Should the Individual Voting Records of Central Bankers be Published?

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Abstract

Should the Individual Voting Records of Central Bankers be Published?

We examine whether it is socially beneficial for the individual voting records of central bank council members to be published when the general public is unsure about central bankers‘ efficiency and central bankers are aiming for re-election. We show that publication is initially harmful since somewhat less efficient central bankers attempt to imitate highly efficient central bankers in their bid to get re-elected. After re-election, however, losses will be lower when voting records are published since the government is more easily able to distinguish highly efficient from less efficient central bankers and can make central bankers individually accountable. Nevertheless, the negative effects of voting transparency predominate and expected overall losses are always larger when voting records are published.

Zusammenfassung

Soll das individuelle Abstimmungsverhalten in den Beschlussfassungsorganen von Zentralbanken veröffentlicht werden?

Wir untersuchen, ob die Veröffentlichung über das individuelle Abstimmungsverhalten von Zentralbankratsmitgliedern gesamtwirtschaftlich nützlich ist, wenn in der Öffentlichkeit Unsicherheit über die Effizienz von Mitgliedern des Zentralbankrats besteht und sich diese um eine Wiederwahl bemühen. Wir weisen nach, dass eine Veröffentlichung zunächst Schaden anrichtet, weil etwas weniger effiziente Mitglieder des Zentralbankrats versuchen, hocheffiziente Zentralbankratsmitglieder in ihren Bemühungen um eine Wiederwahl nachzuahmen. Nach der Wiederwahl sind die Verluste aber geringer, wenn die Abstimmung veröffentlicht wird, weil die Regierung hocheffiziente von weniger effizienten Zentralbankratsmitgliedern leichter unterscheiden und sie einzeln zur Rechenschaft ziehen kann. Die negativen Auswirkungen einer Transparenz des Abstimmungsverhaltens überwiegen aber, und die Nachteile sind insgesamt immer größer, wenn die Abstimmung veröffentlicht wird.

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1 Introduction

The socially desirable degree and nature of transparency for central banks, and for the European Central Bank (ECB) in particular, has stirred a lively discussion among academics and policy-makers. Many of the issues have been raised in the influential study by Goodfriend (1986). The first point to be addressed concerns the definition of the notion of transparency since transparency has different meanings for different people (see e.g. Winkler (2000) and Remsperger and Worms (1999)). At this stage, three clearly different notions can be distinguished: transparency about objectives (goal transparency), transparency about the forecasting methods and the information concerning the state of the economy (knowledge transparency), and transparency about actual decisions and the way they are reached (operational transparency).[1]

Should a higher degree of transparency be required from central banks with respect to all these three aspects of transparency? There exists a reasonably robust conviction that goal transparency is socially desirable. Greater transparency in connection with a central bank's objectives improves credibility and hence policy outcomes (see e.g. King (1997)). In their seminal paper, Cukierman and Meltzer (1986) show that transparency about the intentions of central banks is socially desirable. Recent theoretical examinations by Faust and Svensson (2000), extending the Cukierman and Meltzer model, confirm that increased transparency about central bank objectives is generally socially beneficial since it has a disciplining and moderating influence on the bank's policy. An exception to the above conclusion is Jensen (2000), who points out that for a central bank that initially enjoys high credibility, transparency can be harmful since the requirement to achieve the inflation target can create excessive output variability.

Conflicting views exist about knowledge transparency. A simple argument against knowledge transparency has been provided by Gersbach (1998). If there is a chance

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1 A slightly different cut on the various dimensions of transparency can be found in Geraats (1999).

that the central bank has superior information about supply shocks, the disclosure of the central bank's private information eliminates the possibility of insuring the public against those shocks. In contrast, Geraats (1999) emphasizes that knowledge transparency improves reputation-building for strong, inflation-averse central banks, putting a downward pressure on inflation. On balance, one could argue that knowledge transparency, for instance the publication of the inflation forecast, is socially desirable if reputation-building is the main problem for a central bank. This conclusion would be in line with Gersbach and Hahn (1999), who show that signaling competence by central banks induces lower losses under inflation targeting (which implies the publication of forecasts) than under monetary targeting.

Very little research has been done on operational transparency. Sibert (1999) presents an interesting model of reputation-building in monetary policy committees based on the framework of Kydland and Prescott (1977) and Barro and Gordon (1983). She examines whether individuals have more or less incentive to gain a reputation for being tough on inflation when they are part of a group. Transparency might increase collective reputation-building. Our paper tries to shed light on one aspect of operational transparency, the transparency of individual voting records.

Whether this kind of transparency is socially beneficial is one of the most controversial issues. The publication of voting records is advocated by Buiter (1999), among others. In Buiter's opinion, the confidentiality of votes is likely to excessively enhance the power of the President relative to the other council members. In general, he argues that individual accountability produces better results than collective responsibility. Under individual accountability, members who find themselves in the minority would be able to argue, publicly, their case for a different monetary policy. Additionally, individual members' competence can only be assessed with a track record of individual votes. This is important for reappointments and for departing members' prospects of employment in other responsible positions. On the other hand, Issing (1999), among others, has uttered concern about the pressure that national authorities would exert on the members of the ECB council if individual voting behavior were published.

In our paper, we identify the costs and benefits of voting transparency in a simple model in which central bankers differ in their efficiency and derive utility from being central bankers. We consider a standard aggregate demand and supply framework over two periods; the central bank sets short-term interest rates. Each member of the central bank proposes an interest-rate policy for each period. The interest-rate policy of the central bank is determined by majority voting. Voting transparency means that

individual interest-rate proposals and voting records are published, hence enabling the government to verify how each single central banker has voted.[2] The absence of voting transparency implies that only the adopted interest-rate policy becomes known while both individual voting behavior and the proportion of votes for different interest rates remain the private information of the central bankers.

