begin{cases} B - e_t^i & \text{if the expert is on the committee} \\ 0 & \text{if the expert is not on the committee.} \end{cases} \tag{2}
$$

We assume $B > E$, i.e. an expert prefers to be a committee member even if he exerts the maximum level of effort E. We introduce the following tie-breaking rule: experts vote in line with their signals if they are indifferent between votes.

The sequence of events is as follows:

Period 1

- The principal appoints committee members from a pool of candidates.
- Nature chooses the state of the world.

- Experts may invest in information acquisition.
- Experts receive private signals about the state of the world.
- Experts vote simultaneously.
- Under transparency, individual voting records d_1^i are published. Under opacity, only the decision d_1 becomes known.

Period 2

- The principal observes s_1 and may either re-appoint each committee member or replace him by a new member from a pool of candidates.
- The remaining events are identical to those described for period 1.[6]

Next we make plausible assumptions about re-appointment schemes. We use $\mu_T^i(Z^i)$ $Z^i \in \{C, W\}$ to denote the probability of an expert being re-appointed under transparency if he has made a correct ($Z^i = C$) or a wrong ($Z^i = W$) decision ($\mu_T^i(Z^i) \in [0;1]$).[7] Thus we make the implicit assumption that re-appointment probabilities are symmetric, i.e. the probability of re-appointment depends only on the correctness of the vote.

Moreover, we assume that

$$\mu_T^i(C) \geq \mu_T^i(W) \qquad \forall i \in \{1, 2, ..., N\}. \tag{3}$$

This assumption implies that the probability of re-appointment will never increase if an expert makes a wrong rather than a correct decision.

Under opacity, where only the decision of the committee can be observed, the re-appointment decision depends solely on the outcome of the voting C and not on individual votes. We introduce $\mu_O^i(Z)$ $Z \in \{C, W\}$ to denote the re-appointment probability of expert i if the committee has made the correct (C) or the wrong (W) decision.

[6] We assume that the state of the world is uncorrelated across periods.

[7] In principle, a member's probability of re-appointment could also depend on the other members' votes. However, this can be optimal only if the principal is indifferent between dismissing and re-appointing the respective member. This does not occur in equilibrium.

Accordingly, we consider only symmetric election schemes under opacity, where the probability of re-election does not depend on the particular state of the world but only on the correctness of the decision. We assume that the re-appointment chances of individual experts will increase weakly if the committee has made a correct decision rather than a wrong decision

$$\mu_O^i(C) \geq \mu_O^i(W) \qquad \forall i \in \{1, 2, ..., N\}. \tag{4}$$

3 Behavior of Experts in the Second Period

The behavior of experts in the second period does not depend on the transparency regime. It is obvious that experts will never exert effort in the second period, i.e. $e_2^H = e_2^L = 0$ holds. Thus the utility of an expert holding office in the second period amounts to $u_2^i = B$.

According to the assumptions made in Section 2, experts always vote in line with their private signals in the second period. This implies that the probability of a highly efficient expert voting correctly amounts to $p^H(0)$. The respective probability for a less efficient expert amounts to $p^L(0)$. Recall that our assumptions about $p^X(e_t^i)$ imply that the probability of an expert choosing the correct vote is strictly higher in the case of a highly efficient expert compared to the case of a less efficient expert for a specified level of effort. As a consequence, the principal is always strictly better off if a particular member is highly efficient rather than less efficient.

We summarize our findings in the following lemma:

Lemma 1

In the second period, experts behave in the following way under transparency and opacity: they choose effort levels $e_2^i = 0$ and vote in line with their signals.

4 Transparency

We begin our analysis of transparent committees by examining the optimal voting behavior in the first period. Assume a committee member of type $X \in \{L, H\}$ has received signal σ_1^i. This implies that $s_1 = \sigma_1^i$ is correct with probability $p^X(e_1^i) > 1/2$. There are two cases in line with our assumptions about re-appointment schemes. First, the probability of re-appointment may not depend on the correctness of the individual vote ($\mu_T^i(C) = \mu_T^i(W)$). According to our tie-breaking rule, the committee member will make the decision suggested by his signal. Second, the probability of re-appointment may not be invariant to the correctness of the individual vote, i.e. $\mu_T^i(C) > \mu_T^i(W)$ holds. If the committee member votes for σ_1^i, the probability of being re-appointed amounts to $p^X(e_1^i)\mu_T^i(C)+(1-p^X(e_1^i))\mu_T^i(W)$. By contrast, if the expert votes for $-\sigma_1^i$, then the probability of re-appointment is given by $(1-p^X(e_1^i))\mu_T^i(C)+p^X(e_1^i)\mu_T^i(W)$. Because the expert tries to maximize his re-appointment chances, it is optimal to vote for σ_1^i if

$$p^X(e_1^i)\mu_T^i(C) + (1-p^X(e_1^i))\mu_T^i(W) > (1-p^X(e_1^i))\mu_T^i(C) + p^X(e_1^i)\mu_T^i(W). \quad (5)$$

This inequality always holds for $p^X(e_1^i) > 1/2$ and $\mu_T^i(C) > \mu_T^i(W)$. Hence it is always optimal to vote in line with one's signal. We summarize this finding in the following lemma:

Lemma 2
Under transparency, experts always make the decision suggested by their signals in the first period.

