When the Central Bank looks like a Central Bank: Reconsidering Independence

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Abstract

Although the literature on Central Bank independence provides many informal discussions on the optimal institutional design of the Central Bank, the development of a formal framework to address this issue is still a very much open area. This paper contributes to filling this gap by studying monetary policy making when (i) decisions in the central bank are taken by a committee, rather than a single individual, and (ii) the government has some power over the appointment of central bankers. It is shown that, when the members of the central bank committee have staggered terms and do not vote strategically, the following results hold: 1) Low inflation is more likely to arise under collective, rather than monolithic, decision making. 2) The influence of the government over the appointment of central bankers translates into influence over the choice of monetary policy itself. 3) The ability of the government to affect monetary policy is weakened when the monetary authority is a committee instead of a single individual.

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1 Introduction

Central bank (CB) independence has been the object of a prolific body of literature. Studies have centered their attention on the impact of placing the design of monetary policy in the hands of a policy maker different (generally more conservative) than the government. But moving from the government to an independent central bank causes changes that go well beyond having a more conservative policy maker. The nature of policy making itself is altered, as the basic institutional setting in which a CB acts is different from that surrounding any government. Given this fundamental difference, the study of monetary policy as designed by an independent authority requires a theoretical framework that captures the specific institutional features characterizing central banks.

First, in many cases the monetary authority cannot be identified with *a* policy-maker, but rather with a group of them; monetary policy is often in the hands of a board. Since focusing on a representative agent is in many cases a bad substitute for aggregating preferences over a group, models that consider an individual decision maker may not be adequate to study the decisions of a CB. Specifically, the central issue of CB reputation cannot be correctly addressed if collective decision making is not specifically modeled. When policies are chosen by a group, the value of building a reputation and the time horizon relevant to the decisions are not necessarily equal to those that characterize an individual member. Reputation can be less effective as a disciplining device because an individual member may not see his vote reflected in the actual policy. At the same time, reputation can be more effective because the time horizon relevant to the decisions of the group is generally longer than the one an individual member faces, at least in the case in which the terms of the members are staggered. These features are ignored in a model that does not directly address monetary policy making as a process of collective choice.

Second, the choices of the monetary authority cannot be studied in isolation: even though it is the CB who decides monetary policy, the influence of the government on this choice must be taken into account. In particular, central banks generally face institutional constraints designed to guarantee some level of coordination with the government[1]. Not only do these constraints

[1]In this paper, I refer to "mechanisms of CB-government coordination" in a weak sense. The term here is just meant to capture institutional mechanisms designed to maintain some level of correspondence between the preferences of the two institutions. The need for such

limit the set of policy choices available to the monetary authority, but they also change the incentives that shape the actions of the CB directors. A theoretical framework to study the decisions of the CB should, therefore, take into account the mechanisms of coordination with the government imbedded in the institutional design of the CB.

Given the important effects of these institutional constraints on the actual choices of policy, they should be a central element of any model addressing monetary policy by the central bank. Most of the existing literature, however, ignores them. This work will contribute to filling this gap by presenting a model where the collective nature of monetary policy decisions and a specific institutional channel of interaction between the government and CB directors are explicitly accounted for. This is not the first paper in modeling committee monetary policy making, and it does not differ much from previous works in this specific area. However, there is a value added to studying collective decisions and channels of government's influence on the CB simultaneously, since there is interaction between the two issues. For instance, it will be shown in this paper that the ability of the government to affect the CB's choice of monetary policy depends on whether this choice is made by a committee or a single central banker.

The model I present considers monetary policy as decided by a committee. The government has some influence on the appointment of members to it, a mechanism of CB-government coordination that is used in a variety of countries. Three basic incentives will interact to determine the choices of central bankers: the incentive to vote for their own preferred inflation[2], the incentive to build reputation, and the incentive to signal loyalty to the government with the goal of being reappointed.

The objective is to determine how the introduction of these innovations affects two results of the CB independence literature. These results are: 1) Central bank independence reduces the inflation bias in monetary policy.

mechanisms is highlighted in much of the literature on institutional design of the CB, as perfect CB independence may imply a permanent tension between the objectives of fiscal and monetary policy. Obviously, insitutional constraints are not the only channels of interaction between the Government's and the Central Bank's decisions. Fiscal policy, for example, imposes pressures on the monetary authority through its effects on economic outcomes. The institutional features of the CB-government interaction, however, are the ones addressed in this paper.

[2]Where a central banker's preferred inflation is defined as the inflation rate he chooses when his decision has no intertemporal effects (does not affect his position as central banker, or the reputation of the CB).

2) Central bank independence isolates monetary policy from the political cycle. I find that, when central bakers vote sincerely rather than strategically, these results should be qualified in the following manner: 1) The inflation bias is larger under monolithic rather than collective policy-making, 2) the government's power to reappoint central bankers translates into influence over the choice of monetary policy, and 3) the ability of the government to affect equilibrium inflation is lower under a committee than under a single central banker.

The paper is divided into five sections, including this introduction. The second section briefly reviews some relevant literature, the third one presents the model, and the forth contrasts the results of my basic model with those of three alternative benchmarks. Finally, section five concludes.

2 Relevant literature

The institutional design of the CB has been addressed by many authors. Eijffinger and Haan(1996) and Bianchi (1994), for example, highlight rules on the appointment of CB directors and mechanisms of coordination between the government and the CB as key elements shaping the decisions of the CB. The merits of alternative specifications for these rules and mechanisms are assessed by Cukierman (1996). Meanwhile, Blinder (1998) discusses the importance of collective decision making as a determinant of monetary policy. Few studies, however, formalize the analysis of these institutional features by capturing them into a model.

