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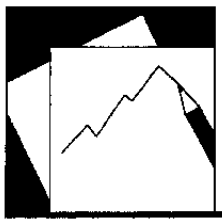

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A Political Agency Theory of Central Bank Independence

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A Political Agency Theory of Central Bank Independence

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Abstract

We propose a theory to explain why, and under what circumstances, a politician gives up rent and delegates policy tasks to an independent agency. We apply this theory to monetary policy by extending a standard dynamic "New-Keynesian" stochastic general equilibrium model. This model gives a new theory of central bank independence that is unrelated to the standard inflation bias problem. We derive several new predictions and show that they are consistent with the data. Finally, we show that while instrument independence of the central bank is desirable, goal independence is not.

JEL Classification Numbers: E58, E61, H11, J45

Keywords: Central Bank Independece, Career Concerns, Elections, Experimetation

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"Many governments wisely try to depoliticize monetary policy by, for example, putting it in the hands of *unelected technocrats with long terms of office* and insulation from the hurly-burly of politics" (emphasis added)

Blinder (1998), pp. 56-57.

I. INTRODUCTION

One of the central questions of the political economy of the government is what decisions should be made by politicians that are subject to frequent elections and what decisions should be delegated to independent agencies that, by design, have a longer time horizon than politicians? Students of political economy observe large variations in institutional arrangements of different countries at different times. In most countries, for example, fiscal policy decisions are made by politicians. On the other hand, complex tasks, such as interpreting the constitution, are often carried out by public officials with longer employment contracts.[2] The judges at the U.S. Supreme Court, for example, are appointed for life, and are independent of/unaccountable to the (elected) executive.[3] Another striking example of a complex task that is left to the bureaucrats is monetary policy. In contrast to fiscal policy, monetary policy is often delegated to an independent institution that is governed by career public officials whose terms of office are longer than the average political cycle.[4] The accountability of these officials to elected representatives varies across countries.

In this paper, we tackle the following questions: why do politicians willingly relinquish a sizable part of their remit and power, and delegate it to independent institutions? And what form might this delegation take (i.e., delegation of instruments, of goals)? We address these questions in the context of monetary policy, a domain where delegation (central bank independence) has gained momentum across the world, especially during the 1990s, yet, at the same time, the foundation of

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[2]Besley and Coate (2001) contrast direct election with political appointment of regulators in a model where electing regulators produces more pro-consumer regulators. (Assuming that regulation is not a salient issue for voters at large, political parties then have an incentive to appoint a regulator who shares the preferences of the regulated industry's stakeholders rather than voters' since for the former the preferences of the regulator is a salient issue.)

[3]Maskin and Tirole (2001) investigate the optimal allocation of power between accountable and *nonaccountable* branches of the government (e.g. a politician and a judge, respectively). One key trade-off associated with accountability is that, although it can screen and discipline office-holders, it also induces them to pander to public opinion.

[4]Moreover, most independent central banks' policy decisions are taken by committees; committee members have staggered contracts, with only a small fraction of the membership being renewed in a given year, so that the committee as a whole does not face an end-of-term problem.

existing theories (the existence of an inflation bias) has been subject to fundamental criticisms. We attempt to answer these two questions, first in a general framework, and then with a particular focus on monetary policy.

We propose a theory of delegation based on optimal contract theory that has roots in corporate finance. We model two trade-offs of delegation in a representative democracy. The cost of delegation is that the electorate is unable to get rid of incompetent officeholders.[5] Thus, if there is uncertainty about the ability of an officeholder, society may be stuck with this incompetent bureaucrat (e.g., a supreme court justice or a central banker) for a long time. The benefit of delegation, however, is that the officeholder has a long-term employment contract, enabling him to have a long-term horizon which may improve his performance. In particular we show that if there is (symmetric[6]) uncertainty about the ability of the officeholder, and/or the aggregate economy, a longer employment contract gives the long-term appointee an incentive to invest more effort into his decision making, thereby increasing the quality of his decisions. This beneficial effect of delegation is analogous to the *experimentation* effect in the industrial organization literature.[7] Although in the paper we focus on increased experimentation as a key benefit from delegation, our framework is flexible enough to accommodate other benefits (e.g., learning-by-doing). We show that both qualitatively and quantitatively, the experimentation channel that we highlight is sufficient to explain endogenous delegation of monetary policy and to replicate the variability of inflation across monetary regimes that is observed across countries.

After illustrating the basic principles of our political agency theory, we use it to establish a new theory of central bank independence (CBI). To do this we extend a standard New Keynesian stochastic general equilibrium model. The resulting theory is radically different from other theories of CBI—which all rely on the presence of an inflation bias in monetary policy as the reason for delegation.[8] Our theory does *not* rely on the inflation bias, time inconsistency problem. The rationale for delegating monetary policy to an independent central banker is that he is given

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[5]This cost of delegation however, is often mitigated in practice by the possible recourse, in extreme circumstances, to remove an officeholder for cause. The Federal Reserve has such a clause concerning its governors in its statutes, even though such a clause has never been used.

[6]Citizens and the officeholder himself have the *same information set*, which is that they only know about the distribution of ability in the economy.

[7]The experimentation literature initially studied the problem of a monopolist facing an unknown demand curve. To maximize future profits (once the true demand curve becomes known), the monopolist is willing to sacrifice short-term profits (by setting its price away from its (myopic) monopoly-maximizing profits) in order to trace out the demand curve more rapidly and reap the long-term benefits more quickly. Prescott (1972) and Grossman, Kihlstom, and Mirman (1977) are early contributions, while Keller and Rady (1999) contains references to recent developments in the literature. Le Borgne and Lockwood (2003) first highlighted the occurrence of an experimentation effect in the career concerns model.

[8]In a classic article, Rogoff (1985)—building on Kydland-Prescott and Barro-Gordon's inflation

a long-term job contract; this, in turn, gives the central banker an incentive to put more effort into the policymaking process than an elected politician would. This extra effort translates, in expectations, into better forecasts and fewer policy mistakes, which increases social welfare—and the politician's own utility—thereby making delegation incentive compatible.

Interestingly, our approach is consistent with Alan Blinder's (1998), former Vice-Chairman of the Federal Reserve, description of the rationale for delegating monetary policy to an independent agency, namely that "monetary policy, by its very nature, requires a long time horizon."