Next, we analyze the optimal choice of effort in the first period. An expert i with efficiency level $X \in \{H, L\}$ chooses e_1^i in order to maximize

$$B - e_1^i + \delta \left[p^X(e_1^i)\mu_T^i(C) + (1-p^X(e_1^i))\mu_T^i(W)\right] B. \quad (6)$$

This yields the first-order condition

$$1 = \delta \left[\mu_T^i(C) - \mu_T^i(W)\right] (p^X)'(e_1^i)B. \quad (7)$$

As a consequence, the optimal level of effort under transparency is given by

$$e_{1,T}^{i,X} = \begin{cases} \left((p^X)'\right)^{-1}\left(\frac{1}{(\mu_T^i(C)-\mu_T^i(W))\delta B}\right) & \mu_T^i(C) > \mu_T^i(W) \\ 0 & \text{for } \mu_T^i(C) = \mu_T^i(W). \end{cases} \tag{8}$$

Equation (8) and our assumptions about p^X immediately imply the following lemma:

Lemma 3

Every expert i chooses a weakly higher level of effort if he is highly efficient rather than less efficient. The probability of expert i choosing a correct vote in the first period is always strictly higher if he is highly efficient rather than less efficient.

In the following, we turn to the optimal re-appointment scheme under transparency. We have already noted that the principal is strictly better off if a particular expert is highly efficient rather than less efficient. As a consequence, it is optimal to re-appoint any expert who is highly efficient with a probability that exceeds the probability of a newly appointed expert being highly efficient. Otherwise it is optimal to dismiss an expert. The probability of an expert who has voted correctly being highly efficient amounts to

$$\kappa^{i,H} = \frac{q^H p^H(e_{1,T}^{i,H})}{q^H p^H(e_{1,T}^{i,H}) + q^L p^L(e_{1,T}^{i,L})}, \tag{9}$$

where we have used the fact that the probability of expert i being highly efficient and choosing the correct vote is $q^H p^H(e_{1,T}^{i,H})$. The probability of a less efficient committee member receiving a correct signal is $q^L p^L(e_{1,T}^{i,L})$. Probability $\kappa^{i,H}$ is higher than the probability of a newly appointed candidate being highly efficient if

$$\frac{q^H p^H(e_{1,T}^{i,H})}{q^H p^H(e_{1,T}^{i,H}) + q^L p^L(e_{1,T}^{i,L})} > q^H, \tag{10}$$

which is equivalent to

$$p^H(e_{1,T}^{i,H}) > q^H p^H(e_{1,T}^{i,H}) + (1 - q^H)p^L(e_{1,T}^{i,L}). \tag{11}$$

This inequality always holds, because $0 < q^H < 1$ and $p^H(e_{1,T}^{i,H}) > p^L(e_{1,T}^{i,L})$, which follows from Lemma 3. Hence it is strictly optimal to re-appoint a committee member who has voted correctly. Analogous arguments show that it is strictly optimal to dismiss a committee member who has chosen the wrong decision. We summarize these results in the following lemma:

Lemma 4

Under transparency, the optimal re-appointment scheme is given by

$$\mu_T^i(Z^i) = \begin{cases} 1 & \textit{for } Z^i = C \\ 0 & \textit{for } Z^i = W. \end{cases} \tag{12}$$

Using (8), the equilibrium level of effort under transparency is given by

$$e_{1,T}^X = \left((p^X)'\right)^{-1}\left(\frac{1}{\delta B}\right) \qquad \forall X \in \{H, L\}. \tag{13}$$

5 Opacity

It is obvious that under opacity experts will always vote in line with their signals in the first period. This will increase their chances of re-election for $\mu_O^i(C) > \mu_O^i(W)$. For $\mu_O^i(C) = \mu_O^i(W)$ this behavior is chosen in accordance with our tie-breaking rule. What remains to be examined is the levels of effort chosen by highly efficient and less efficient experts. For this purpose, it will be useful to introduce the probability of i being pivotal in the first period, which will be denoted by χ_i.[8]

The effort level $e_1^{i,X}$ of expert i for efficiency X is chosen so as to maximize

$$\phi^{i,X} := -e_1^{i,X} + \delta\chi_i \left[p^X(e_1^{i,X})\mu_O^i(C) + (1 - p^X(e_1^{i,X}))\mu_O^i(W)\right] B, \tag{14}$$

where we have omitted terms that are invariant to expert i's choice of effort. Optimization yields the first-order condition

$$1 = \delta\chi_i \cdot (p^X)'(e_1^{i,X}) \left[\mu_O^i(C) - \mu_O^i(W)\right] B. \tag{15}$$