Among the few formal models that have been put forward, those in Waller(1989), Sibert(1999) and Cothren(1988) analyze the decisions of a monetary committee whose members vote over possible policy choices. According to these papers, differences with the single policy maker case arise in three inter-related areas: a smoother evolution in the preferences of the CB, relevant time horizons and reputation building. First, the time horizon relevant for the policy decision is larger under a committee, provided that the terms of its members are staggered. Indeed, with staggered terms the public considers the board infinitely lived, even if individual members serve only finite terms and live finite lives. It is then possible to sustain a low inflation equilibrium even if monetary policy-making takes the form of a repeated game with high inflation as the only equilibrium of the static game. In this dimension, therefore, collective decision making on monetary policy

tends to generate lower inflation than individual decision making.

Second, the preferences of a committee whose members serve staggered terms vary more smoothly than those of an individual decision maker: in the former case, the preferences of the CB are always evolving in a smooth manner, while in the latter they remain unchanged within a central banker's term and then change abruptly. . This "inertia" element affects the public's expectations about inflation. In the end, it tends to reduce equilibrium inflation with respect to the single policy maker case, given that the policy makers realize that their decisions will affect inflation expectations over a longer horizon.

As for reputation building, from the point of view of each central banker the incentive to build a reputation is modified in two -conflicting- ways with respect to the case of a single policy maker. First, the value of trying to build reputation declines because the public knows that there is not perfect continuity of the board between one period and another, and therefore gives less value to today's inflation when forming inflation expectations for tomorrow. Second, a member's payoff to voting for inflation also declines because his vote will not necessarily be reflected in the outcome. As a result, there can be more or less reputation building than in models with a single central banker.

Another approach to group decision making by the CB is presented by Faust(1996), who studies the decisions of a monetary board whose members bargain over inflation. He finds that a policy committee in which the interests of all groups are appropriately balanced will reduce equilibrium inflation with respect to what the majority of the population would choose in a general election.

Finally, some mechanisms of CB-government coordination are addressed by Havrilesky (1995, chapter 9). In particular, he studies the appointment of central bankers by the president, a decision the author compares with a problem of portfolio choice. Two, mutually exclusive, desirable characteristics of CB directors must be balanced: reliability and representation (of all groups in society). The former provides less political support than the latter, but is less risky. The optimal choice is a combination of the two types.

3 The model

I propose a model in which the collective nature of CB decisions and the existence of institutional mechanisms for coordination with the government are explicitly considered in a simultaneous manner. To model coordination between the government and the CB, I give the president power to decide on the reappointment of CB directors. Monetary policy is chosen by a committee of central bankers who vote over inflation rates.

3.1 General Setting

Monetary policy is decided by the CB board, which has $n = 2s+1$, members that vote over different possible inflation rates, where $s \geq 1$. Each member of the board is drawn from a pool of potential policy makers who live for z periods. They care about inflation and economic activity, in the same fashion captured by the Barro-Gordon model (Barro and Gordon 1983a and 1983b). Additionally, they receive utility from being in office. Their preferences when just born are hence captured by the loss function:

$$L_0^i = E \sum_{k=0}^{z} \beta^k \left[(y^* - y_k) + a^i (\pi_k)^2 - bO_k^i \right] \tag{1}$$

where

$$y_k = \overline{y} + (\pi_k - \pi_k^e) \tag{2}$$

$b > 0$, $a^i > 0$, i captures the type of a policy-maker, which is his private information, and

$$\begin{array}{c} O_k^i = 1 \text{ if he is in office in period } k \\ O_k^i = 0 \text{ otherwise} \end{array} \tag{3}$$

The loss function is meant to capture the fact that each director balances three different goals: reducing the gap between output and its target level y^*, driving inflation to its target level of zero, and being in office. The two first terms of the loss function are standard in the literature. The last captures the benefit derived from being in office. The type of a policy maker, hawk or dove, depends on whether he is, respectively, more or less inclined to fight against inflation: $a^h > a^d$. In fact, I assume that hawks only care about

driving inflation to zero, that is $a^h = \infty$ [3]. The unconditional probability of a given individual being of a particular type is assumed to be $\frac{1}{2}$.

I assume that a policy maker can be first appointed to office only in period 1 of his life, and can serve for a maximum of z periods[4]. After each period, however, he must go through a reappointment process that determines if he continues in office or steps down. The reappointment decision is taken by the president, who must change m members of the board in each period (with $m \leq s$)[5]. To this effect, he chooses which m members will be retired and then chooses their replacements from the pool of potential policy makers.

The government's only role is deciding on the reappointment of Central Bankers. There is a president that changes every period[6], and whose name is also drawn from the pool of newly born potential policy-makers. His preferences are thus captured by equation 1, and he can be dove or hawk. I further assume that the president is randomly selected by nature, and his type is announced to everyone by nature as well. The president has a seat -but no vote- in the committee, so that he observes the vote of each central banker.

The timing of events is as follows: each period t is divided into three subperiods, t^-, t, t^+. At t^- nature designates the president and announces his type. At t the CB board -whose composition is "inherited" from the previous period- chooses inflation given inflation expectations and the type of the government. The government observes the votes of the central bankers and the public observes the inflation rate. With this information, at t^+ the

[3]This assumption also means that the hawk policy maker does not care about being in office, which is extreme. Furthermore, it shuts down some potentially interesting features of the model, like the possibility that hawks signal their type. It is imposed here to concentrate in the specific feature of mimicking by the weak type, and study in this simpler case the effects of the institutional constraints I introduce. However, a relaxation of this assumption is an interesting extension that should be the focus of a future version of the model.

[4]This assumption is not crucial to the results, but facilitates getting them in a cleaner manner. It basically implies that a central banker is not concerned about what may happen after his maximum period in office.

[5]The case of a central banker that reaches the end of his z term can potentially arise, and complicates the analysis in non interesting ways. I therefore assume that a policy maker that steps down at the end of his z term is replaced by nature with a newly born policy maker of his same type. The president must change m central bankers *besides* the one for whom the z term expired.