Since our theory does not rely on any dynamic inconsistency problem, it also answers common criticisms of existing CBI theories (e.g., McCallum (1995), Blinder (1998), Vickers (1998), and Posen (1993, 1995)). First, is the argument that, in practice, central bankers do not attempt to target a level of output exceeding the natural rate—so that central banks do not suffer from an inflation bias. If we believe in this argument, then the economic literature does not offer us a rationale for establishing independent central banks. A second criticism applies to the recent contracting approach (Persson and Tabellini (1993), Walsh (1995), Svensson (1997)) to solving the inflation bias (assuming it is a problem) stemming from a dynamic inconsistency problem. As argued by McCallum (1995) and others, this approach "merely relocates" the problem, it does not solve it. Another type of critique (Posen, 1993, 1995) is that the observed relationship between inflation and central bank independence observed in the data does not reflect—as existing theories claim—a causal relationship, but is simply due to an omitted variable problem: namely citizens' preferences towards inflation, which leads them to develop institutions that support these preferences. In our theory, central bank independence endogenously arises (or not) based on citizens' preferences; our model therefore answers Posen's endogeneity criticism. Finally, another critique is that, since dynamic inconsistency problems are, arguably, even more pervasive and acute in the domain of fiscal policy (taxation being a prime example) rather than monetary policy, why is it that fiscal policy is not delegated to an independent agency? In our theory the delegation of a specific task depends on two factors: (1) the complexity of the task itself,[9] and (2) on the level of rent that the officeholder derives from managing this public good. It is quite plausible, and is indeed the conventional wisdom, that the effects of monetary policy (often described as more art than science!) are subject to considerably more uncertainty than most other public policy choices.

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bias problem—shows that appointing a central banker who is more conservative than society improves the credibility-flexibility trade-off. Persson and Tabellini (1993) and Walsh (1995) suggest that optimally chosen state-contingent wage contracts for the central banker can eliminate the inflation bias and achieve the second-best equilibrium. Finally, Svensson (1997) and Lockwood (1997) show that inflation targets given by society/government to the central banker can be a means to achieve these optimal contracts. (see Drazen (2000), and Persson and Tabellini (2000) for a textbook exposition of these models and the literature.)

[9]That is, how much uncertainty there is surrounding the effects of the officeholder's ability in managing this task/public good.

It is also quite likely that politicians derive more rent (either in the form of prestige, or in more direct, monetary forms: pork, corruption, etc.) from fiscal policy than from monetary policy. Both these factors can explain why many democracies put monetary policy in the hands of independent institutions but keep fiscal policy in the hands of politicians.

Our novel approach also enables us to address, from a different perspective, an important issue of the delegation process: what form does delegation takes when it occurs? That is, should the central bank have *instrument* and *goal* independence (using Debelle and Fischer's (1994) terminology), where the former applies to a central bank that has the power to determine its own goal(s), and the latter refers to a central bank that has the power to use its policy tools freely and to make its policy decisions without political interference—regardless of whether its goals are determined by politicians or not). The Bank of England is an example of an instrument independent but goal-dependent central bank, while the U.S. Federal Reserve, although being also instrument independent,[10] is closer to being goal independent.[11] A consensus exists in the literature that instrument independence is desirable, however, there is less agreement on goal independence. On the one hand, Rogoff's (1985) conservative central banker has both goal and instrument independence (he is given control over monetary policy and can freely maximize his own utility[12]). On the other hand, the contracting approach (e.g., Walsh, 1995) (generally[13]) advocates instrument independence but goal dependence: the central banker is the agent of a principal (government, parliament) to which he is accountable. The contracting approach however has been criticized on various grounds.[14] We show that, in our model, instrument independence

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[10]Barring an act of Congress, a Federal Reserve decision on monetary policy cannot be reversed by political authorities. Such a procedure has never been used since the creation of the Fed in 1913.

[11]The Fed's mandate is cast in very broad terms and covers conflicting tasks (to purse both "maximum employment" and "stable prices") leaving its governing body ample latitude in interpreting and assigning relative weights among those objectives.

[12]As pointed by Fischer (1995), "the government tries to choose the right central banker, but—as in the case of Supreme Court justices—the behavior of a central banker may be different after appointment than before." (p. 202.)

[13]Muscatelli (1998) shows that, when there is uncertainty about central bank preferences (a realistic feature), then "the central bank may be made more accountable by allowing it to set its own targets, i.e. by making it *goal-independent*" (p. 529)

[14]In particular, aside from McCallum's (1995) critique described above, as pointed by Walsh (1995) himself, the effectiveness and implementability of his contractual approach is questionable (the use of state-contingent wage contracts). In Svensson's (1997) inflation-targeting approach, the equilibrium inflation is always *higher* than the inflation target set by the politician to the central banker; the central banker is therefore in breach of its contractual goal but the politician is, in fact, very happy with such an outcome. Another weakness of the contractual approach is the reliance on explicit pecuniary contracts, which are well known to be low powered in the public sector (Wilson, 1989).

can be an optimal strategy for a politician and, when this arises, this is always a welfare-increasing strategy for society. We also show that, when the conditions for independence are satisfied, the politician prefers to grant the central bank goal independence, even though this strategy produces lower social welfare than a regime where the central bank is goal dependent; In a democratic society, goal dependence of the central bank ensures that the current majority of the voting population cannot suppress the preferences and goals of a future majority. To the best of our knowledge, this is the first paper that establishes these results in a realistic contractual framework.

We derive five key empirical predictions of our theory—the first two are macroeconomic predictions while the last three are related to contractual, social, and political variables; these latter set of predictions is new to the literature. The first prediction is that CBI results, on average, in lower inflation, both in terms of level and variability. This arises in our model because, when monetary policy is delegated, the central banker supplies more effort in forecasting shocks, thereby getting more accurate forecasts and less policy errors. Second, CBI results in lower output variability. This, again, arises because of the better forecasts of the central banker, which result in fewer destabilizing monetary policy errors. Third, the longer the tenure of central bank governors, the lower are the first two moments of inflation and the volatility of the output gap. Fourth, central bank independence should only be observed in countries where the central bank governing body has a longer time horizon in office than the elected politicians that would otherwise be in charge of monetary policy. (Dictators are therefore not expected to appoint independent central bankers.) Finally, our fifth prediction is that the more corrupt a country, the less independent its central bank. The macroeconomic predictions are broadly consistent with the large empirical studies on CBI and macroeconomic outcomes, although the "stylized facts" in this literature are not uncontroversial. We present evidence that our last three predictions are also consistent with the data.

Our contracting/agency model builds on the seminal career concerns model of Holmström (1982/1999)[15] and on two extensions of this model: the first by Dewatripont, Jewitt, and Tirole (DJT) (1999) in which they consider, in a myopic setting, the case where managerial ability and effort are complementary; the second by Persson and Tabellini (2000) and, especially, Le Borgne and Lockwood (2003) where they transpose the managerial Holmström-DJT models to an electoral agency context: i.e., the manager is replaced by an elected official with a fixed rent from office instead of an endogenous wage. The career concerns model seems particularly suited to an electoral environment for two reasons: (1) financial incentives to motivate elected officials are extremely limited compared to the various schemes available in the private sector (e.g., bonus, stock options, etc.). The compensation package of elected officials (or central bankers) is limited to a fixed salary and some perks, both of which are unrelated to their performance

[15]Holmström shows that a manager of unknown ability can be induced to supply effort by relying, not on explicit incentives, but on the manager's concerns about his future career; i.e., implicit incentives motivate the manager.

on the job: pecuniary incentives are *low powered* for elected officials (and civil servants). (2) Counterbalancing this is the threat of dismissal at election time. As Barro (1973) and Ferejohn (1986) have first shown, through this mechanism, elections help citizens to "control" politicians.