The benefits of voting transparency arise from the way it enables the government to distinguish the highly efficient from the somewhat less efficient central bankers more easily. The government can thus improve the overall competence of the central bank council over time by reelecting only manifestly highly efficient central bankers. But there is a serious disadvantage to transparency. To avoid being dismissed, less efficient central bankers will try to give the impression of expertise whenever their individual behavior can be observed. They propose the interest policies which a highly efficient central banker would vote for. But since they do not know whether interest rates should be raised or lowered, the probability of them erring is fifty percent. The likelihood that the central bank will adopt the appropriate interest-rate policy decreases and social losses are higher than they would be in the absence of transparency, as this enables less efficient central bankers to abstain. We show that these costs exceed the benefits of transparency gained by assembling a highly efficient central bank council.

However, it is premature at this stage to advocate non-transparency for voting records. Apart from the issue of the robustness of our model, the main reason for caution is that the transparency of voting records can be beneficial if central bankers differ with respect to preferences, i.e. with respect to different emphases on inflation and output stabilization. In this case transparency can help to change the median central banker's preferences in the direction of the socially desirable preferences faster than would be the case with non-transparency.[3]

Our model also implies that both less efficient central bankers and highly efficient central bankers prefer opacity over transparency. This implication of our model might explain why central bankers may sometimes be reluctant to publish voting records.

Can our results be applied to the ECB?[4] The ECB does not publish voting records. During the press conferences after the General Council meetings the President, Mr.

2 Note, however, that most supporters of voting transparency favor the publication of non-attributed voting records (see e.g. Buiter (1999).

3 A formal treatment of this case is set out in Gersbach and Hahn (2000).

4 However, the debate about transparency is not limited to the ECB. A number of studies have examined the transparency of the Federal Open Market Committee's (FOMC) decisions. Most recently, Lapp, Pearce, and Laksanasut (2000) show that monetary policy was less transparent in the Greenspan era than under the Volcker chairmanship.

Duisenberg, gives only a summary of the discussion among the members. However, one member of the European Commission (EC) attends the meetings of the General Council without the right to vote. Since secrecy is required from the EC observer and the members of the General Council, one can assume that it is possible to describe the ECB with the opacity case which figures in our model.

Even though it might be possible for secrecy to be violated and information about the meetings to leak out to governments (again, cf. Buiter (1999)), the ECB's voting procedure can still be regarded as relatively opaque. Duisenberg has often stressed that decisions are reached by consensus and not by a formal vote (cf. e.g. the ECB press conference by Duisenberg and Noyer (2000)). Thus, even with an outside observer present, the General Council can achieve voting opacity.

In our model, every central banker can be reelected for a second term. The members of the Executive Board of the ECB, who together with the Presidents of the Euro area's eleven National Central Banks (NCBs) constitute the General Council, are appointed for a single term of eight years. This term is not renewable. But even without the possibility of reelection, our model yields similar results if less efficient central bankers wish to be perceived as highly efficient for other reasons. For example, they might aspire to other responsible positions after their term on the central bank council. Or they might simply dislike the idea of appearing less efficient to the public than their colleagues.

The paper is organized as follows: In the next section, we describe the model. In section 3, we simplify the social loss function. The reappointment scheme is derived in section 4. In the following two sections, the results for the first and the second period are derived. Then we will attempt an overall comparison between transparency and opacity in section 7. Since the equilibria for opacity and transparency are not unique, we proceed in section 8 to discuss which refinements could be used for choosing unique equilibria and what results are to be expected under these refinements. Section 9 presents our major conclusions.

2 The Model

We examine a two-period model in which the government can reelect or dismiss members of the central bank council after the first period.

Consider the following standard aggregate demand and aggregate supply equations, which hold in any period:[5]

$$y^d = \alpha\big(r - (i - \pi)\big) \tag{1}$$

$$y^s = \beta(\pi - \pi^e) + \varepsilon \tag{2}$$

α and β are positive parameters, r is the natural real rate of interest, i the short-term nominal interest rate and the central bank's instrument variable. Inflation is denoted by π and expected inflation by π^e. To simplify the exposition, we assume only two possible realizations for the supply shock $\varepsilon \in \{-s, s\}$. y^d and y^s are measured as deviations from the natural rate of output.

Social losses in any period are given by:

$$l = \pi^2 + ay^2 \tag{3}$$

$a > 0$ denotes the weight on output stabilization. Since there is no output target above the natural level, there will be no inflation bias in our model.

A crucial issue is the utility gained by central bankers when in office. There are two possible motives. Central bankers can be motivated by certain policies, i.e. they would like to minimize their individual loss function depending only on inflation and output.[6] Or they may derive additional private benefits from being a central banker, i.e. from the prestige and the satisfaction of the work on the council. Both approaches to the formulation of utilities for central bankers are equally plausible and give rise to transparency issues. In this paper, we follow the latter approach; each central banker is assumed to draw large private benefits from being on the council. For simplicity, these benefits are assumed to be so large that a central banker will always prefer any situation where he is a member of the council over any situation where he is not. A central banker's losses are given by:

$$l^{CB} = \pi^2 + ay^2 - B \tag{4}$$

B denotes private benefits emanating from being a member of the central bank council. These benefits are zero if not a member and large otherwise.

5 We will omit the subscripts denoting the period whenever possible.

6 The case where central bankers want to minimize the social loss function is a special case.

It is obvious that the publication of voting records can only have a differential impact if there is some heterogeneity among central bankers.[7] There are two possibilities for differences among central bankers to emerge:

- central bankers may have different preferences, e.g. put different emphasis on output stabilization;
- central bankers may have different degrees of knowledge concerning the way the economy works.

In this paper, we will explore the second avenue and distinguish between highly efficient and less efficient central bankers.[8] A highly efficient central banker will have more accurate judgments about the magnitude of shocks in the economy. We assume that the judgment of a highly efficient central banker will be correct with probability p $(1/2 < p \leq 1)$, and wrong with probability $1 - p$. Probability p is the same for all highly efficient central bankers and is commonly known. Less efficient central bankers have a lower ability to judge the future course of the economy and we assume that the probability of their predicting shocks correctly amounts to $1/2$. In other words, a less efficient central banker does not have any informative indications about the magnitude of shocks.