Thus the optimal level of effort under opacity is

$$e_{1,O}^{i,X} = \begin{cases} \left((p^X)'\right)^{-1}\left(\frac{1}{(\mu_O^i(C)-\mu_O^i(W))\chi_i\delta B}\right) & \text{for } \chi_i(\mu_O^i(C) - \mu_O^i(W)) > 0 \\ 0 & \text{for } \chi_i(\mu_O^i(C) - \mu_O^i(W)) = 0. \end{cases} \tag{16}$$

Our assumptions about $p^X(.)$ again imply:

[8] Note that χ_i depends on the effort levels $e_1^{j,H}$ and $e_1^{j,L}$ $j \neq i$ of the other experts.

Lemma 5

Under opacity, each expert i chooses a weakly higher level of effort if he is highly efficient rather than less efficient. His probability of obtaining a correct signal is strictly higher if he is highly efficient rather than less efficient.

Because in the first period highly efficient experts are always more likely to vote correctly compared to less efficient committee members, a committee that has made a correct decision is always strictly more likely to arrive at a correct decision in the second period than a newly appointed committee. Similarly a committee that has made a wrong decision is always strictly less likely to arrive at a correct decision in the second period than a newly appointed committee. These findings imply the next lemma.

Lemma 6

Under opacity, the principal's optimal re-appointment scheme is given by

$$\mu_O^i(Z) = \begin{cases} 1 & \text{for } Z = C \\ 0 & \text{for } Z = W. \end{cases} \tag{17}$$

Now the level of effort in the equilibrium under opacity can be written as

$$e_{1,O}^{i,X} = \left((p^X)'\right)^{-1} \left(\frac{1}{\chi_i \delta B}\right). \tag{18}$$

In the Appendix, we prove the following proposition:

Lemma 7

Under opacity, there exists a unique solution for the optimal levels of effort. Each committee member of efficiency level $X \in \{H, L\}$ chooses

$$e_{1,O}^{X} = \left((p^X)'\right)^{-1} \left(\frac{1}{\chi \delta B}\right), \tag{19}$$

where

$$\chi = \binom{N-1}{\frac{N-1}{2}} \left(q_H p^H(e_{1,O}^H) + q_L p^L(e_{1,O}^L)\right)^{\frac{N-1}{2}} \left(1 - q_H p^H(e_{1,O}^H) - q_L p^L(e_{1,O}^L)\right)^{\frac{N-1}{2}}. \tag{20}$$

6 Comparison of Transparency and Opacity

Finally, we now compare the principal's utility under transparency and under opacity. It will be useful to introduce

$$\mathcal{P}(p) = \sum_{n=(N+1)/2}^{N} \binom{N}{n} p^n (1-p)^{N-n}, \tag{21}$$

which is the probability of the committee reaching a correct decision if there is a probability p of each individual member making a correct decision. In the first period under transparency, a highly efficient expert will choose the correct vote with probability $p^H(e^H_{1,T})$. A less efficient expert's likelihood of choosing the correct vote is $p^L(e^L_{1,T})$. Because the prior probability of a member being highly efficient is q^H, the probability of an expert making a correct decision in the first period is given by

$$\rho_{1,T} := q^H p^H(e^H_{1,T}) + (1-q^H)p^L(e^L_{1,T}). \tag{22}$$

Hence the principal's expected utility in the first period is

$$u^P_{1,T} = \mathcal{P}(\rho_{1,T}). \tag{23}$$

Under opacity, the probability of an individual expert voting correctly in the first period is given by

$$\rho_{1,O} := q^H p^H(e^H_{1,O}) + (1-q^H)p^L(e^L_{1,O}). \tag{24}$$

As a consequence, the principal's expected utility under opacity is given by

$$u^P_{1,O} = \mathcal{P}(\rho_{1,O}). \tag{25}$$

Because $p^X(.)$ is a strictly monotonically increasing function and $e^X_{1,T} > e^X_{1,O}$, we obtain $\rho_{1,T} > \rho_{1,O}$. Probability $\mathcal{P}(p)$ is strictly monotonically increasing in p. This yields the following proposition:

Proposition 1

The principal's first-period utility is always higher under transparency than under opacity, i.e. $u^P_{1,T} > u^P_{1,O}$.

In the second period, it appears plausible that the principal's utility will be higher under transparency. This stems from the observation that transparency improves the principal's ability to distinguish highly efficient from somewhat less efficient committee members. However, this is not always the case, as transparency might cause a convergence of the signal qualities for highly efficient and less efficient members. This countervailing effect may reduce the government's ability to distinguish between highly efficient and less efficient members.