The outline of the paper is as follows. Section II develops our basic political agency framework. Section III applies the model of Section II.A to a monetary policy context. It illustrates the rationale for central bank independence; differentiates and analyzes two concepts of independence (instrument and goal independence); and then draws some empirical predictions of the theory. Finally, Section IV concludes and draws some policy implications.

II. The Model

The economy is populated by a set N of citizens with $\#N = n > 3$ and evolves over two time periods, $t = 1, 2$. There is a political office that can be occupied by only one citizen, the "officeholder" or "politician". In this representative democracy, the officeholder is entrusted with (and held accountable for) the economy's public good. (We can think of this public good as being monetary policy). Immediately after being elected the officeholder can decide whether to perform this task himself or to delegate it to an appointed agent (e.g. a central banker).

A. Political Agency Setup

Here we present a simple setup where citizens' utilities are a function of a public good. The production of this good requires an officeholder whose ability and effort enter the production function of the public good.

Citizens' Preferences

A citizen j has a total payoff

$$v_t^j = v_t^c\left(e_t^o, \theta^o\right) + Z\left(j\right)\left[R - c\left(e_t^o\right)\right] \tag{1}$$

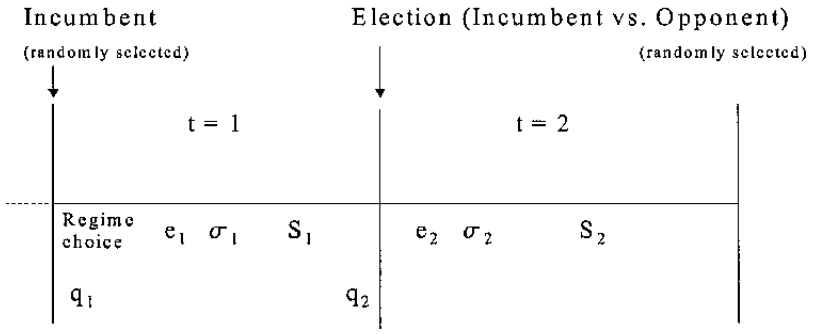
where $v_t^c\left(.\right)$ is a payoff common to all citizens at time t; this payoff depends on the production of a public good which itself is an increasing function of the effort (e_t^o) and ability (θ^o) of the public official in charge of this good (the officeholder).[16] $Z(.)$ is a binary variable which is equal to one if citizen j is the officeholder, and zero otherwise, i.e.

$$Z\left(j\right) = \begin{cases} 1 & \text{if } j = o \\ 0 & \text{if } j \neq o \end{cases} \tag{2}$$

R is an "ego rent" from being in office and managing the public good (as in Rogoff, 1990), deriving from the prestige associated with managing public affairs, and $c\left(.\right)$ is a function representing the cost of effort the officeholder expands in managing the public good. We assume

[16]Throughout, the superscript c (o) refers to citizens (the officeholder).

Figure1: Time line



that $c(.)$ is strictly increasing and convex, and $c(0) = 0$, $c\prime(0) < 1$.[17] To simplify the notation, we omit the index "o" to e_t and θ since only the officeholder's effort and ability matter to citizens.

Time Line

The time line (depicted in Figure 1) is the following. First, at the beginning of game (immediately after being elected), the politician has to decide whether to produce the public good himself or to delegate it.[18] Then, at the beginning of each period $t = 1, 2$, the officeholder has to decide how much effort to exert in order to receive a signal σ_t (make a forecast) about a shock S_t that will occur later in the period.

The combination of the officeholder's forecast and the realization of the shock produce a state s. The probability that a shock S occurs conditional on the officeholder receiving a signal σ, on effort level e, and on expected ability θ is $f_s(e_t, \theta)$; while the probability that the officeholder receives signal σ conditional on the shock being S (and his effort level e and expected ability θ) is $g_s(e_t, \theta)$.

Public Good Technology

To make our point in the simplest setup possible, we assume that two signals and two shocks can

[17]The last condition $c'(0) < 1$ ensures that myopic effort is positive.

[18]As is standard in the contract theory literature, it is assumed that whatever the type of contract the politician (principal) writes with the central banker (agent), it is enforceable in court by both parties so that unilateral breach of the contract is not possible (or, alternatively, entails a prohibitive cost).

occur, i.e. $\sigma_t \in \{\sigma^H, \sigma^L\}$, $S_t \in \{S^H, S^L\}$, and $p = \Pr(S = S^H)$, $1 - p = \Pr(S = S^L)$. Four possible states (s) can therefore arise in a given period depending on whether the shock (labeled as H or L) has been rightly (R) or wrongly (W) predicted: i.e. $s = S\sigma \in \{HR, HW, LR, LW\}$. Let us denote

$$f_{S\sigma}(e_t) \equiv \Pr\left(S_t = S^i \mid e_t, \theta, \sigma_t = \sigma^j\right); \quad i, j \in \{H, L\} \tag{3}$$

where, if $i = j$ then $f_{S\sigma}(e_t) = f_{iR}(e_t)$, and if $i \neq j$ then $f_{S\sigma}(e_t) = f_{iW}(e_t)$. In (3) above, θ is a random draw from a distribution that can take two values: $\theta_H > \theta_L > 0$ with probabilities q_1 and $1 - q_1$, respectively. We refer to $a \in \{H, L\}$ as the (ability) types of the citizens. We assume that citizens do not know $\theta = (\theta_1, ..., \theta_n)$ but all know the joint distribution of θ (i.e., there is *symmetric incomplete information*, as in Holmström (1982/1999)).

Following Holmström (1999), we assume that the quality of the output being produced by the officeholder (i.e., the forecast) is an increasing function of both "ability" (θ) and effort (e) and, importantly, that θ and e are *complementary* in the forecasting technology (this follows Dewatripont, Jewitt and Tirole (1999)),[19] i.e.

$$f_{SR}(e_t) = \Pr\left(S = S^i\right) + \theta e_t; \quad f_{SW}(e_t) = \Pr\left(S = S^i\right) - \theta e_t; \quad i \in \{H, L\} \tag{4}$$

where $\Pr(S = S^i) \leq f_{SR}(e_t \mid \theta) < 1$.