We will consider a two-period model, with the periods denoted by $t = 1$ and $t = 2$. Overall social losses are given by:

$$L = (\pi_1^2 + ay_1^2) + \delta(\pi_2^2 + ay_2^2) \tag{5}$$

δ $(0 < \delta < 1)$ denotes the discount factor. The subscripts denote the period.

Accordingly, a central banker's losses amount to:

$$L^{CB} = (\pi_1^2 + ay_1^2 - B_1) + \delta(\pi_2^2 + ay_2^2 - B_2) \tag{6}$$

Monetary policy is in the hands of the council of the central bank, which decides by majority rule which short-term interest rate will be set.

7 The heterogeneity could also be caused by identical central bankers belonging to different generations. A model of overlapping generations of central bankers is examined in Sibert (1999).

8 An analysis of the first case is conducted in Gersbach and Hahn (2000).

The sequence of events is as follows:

- **1st Period**
  - At the beginning of the first period, the council is formed, comprising N central bankers ($N \geq 1$, N odd). There is equal probability of any member being highly efficient or less so. The efficiency of each member is private information.
  - The public forms expectations about inflation.
  - Highly efficient central bankers observe a signal indicating the magnitude of the shock. The probability of a highly efficient central banker's judgment being correct is p.
  - Members simultaneously vote for their preferred interest rate i. Members are allowed to abstain.
  - The interest rate preferred by the median central banker is set by the central bank. In the case of several median positions, each of the median positions is equally likely to win.
  - The shock materializes and is observed by the central bankers and the government. Inflation and output are determined accordingly.
  - Voting records are either published under a transparency requirement or remain secret for all outsiders under opacity.
- **2nd Period**
  - At the beginning of the second period, the reelection of the members of the central bank council takes place. The government can dismiss any central banker and replace him by another central banker from a pool of candidates. The probability of newly elected central bankers being highly efficient is $1/2$.
  - The public forms expectations about inflation.
  - Highly efficient central bankers observe a signal indicating the magnitude of the shock. The probability of their judgment being correct is p.
  - Members simultaneously vote for their preferred interest rate i. Members may abstain.

– The interest rate of the median voter is set by the central bank. In the case of a draw, the interest rate is set to the value that would be optimal if no shocks were present.[9]

– The shock materializes. Inflation and output are determined accordingly.

3 The Equilibrium and the Social Loss Function

In this section, we simplify the expression of the loss function. Equilibrium requires $y^d = y^s$ in every period, which implies:

$$\alpha\big(r - (i - \pi)\big) = \beta(\pi - \pi^e) + \varepsilon \tag{7}$$

We immediately obtain the inflation rate:

$$\pi = \frac{-\alpha(i - r) + \beta\pi^e - \varepsilon}{\beta - \alpha} \tag{8}$$

Without any real shock to the economy, i.e. $\varepsilon = 0$, each central banker would choose $i = r$ to minimize social losses. Since the public does not know the magnitude of the shock when forming its expectations and there is no inflation bias, it will rationally expect $i^e = r$ and $\pi^e = r - i^e = 0$.[10] Then equation (8) simplifies to:

$$\pi = -\frac{\alpha(i - r) + \varepsilon}{\beta - \alpha} \tag{9}$$

In the following, we will assume $\beta > \alpha$. Otherwise inflation would increase if the central bank raised the interest rate, which seems less plausible.

Inserting equation (9) into the expression for y^d in equation (1) yields the equilibrium output as a function of i:

$$y = -\frac{\alpha\big(\beta(i - r) + \varepsilon\big)}{\beta - \alpha} \tag{10}$$

Social losses for one period are therefore given by:

$$l = \frac{\big(\alpha(i - r) + \varepsilon\big)^2 + a\alpha^2\big(\beta(i - r) + \varepsilon\big)^2}{(\beta - \alpha)^2} \tag{11}$$

9 Note that the assumption is slightly different from the corresponding assumption in the first period. In the first period central bankers do not want the government to believe that they are less efficient and this will prevent them from choosing the value that would be optimal if no shocks were present. The assumption, however, is not essential to our results, especially if the central bank council is a relatively large body.

10 Obviously, $\pi^e = 0$ is part of an overall Bayesian Nash equilibrium. It can readily be verified later that $\pi^e = 0$ are the equilibrium beliefs.

Minimizing per-period social losses with respect to i yields the optimal interest rate i^*:

$$i^* - r = -\frac{1 + a\alpha\beta}{\alpha(1 + a\beta^2)}\,\varepsilon \tag{12}$$

We can now restate the problem of minimizing social losses. If the council could observe ε without noise, the socially optimal interest rate would be given by (12). Any deviation from i^* creates social losses which are quadratic in $i - i^*$. Therefore, an equivalent problem for central bankers is to minimize:

$$\mathcal{L} = (I - I^*)^2 \tag{13}$$

where $I := i - r$ and $I^* := i^* - r$. The central bank now chooses I and faces shocks to the optimal interest rate of I^*. We normalize the two possible realizations of I^* to 1 and -1, respectively. This, of course, simplifies the analysis but is not crucial to our results.[11]

4 Reelection Schemes

In this section, we discuss the government's reelection procedure. While the optimal reelection procedure and the monetary policy proposed by highly efficient and less efficient central bankers interact, we simplify the analysis at this stage by assuming a certain pattern of monetary policy for different types of central banker. Later we will justify these assumptions as equilibrium strategies. It is, however, important to note that the equilibrium we are constructing is not unique. In section 9 we discuss the other equilibria that exist and whether our main results hold for those as well.

We assume that one out of only two different possible interest rates will be chosen in the first period of the game. Highly efficient members will either vote for a positive or for a negative interest rate I, depending on the signal they have received about the shock.

Under transparency, less efficient central bankers will randomize between the two possible positions of a highly efficient central banker. Under opacity, less efficient central bankers will abstain. For the present purpose these assumptions will help us to derive the optimal reelection scheme. Later we will show that given the government's reelection scheme the assumed behavior does indeed minimize central bankers' losses.

11 Normalizing the two possible realizations of I^* to 1 and -1 is equivalent to a linear transformation of the interest rates. For our purposes it does not matter whether the central bank chooses the interest rate or the interest rate times a constant expression which is $\frac{1+a\alpha\beta}{\alpha(1+a\beta^2)}$.