In order to make this more precise, we need to introduce additional notation. Suppose that experts could be rewarded for making correct decisions. The reward in utility units is denoted by $R \in [0; \delta B]$. In the following we use $e^H(R) = \left((p^H)'\right)^{-1}\left(\frac{1}{R}\right)$ and $e^L(R) = \left((p^L)'\right)^{-1}\left(\frac{1}{R}\right)$ to denote the optimal choice of high and low ability types respectively. Now we are in a position to define the following property:

Definition 1

The functions $p^H(e)$ and $p^L(e)$ have the property of non-decreasing quality differences (NDQD) if the following condition holds for all $R \in [0; \delta B]$:

$$\frac{d\,\left(p^H(e^H(R)) - p^L(e^L(R))\right)}{d\,R} \geq 0. \tag{26}$$

Intuitively, this property ensures that a marginal increase in the rewards for correct decisions will increase the signal quality gap between highly efficient and less efficient members.

Condition (26) can be rewritten as $\frac{d\,p^H(e^H(R))}{d\,R} \geq \frac{d\,p^L(e^L(R))}{d\,R}$. However, NDQD is stronger than our assumption $p^{H\prime}(e) \geq p^{L\prime}(e)\ \forall e \in [0; E[$, because of $e^H(R) \geq e^L(R)$ and the concavity of $p^H(e)$.

NDQD is fulfilled, for example, if $p^H(e) = p^L(e) + c$ $(c > 0)$ holds in addition to our assumptions. This is a consequence of the fact that for this specification $e^H(R) = e^L(R)$ holds for all $R \in [0; \delta B]$.[9]

[9]To give another example, we note that $p^X(e) = a^X e^\alpha + b^X$ $(X \in \{H, L\})$ satisfies the assumptions laid out in Section 2 for $\alpha \in]0;1[$, $0 < a^L \leq a^H \leq \min\left\{\frac{1-b^H}{E^\alpha}; \frac{E^{1-\alpha}}{\alpha\delta B}\right\}$ and $0 < b^L < b^H < 1$. It is straightforward but tedious to show that NDQD always holds in this case.

In the Appendix we show

Proposition 2

If the functions $p^H(e)$ and $p^L(e)$ satisfy NDQD, then the principal's second-period utility is always higher under transparency than under opacity, i.e. $u^P_{2,T} > u^P_{2,O}$.

If NDQD does not hold, then it is conceivable that the principal's utility in the second period is higher under opacity. Under transparency, the increased effort might lead to almost identical signal qualities in the first period, which makes it virtually impossible for the principal to distinguish highly efficient from less efficient experts.

It is also interesting to consider whether committee members would find transparency desirable. A transparency requirement affects committee members' utilities in two ways. First, transparency induces higher effort in the first period, which is detrimental from the members' point of view. Second, it also affects the probability of their being re-appointed. It is conceivable that in some cases transparency will increase this probability. However, for large committees one can reach a clear-cut finding:

Proposition 3

For sufficiently large committees, transparency is always detrimental to committee members.

This follows from the fact that for sufficiently large committees the probability of a correct decision being reached and hence of each member being re-appointed converges to one. This is a consequence of the Condorcet Jury Theorem, which can be applied in our case because of our assumption that $p^H(0) \geq p^L(0) > \frac{1}{2}$. This condition implies that each individual committee member is always strictly more likely to choose the correct vote than the wrong vote, even if he exerts no effort. Under transparency, the probability of re-appointment does not depend on committee size and is given by $p^X(e^X_{1,T})$, which is strictly smaller than one. Our finding may explain why many monetary policy committees have not adopted transparent decision-making voluntarily, but only as a consequence of substantial external pressure.

7 Unknown Own Ability

Up to now, we have assumed that experts know their own ability. An alternative assumption would be that experts do not have superior information about their own efficiency. This case is considered in this section.

If experts do not know their own abilities, each expert estimates his probability of being highly efficient to be q^H and the probability of his being less efficient to be q^L. It will be useful to introduce

$$p^{UA}(e) := q^H p^H(e) + q^L p^L(e). \tag{27}$$

Probability $p^{UA}(e)$ gives the probability of an expert of unknown ability (UA) receiving a correct signal, given that he has chosen effort e. Applying the assumptions regarding $p^L(.)$ and $p^H(.)$, it is readily verified that $p^{UA}(e)$ satisfies

$$\begin{aligned} &\frac{\partial p^{UA}}{\partial e_t^i}(e_t^i) > 0 && \frac{\partial^2 p^{UA}}{\partial (e_t^i)^2}(e_t^i) < 0 && \forall e_t^i \in [0; E[, \\ &\lim_{e_t^i \to E} \frac{\partial p^{UA}}{\partial e_t^i}(e_t^i) < \frac{1}{\delta B} && \lim_{e_t^i \to 0} \frac{\partial p^{UA}}{\partial e_t^i}(e_t^i) = \infty && \forall e_t^i \in [0; E[. \end{aligned}$$