We can now specify $v_t^c(e_t, \theta)$, the payoff common to all citizens:

$$v_t^c = -\sum_a \sum_s q^a f_s(e, \theta_a) L^s \tag{5}$$

where $q^a = \Pr(\theta = \theta_a)$, $a \in \{H, L\}$, $f_s(e, \theta_a)$ is the probability that state of the world s occurs given officeholder's effort e and ability θ_a; $L^s > 0$ is the (constant[20]) loss function associated with state $s \in \{HR, HW, LR, LW\}$, and $0 \leq L^{HR} = L^{LR} < L^{HW} = L^{LW}$.

Institutions

The politician (randomly selected from the set of citizens), once elected at the beginning of period $t = 1$ decides to have the public good being produced under one of two possible institutions/regimes:

Appointment/delegation

At the beginning of period $t = 1$, the politician j appoints an agent to be officeholder and produce the public good. Since all citizens are ex ante identical, this agent is randomly selected by the

[19]For simplicity we assume that there is a symmetric technology between receiving a high or a low productivity signal.

[20]In Section III, we endogenize this loss function.

politician from the set of citizens, and is (contractually) in office for both periods. When the politician delegates the production of the public good his utility then becomes the same as that of a (representative) citizen (he is not in charge of producing the public good, so $j \neq o$ in (1)). Indeed, in our simple setting, only one public good is produced; once the politician has delegated it, he has no explicit role left in our model.[21]

Democracy

At the beginning of period $t = 1$, the elected politician decides to produce the public good himself. The politician is in office during period $t = 1$ but faces an election at the beginning of period 2. At this stage, an opponent is randomly selected from the set of remaining citizens. The citizens then vote on the opponent versus the incumbent, and the winner is the officeholder in period $t = 2$.

Our modeling of democracy abstracts from the entry decisions of candidates while allowing the electorate to "fire" bad officeholders. As shown in Le Borgne and Lockwood (2003), given the assumption of symmetric incomplete information, this simplification has no effect on the equilibrium outcome of the game.[22]

In both cases, for consistency, we impose the individual rationality condition that the officeholder prefers to be in office than not.

B. Equilibrium

In order to decide whether to produce the public good himself or to delegate it, the politician has to compare his utility under both regimes. This, in turn, is a function of the equilibrium level of effort and ability expected under these regimes. This section analyzes and compares these variables.

Myopic Choice of Effort

We solve the officeholder's decision problem with the usual dynamic programming approach. In the last period ($t = 2$) we have a static game; we call the resulting effort choice as "myopic." The maximization problem of the officeholder (politician or appointee) is to[23] $\max_e E^\theta E^S[v^o]$, i.e., to $\max_e -\sum_{a\in\{H,L\}} \sum_s q_1^a f_s(e,\theta_a) L^s + R - c(e)$. The first-order condition w.r.t. e is

$$(q\theta_H + (1-q)\theta_L)\left[L^{HW} - L^{HR} + L^{LW} - L^{LR}\right] = c'(e) \tag{6}$$

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[21] Although, since the politician is the appointee's principal, he still has a monitoring role but, as detailed later, since the appointee's incentives are aligned with those of citizens, this monitoring role is irrelevant.

[22] The assumption of exogenous candidate entry would not be innocuous should we have assumed asymmetric rather that symmetric incomplete information (see Le Borgne and Lockwood, 2002)

[23] Whenever no confusion is possible, the time subscript is omitted.

which leads to the equilibrium level of effort $e = e^*(q) > 0$, and it can be shown (see the Mathematical Appendix) that e^*, v^o, v^c are strictly increasing in q, and that $v^o(q) > 0$, $v^c(q) > 0$.

Dynamic Effort Level Under Appointment

Before analyzing the first period game, it is useful to derive the appointee's posterior beliefs, $q_2(e_1, S_1, \sigma_1) = \Pr(\theta = \theta_H \mid e_1, S_1, \sigma_1)$, and study some of their properties. q_2 is obtained from Bayes rule. Since there are four possible states $s \in \{HR, HW, LR, LW\}$, four posteriors need to be formed. From Bayes rule, we therefore have[24]

$$q_2^s = \frac{q_1}{q_1 + (1 - q_1) LR_s}, \quad s \in \{HR, HW, LR, LW\} \tag{7}$$

where LR_s is the likelihood ratio for state s, i.e., $LR_s = \Pr(\sigma_1 \mid e_1, \theta_L, S_1) / \Pr(\sigma_1 \mid e_1, \theta_H, S_1)$. Note that $0 < LR_R < 1 < LR_W$, and therefore $0 \leq q_2^W < q_1 < q_2^R \leq 1$, where the subscripts R, W stand for the states where the forecast were, respectively, right and wrong ($R \in \{HR, LR\}$, and $W \in \{HW, LW\}$). We can also show that $\partial q_2^W(e_1)/\partial e_1 \leq 0$ and $\partial q_2^R(e_1)/\partial e_1 > 0$ (see the Mathematical Appendix); i.e., when the incumbent receives a wrong (correct) signal, a marginal increase in effort decreases (increases) the posterior probability that the incumbent is of high ability.

We can now analyze the first-period problem of the appointee, i.e. $\max_{e_1} E_1^\theta E_1^S [v_1^o] + E_1^\theta E_1^S [v_2^o(q_2(e_1))]$, or

$$\begin{aligned} &\max_{e_1} -\textstyle\sum_a \sum_{s_1} q_1^a f_{s_1}(e, \theta_a) L^{s_1} + R - c(e_1) \\ &-\textstyle\sum_a \sum_{s_1} q_1^a f_{s_1}(e_1, \theta_a) \sum_{s_2} f_{s_2}(e_2(q_2^{s_1}(e_1)), \theta_a) [L^{s_2} - R + c(e_2(q_2^{s_1}(e_1)))] \end{aligned} \tag{8}$$

The first-order condition w.r.t. e_1 is:

$$(q_1\theta_H + (1 - q_1)\theta_L)\left[L^{HW} - L^{HR} + L^{LW} - L^{LR}\right] + \frac{\partial E[v_2^o(q_2(e_1))]}{\partial e_1} = c'(e_1) \tag{9}$$

[24]Detailed posteriors can be found in the Mathematical Appendix.