Under transparency, it is optimal for the government to reelect any central banker who voted for the policy representing the position of a central banker with a correct estimate of the shock, and to dismiss all other central bankers. This strategy will minimize expected social losses in the second period. Assume the shock is positive, i.e. $I^* = 1$, then

$$\begin{array}{lcl} I_i \geq I^H & \Rightarrow & \text{member } i \text{ is reelected} \\ I_i < I^H & \Rightarrow & \text{member } i \text{ is dismissed} \end{array}$$

I_i is the vote of member i and I^H is the interest rate a highly efficient central banker would choose in equilibrium if he gaged the sign of the shock correctly. An analogous reelection scheme holds for negative shocks.

In the absence of transparency, the government will either fire the whole council or leave them in office, since the government does not know how each single central banker has voted. If the central bank sets an interest rate I that indicates that a majority of the voting central bankers estimated the shock correctly, then the central bank council will be left in office; otherwise it will be dismissed. The reelection scheme for $I^* = 1$ is given by:

$$\begin{array}{lcl} I \geq I^H & \Rightarrow & \text{the whole council is reelected} \\ I < I^H & \Rightarrow & \text{the whole council is dismissed} \end{array}$$

A subgame perfect Bayesian equilibrium consists of monetary policy votes in the first and second period, of the reelection scheme, and of the public's inflation expectations. Since first-period equilibrium monetary policy votes are independent of second-period votes, we can examine the first period before analyzing the second.

5 The First Period

5.1 Opacity

We will first derive the interest rate I^H that a highly efficient central banker would choose if he were alone. Expected losses would be:

$$\mathcal{L}_1|_{alone} = p(1-|I|)^2 + (1-p)(1+|I|)^2 \tag{14}$$

The first-order condition yields:

$$-p(1-|I^H|) + (1-p)(1+|I^H|) = 0 \tag{15}$$

which implies that the optimal interest rate is given by

$$I^H = \pm(2p-1) \tag{16}$$

with $I^H = +(2p-1) > 0$ if the signal about the shock is positive and $I^H = -(2p-1) < 0$ otherwise. Not surprisingly, a highly efficient central banker would choose a more cautious policy if uncertainty is rather large; this would be reflected by a small value for p.

In the appendix we prove:

Proposition 1
In the first period, under opacity, the following Nash equilibrium exists. Each highly efficient central banker will choose:

$$I^H = \pm\big(2p-1\big) \tag{17}$$

where $I^H = +(2p-1) > 0$ if the central banker expects the shock to be positive and $I^H = -(2p-1) < 0$ otherwise. The less efficient central bankers abstain. If no highly efficient central banker is present, the council randomizes between the two possible values of I^H.

Proof of Proposition 1
In the absence of transparency, less efficient members will abstain because they know that they would otherwise exacerbate the results of monetary policy and additionally lower their chances of getting reelected.

Assume a highly efficient central banker would favor an interest rate of $|I'| > |I^H|$. He knows that his vote would not usually change the median position, unless he were the

only highly efficient central banker.[12] But if that were the case, he would by definition prefer to choose I^H.

No central banker would ever choose an interest rate of $|I'| < |I^H|$ since the whole council would be dismissed if he were the median voter.

□

Assume the size of the central bank council to be $N \geq 1$ and the number of highly efficient members to be n. Note that n is known neither to the central bankers nor to the government. The probability of the median central banker's estimating the direction of the shock correctly is equal to the probability that the estimate of at least $(n+1)/2$ central bankers' is correct and is given by:

$$P(n) = \begin{cases} \sum_{i=(n+1)/2}^{n} \binom{n}{i} p^i (1-p)^{n-i} & \text{if } n \text{ odd} \\ \sum_{i=n/2+1}^{n} \binom{n}{i} p^i (1-p)^{n-i} + \frac{1}{2}\binom{n}{n/2} p^{n/2}(1-p)^{n/2} & \text{if } n \text{ even} \end{cases} \tag{18}$$

The last term of $P(n)$ for an even value of n gives the probability of a correct direction of the interest rate in the case of a draw. There will be a randomization between the two choices, reflected by the factor $1/2$.[13]

It is useful to define:

$$\overline{P} = \frac{1}{2^N} \sum_{n=0}^{N} \binom{N}{n} P(n) \tag{19}$$

which is the probability that an outside observer assigns to the eventuality of the median central banker's vote being directionally correct.

With the use of $\overline{P}$, expected losses in the first period, denoted by $\mathcal{L}_1^O$, are given by:

$$\mathcal{L}_1^O = \overline{P}(1 - |I^H|)^2 + (1 - \overline{P})(1 + |I^H|)^2$$

which together with equation (17) can be rewritten as:

$$\mathcal{L}_1^O = 4\big(p^2 - 2\overline{P}p + \overline{P}\big) \tag{20}$$

$\mathcal{L}_1^O$ depends negatively on p in two ways. If p increases, the interest rate will move closer to the optimal interest rate and the probability that the council takes a correct vote will increase additionally. As corollaries we obtain:

12 Or, for completeness, he could be the median central banker with probability $1/2$ if only one other central banker were efficient; this would not change the line of argument.

13 Note that $P(n+1) = P(n)$ if n is odd. An increase of the number of highly efficient central bankers by one when n is odd produces more ties and more correct judgments of the interest-rate policy of the majority. The two effects cancel each other out.

Corollary 1

If the central bank council is very large, the median position is always directionally correct, i.e.

$$\lim_{N\to\infty} \overline{P} = 1$$

Corollary 2

If the central bank council is very large and the probability of each highly efficient central banker's signal being correct is $p = 1$, then losses approach zero, i.e.

$$\lim_{N\to\infty} \mathcal{L}_1^O = 0$$

The two corollaries are implications of the law of large numbers. The first corollary is a variant of the Condorcet Jury Theorem.[14]

We can now easily verify that the reelection scheme proposed in section 4 does indeed represent an equilibrium strategy. Since the expected overall competence of a council that has chosen a directionally correct interest rate is higher than the expected overall competence of a newly elected council, it is optimal to reelect the original council. On the other hand, if the council has chosen a directionally wrong interest rate, its expected competence is lower than the expected competence of a newly elected council. Thus, dismissing the council will minimize expected social losses in the second period.