The equilibrium under transparency can be characterized as follows

Lemma 8

Under transparency, the optimal re-appointment scheme if experts do not know their own ability is

$$\mu_T^{i,UA}(Z^i) = \begin{cases} 1 & \text{for } Z^i = C \\ 0 & \text{for } Z^i = W. \end{cases} \tag{28}$$

All experts vote in line with their private signals and the equilibrium level of effort in the first period is

$$e_{1,T}^{UA} = \left((p^{UA})'\right)^{-1}\left(\frac{1}{\delta B}\right). \tag{29}$$

The proof is completely analogous to the proofs for transparency and known ability. It is therefore omitted.

Similarly, for opacity we obtain

Lemma 9

Under opacity, the optimal re-appointment scheme if experts do not know their own ability is

$$\mu_T^{i,UA}(Z) = \begin{cases} 1 & \textit{for } Z = C \\ 0 & \textit{for } Z = W. \end{cases} \tag{30}$$

All experts vote in line with their private signals and the equilibrium level of effort in the first period is

$$e_{1,O}^{UA} = \left((p^{UA})'\right)^{-1} \left(\frac{1}{\chi^{UA}\delta B}\right), \tag{31}$$

where

$$\chi^{UA} = \binom{N-1}{\frac{N-1}{2}} \left(p^{UA}(e_{1,O}^{UA})\right)^{\frac{N-1}{2}} \left(1 - p^{UA}(e_{1,O}^{UA})\right)^{\frac{N-1}{2}}. \tag{32}$$

We note that $e_{1,T}^{UA} > e_{1,O}^{UA}$ holds, which implies $p^{UA}(e_{1,T}^{UA}) > p^{UA}(e_{1,T}^{UA})$. Thus the probability of an individual member choosing a correct vote is larger under transparency compared to opacity. In the next proposition we compare the principal's utility under transparency and opacity if experts do not know their own ability.

Proposition 4

With unknown own ability of experts, the principal's first-period utility is always higher under transparency than under opacity, i.e. $u_{1,T}^{P,UA} > u_{1,O}^{P,UA}$.

Proof

The probability of a correct decision being reached, $\mathcal{P}(p)$, is a strictly increasing function of p. This implies $u_{1,T}^{P,UA} = \mathcal{P}\left(p^{UA}(e_{1,T}^{UA})\right) > \mathcal{P}\left(p^{UA}(e_{1,O}^{UA})\right) = u_{1,O}^{P,UA}$.

□

For experts who know their own ability, we have shown that the principal's second-period utility is higher under transparency if NDQD, i.e. (26), holds. For unknown ability of experts, the respective condition is

$$\frac{d\left(p^H(e^{UA}(R)) - p^L(e^{UA}(R))\right)}{d\,R} \geq 0, \tag{33}$$

where $e^{UA}(R) := \left((p^{UA})'\right)^{-1}\left(\frac{1}{R}\right)$. Because of assumption $\frac{\partial p^H}{\partial e_t^i}(e_t^i) \geq \frac{\partial p^L}{\partial e_t^i}(e_t^i) \forall e_t^i \in [0; E[$ and $e^{UA\prime}(R) = -\frac{1}{R^2 p^{UA\prime\prime}(e(R))} > 0 \;\forall R \in [0; \delta B]$, Condition (33) always holds. This immediately implies

Proposition 5

With unknown ability, the principal's second-period utility is always higher under transparency than under opacity, i.e. $u_{2,T}^{P,UA} > u_{2,O}^{P,UA}$.

Intuitively, the proposition can be explained in the following way. All experts choose the same levels of effort if they do not know their abilities. Transparency increases the effort of all experts by the same amount, which makes the probability of a highly efficient expert voting correctly increase more strongly than the respective probability for a less efficient expert. Consequently, the principal can distinguish more easily between highly efficient and less efficient experts, which definitely results in higher second-period utility. To sum up, transparency is always beneficial to the principal in both periods if experts do not know their own ability.

8 Conclusions

In this paper we have shown that transparency leads to higher intensity of information collection on the part of committee members, because their individual voting behavior can be observed and they want to appear as competent individuals in order to remain in office. Due to the higher probability of a correct outcome, the principal's first-period utility is always higher under transparency than under opacity. In the second period, the principal's utility is also higher under transparency, unless transparency induces a strong convergence in the signal qualities of highly efficient and less efficient committee members. Then the principal's ability to identify and re-appoint highly efficient members is diminished. If experts do not know their own ability, transparency makes the principal always better off in the second period.

Transparency harms committee members because it forces them to exert more effort. For sufficiently large committees, we have shown that transparency also reduces committee members' re-appointment prospects. This may explain why committee members are sometimes reluctant to publish voting records.