where $\partial E\left[v_2^o\left(q_2\left(e_1\right)\right)\right]/\partial e_1 = \Phi_1^A + \Phi_2^A + \Phi_3^A + \Phi_4^A$, and[25]

$$\begin{aligned}
\Phi_1^A &\equiv 2\left(q_1\theta_H + (1-q_1)\theta_L\right)\left[-c\left(e_2\left(q_2^R\left(e_1\right)\right)\right) + c\left(e_2\left(q_2^W\left(e_1\right)\right)\right)\right] \\
\Phi_2^A &\equiv 2\left(q_1\theta_H^2 + (1-q_1)\theta_L^2\right)\left[L^{HW} - L^{HR} + L^{LW} - L^{LR}\right]\left[e_2\left(q_2^R\left(e_1\right)\right) - e_2\left(q_2^W\left(e_1\right)\right)\right] \\
\Phi_3^A &\equiv 2\left[q_1\left(1/2 + \theta_H e_1\right)\theta_H + (1-q_1)\left(1/2 + \theta_L e_1\right)\theta_L\right]\left[L^{HW} - L^{HR} + L^{LW} - L^{LR}\right] \\
&\quad * \frac{\partial e_2\left(q_2\left(e_1\right)\right)}{\partial q_2\left(e_1\right)}\left\{\frac{\partial q_2^R\left(e_1\right)}{\partial e_1} + \frac{\partial q_2^W\left(e_1\right)}{\partial e_1}\right\} \\
\Phi_4^A &\equiv -2\left[q_1\left(1/2 + \theta_H e_1\right) + (1-q_1)\left(1/2 + \theta_L e_1\right)\right] \\
&\quad * \frac{\partial e_2\left(q_2\left(e_1\right)\right)}{\partial q_2\left(e_1\right)}\left\{\frac{\partial c\left(e_2\left(q_2^R\left(e_1\right)\right)\right)}{\partial e_2\left(q_2^R\left(e_1\right)\right)}\frac{\partial q_2^R\left(e_1\right)}{\partial e_1} + \frac{\partial c\left(e_2\left(q_2^W\left(e_1\right)\right)\right)}{\partial e_2\left(q_2^W\left(e_1\right)\right)}\frac{\partial q_2^W\left(e_1\right)}{\partial e_1}\right\}
\end{aligned}$$

Let the value of e_1 that solves (9) be e_1^A.[26] Inspection of the first-order condition reveals that the first term on the left-hand side of (9) is the first-period (myopic) gain from a small increase in effort. The second term on the left-hand side ($\partial E\left[v_2^o\left(.\right)\right]/\partial e_1$) represents the marginal benefit (since $\partial E\left[v_2^o\left(.\right)\right]/\partial e_1 > 0$—see Proposition 1 and its proof below) from changing e_1 from its myopic level $e^*\left(q_1\right)$; $\partial E\left[v_2^o\left(.\right)\right]/\partial e_1$ is composed of four Φ^A terms. The first one (Φ_1^A) is negative and represents the marginal (dis)incentive to increase first-period effort (since this results in a higher cost of effort in period two).[27] The second term (Φ_2^A) is positive and represents the marginal incentive in increasing first-period effort due to the change in second-period equilibrium effort level stemming from the posterior probability of being a high ability type. The Φ_3^A term is negative[28] and represents the marginal incentive in increasing e_1^A arising from the change in second-period effort induced by increasing first-period effort. The final term, Φ_4^A, represents the marginal incentive to increase e_1^A due to the change in the cost of second-period effort induced by increasing first-period effort.

Following Holmström (1982/1999) and the subsequent literature, let us denote the $\Phi_1^A < 0$ term a *Career Concern* effect; i.e., the extra effort the incumbent is willing (or not) to supply in order to remain in office. Since, in the Appointment regime the incumbent has tenure, he receives the net rent from office ($R - c(e_t)$, $t = 1, 2$) in both periods with probability one. Increasing e_1 reduces

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[25]For ease of exposition, we assume $p = 1/2$. The general case where $0 < p < 1$, is available from the authors.

[26]where the superscript A stands for the Appointment regime.

[27]The negative sign in front of $c\left(e_2\left(q_2^R\left(e_1\right)\right)\right)$ arises because, in the case a marginal increase in e_1 leads to a correct forecast, then the posterior $q_2^R > q_1$, which increases e_2 and its associated cost $c\left(.\right)$; however, if a marginal increase in e_1 leads to a wrong forecast, then the posterior $q_2^W < q_1$, which decreases e_2 and its associated cost $c\left(.\right)$; hence the positive sign in front of $c\left(e_2\left(q_2^W\left(e_1\right)\right)\right)$.

[28]$\Phi_3^A < 0$ since $\partial e_2\left(q_2\left(e_1\right)\right)/\partial q_2\left(e_1\right) > 0$, $\partial q_2^R\left(e_1\right)/\partial e_1 > 0$, $\partial q_2^W\left(e_1\right)/\partial e_1 < 0$, and $\left|\partial q_2^R\left(e_1\right)/\partial e_1\right| < \left|\partial q_2^W\left(e_1\right)/\partial e_1\right|$ (see the Mathematical Appendix for details).

the net rent from office so that the tenured appointee has no incentive to try to impress favorably his principal (by increasing his posterior probability of being a high-ability type); on the contrary, since he cannot be fired by the principal, the agent prefers to slack on the job since it directly increases his net private rent.

Let us label the remaining terms ($\Phi_2^A + \Phi_3^A + \Phi_4^A > 0$[29]) as an *experimentation* effect; i.e., the marginal increase in effort that the incumbent is willing to supply in the first period (and therefore his willingness to pay a short-term cost through the increased cost of effort $c(e_1)$), in order to obtain a more accurate (posterior) belief about his ability θ in the second period of the game (resulting in a long-term benefit since his second-period equilibrium effort level will better reflect his true ability). We can notice that the experimentation effect is increasing in $(\theta_H - \theta_L)$: the higher the spread in ability types, the higher the incentive for the incumbent to learn quickly his type.

We can now summarize our results regarding equilibrium effort levels under the Appointment regime:

Proposition 1. (Experimentation Under Appointment) *In the second period, the appointee chooses the myopic level of effort $e^*(q_2)$, conditional on his posterior belief. In the first period, the appointee will choose to experiment by choosing a higher effort than the myopic one, $e_1^A > e^*(q_1)$.*

Proof. After inserting the equilibrium values of $e_2\left(q_2^R(e_1)\right), e_2\left(q_2^W(e_1)\right)$ into $\Phi_1^A+\Phi_2^A+\Phi_3^A+\Phi_4^A$, these four effects can be paired so that:

$$\Phi_1^A + \Phi_2^A = \frac{8e_1q_1^2(1-q_1)^2(\theta_H-\theta_L)^4\left[L^{HW}-L^{HR}+L^{LW}-L^{LR}\right]^2}{\alpha\left(1-2e_1\left[q_1\theta_H+(1-q_1)\theta_L\right]\right)^2\left(1+2e_1\left[q_1\theta_H+(1-q_1)\theta_L\right]\right)^2}$$

$$\Phi_3^A + \Phi_4^A = \frac{e_1q_1(1-q_1)(\theta_H-\theta_L)^2\left[L^{HW}-L^{HR}+L^{LW}-L^{LR}\right]}{1/2-e_1\left[q_1\theta_H+(1-q_1)\theta_L\right]}$$

which are clearly positive. It is then obvious that $e_1^A > e^*(q_1)$ from the comparison of the first-order conditions (6) and (9) since $\partial E\left[v_2^o(.)\right]/\partial e_1 > 0$ in (9). □

Dynamic Effort Level Under Democracy

This case is more complex, as we have a game of incomplete information. We characterize the perfect Bayesian equilibria (PBE) of this game. Suppose first that the opponent $k \in N$ to the incumbent $l \in N$, is elected for the second period of the game (i.e., he defeats the first-period incumbent). His choice of actions is $e_{k,2} = e^*(q_1)$, because he has no additional information

[29]The sign of the experimentation term is immediate since, from the proof of Proposition 1 below, we know that $\Phi_1^A + \Phi_2^A > 0$ and that $\Phi_3^A + \Phi_4^A > 0$, and we also know that $\Phi_1^A < 0$.

about his own competence. So, the expected utility to any citizen $l \neq k$ from electing the opponent is $v_2^c(q_1)$.