5.2 Transparency

With respect to the highly efficient central bankers' behavior the Nash equilibrium under transparency will be quite similar to the equilibrium developed in the last section. But less efficient central bankers will not abstain. The government would observe who abstained and would dismiss the respective members to improve the pool of highly efficient central bankers. Therefore, less efficient central bankers will randomize between the two possible interest rates of highly efficient central bankers in order to have a fifty percent chance of not being detected as less efficient. Compared to the case without transparency this effect will increase social losses in the first period since the probability that the median voter is correct will decrease.

14 The Condorcet Jury Theorem, which states that under majority voting, there is a very high probability of large electorates with diverse information reaching correct decisions, goes back to Condorcet (1785) (see Klevorick, Rothschild, and Winship (1984), Miller (1986), Grofman and Feld (1988), Young (1988), Ladha (1992), and Berg (1993)). Austen-Smith and Banks (1996), Feddersen and Pesendorfer (1996, 1997), and Myerson (1998) have shown that taking the possibility of strategic voting into account considerably restricts the potential for generalizing on the informational efficiency of majority voting.

In the appendix we prove:

Proposition 2

Under transparency, the following Nash equilibrium exists in the first period. Each highly efficient central banker will choose:

$$I^H = \pm\big(2p-1\big)$$

where $I = +(2p-1) > 0$ *if the central banker expects the shock to be positive and* $I = -(2p-1) < 0$ *otherwise. Less efficient central bankers will randomize between the two possible values of* I^H *with equal probability.*

Proof of Proposition 2

Under transparency, less efficient central bankers will try to make the government believe that they are highly efficient because they obtain large private benefits from being central bankers and thus want to be reelected. This will induce them to randomize between the two possible positions of highly efficient central bankers.

No central banker could profit from choosing an interest rate I' with $|I'| > |I^H|$ since he could not change the median position of the central bank council and would not increase the probability of getting reelected either.

No central banker would ever choose an interest rate with $|I'| < |I^H|$ because he would not be reelected if he did.

□

In order to derive expected losses, we will first define the probability, denoted by $Q(n)$, that if n members of the council are highly efficient the median central banker will choose the correct interest rate.

$$Q(n) = \sum_{j=(N+1)/2}^{N} \left(\sum_{i=0}^{j} \binom{n}{i} p^i (1-p)^{n-i} \binom{N-n}{j-i} \left(\frac{1}{2}\right)^{N-n} \right) \tag{21}$$

The index j indicates that j members of the central bank council vote correctly. Thus, the first sum starts at $(N+1)/2$ and ends at N, which takes into account all possibilities of more than half of the members voting correctly. There are always several possibilities of j members voting correctly. The index i describes the number of highly efficient members voting correctly while $j-i$ less efficient members will choose the right interest rate.

In contrast to the case of $P(n)$, there is no necessity to consider a draw when calculating $Q(n)$. Under transparency, all members will vote and N is assumed to be odd.

Again, it is useful to define

$$\overline{Q} = \frac{1}{2^N} \sum_{n=0}^{N} \binom{N}{n} Q(n) \tag{22}$$

which is the probability that an outside observer assigns to the eventuality of a median central banker voting correctly.

With this definition, we immediately obtain expected losses in the first period as:

$$\mathcal{L}_1^T = 4\big(p^2 - 2\overline{Q}p + \overline{Q}\big) \tag{23}$$

As corollaries we observe:

Corollary 3
If the central bank council is very large, the median position is always directionally correct, i.e.

$$\lim_{N\to\infty} \overline{Q} = 1$$

Corollary 4
If the central bank council is very large and the probability of each highly efficient central banker's signal being correct is $p = 1$, then losses approach zero, i.e.

$$\lim_{N\to\infty} \mathcal{L}_1^T = 0$$

The corollaries are similar to corollaries 1 and 2 and again follow from the law of large numbers. In order for corollary 3 to hold, it is important for the likelihood of a single central banker being correct to be strictly larger than $1/2$. But this likelihood amounts to $1/2 \cdot 1/2 + 1/2 \cdot p$ where we have used that the probability of central bankers being less efficient or highly efficient is $1/2$, the probability of less efficient central bankers voting directionally correct is $1/2$, and the probability of highly efficient central bankers being correct is p.

We will now demonstrate that the proposed reelection scheme in section 4 is optimal. When the government reelects the central bankers, it will try to minimize expected second period losses. The probability of a newly elected central banker being highly efficient is one half. Thus, it is reasonable to reelect any central banker whose probability of being highly efficient is higher than fifty percent and to dismiss the other central bankers. One can easily verify that the probability of a central banker who chose a directionally correct (wrong) interest rate being highly efficient is $q := p/(p + 1/2) > 1/2$

$(1 - q < 1/2)$.[15] Therefore, the proposed reelection scheme states an equilibrium strategy.

5.3 Comparison

We compare first-period losses with the following proposition:

Proposition 3
Losses in the first period are always larger under transparency than under opacity, i.e.

$$\mathcal{L}_1^O < \mathcal{L}_1^T$$

The proof is straightforward. For any n, it is easy to show that $P(n) > Q(n)$. Then one can conclude that $\overline{P} > \overline{Q}$, which implies the above proposition.

This result is quite plausible. Under transparency, no less efficient central banker will dare to abstain since he would not be reelected if he did. This will induce less efficient central bankers to randomize between the two possible positions of highly efficient central bankers. That will decrease the probability of a correct decision being reached.

6 The Second Period

6.1 Opacity

In the second period again, only highly efficient council members will vote since less efficient central bankers would decrease the likelihood of the central bank's decision being correct. Highly efficient central bankers will choose $I = \pm|I^H|$.