If we take a broader view on whether transparency in committees is desirable, our paper may help to draw a sharper line. If prior investment in knowledge acquisition by committee members is crucial, transparency is advisable. This may be the case in standing expert committees that face heterogeneous and varying tasks. For instance, the council of economic advisors to the Ministry of Economic Affairs in Germany has recently adopted more transparent rules to foster information acquisition.[10] For other committees, investments into information acquisition are less important, but the abilities of members play an important role. Examples include academic recruiting committees and juries. Then opacity may be justified in light of the literature discussed in the introduction, which identifies distortionary behavioral effects of transparency.

[10]Source: private communication.

A Proof of Proposition 7

First we argue that the effort levels given in the proposition are optimal. If all experts choose the same level of effort for a particular level of efficiency, then the probability of an individual expert choosing the correct vote amounts to $q_H p^H(e^H_{1,O}) + q_L p^L(e^L_{1,O})$, because the probability of an expert being highly efficient and choosing the correct vote is $q_H p^H(e^H_{1,O})$, and the probability of an expert being less efficient and choosing the correct vote is $q_L p^L(e^L_{1,O})$. As a consequence, the probability of exactly one half of $N-1$ experts voting for the correct option and the other half voting for the wrong option is

$$\chi = \binom{N-1}{\frac{N-1}{2}} \left(q_H p^H(e^H_{1,O}) + q_L p^L(e^L_{1,O})\right)^{\frac{N-1}{2}} \left(1 - q_H p^H(e^H_{1,O}) - q_L p^L(e^L_{1,O})\right)^{\frac{N-1}{2}}, \quad (34)$$

which is the expression given in the proposition. The optimal level of effort follows from Equation (18).

Second, we show that the effort levels are unique. We apply the classic work by Rosen (1965), who derives the uniqueness of equilibrium for strictly concave games. Let us consider the following normal-form game with $2N$ players, where the players are denoted by $(1, L)$, $(1, H)$, $(2, L)$, $(2, H)$, ... $(N-1, L)$, $(N-1, H)$, (N, L), (N, H). Each player $(i, X) \in \{1, 2...N\} \times \{L, H\}$ has the utility function $\phi^{i,X}$ (cf. Equation (14)). This game captures the choice of effort by committee members in the first period of the game considered in this paper.

Theorem 2 in Rosen (1965), p. 524, implies that the equilibrium is unique if all $\phi^{i,X}$ are strictly concave functions of $e_1^{i,X}$.[11] Differentiating $\phi^{i,X}$ (see Equation (14)) with respect to $e_1^{i,X}$ yields

$$\frac{\partial \phi^{i,X}}{\partial e_1^{i,X}} = -1 + \delta \chi_i \left[\mu^i_O(C) - \mu^i_O(W)\right] \frac{\partial p^X(e_1^{i,X})}{\partial e_1^{i,X}} B, \quad (35)$$

where we have used the fact that χ_i does not depend on $e_1^{i,X}$ because the probability

[11] If all $\phi^{i,X}$ are strictly concave, this implies that any weighted sum of the payoff functions with positive weights (which corresponds to $\sigma(x, r)$ as defined in (3.8) in Rosen (1965)) is diagonally strictly concave. Theorem 2 is applicable because we are considering orthogonal constraint sets.

of member i being pivotal does not depend on his effort but only on the strategies of the other committee members.

The second derivate can now be calculated as

$$\frac{\partial^2 \phi^{i,X}}{\partial \left(e_1^{i,X}\right)^2} = \delta \chi_i \left[\mu_O^i(C) - \mu_O^i(W)\right] \frac{\partial^2 p^X(e_1^{i,X})}{\partial \left(e_1^{i,X}\right)^2} B. \tag{36}$$

This expression is always negative because $\chi_i > 0$, $\mu_O^i(C) > \mu_O^i(W)$, and $\frac{\partial^2 p^X(e_1^{i,X})}{\partial \left(e_1^{i,X}\right)^2} < 0$. Hence $\phi^{i,X}$ are strictly concave functions of $e_1^{i,X}$ $\forall i = 1..N, X \in \{H, L\}$ and the equilibrium is unique.

□

B Proof of Proposition 2

As a first step, we deal with the probability of a correct outcome as a function of the number of highly efficient candidates where λ^X denotes the probability of a member with an efficiency level of $X \in \{H, L\}$ choosing the correct vote. This probability can be written as

$$\pi_n(\lambda^H, \lambda^L) = \sum_{i=\frac{N+1}{2}}^{N} \left(\sum_{j=0}^{\min(n,i)} \binom{n}{j} (\lambda^H)^j (1-\lambda^H)^{n-j} \cdot \binom{N-n}{i-j} (\lambda^L)^{i-j} (1-\lambda^L)^{N-n-(i-j)} \right).$$

In this expression, integer i denotes the number of votes in favor of the correct decision. $\sum_{j=0}^{\min(n,i)} \binom{n}{j} (\lambda^H)^j (1-\lambda^H)^{n-j}$ gives the probability of j out of n highly efficient members voting correctly, and $\binom{N-n}{i-j} (\lambda^L)^{i-j} (1-\lambda^L)^{N-n-(i-j)}$ stands for the probability of $i-j$ less efficient members out of a total of $N-n$ less efficient members voting for the correct interest rate.