Now, at the time the electorate votes, every citizen has had the chance to observe S_1 and σ_1, the first-period shock and the incumbent's signal, respectively. Voters then update, using Bayes rule, their belief that the incumbent is a high-type. When forming the posterior q_2, citizens rationally deduce that in the first period, the incumbent has taken equilibrium action e_1^D.[30] Let their posterior probabilities that the incumbent is competent be $q_2^c(S_1, \sigma_1)$. Note that we use the c superscript to distinguish citizens' posterior from the first-period officeholder's *own* (state-contingent) posterior (defined in (7)). However, note that in equilibrium, $q_2^c(S_1, \sigma_1) = q_2(S_1, \sigma_1)$.

Then, the second-period expected utility that citizens can expect from the incumbent is $v_2^c(q_2^c(S_1, \sigma_1))$. So, given the tie-breaking rule, all the citizens (apart from the incumbent and the opponent) will vote for the incumbent if and only if $v_2^c(q_2(S_1, \sigma_1)) \geq v_2^c(q_1)$, i.e.[31]

$$\left\{ \begin{array}{l} \left[f_{HR}\left(e^*\left(q_1\right)\right) - f_{HR}\left(e^*\left(q_2\right)\right)\right]\left(L_2^{HR} - L_2^{LW}\right) \\ + \left[f_{LR}\left(e^*\left(q_1\right)\right) - f_{LR}\left(e^*\left(q_2\right)\right)\right]\left(L_2^{LR} - L_2^{HW}\right) \end{array} \right\} \geq 0 \tag{10}$$

If the incumbent correctly forecast the shock S_1, then the posterior q_2^R is greater than q_1, and since v_2^c is strictly increasing in its argument, then the incumbent is re-elected (all the left-hand side terms of the above inequality are strictly positive so that the inequality—voting for the incumbent—is satisfied). By the same reasoning, if the incumbent's forecast turns out to be wrong he is removed from office (since $q_2^W < q_1$).

We now need to ensure that it is individually rational for both the incumbent and the opponent to stand for election, given voters' cutoff rule. The net gain to winning the election for the incumbent is $v^o(q_2(S_1, \sigma_1)) - v^c(q_1)$. The individual rationality condition requires that this gain be positive for $q_2(S_1, \sigma_1) \geq q_1$. But from the section "Myopic Choice of Effort", we know that $v^o(.)$ is increasing in q, so we only need that $v^o(q_1) - v^c(q_1) = R - c(e^*(q_1)) \geq 0$. We therefore assume the following:

A1. $R \geq c(e^*(q_1))$.

which simply says that the net ego rent from office is nonnegative given prior q_1.

We can now write the second-period equilibrium continuation payoff of the incumbent conditional

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[30] where the superscript D stand for democracy.

[31] As there are more than three citizens by assumption, this voting strategy determines the outcome of the election, i.e., how the incumbent and the opponent vote is irrelevant.

on S_1, σ_1, e_1, i.e.

$$w(S_1,\sigma_1,e_1)=\begin{cases} v_2^o(q_2), & \text{if } (S_1,\sigma_1)=\{HR,LR\} \\ v_2^c(q_1), & \text{if } (S_1,\sigma_1)=\{HW,LW\} \end{cases} \tag{11}$$

So, the expected second-period continuation payoff of the incumbent, conditional on first-period effort, $E[w(.)]$ is equal to

$$-\sum_{a\in\{H,L\}} q_1^a \left\{ \begin{array}{c} \sum_{R\in\{HR,LR\}} f_R(e_1,\theta_a)\sum_s f_s\left(e_2\left(q_2^R(e_1)\right),\theta_a\right)\left[\begin{array}{c} L^s-R \\ +c\left(e_2\left(q_2^R(e_1)\right)\right)\end{array}\right] \\ +\sum_{W\in\{HW,LW\}} f_W(e_1,\theta_a)\sum_s f_s\left(e_2(q_1),\theta_a\right)L^s \end{array} \right\} \tag{12}$$

Given the continuation payoff (12), the choice of first-period policies and effort of the incumbent solves $\max_{e_1} E_1^\theta E_1^S[v_1^o] + E_1^\theta E_1^S[w(e_1, q_2(e_1))]$. The first-order condition gives:

$$(q_1\theta_H+(1-q_1)\theta_L)\left[L^{HW}-L^{HR}+L^{LW}-L^{LR}\right]+\frac{\partial E\left[w_2^o(q_2(e_1))\right]}{\partial e_1}=c'(e_1) \tag{13}$$

Let the value of e_1 that solves (13) be e_1^D. As in the Appointment case, the first term on the left-hand side of (13) is the first-period (myopic) gain from a small increase in effort. The second term on the left-hand side represents the marginal benefit (if $\partial E[w(.)]/\partial e_1 > 0$) from changing e_1 from its myopic level $e^*(q_1)$; After some manipulation, this term can be expressed as the sum of four effects, i.e.[32]

$$\frac{\partial E\left[w_2^o(q_2(e_1))\right]}{\partial e_1}=\Phi_1^D+\Phi_2^D+\Phi_3^D+\Phi_4^D \tag{14}$$