It is straightforward to show:

Proposition 4
Under opacity, the following Nash equilibrium exists in the second period. All less efficient central bankers abstain, and all highly efficient central bankers choose $I_i = \pm(2p - 1)$. *If no highly efficient central banker is present, the interest rate* $I = 0$ *will be chosen.*

15 The probability of a highly efficient central banker choosing a correct interest rate is p, for a less efficient central banker it is $1/2$. This means that p and $1/2$ are the relative probabilities of a central banker who has chosen the correct interest rate being either highly efficient or less efficient. Thus, the probability of a central banker who has voted for a correct interest rate being highly efficient is q.

To derive expected losses, we need to distinguish whether the council has been dismissed or left in office. If the central bank council is dismissed, expected losses will differ slightly from the losses computed for the first period. If no highly efficient central bankers are present on the council, $I = 0$ minimizes social losses. In this case, the council has randomized in the first period between $I^H = \pm(2p-1)$ in order to avoid dismissal.

Thus, if the central bank council has not been reelected expected losses amount to:

$$\mathcal{L}_2^O|_{new\ council} = 4\big(p^2 - 2\overline{P}p + \overline{P}\big) - \frac{1}{2^N}\big(2p-1\big)^2$$

For large values of N, $\mathcal{L}_2^O|_{new\ council}$ and $\mathcal{L}_1^O$ will be identical, since it is then extremely unlikely that there will be no highly efficient central banker present.

Overall expected losses in the second period amount to:

$$\begin{aligned}\mathcal{L}_2^O =& \frac{1}{2^N}P(0) + 4\,\frac{1}{2^N}\sum_{n=1}^{N}\binom{N}{n}\Big[P(n)\Big(P(n)(1-p)^2 + \big(1-P(n)\big)p^2\Big)\Big] \\ &+ 4\,\frac{1}{2^N}\sum_{n=0}^{N}\binom{N}{n}\Big[\big(1-P(n)\big)\Big(p^2 - 2\overline{P}p + \overline{P} - \big(1/2^N\big)\big(p-1/2\big)^2\Big)\Big]\end{aligned} \tag{24}$$

If the central bank council has been disbanded, expected losses will be $\mathcal{L}_2^O|_{new\ council}$, which yields the last term of equation (24). The first and second term correspond to the losses when the central bank council is reelected; the probability of this is $P(n)$. Given that the number of highly efficient central bankers is $n \geq 1$ in the second period, second-period losses amount to $4\Big(P(n)(1-p)^2 + \big(1-P(n)\big)p^2\Big)$, which is the expression appearing in the first sum.

Expression (24) can be simplified to:

$$\begin{aligned}\mathcal{L}_2^O =& \frac{1}{2^{N+1}} + 4\Bigg[\overline{P}p^2 - 2p\overline{P^2} + \overline{P^2} - \big(1/2^{N+1}\big)p^2 \\ &\qquad + (1-\overline{P})\Big(p^2 - 2\overline{P}p + \overline{P} - \big(1/2^N\big)\big(p-1/2\big)^2\Big)\Bigg] \\ =& \ 4\Big(p^2 + (2p-1)\big(\overline{P}^2 - \overline{P^2} - \overline{P}\big)\Big) - \frac{1}{2^{N+1}}(2p-1)(2p+1) - \frac{1}{2^N}\big(1-\overline{P}\big)(2p-1)^2 \\ =& \ 4p^2 + (2p-1)\Big[4\big(\overline{P}^2 - \overline{P^2} - \overline{P}\big) + \frac{1}{2^N}\Big(3p - 1/2 + (2p-1)\overline{P}\Big)\Big]\end{aligned}$$

where we have used:

$$\overline{P^2} := \frac{1}{2^N} \sum_{n=1}^{N} \binom{N}{n} \big(P(n)\big)^2$$

6.2 Transparency

In the second period, the equilibrium losses under transparency will be the same for a given number of highly efficient central bank members as under opacity. Less efficient central bankers will abstain because they can gain no benefits from making the government believe that they are highly efficient, but would exacerbate social losses if they voted. However, the probabilities that n central bankers will be highly efficient in the second period are different under transparency, thus changing expected losses in comparison to opacity. In the second period, expected losses will be smaller under transparency since the average number of highly efficient central bankers will be larger. This is due to the fact that the government is better able to distinguish highly efficient from less efficient central bankers when each central banker can be made accountable for his preferred policy.

It is easy to show:

Proposition 5
In the second period, under transparency, the following Nash equilibrium exists. All less efficient central bankers abstain, and all highly efficient central bankers choose $I_i = \pm(2p-1)$. *If no highly efficient central banker is present, the interest rate* $I = 0$ *is chosen.*

If we define $\rho_N(n)$ as the probability of n highly efficient central bankers being present in the second period and the size of the council amounting to N, expected losses can be written as:

$$\mathcal{L}_2^T = \rho_N(0) + 4 \sum_{n=1}^{N} \rho_N(n) \big(p^2 - 2P(n)p + P(n)\big) \tag{25}$$

or as

$$\mathcal{L}_2^T = \rho_N(0) + 4\Big(\big(1-\rho_N(0)\big)p^2 - 2\widetilde{P}p + \widetilde{P}\Big) \tag{26}$$

where we have used the following definition:

$$\widetilde{P} := \sum_{n=1}^{N} \rho_N(n) P(n) \tag{27}$$

$\widetilde{P}$ can be interpreted as the probability that the central bank council will estimate the shock correctly.