For a given number of highly efficient members, n, the probability of a correct decision in the second period is $\pi_n(p^H(0), p^L(0))$, because all members exert no effort in the second period. It is obvious that $\pi_n(p^H(0), p^L(0))$ is a strictly increasing function of n. Intuitively, the more highly efficient members there are, the higher is the probability of a correct decision in the second period, because highly efficient members vote correctly with probability $p^H(0)$, whereas less efficient members only make a correct decision with probability $p^L(0) < p^H(0)$.

For given numbers of highly efficient and less efficient members the principal's utility in the second period is thus independent of the transparency regime. However, the distribution of highly efficient and less efficient members will be different. Therefore it is necessary to analyze this distribution under both scenarios. We use $\xi_{R,n}$ to denote the probability of n members being highly efficient in the second period under regime $R \in \{T, O\}$.

We derive $\xi_{T,n}$ first. In the second period, the probability of an individual expert being highly efficient under transparency is

$$Q_{2,T}^H := q^H p^H(e_{1,T}^H) + \left\{q^H \left[1 - p^H(e_{1,T}^H)\right] + (1 - q^H) \left[1 - p^L(e_{1,T}^L)\right]\right\} q^H. \qquad (37)$$

The first summand gives the probability of the member in the first period being highly efficient and choosing the correct vote, which entails re-appointment. The second summand corresponds to the eventuality that an expert may choose a wrong vote and be replaced by a highly efficient expert. Using $Q_{2,T}^H$, we can write $\xi_{T,n}$ as

$$\xi_{T,n} = \binom{N}{n} \left(Q_{2,T}^H\right)^n \left(1 - Q_{2,T}^H\right)^{N-n} \qquad (38)$$

The respective probability under opacity is more difficult to derive, because the probability of an individual committee member being highly efficient depends on the outcome of the voting and thus on the behavior of all committee members rather than the individual's behavior alone.

$$\begin{aligned}\xi_{O,n} =& \binom{N}{n} (q^H)^n (1 - q^H)^{N-n} \pi_n \left(p^H(e_{1,O}^H), p^L(e_{1,O}^L)\right) \\ &\qquad + (1 - \mathcal{P}(\rho_{1,O})) \cdot \binom{N}{n} (q^H)^n (1 - q^H)^{N-n} \\ =& \binom{N}{n} (q^H)^n (1 - q^H)^{N-n} \left[1 + \pi_n \left(p^H(e_{1,O}^H), p^L(e_{1,O}^L)\right) - \mathcal{P}(\rho_{1,O})\right]\end{aligned} \qquad (39)$$

Now the principal's expected utility in the second period under regime $R \in \{T, O\}$ can be expressed as

$$u_{2,R}^P = \sum_{n=0}^{N} \xi_{R,n} \pi_n (p^H(0), p^L(0)) \qquad (40)$$

We have already noted that $\pi_n(p^H(0), p^L(0))$ is strictly increasing in n. As a consequence, the principal's expected utility in the second period is higher under transparency if the distribution of highly efficient members in the second period first-order dominates the respective distribution under opacity. First-order stochastic dominance will be derived in Section C.

□

C First-order Stochastic Dominance

We proceed in two steps. First we show that under the assumption that all members choose their equilibrium effort levels in the first period the distribution of highly efficient members under transparency first-order stochastically dominates the distribution one would obtain under transparency in the second period if all members chose the effort levels optimal under opacity ($e^X_{1,O}$) in the first period. The probability mass function for the latter distribution will be denoted by $\widetilde{\xi}_{T,n}$. Second, we show that this distribution first-order stochastically dominates the distribution of highly efficient members under opacity. As a consequence, we arrive at the finding that the distribution of highly efficient members in the second period under transparency first-order dominates the respective distribution under opacity.