where

$$\begin{aligned}
\Phi_1^D &\equiv 2\left[q_1\theta_H+(1-q_1)\theta_L\right]\left\{R-c\left(e_2\left(q_2^R(e_1)\right)\right)\right\} \\
\Phi_2^D &\equiv 2\left[q_1\theta_H^2+(1-q_1)\theta_L^2\right]\left[L^{HW}-L^{HR}+L^{LW}-L^{LR}\right]\left(e_2\left(q_2^R(e_1)\right)-e_2(q_1)\right) \\
\Phi_3^D &\equiv 2\left[\begin{array}{c} q_1(1/2+\theta_H e_1)\theta_H \\ +(1-q_1)(1/2+\theta_L e_1)\theta_L\end{array}\right]\left[L^{HW}-L^{HR}+L^{LW}-L^{LR}\right]\frac{\partial e_2\left(q_2^R(e_1)\right)}{\partial q_2^R(e_1)}\frac{\partial q_2^R(e_1)}{\partial e_1} \\
\Phi_4^D &\equiv -2\left[q_1(1/2+\theta_H e_1)+(1-q_1)(1/2+\theta_L e_1)\right]\frac{\partial c\left(e_2\left(q_2^R(e_1)\right)\right)}{\partial e_2\left(q_2^R(e_1)\right)}\frac{\partial e_2\left(q_2^R(e_1)\right)}{\partial q_2^R(e_1)}\frac{\partial q_2^R(e_1)}{\partial e_1}
\end{aligned}$$

which, after inserting the equilibrium conditions for second period effort levels, simplifies to $\partial E\left[w_2^o(q_2(e_1))\right]/\partial e_1 = \Phi_1^D + \Phi_2^D > 0$ (since $\Phi_3^D + \Phi_4^D = 0$), i.e.

$$\begin{aligned}
\frac{\partial E\left[w_2^o(q_2(e_1))\right]}{\partial e_1} &= 2\left[q_1\theta_H+(1-q_1)\theta_L\right]\left\{R-c\left(e_2\left(q_2^R(e_1)\right)\right)\right\} \\
&+\frac{4e_1q_1(1-q_1)(\theta_H-\theta_L)^2\left[q_1\theta_H^2+(1-q_1)\theta_L^2\right]\left[L^{HW}-L^{HR}+L^{LW}-L^{LR}\right]^2}{\alpha\left(1+2e_1\left[q_1\theta_H+(1-q_1)\theta_L\right]\right)}
\end{aligned}$$

[32]Derivations available from the authors.

Notice that the four effects encountered in the Appointment regime still arise, although in a modified form. Under Democracy, the benefits from the first-period marginal increase in effort only accrue to the incumbent provided he is re-elected; this affects the four effects in the following ways.

First, the *career concerns* effect (Φ_1^D) is now a function of the net rent from office ($R - c(.)$) rather than solely of function of cost of effort as in Φ_1^A; also, in Φ_1^D only the second-period effort associated with a correct first-period forecast is taken into account since with a wrong forecast the incumbent is not re-elected. Under the democratic regime, the *career concerns* effect captures the incentive the first-period incumbent has to increase effort above its myopic level so as to raise the probability of staying in office and receiving the net rent from office on top of the utility that each (representative) citizen obtains (we can see that Φ_1^D, the career concerns effect on e_1, is increasing in the (future) net rent from office: $R - c(e_2)$). The career concerns effect could also be coined a *tournament* effect (Lazear and Rosen (1981); Green and Stokey (1983)), since it induces extra effort through the reward of a prize (the net ego rent from office) which is only available to the winner of the election. Note that since $R - c(.) > 0$ (from Assumption 1), then $R > c\left(e_2\left(q_2^W(e_1)\right)\right)$ so that $R - c\left(e_2\left(q_2^R\right)\right) > -c\left(e_2\left(q_2^R\right)\right) + c\left(e_2\left(q_2^W\right)\right)$ and therefore $\Phi_1^D > 0 > \Phi_1^A$.

The second effect (Φ_2^D) is similar to that of Φ_2^A except that, under democracy, this positive effect on effort is reduced since, should a wrong forecast occur, the incumbent is fired; this truncates the officeholder's benefit from higher effort from a function of $e_2\left(q_2^R(e_1)\right) - e_2\left(q_2^W(e_1)\right)$ to the smaller[33] function $e_2\left(q_2^R(e_1)\right) - e_2(q_1) > 0$.

The third and fourth effects are similarly affected compared to these effects in the Appointment case. However, we can notice that Φ_3^D and Φ_4^D can now easily be signed: Φ_3^D is strictly positive since $\partial q_2^R(e_1)/\partial e_1 > 0$, and $\partial e_2\left(q_2^R(e_1)\right) / \partial q_2^R(e_1) > 0$, and $\Phi_4^D < 0$ since $\partial q_2^R(e_1)/\partial e_1 > 0$, $\partial c\left(e_2\left(q_2^R(e_1)\right)\right) / \partial e_2\left(q_2^R(e_1)\right)$, and $\partial e_2\left(q_2^R(e_1)\right) / \partial q_2^R(e_1)$.

So, to summarize,

$$\frac{\partial E\left[w_2^o\left(q_2(e_1)\right)\right]}{\partial e_1} > 0 \tag{15}$$

which leads to the following proposition:

Proposition 2. (Effort Under Democracy) *In the second period, the elected official chooses the myopic level of effort $e^*(q_2)$, conditional on his posterior belief. In the first period, the official will choose a higher effort than the myopic one, $e_1^D > e^*(q_1)$.*

Proof. Obvious from the comparison of the first-order conditions (6) and (13) since

[33]Since, from Bayes rule, $q_2^R > q_1 > q_2^W$.

$\partial E\left[w_2^o\left(.\right)\right]/\partial e_1 > 0$ in (13). □

Expected Ability, Effort Levels, and Welfare Across Regimes

In deciding whether to retain or delegate the production of the public good, the newly elected politician has to compare two key variables across regimes and their overall effect on expected utility: the expected ability of the officeholder, $E_1[\theta^o]$; and the equilibrium levels of effort.

Ability Across Regimes The comparison of expected officeholder ability across regimes is immediate. In the first period, under both regimes, the expected probability of having a high ability officeholder is q_1. In the Appointment regime, q_1 is also the probability of having a competent officeholder in the second period since the first-period appointee has tenure. In the Democratic regime, the second-period expected utility, as of period one, is naturally higher than the prior q_1 since, given the re-election rule, if $q_2 = q_2^W < q_1$ the incumbent is fired and replaced with a randomly selected opponent with expected ability q_1 (if $q_2 = q_2^R > q_1$ the incumbent is re-elected). Hence, under democracy, the second-period expected probability of having a high-ability officeholder is

$$E_1[q_2 \mid Dem.] = q_2^{HR} f_{HR} + q_2^{LR} f_{LR} + q_1 \left(f_{HW} + f_{LW}\right) > q_1 \tag{16}$$

so that

$$E_1[q \mid Dem.] = \frac{q_1 + q_2^{HR} f_{HR} + q_2^{LR} f_{LR} + q_1 \left(f_{HW} + f_{LW}\right)}{2} > E_1[q \mid Appt.] = q_1 \tag{17}$$