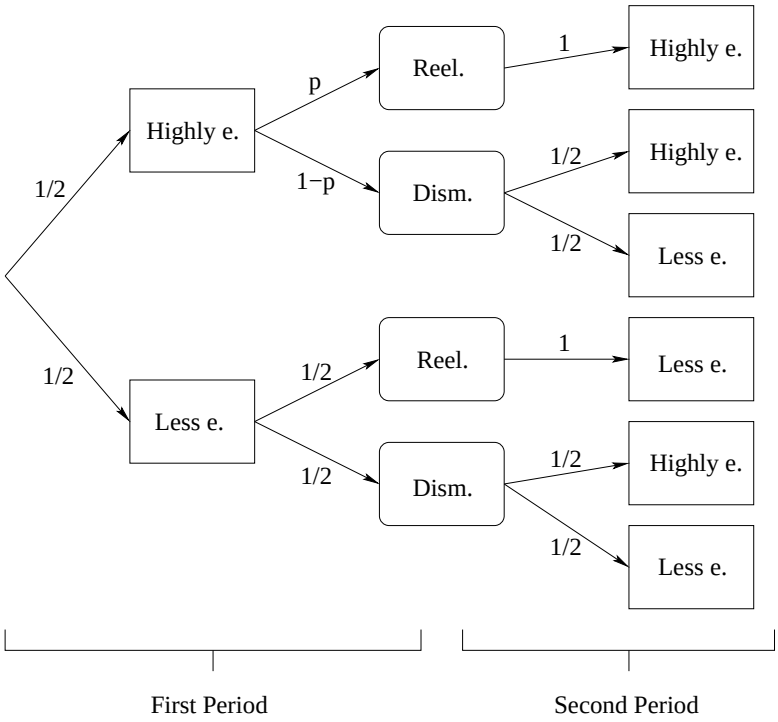

Figure 1: The calculation of $\rho_1(0)$ and $\rho_1(1)$.

To determine $\rho_N(n)$, we will first derive $\rho_1(0)$ and $\rho_1(1)$. According to figure 1, the probability of a single central banker being highly efficient in the second period is made up of three factors. First, nature determines whether a central banker is highly efficient in the first period. Second, reelection takes place. Third, nature determines whether a newly elected central banker is highly efficient or not. We obtain the following expression:

$$\begin{aligned} \rho_1(1) &= \frac{1}{2}\cdot p\cdot 1+\frac{1}{2}\cdot(1-p)\cdot\frac{1}{2}+\frac{1}{2}\cdot\frac{1}{2}\cdot\frac{1}{2} && (28)\\ &= \frac{1}{4}p+\frac{3}{8} && (29)\end{aligned}$$

It is now easy to derive $\rho_1(0)$:

$$\begin{aligned} \rho_1(0) &= 1-\rho_1(1) && (30)\\ &= -\frac{1}{4}p+\frac{5}{8} && (31)\end{aligned}$$

For $p=1/2$ we obtain $\rho_1(0)=\rho_1(1)=1/2$, which is plausible since, for $p=1/2$, both types are indistinguishable and thus occur with equal probability. Having determined

$\rho_1(0)$ and $\rho_1(1)$, we can construct $\rho_N(n)$ by observing that the probability of a single central banker being highly efficient in the second period depends neither on the total number of central bankers N nor on the number of highly efficient central bankers n. We thus obtain the binomial expression:

$$\rho_N(n) = \binom{N}{n} \big(\rho_1(1)\big)^n \big(\rho_1(0)\big)^{N-n} \tag{32}$$

6.3 Comparison

We compare social losses in the second period using the following proposition:

Proposition 6
Losses in the second period are always smaller under transparency.

This is more or less obvious. The average number of highly efficient central bankers in the second period will be larger under transparency since the government can dismiss or reelect single members of the central bank council. Since less efficient members will always abstain in the second period, losses are smaller under transparency due to the larger number of highly efficient central bankers; this, in turn, increases the likelihood of the central bank being correct.

7 Overall Comparison

So far, we have established that under opacity losses are lower in the first period but larger in the second. The final step is to compare overall losses. While it is hard to compare losses analytically due to the complexity of the respective expressions, the terms can be calculated numerically for any probability p and any number of central bank council members N.

E.g. figure 2 shows social losses for both periods and under both scenarios as a function of N for the parameter $p = 0.8$.

Losses always decrease when N increases since the likelihood that the central bank takes directionally correct decisions increases. We also see that under each scenario losses are smaller in the second period compared to the first period. This is due to the following effects: First, especially for small N, losses will differ because in the first period there is socially wasteful randomization in the case of a draw. Second, under both scenarios the average number of highly efficient central bankers is larger in the second period.