[6]In other words, the time unit is the presidential term. This is not unrealistic: in many countries the terms of at least some Central Bankers extend beyond that of the president.

government decides which members to replace and who will replace them, while the public chooses expected inflation for $t+1$. Notice that this structure implies that the president can only affect future inflation, not inflation for his own term. This is consistent with his preferences, as given by equation 1, and with the fact that his life extends beyond his presidential term.

3.2 The problem of a central banker

Let the ij central banker be one of type i and vintage j (the one that is serving his j-th year as director). Notice that in each period there can be more than one ij central banker. In period t, ij chooses his vote to minimize a loss function of the form:

$$L^i_{j,t} = E_t \sum_{k=0}^{z-j} \beta^k \left[(y^* - y_{t+k}) + a^i \left(\pi_{t+k}\right)^2 - bO^i_{j,t+k} \right] \tag{4}$$

Let $R^i_{j,t+k}$ be a discrete variable capturing the event that, given that in $t+k$ he is in office, he is reappointed by the $t+k$'s government to be in office in $t+k+1$:

$$\begin{array}{c} R^i_{j,t+k} = 1 \text{ if reappointed in } t+k \\ R^i_{j,t+k} = 0 \text{ otherwise} \end{array} \tag{5}$$

given that $O^i_{j,t+k} = 1$. For a central banker born in period t, $O^i_{j,t+k}$ $(k \geqslant 1)$ can be rewritten as $O^i_{j,t+k} = O^i_{j,t} * R^i_{j,t} * R^i_{j,t+1} * ... * R^i_{j,t+k-1}$. Noting that $O^i_{j,t} = 1$ the loss function becomes:

$$L^i_{j,t} = E_t \sum_{k=0}^{z-j} \beta^k \left[(y^* - y_{t+k}) + a^i \left(\pi_{t+k}\right)^2 \right] - b - E_t \sum_{k=1}^{z-j} b \prod_{f=0}^{k-1} R^i_{j,t+f} \tag{6}$$

3.3 The case of no reputation building

Consider the case where reputation is not an issue: the policy makers do not consider intertemporal effects of their votes. In this case the expected inflation and the probability of being reelected in following periods are taken as exogenous. Each policy maker's preferred policy will be given by $\pi = \frac{1}{2a^i}$. We will limit the agenda to choices between the two preferred rates $\pi = 0$

and $\pi = \frac{1}{2a^d} = \pi^d$. Faced with this agenda[7], each hawk will vote for the first rate and each dove will vote for the second. Which one is actually adopted depends on the balance between hawks and doves in the board.

3.4 Accounting for Reputation

Now take the case in which today's choices over π have effects on future constraints. The focus in this section will be on the conditions under which a low inflation equilibrium can be achieved at period t. I will again limit to the choice between $\pi = 0$ and $\pi = \pi^d$. Notice that here dynamic considerations can drive dove central bankers to vote for low inflation, as long as $\beta > 0$.

I will also focus on an equilibrium in which the inflation rate chosen for today will be in place for ever after. This is clearly a non plausible assumption, as it imposes a given voting strategy to central bankers of the future, but it greatly simplifies matters. Although it is an ad-hoc assumption, the interest in this paper is in the contrast between the "committee under government influence" case and alternative designs of the CB. To the extent that the assumption about today's choice of inflation being in place for ever after is present in all of those alternatives, my final conclusions are not a consequence of this, admittedly implausible, assumption. Of course, this does not imply that the assumption is innocuous; on the contrary, it artificially favors the choice of low inflation over high inflation. However, this effect is present in all the cases I solve for and, hence, should not be driving my conclusions about low inflation being more likely under some regimes than others.

One additional problem with the assumption that future central bankers, regardless of their type, will vote for the same inflation rate chosen in t is that it leaves us with no reason why the government would prefer reappointing central bankers of a given type. Since one of the mechanisms I want to stress depends on the fact that the government does have clear preferences toward central bankers of its own type, I need to introduce some element that justifies this preference. To this end, I will assume that in each period there is a probability q that the value of β will jump to zero for the duration of that period. If this event is realized, dove central bankers will vote for π^d independently of any other considerations, while hawk ones will continue to

[7] As pointed out by Cothren (1988), this case can be rationalized as a votation over an agenda proposed by the same members of the board. Members propose an inflation rate that is either rejected or accepted.

vote for zero. Hence, the government has an incentive to reappoint central bankers of its own type, in preparation for the event that β becomes zero in the following period. It can be shown that, if one assumes that q is sufficiently small, all the conditions found under the assumption that $q = 0$ still hold[8]. I will thus assume that q is infinitesimally small, and solve the model as if q was actually zero.

An important point to note here is that, although these assumptions are in essence artificial, they represent very plausible and realistic phenomena. In particular, they are designed to capture the fact that the government prefers having central bankers with preferences that are closer to their own.

In what follows, I present optimal strategies for the public, the government, and today's central bankers, given these assumptions. A discussion showing that each of these strategies is optimal given the others will be presented at the end of the section.

3.4.1 The public

First, consider the decisions of the public about expectations of future inflation. Given the assumption that the choice of inflation in t stays in place for ever after, it is optimal for the public to form expectations of inflation in $t + k$ $(k > 0)$ according to:

$$\pi^e_{t+k} = 0 \text{ if } \pi = 0 \text{ in all previous periods}$$

$$\text{and} \tag{7}$$

$$\pi^e_{t+k} = \pi^d \text{ otherwise}^9$$

[8] q can be made infinitesimaly small because the action of reappointing one director, as opposed to any other, does not generate any cost to the government. Thus, any positive value of q makes the trick of creating an incentive for the government to reelect his own type.