We now define $\widetilde{Q}^H_{2,T}$ as

$$\widetilde{Q}^H_{2,T} := q^H p^H(e^H_{1,O}) + \left\{q^H \left[1 - p^H(e^H_{1,O})\right] + (1 - q^H) \left[1 - p^L(e^L_{1,O})\right]\right\} q^H. \tag{41}$$

This expression is identical to $Q^H_{2,T}$ as defined in Equation (37) except for the fact that we have replaced the effort levels under transparency by the effort levels under opacity. Thus $\widetilde{Q}^H_{2,T}$ corresponds to the probability under transparency of an individual member being highly efficient in the second period assuming that all members have chosen the effort levels they would find optimal under opacity in the first period. Having defined $\widetilde{Q}^H_{2,T}$, we can express $\widetilde{\xi}_{T,n}$ in the following way:

$$\widetilde{\xi}_{T,n} = \binom{N}{n} \left(\widetilde{Q}^H_{2,T}\right)^n \left(1 - \widetilde{Q}^H_{2,T}\right)^{N-n} \tag{42}$$

Note that the distributions described by the probability mass functions $\xi_{T,n}$ and $\widetilde{\xi}_{T,n}$ are binomial distributions. Thus the first distribution first-order stochastically dominates the second distribution if $Q^H_{2,T} \geq \widetilde{Q}^H_{2,T}$, which means that the individual probability of being highly efficient under transparency in the second period is higher if all members choose the effort levels optimal under transparency rather than those optimal under opacity. This is shown in the following. Using (37) and (41), we obtain

$$\begin{aligned} Q^H_{2,T} - \widetilde{Q}^H_{2,T} &= q^H \left(p^H(e^H_{1,T}) - p^H(e^H_{1,O})\right) \\ &\qquad - \left\{q^H \left[p^H(e^H_{1,T}) - p^H(e^H_{1,O})\right] + (1-q^H)\left[p^L(e^L_{1,T}) - p^L(e^L_{1,O})\right]\right\} q^H \\ &= q^H(1-q^H)\left[p^H(e^H_{1,T}) - p^H(e^H_{1,O}) - \left(p^L(e^L_{1,T}) - p^L(e^L_{1,O})\right)\right]. \end{aligned}$$

This expression is weakly positive if

$$p^H(e^H_{1,T}) - p^H(e^H_{1,O}) - \left(p^L(e^L_{1,T}) - p^L(e^L_{1,O})\right) \geq 0. \tag{43}$$

This condition is fulfilled if NDQD holds.

□

References

John Fingleton and Michael Raith. Career Concerns of Bargainers. *Journal of Law, Economics, and Organization*, 21(1):179–204, 2005.

Dino Gerardi and Leeat Yariv. Information Acquisition in Committees. *Games and Economic Behavior*, 2007. forthcoming.

Kerstin Gerling, Hans Peter Grüner, Alexandra Kiel, and Elisabeth Schulte. Information Acquisition and Decision Making in Committees: A Survey. *European Journal of Political Economy*, 21(3):563–597, September 2005.

Hans Gersbach. Information Efficiency and Majority Decisions. *Social Choice and Welfare*, 12(4):363–370, October 1995.

Hans Gersbach and Volker Hahn. Voting Transparency, Conflicting Interests and the Appointment of Central Bankers. *Economics and Politics*, 16(3):321–345, November 2004.

Hans Gersbach and Volker Hahn. Should the Individual Voting Records of Central-Bank Council Members be Published? *Social Choice and Welfare*, 2007. forthcoming.

Bengt Holmström. Managerial Incentive Problems: A Dynamic Perspective. In *Essays in Economics and Management in Honor of Lars Wahlbeck*. Swedish School of Economics, Helsinki, 1982. Reprinted in: 1999. Review of Economic Studies 66 (1), 169-182.

Gilat Levy. Decision Making in Committees: Transparency, Reputation and Voting Rules. *American Economic Review*, 2007. forthcoming.

Jacob Marschak and Roy Radner. *Economic Theory of Teams*. Yale University Press, New Haven and London, 1972. Cowles Foundation for Research in Economics at Yale University, Monograph 22.

Kaushik Mukhopadhaya. Jury Size and the Free Rider Problem. *The Journal of Law, Economics, and Organization*, 19(1):24–44, 2003.

Marco Ottaviani and Peter Sørensen. Information Aggregation in Debate: Who Should Speak First? *Journal of Public Economics*, 81(3):393–421, 2001.

Nicola Persico. Committee Design with Endogenous Information. *Review of Economic Studies*, 71(246):165–191, January 2004.

Andrea Prat. The Wrong Kind of Transparency. *American Economic Review*, 95(3): 862–877, June 2005.

J. B. Rosen. Existence and Uniqueness of Equilibrium Points for Concave N-Person Games. *Econometrica*, 33(3):520–534, July 1965.

David Scharfstein and Jeremy Stein. Herd Behavior and Investment. *American Economic Review*, 80(3):465–479, June 1990.

Anne Sibert. Monetary Policy Committees: Individual and Collective Reputation. *Review of Economic Studies*, 70:649–665, 2003.

David Stasavage. Polarization and Public Deliberation. mimeo, February 2006.

Brett Trueman. Analyst Forecasts and Herding Behavior. *The Review of Financial Studies*, 7(1):97–124, 1994.

Bauke Visser and Otto Swank. On Committees of Experts. *Quarterly Journal of Economics*, 122(1):337–372, February 2007.