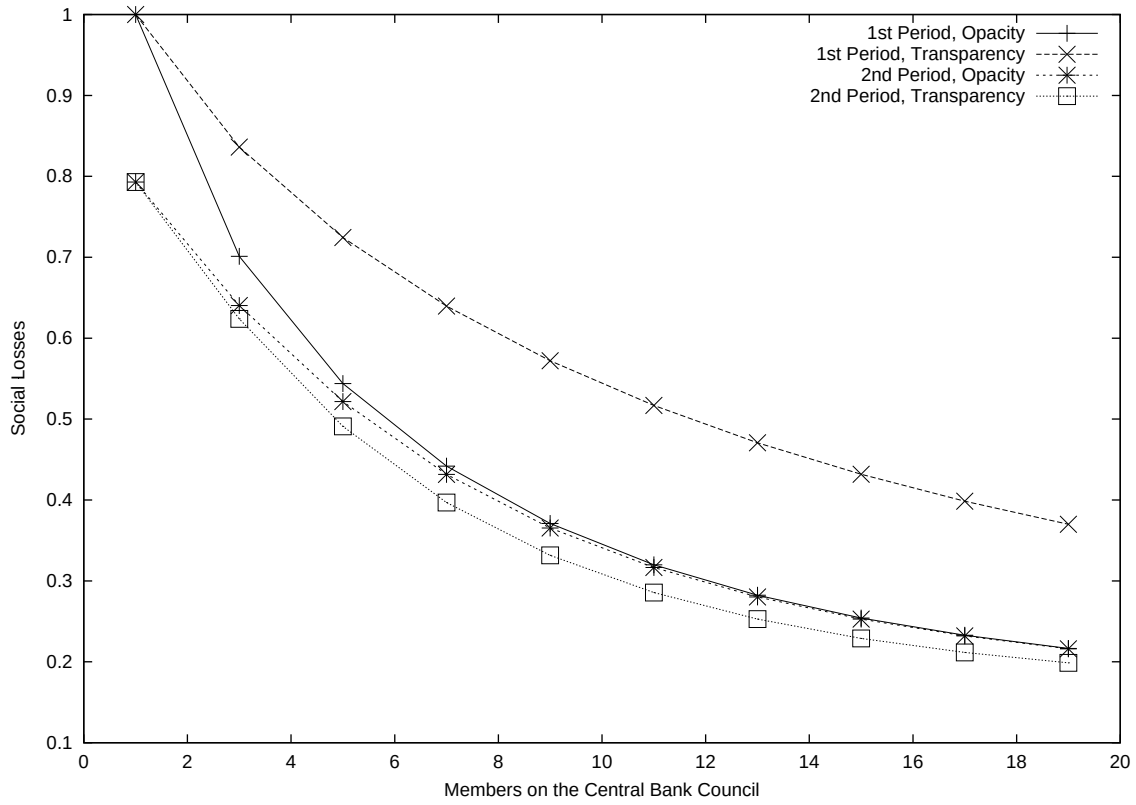

Figure 2: Social losses depending on the number of central bankers

A larger average number of highly efficient central bankers also lowers second period losses under transparency compared to second period losses under opacity. However, first period losses under transparency are rather large, since less efficient members do not abstain but randomize between the two highly efficient central bankers' positions. For $N = 1$, it does not matter whether we consider transparency or opacity. Therefore, social losses under both scenarios are always identical for $N = 1$.

Since the above pattern holds for different values of p, we summarize our main comparison with the following simulation result:

Simulation Result 1

If $N > 1$, overall expected losses are always larger under transparency no matter how large the discount rate δ, $0 < \delta < 1$.

The simulation result is supported by our numerical simulations but no formal proof is available as yet. While transparency always reduces second period losses, it always increases first period losses. It is not a priori clear which effect dominates. However, our numerical computations indicate that for any $p > 1/2$ and $N > 1$, the absolute value of

the difference of first period losses always exceeds the absolute value of the difference of losses in the second period. Therefore, we can conclude that overall expected losses are always larger under transparency, independently of the parameter δ.

8 Equilibrium Selection

In this section we discuss the multiplicity of equilibria and its consequences for the relative advantages of transparency and opacity. We have only considered equilibria in which every highly efficient central banker chooses exactly the interest rate he would choose if he could determine monetary policy alone. These equilibria are not very efficient, i.e. equilibria with lower expected losses do exist. For instance, even when the central bank council is extremely large, losses for $p < 1$ do not approach zero although the median voter is certainly correct. But losses would approach zero if the interest rates $I' = \pm 1$ were chosen instead of $I^H = \pm(2p-1)$.

We might consider equilibria with interest rates minimizing losses from an ex ante viewpoint. For example, under opacity, the government would like to choose a reelection scheme where the central bank council is only reelected when the absolute value of the interest rate exceeds or equals $2\overline{P}-1$ and the sign of the interest rate is correct.[16] In the second period, every highly efficient central banker could choose interest rates that would be optimal if every other highly efficient central banker chose these interest rates as well. Second-period interest rates would then depend on the total expected number of highly efficient central bankers. If a highly efficient central banker expected there to be a large number of highly efficient colleagues, he would prefer a large absolute value of the interest rate; by contrast, he would choose a more cautious policy if he expected the number of highly efficient colleagues to be small.

The respective equilibrium implies another advantage of opacity. Assume the central bank council has been reelected under opacity. Then central bankers know precisely the number of highly efficient colleagues since they can observe how many central bankers abstained in the first period. Knowing the exact number of highly efficient colleagues, they could choose interest rates which would imply relatively low second period social losses. Under transparency, however, central bankers never know exactly how many highly efficient central bankers are on the council because they cannot distinguish reelected highly efficient central bankers from less efficient central bankers who estimated the correct direction of the shock by mere luck. Therefore, uncertain

16 Ex ante the interest rate $2\overline{P}-1$ is optimal since it solves $\min_I\{\overline{P}(1-I)^2+(1-\overline{P})(1+I)^2\}$.

about the number of highly efficient colleagues, they could not choose interest rates as appropriate as they would be under opacity. To sum up, opacity would enable central bankers to vote open-mindedly, which, in turn, would improve the central bankers' knowledge about their colleagues' competence. This might enable central bankers to pursue a more favorable monetary policy.

9 Discussion and Conclusion

In this paper we have emphasized that there are costs and benefits of voting transparency and that the costs can justify opacity. This conclusion is not restricted to central bank councils; it could also be applied to other committees consisting of members with different degrees of competence, identical utility functions, and the desire to be reelected due to the large private benefits this implies.

If, contrary to our assumption, private benefits from holding office are very low, opacity and transparency are equivalent with respect to policy outcomes. In both cases, less efficient central bankers would immediately resign because they would not want to exacerbate the central bank's judgment about the appropriate monetary-policy stance.

It is an interesting question whether central bankers would prefer transparency over opacity from an ex ante point of view. Our model suggests the following. Less efficient central bankers have a probability of one half of getting reelected under transparency. Under opacity the probability of getting reelected is higher. Therefore incompetent central bankers prefer opacity over transparency. A similar argument holds for highly efficient central bankers. Thus both less efficient central bankers and highly efficient central bankers prefer opacity over transparency from an ex ante point of view. This implication of our model might explain why central bankers may sometimes be reluctant to impose transparency on monetary policy.

The results of our model would not change if we considered different demand and supply equations, as long as these were linear and did not depend on lagged or future variables and as long as losses are quadratic. However, our analysis is still only a first step towards a firm conclusion about the social desirability of voting transparency. Our analysis could and should be extended in various directions. By incorporating long-term perspectives, and thus more than two terms for central bankers, the balance of costs and benefits might go more toward transparency, but it is unlikely that the relative comparison would change. In future work, it will be more important to allow

for a richer variety of shocks making it more difficult to infer who is highly efficient and who is not.

Finally, the negative value of transparency in our set-up has to be contrasted with the positive effects when central bankers have equal competence but differ in the emphasis they put on employment relative to inflation. Whether transparency is socially desirable from an overall perspective depends entirely on the kind of heterogeneity within the central bank council and on the magnitude of the private benefits emanating from holding office.

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