[9] Actually, the assumption is that the choice of inflation made in t prevails for ever after, *except in any periods in which* $\beta = 0$. Letting $q = \Pr(\beta_{t+k} = 0)$ and $M_{t+k} = d$ if doves are majority in $t + k$, the precise form of future expectations is:

$\pi^e_{t+k} = (1 - q)\pi^d + q\left[\Pr\left(M_{t+k} = d\right)\right]\pi^d$

if $\pi = \pi^d$ in any previous period

$\pi^e_{t+k} = q\left[\Pr\left(M_{t+k} = d\right)\right]\pi^d$ otherwise. Since $q \to 0$, this reduces to the proposed expression for expectations.

3.4.2 The government

Turn now to the government's decision. Given the assumptions above, the president cannot affect today's choice of inflation (chosen by a board whose composition he cannot modify), and cannot affect future inflation expectations, which depend solely on today's inflation. Hence, it is optimal for him to concentrate on trying to generate in $t+1$ his preferred level of inflation. He, therefore, chooses the values of $R^i_{j,t}$ that maximize the proportion of members of next period's board that are his same type. He must base his decision on the individual votes, which constitute the most relevant information he has at hand. Let π^g_t be the inflation rate preferred by the type of period t's government in the static context ($\pi^g_t = 0$ if the president is hawk and $\pi^g_t = \pi^d$ if he is dove), π^{-g}_t be the rate preferred by the opposite type, and V^{-g}_t be the number of votes for π^{-g}_t. Let $v^i_{j,t}$ be equal to the inflation rate for which ij votes in t. The following strategy will be optimal for the government:

$$\begin{array}{l} \text{If } v^i_{j,t} = \pi^{-g}_t \text{ and } V^{-g} > m \text{ replace } ij \text{ with prob. } \frac{m}{v^{-g}} \\ \text{If } v^i_{j,t} = \pi^{-g}_t \text{ and } V^{-g} < m \text{ replace } ij \text{ with prob. } 1 \\ \text{If } v^i_{j,t} = \pi^{g}_t \text{ and } V^{-g} > m \text{ replace } ij \text{ with prob. } 0 \\ \text{If } v^i_{j,t} = \pi^{g}_t \text{ and } V^{-g} < m \text{ replace } ij \text{ with prob. } \frac{m-v^{-g}}{n-v^{-g}} \end{array} \tag{8}$$

In words, the government prefers replacing those bankers that vote for π^{-g}_t. The reason is simple: a hawk central banker will never vote for positive inflation. A hawk government thus wants to replace ij if $v^i_{j,t} = \pi^d$ because that vote reveals that ij is dove. For the same reason, a dove government will want to keep ij if π^d is his vote. Therefore, both types of governments prefer replacing central bankers that voted for the type opposite to that of the president.

As for the decision of who will replace the "non reappointed" central bankers, notice that the government has no relevant information to make any distinction among the members of the pool of potential policy makers. He will, therefore, randomly choose the corresponding m potential policy makers. This feature reflects the fact that I model *reappointment*, as opposed to *appointment*.

3.4.3 Central banker's voting strategy in t

Knowing the government's strategy, the central banker's problem can be written in a more appropriate form. Since the probability of reappointment in any given period depends only on the vote in that period, $R^i_{j,t+u}$ and $R^i_{j,t+f}$ are independent events for any $f \neq u$. Furthermore, given that the expected type of the government is the same for all future periods, $Pr\left(R^i_{j,t+f}=1\right)$ is treated as a constant from the point of view of t for any value of f, except for $f=0$. The loss function in equation 6 can be thus re-written as:

$$\begin{array}{c} L^i_{j,t} = E_t\left\{\sum_{k=0}^{z-j}\beta^k\left[(y^*-y_{t+k})+a^i\left(\pi_{t+k}\right)^2\right]\right\}-b \\ -b\sum_{k=1}^{z-j}\beta^k p^{k-1}\Pr\left(R^i_{j,t}=1\right) \end{array} \tag{9}$$

where $p=\Pr(R^i_{j,t+f}=1)$ for any $f>0$.

Furthermore, given the strategy of the government, the ij central banker knows:

$$\Pr\left(R^i_{j,t}=1\ /\ v^i_{j,t}=\pi^g_t\right) > \Pr\left(R^i_{j,t}=1\ /\ v^i_{j,t}=\pi^{-g}_t\right) \tag{10}$$

for all i, j, and t.

Therefore, after accounting for the strategies of the government and the public, each central banker will choose his vote to minimize the loss function:

$$\begin{array}{c} L^i_{j,t} = E_t\left\{\sum_{k=0}^{z-j}\beta^k\left[\left(y^*-\overline{y}-\pi_{t+k}+\pi^e_{t+k}\right)+a^i\left(\pi_{t+k}\right)^2\right]\right\}-b \\ -\frac{b}{p}\Pr\left(R^i_{j,t}=1\right)\sum_{k=1}^{z-j}\beta^k p^k \end{array} \tag{11}$$

subject to the constraints imposed by the government's decisions (10) and the mechanism of formation of inflation expectations (7).

Notice that π^e_{t+k} enters the central banker's period-t loss function. Since π^e depends on past inflation, this gives the central banker incentives to help building a reputation of the CB being tough. In other words, he has incentives

to help choosing low inflation to convince the public that the CB is tough, driving down future inflation expectations. Since this phenomenon is linked to the building of reputation of the CB as a group, I will refer to it as the building of "collective reputation" throughout the paper.

At the same time, the possibility of affecting one's chances of being reappointed introduces an element of "individual reputation": each director wants to convince the government that he is of the same type as the president. While collective reputation (facing the public) is relevant to affect future inflation expectations, individual reputation (facing the government) is relevant to affect future chances of being in office[10].

Consider the problem of a central banker who has to choose how to vote. His decision will depend crucially on whether he votes strategically or not. In this paper, I will solve only the case of non-strategic, or sincere, voting. That is, I assume the central banker votes for the rate he actually prefers, once he has taken into account the three incentives that shape his decision: collective reputation, individual reputation, and his static preferences. If I were to allow for strategic voting, the same results would be obtained only if each central banker believes his vote will actually change the choice of π[11].

Consider the voting decision of a central banker at time t. Given the public's strategy, he will choose between $\pi_t = 0$ with $\pi^e = 0$ and $\pi = 0$ ever after, and $\pi_t = \frac{1}{2a^d} = \pi^d$ with $\pi^e = \pi^d$ and $\pi = \pi^d$ ever after.

If this director is a hawk, he is only concerned about reducing inflation, so that he will vote for $\pi = 0$. The decision for doves, however, is more involved. They must evaluate the trade-off between choosing their preferred "static" rate, maintaining individual reputation to the eyes of the government, and maintaining collective reputation to the eyes of the people.

Voting for $\pi = 0$ will yield a loss of:

[10]Building a reputation makes sense only when there is no perfect information about the type of the decision maker. In this case the public does not know the type of the central bankers. The government also ignores the type of each member, even though it observes individual votes. The reason is that votes are not perfect indicators of types because, as we will show below, there is a pooling equilibrium in which dove central bankers mimic tough ones by voting for low inflation.

[11]This last discussion provides a clue to understanding the technical solution to the case of sincere voting: the voting strategy that emerges in this case is the same that would be obtained if one solves for the optimal strategy of a decisive central banker when strategic voting is allowed.

$$\begin{array}{c} L_j^d(v_{j,t}^d = 0) = -b + \sum_{k=0}^{z-j} \beta^k \left(y^* - \overline{y}\right) \\ -b \Pr\left(R_{j,t}^d = 1 \ / \ v_{j,t}^i = 0\right) \left[\beta \frac{1-(\beta p)^{z-j}}{1-\beta p}\right] \end{array} \tag{12}$$

while voting for $\pi = \pi^d$ will yield a loss of:

$$\begin{array}{c} L_j^d(v_{j,t}^d = \pi^d) = -b + \sum_{k=0}^{z-j} \beta^k \left(y^* - \overline{y}\right) - \frac{1}{4a^d} + \sum_{k=0}^{z-j} \beta^k \frac{1}{4a^d} \\ -b \Pr\left(R_{j,t}^d = 1 \ / \ v_{j,t}^i = \pi^d\right) \left[\beta \frac{1-(\beta p)^{z-j}}{1-\beta p}\right] \end{array} \tag{13}$$

A dove director facing this choice will vote for $\pi = 0$ at time t if and only if $L_j^i(v_{j,t}^i = \pi^d) \geq L_j^i(v_{j,t}^i = 0)$. That is, if and only if:

$$\frac{\beta\left(1-\beta^{z-j}\right)}{1-\beta} \geq 1 + b4a^d \left[\beta \frac{1-(\beta p)^{z-j}}{1-\beta p}\right] \Delta \tag{14}$$

where

$$\Delta = \Pr\left(R_{j,t}^d = 1 \ / \ v_{j,t}^d = \pi^d\right) - \Pr\left(R_{j,t}^d = 1 \ / \ v_{j,t}^d = 0\right) \tag{15}$$

The term in the left hand side of 14 captures what I have termed "collective reputation": considerations about future inflation expectations generate an incentive for the director to vote for zero inflation. This incentive is larger the larger β and $(z-j)$ are, or equivalently, it is larger the more important the future is, and the longer is the time horizon the central banker has to be concerned about. The second term in the right hand side of the inequality captures "individual reputation", which creates incentives for the director to vote for the rate preferred by the government. Again the strength of this incentive is increasing in β and $(z-j)$. It is also increasing in b, the relative importance the director gives to being in office in future periods. If the government is hawk, both reputation effects move in the same direction, pushing the director to vote for zero inflation. If it is dove, however, the two effects create opposing incentives.

Some interesting features arise. First, notice that the sign of Δ depends on the government's type, with $\Delta > 0$ if the government is dove and $\Delta < 0$ in the opposite case. Hence the government's type affects the central banker's vote, and therefore the actual choice of inflation. Second, "younger" directors

(those for whom $(z-j)$ is higher) are more likely to vote for a zero inflation rate [12].

The strategy of a dove decisive central banker of vintage j in period t is therefore:

$$\begin{array}{c} v^d_{j,t} = 0 \text{ if 14 is satisfied} \\ v^d_{j,t} = \pi^d \text{ otherwise} \end{array} \tag{16}$$

3.4.4 Central banker's voting strategy in $t+k$

Consider the voting strategy of a central banker of any type in any period $t+k$, where $0 < k < z-j$. The assumption that the inflation rate chose in period t is to be in place for ever after implies:

$$\begin{array}{c} v^i_{j,t+k} = 0 \text{ if } \pi_t = 0 \\ v^i_{j,t+k} = \pi^d \text{ otherwise} \end{array} \tag{17}$$

for $j < z$, and

$$v^i_{z,t+k} = \frac{1}{a^i}$$

that is, he votes for t's inflation rate in all periods, except his last period, when he votes for his preferred rate[13].

3.4.5 Consistency of strategies

Notice that the mechanism used by the public to form expectations (equation 7) is optimal given 17. Also the strategy of a period-t central banker(equation 16) is optimal given 7 and 17. The strategies for the public and the central bankers are, thus, ex-post consistent with each other.

[12] That this is the case can be seen directly from condition 14 if the government is hawk ($\Delta < 0$). To see that this holds also if the government is dove, rewrite condition 14 by multiplying both sides by $\frac{1-\beta}{\beta\left(1-\beta^{z-j}\right)}$. The right hand side of the condition thus writen is decreasing in $z-j$. Intuitively, the collective-reputation effect dominates the individual reputation effect. The reason is that, if a director's vote affects inflation expectations, it does so for all future periods. Meanwhile, its effects on the flow of utility derived from being in office are discounted by the probability of survival for each upcoming period (p^k).

[13] Note that the vote of central bankers who are in their last period does not decide inflation because the maximum number of member of a given vintage is $m < s+1$.

As for the government's strategy, several aspects must be discussed. First, as argued above, the idea that the president prefers reappointing CB directors of his same type is consistent with my assumption of a potential change of β to zero.

A second aspect worth of discussion in the government's side is its reappointing strategy, captured by expression 8. The fact that the government does not take into consideration the vintage of a central banker when deciding on his reappointing may seem puzzling. However, it is perfectly consistent with the incentives the government faces, as the reason why the government favors its own type is that the discount factor may take the value of zero in period $t+1$. If this event is realized, each central banker of period $t+1$ will vote for the rate preferred by his type independently of his vintage. Therefore the period t government has no incentive to distinguish between different vintages when deciding which central bankers to reappoint.

Finally, it may seem plausible to argue that period $t's$ president may try to minimize future losses by affecting inflation expectations, rather than the composition of the board. In other words, one may think that a dove government will choose to favor hawks for reappointment because announcing that he will do so creates an incentive for CB directors to vote for zero inflation, which in turn helps reducing future inflation expectations. However, this alternative strategy is time inconsistent and, therefore, can not be an equilibrium strategy. To see why this is the case, notice that, after the CB has chosen inflation, the government will have no incentives left to carry out the threat of reappointing members of the opposite types.

Given the discussion above, the strategies of the public, the government, and the central bankers (as captured by expressions 7, 8, and 16) are mutually consistent and can constitute a set of equilibrium strategies.

3.4.6 Committee's Decisions

Turn now to the problem of aggregating the votes of members of the CB board into a policy choice. The low inflation equilibrium at time t will only be supported if there are at least $s+1$ votes for $\pi_t = 0$. Let h_{t+k} and d_{t+k} be the number of hawk and dove directors at any moment $t+k$, $h_{t+k} + d_{t+k} = n$ for all $k \geq 0$. Let D_{t+k} be the set of decisive doves at $t+k$: those whose votes define whether or not $\pi = 0$. Notice that, given that younger doves have more incentives to vote for $\pi = 0$ (see section 3.4.3), the doves in D_{t+k} have to be the youngest doves. Therefore, D_{t+k} is the set of $s + 1 - h_{t+k}$

youngest doves if $h_{t+k} < d_{t+k}$, and is an empty set if the opposite is true.

A low inflation equilibrium starting at time t can be supported in two cases. First, if at time t there are more hawks than doves ($h_t > d_t$), because hawks always vote for zero inflation. Second, if $d_t > h_t$ but all the members of D_t vote for $\pi = 0$. Notice that for this to be the case it is sufficient that the oldest dove in D_t (oldest doves, if there is more than one of this same vintage) finds it optimal to vote for $\pi = 0$. Given the discussions in sections 3.4.3 and 3.4.5, this will be the case if condition 14 is fulfilled for the oldest member of D_t.

The following proposition then holds:

Proposition 1 *Under the assumptions that today's policy choice is in place for ever after and central bankers do not vote strategically, an equilibrium with* $\pi_{t+k} = 0$, $\pi^e_{t+k} = 0$ *for all* $k \geq 0$ *can be supported if:*

a) $h_t > d_t$

or

b) $d_t > h_t$ *and condition 14 is satisfied for the oldest decisive dove in the committee (oldest member of* D_t*).*

Given proposition 1 and the discussion in section 3.4.3, for any given value of b a zero inflation equilibrium is more likely to arise if the government is hawk. This result highlights the fact that, when the institutional relationship between the government and the CB is explicitly accounted for, the government's preferences do affect equilibrium inflation. However, to understand how important is this effect and how the equilibrium in this setting differs from other cases, it is necessary to compare this results with those that emerge from alternative institutional frameworks. Section 4 undertakes this comparison.

4 Putting the results in perspective

What are the implications of proposition 1? Is a low inflation equilibrium more or less likely to arise under a CB committee than under a single government? Is it more or less likely when the government has power over the reappointment of central bankers? To answer these questions, results for benchmark cases are needed. Define the following benchmark cases (in all of them central bankers can be either hawk or dove, with their types being private information):

- **Benchmark 1: a single central banker under no influence from the government**

There is a single policy-maker who serves a term of certain duration (z periods) and chooses π_t to minimize the loss function in equation 6, with $\Pr(R^i_{j,t} = 1) = 1$. Notice that there is still room for a dove central banker to choose zero inflation, since the public does not know his type.

- **Benchmark 2: a committee CB under no influence from the government**

Monetary policy is chosen by a committee of n members, each serving a term of certain duration (z periods). Their terms are staggered, with m members stepping down each period and being replaced by randomly chosen central bankers. Central bankers vote over inflation rates, and each one chooses his vote to minimize the loss function in equation 6, with $\Pr(R^i_{j,t} = 1) = 1$.

- **Benchmark 3: a single central banker that can be retired from office by the government**

There is a single central banker who can serve for a maximum of z periods, but must be reappointed by the government each new period. He chooses inflation to minimize the loss function in equation 6.

For consistency with section 3, I will initially assume that all the agents follow the same strategies they use in the model of that section[14]. In particular, central bankers vote in the future according to 17. Also, inflation expectations follow 7 except in the last period of a single central banker's term, when $\pi^e = \frac{\pi}{2}$ if $\pi = 0$ in all previous periods, and $\pi^e = \pi^d$ otherwise[15].

The following propositions can be proven:

Proposition 2 *In the case of an individual central banker under no government influence (benchmark 1) a zero inflation equilibrium can only be sustained if the central banker is hawk.*

[14]Some of these strategies, however, cannot be sustained in each of these benchmarks. Their failure drives the results in the following set of propositions.

[15]This is consistent with Bayesian updating of the expectations, given that I do not allow mixed strategies by the central bankers, and given that equation 17. implies $\Pr(v^i_j = 0/i = d) = 1$ if $\pi_t = 0$, $\Pr(v^i_j = 0/i = d) = 0$ otherwise (for $j < z$).

Proposition 3 *In the case of a committee CB under no government influence (benchmark 2) a zero inflation equilibrium can be sustained if the majority of the members are hawks or, if this is not the case, if the following condition holds for the oldest decisive dove in the committee:*

$$\beta \frac{1-\beta^{z-j}}{1-\beta} \geq 1 \tag{18}$$

Proposition 4 *In the case of a single central banker whose reappointment is in the hands of the government (benchmark 3) a zero inflation equilibrium can be sustained only if the central banker is hawk*

Proposition 3 can be seen directly by noting that the probability of being reappointed does not depend on the inflation choice, so that $\Delta = 0$ in condition 14. Formal proofs for 2 and 4 are provided in appendices A.1 and **??**.

Propositions 1 through 4 provide the answers to our earlier questions. First, moving from an individual central banker to a committee increases the likelihood of a zero inflation equilibrium being played. For example, compare propositions 2 and 3; a dove single central banker would never choose zero inflation, but a committee dominated by doves may do so. The basic mechanism behind this result is closely related to that proposed by Cothren. Given that there is space for vintage heterogeneity within a committee, there could always be enough "young blood" in the board to sustain low inflation. In contrast, a single central banker will always reach a final period in which he will play high inflation if he is of the weak type, and this unravels a high inflation equilibrium.

Second, from comparing propositions 1 and 3 or propositions 2 and 4 notice that, relative to the case of no government influence, zero inflation is more likely if CB directors are reappointed by a hawk government, and less likely if they are reappointed by a dove government. Notice also that inflation is independent of the government's type only when the reappointment of central bankers does not depend on the government.

Finally, propositions 1 and 4 imply that the ability of the government to affect inflation, if it can decide on the reappointment of central bankers, is lower when inflation is chosen by a board rather than an individual. In particular, although zero inflation cannot occur under a single central banker if the government is dove, it can arise under a CB board even if the government is dove, as long as β is large enough and b small enough.

Important results from the theory of CB independence must be qualified in light of propositions 1 through 4 and their implications. First, a formal separation of monetary and fiscal policy making can indeed reduce inflation bias and the dependence of monetary policy on the electoral cycle. However, this effect depends strongly on the effective independence of the CB, as captured by the number of CB directors whose reappointment depends on the government and the importance directors give to reappointment[16]. Second, for any given values of b and m, an independent CB is more capable of reducing the inflation bias and the effective influence of the government over monetary policy if the CB takes the form of a committee instead of a single central banker.

5 Conclusions

These paper has studied monetary policy-making when decisions in the CB are taken by a committee and the government has some power over the reappointment of central bankers. The focus has been a simplified solution under sincere voting. Three basic results emerge under this solution:

1) Inflation bias is greater under monolithic rather than collective decision making.

2) The ability of the CB to isolate monetary policy from government pressures is negatively related to the degree of influence of the government over central bankers, given here by the number of CB directors over whose reappointment the government can decide and by the importance central bankers give to reappointment.

3)Committee decision making reduces the effective power of the government to affect monetary policy, with respect to the single central banker case.

This results offer a first look into the theoretical effects of combining committee decision-making in the CB with the appointment of central bankers by the government. However, their scope is restricted by the assumptions under which they were generated, notably those of a permanent choice of policy, and non-strategic voting on the part of CB directors. A more comprehensive treatment, therefore, requires developing extensions of this framework. First,

[16]Some of these ideas have been part of the literature on the institutional design of a CB for a long time (see Cukierman 1992 and 1996). The model in this paper formalizes them.

the assumption that the inflation rate chosen for t will be in place for ever after, and other artificial assumptions derived from this one, must be relaxed. These changes will not only generate a more plausible solution, but will also open the door for the study of the specific form of political cycle affecting monetary policy.

Second, strategic voting must be considered. This is an extremely interesting extension since, in a sense, the result obtained under sincere voting that collective decision making contributes to isolating monetary policy from the political cycle is not entirely surprising. In fact, in many cases the purpose of having many directors with staggered terms is precisely to assure that the preferences of the CB evolve more smoothly than they would under alternative institutional designs. However, allowing for strategic voting may very well reverse this result. The intuition is that under strategic voting the vote of each central banker may be dominated by his incentive to be reappointed. Hence, the choice of inflation will be more heavily influenced by the type of the government, perhaps so much that the government's influence will be stronger than under an individual central banker.

Third, it would be interesting to relax the assumption that hawk central bankers only care about inflation. This modification would open the door for potential signaling from tough central bankers. Interestingly, in this model the tough type may also want to mimic the weak one, if the government is dove and the incentive to be reappointed is strong enough. This possibility is even more important under strategic voting, where the reappointment incentive is strongest. This extension of the model can therefore potentially weaken even further the ability of a committee design to smooth out the influence of the government on monetary policy.

Finally, the present version of the model oversimplifies the nature of the government. In particular, it does not study the mechanisms of election of the government, and how they interact with the choices of the government regarding the reappointment of central bankers. Explicitly accounting for the possibility that the government is democratically elected, and that its choices about the composition of the CB affect its probability of reelection may thus be a very interesting road to pursue.

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A Appendix

A.1 Proof for proposition 2

Consider the case of a single central banker under no government influence, choosing inflation for period t. The public forms expectations according to 7 in all future periods, except the period z of any central banker's term, when $\pi^e = \frac{\pi^d}{2}$ if $\pi = 0$ in all previous periods, $\pi^e = \pi^d$ otherwise. There are only two possible optimal strategies for a dove policy maker: choosing π^d at all periods, or choosing $\pi = 0$ from his first period to some period T (with $T \leq z$) and then switching to $\pi = \pi^d$ and keeping high inflation for the rest of his term. The losses associated with different $T's$ are (to simplify the notation, let $j = 0$, $Y = \pi_t^e + z(y^* - \tilde{y} - b)$):

$$L(T < z) = Y - \beta^T \frac{\pi^d}{2} + \frac{\pi^d}{2} \frac{\beta^{T+1}\left(1 - \beta^{z-T}\right)}{1 - \beta} \tag{19a}$$

$$L(T = z) = Y - \beta^z \left(\pi^d - \frac{\pi^d}{2}\right) + \frac{\pi^d}{2}\beta^z = Y \tag{20a}$$

By comparing $L(T = t_0)$ versus $L\left(T = t_0 - 1\right)$ it is easy to see that:

1) If $\beta < \frac{1}{2}$, the T that minimizes $L(T < z)$ is $T = 0$. Also, $L(T = 0) < L(T = z)$, so $\pi_t = \pi^d$ is the policy choice at t.

2) If $\beta \geq \frac{1}{2}$ the T that minimizes $L(T < z)$ is $T = z - 1$. Moreover, $L(T = z - 1) < L(T = z)$, so that a dove policy maker will choose to keep $\pi = 0$ until his next-to-last period in office, when he will raise inflation to π^d. However, people will anticipate this behavior, and inflation expectations will jump to $\frac{\pi^d}{2}$ in period $z - 1$, rather than in period z. Hence, by the reasons just presented, the dove central banker will choose to inflate at $z - 2$ instead of $z - 1$, and so on. The problem then unravels in such a way that the central banker ends up switching to π^d at t. Hence, the equilibrium policy choice is π^d also in the $\beta \geq \frac{1}{2}$ case.

A.2 Proof for proposition 4

Consider the case of a single central banker whose reappointment is in the hands of the government. If the central banker chooses $\pi = \pi^d$, he is revealed as a dove. If, on the other hand, he chooses $\pi = 0$, the president assigns a probability less than or equal to $\frac{1}{2}$ to this director being a dove[17]. Hence, a hawk president does not reappoint a central banker that votes for π^d, but does reappoint one that votes for 0, since the president cannot do better by not reappointing the incumbent (as the probability of any potential new policy maker being a dove is $\frac{1}{2}$). In turn, a dove government reappoints a CB who chooses high inflation, and reappoints a CB who chooses zero inflation only if the president assigns $\Pr(dove/\pi = 0) = \frac{1}{2}$.

Suppose again that people form expectations according to 7 except in the z period of any central banker, when $\pi^e = \frac{\pi^d}{2}$ if $\pi = 0$ in all previous periods, and $\pi^e = \pi^d$ otherwise. Solving by backward induction, consider the choice of a dove central banker in period $z-1$ (in period z he chooses π^d with probability 1). Let L_z^i be his period-z losses if he is not reappointed for period z and a central banker of type i replaces him. Notice that, given 17 and 7, $L_z^h = L_z^d = 0$ if $\pi_{t+k} = 0$, and $L_z^h = L_z^d = \frac{\pi^2}{2}$ if $\pi_{z-1} = \pi^d$..

Suppose the government is dove. I will take the case with the most incentives to choose $\pi_t = 0$, by assuming the government assigns $\Pr(dove/\pi = 0) = \frac{1}{2}$, so that the CB knows he will be reappointed independently of his vote. Then the central banker chooses zero inflation in $z-1$ if:

$$-b - \beta b \leq -\frac{\pi^d}{2}(1-\beta) - b - \beta b$$

which is never the case given the assumed parameter configuration. Therefore, the dove central banker will choose π^d in period $z-1$. But people will recognize this incentive and adjust their expectations. Inflation expectations will jump to π^d at $z-1$ rather than z. But then in period $z-2$ the central banker will also vote for π^d. The argument is repeated over and over again, to the point where the central banker finds it optimal to switch to high inflation from his first period in office. Under a dove government, therefore, a

[17] With bayesian updating, $\Pr(dove/\pi = 0) = \frac{\Pr(\pi=0/dove)\Pr(dove)}{\Pr(\pi=0/dove)\Pr(dove)+\Pr(hawk)}$
$= \frac{\Pr(\pi=0/dove)}{1+\Pr(\pi=0/dove)} \leq \frac{1}{2}$ for any $\Pr(\pi = 0/dove) \leq 1$

zero inflation equilibrium is not feasible to a dove central banker[18].

If, in turn, the government is hawk, the CB knows that he will be reappointed only of he votes for zero inflation, and that if he has to step down his replacement is dove or hawk each with probability 0.5. Then he will prefer choosing $\pi = 0$ at $z - 1$ if:

$$-b - \beta b \leq -\frac{\pi^d}{2} - b + \beta \left(\frac{1}{2}L_z^h + \frac{1}{2}L_z^d\right)$$

or, equivalently, if :

$$-\beta b \leq -\frac{\pi^d}{2}(1 - \beta)$$

That is, with a hawk government the dove CB will choose low inflation in $z-1$ if β and b are large enough. Given that the incentive to vote for zero inflation is higher for younger central bankers, this implies the CB will vote for zero inflation in all periods earlier than $z-1$ if β and b are large enough. Hence, a dove central banker can support a zero inflation equilibrium if the government is hawk, and the future and the reappointment incentive are sufficiently important.

[18]Notice we proved this assuming the dove government reappoints any central banker, independently of the choice of inflation. If we let $\Pr(dove/\pi = 0) < \frac{1}{2}$ then the case for high inflation is even stronger, and the result that no low inflation choice is possible by a dove CB under a dove government will also hold.