Effort Levels Across Regimes Since, in the last period of the game, conditional on posterior belief about type, the same equilibrium effort level occurs under both regimes (i.e. $e^*\left(q\right)$), the interesting comparison is therefore in the first period (i.e. comparing e_1^A and e_1^D). Inspection of (9) and (13) reveals that this depends on the sign of Δ, where

$$\Delta \equiv \frac{\partial E\left[w\left(.\right)\right]}{\partial e_1} - \frac{\partial E\left[v_2^o\left(.\right)\right]}{\partial e_1} = \Phi_1^D - \Phi_1^A + \Phi_2^D - \Phi_2^A + \Phi_3^D - \Phi_3^A + \Phi_4^D - \Phi_4^A \tag{18}$$

and

$$\begin{aligned}
\Phi_1^D - \Phi_1^A &= 2\left[q_1\theta_H + \left(1-q_1\right)\theta_L\right]\left\{R - c\left(e_2\left(q_2^W\left(e_1\right)\right)\right)\right\} > 0 \\
\Phi_2^D - \Phi_2^A &= -2\left[q_1\theta_H^2 + \left(1-q_1\right)\theta_L^2\right]\left[\begin{array}{c} L^{HW} - L^{HR} \\ +L^{LW} - L^{LR} \end{array}\right]\left(e_2\left(q_1\right) - e_2\left(q_2^W\left(e_1\right)\right)\right) < 0 \\
\Phi_3^D - \Phi_3^A &= \left\{\begin{array}{c} -2\left[q_1\left(1/2 + \theta_H e_1\right)\theta_H + \left(1-q_1\right)\left(1/2 + \theta_L e_1\right)\theta_L\right] \\ \left[L^{HW} - L^{HR} + L^{LW} - L^{LR}\right]\frac{\partial e_2\left(q_2^W\left(e_1\right)\right)}{\partial q_2^W\left(e_1\right)}\frac{\partial q_2^W\left(e_1\right)}{\partial e_1} \end{array}\right\} > 0 \\
\Phi_4^D - \Phi_4^A &= 2\left[\begin{array}{c} q_1\left(1/2 + \theta_H e_1\right) \\ +\left(1-q_1\right)\left(1/2 + \theta_L e_1\right) \end{array}\right]\frac{\partial e_2\left(q_2\left(e_1\right)\right)}{\partial q_2\left(e_1\right)}\frac{\partial c\left(e_2\left(q_2^W\left(e_1\right)\right)\right)}{\partial e_2\left(q_2^W\left(e_1\right)\right)}\frac{\partial q_2^W\left(e_1\right)}{\partial e_1} < 0
\end{aligned}$$

So, to summarize:

$$\Phi_1^D - \Phi_1^A > 0;\ \Phi_2^D - \Phi_2^A < 0;\ \Phi_3^D - \Phi_3^A > 0; \text{ and } \Phi_4^D - \Phi_4^A < 0$$

The net effect on the sign of Δ of these four conflicting effects depends on parameter values. Although it is not possible to analytically sign Δ (it can take either sign, as shown in Example 1 below), we can see that Δ is more likely to be positive the larger the career concerns effect and the smaller the experimentation effect, i.e., the larger the net ego rent from office $(R - c\left(e_2\left(q_2^W\left(e_1\right)\right)\right))$ and the smaller the benefit from experimentation (which depends on the ability spread: $\theta_H - \theta_L$).

Example 1. We assume that the cost of effort function takes the (standard[34]) quadratic form, i.e., $c(e) = \alpha_1 e + \alpha_2(e^2)/2$. The equilibrium values obtained are the following:

Table 1: Equilibrium Effort Levels e_1^A, e_1^D, and $e^*\left(q_1\right)$.

$\backslash\ R - c(e):$	$\simeq 0\ (1.10^{-6})$	0.12	0.24	$e^*(q_1)$
$\theta_H - \theta_L:$				
0.50	.0651, .06507	.065, .08	.065, .10	.065
1.00	.132, .129	.13, .17	.13, .20	.127
1.58	.30, .25	.30, .31	−, −	.20

The other parameters are: $L^{HW} = L^{LW} = 1$, $L^{HR} = L^{LR} = 1/2$, so that $L^{HW} - L^{HR} + L^{LW} - L^{LR} = 1$, $\alpha_1 = 0$, $\alpha_2 = 4$, and $p = q_1 = 1/2$.

We can now summarize our results with the following proposition.

Proposition 3. (Comparing Ability and Effort Across Regimes) *(For $p = 1/2$). (1) Effort: in the second period, conditional on posterior belief, the same myopic level of effort is chosen in both regimes; in the first period, provided the net ego rent $(R - c(.))$ is ısmall enough] and the ability spread $(\theta_H - \theta_L)$ is ılarge enough], then it is possible to have $e_1^A > e_1^D$. (2) Ability: the first-period expected probability of having a high ability officeholder in both periods is higher under Democracy than under Appointment.*

Proof. Example 1 proves that $e_1^A > e_1^D$ can occur, while point (2) of the proposition follows from the previous discussion. □

[34]This is, for instance, the functional form used by Dewatripont, Jewitt and Tirole (1999) in their related Career Concerns model.

Welfare Across Regimes Now the interesting question is: will a newly elected politician delegate the production of the public policy if the conditions are such that $e_1^A > e_1^D$ (i.e., $R - c(.) \simeq 0$, and $\theta_H - \theta_L$ is "large")? Proposition 3 highlights a trade-off between the two regimes: on the one hand, the equilibrium level of *effort is higher under Appointment*, but, on the other hand, the *expected quality of the officeholder is lower under Appointment*. Delegation occurs if and only if the politician's ex ante utility over both periods under the Appointment regime (which is the same as that of a representative citizen[35]) is strictly higher than the ex ante utility that the politician/officeholder obtains under the Democracy regime; i.e., iff

$$v^c(Appointment) > v^o(Democracy) \tag{19}$$

where

$$\begin{aligned} v^c(Appoint.) &= -\sum_a \sum_{s_1} q_1^a f_{s_1}\left(e_1^A, \theta_a\right) L^{s_1} \\ &\quad -\sum_a \sum_{s_1} q_1^a f_{s_1}\left(e_1^A, \theta_a\right) \sum_{s_2} f_{s_2}\left(e_2^*\left(q_2^{s_1}\left(e_1^A\right)\right), \theta_a\right) L^{s_2} \end{aligned} \tag{20}$$

$$\begin{aligned} v^o(Dem.) &= -\sum_a \sum_s q_1^a f_s\left(e_1^D, \theta_a\right) L^s + R - c\left(e_1^D\right) \\ &\quad -\sum_a q_1^a \left\{ \begin{array}{c} \sum_{R=\{HR,LR\}} f_R\left(e_1^D, \theta_a\right) \sum_s f_s\left(e_2^*\left(q_2^R\left(e_1^D\right)\right), \theta_a\right) \left[\begin{array}{c} L^s - R \\ +c\left(e_2^*\left(q_2^R\left(e_1^D\right)\right)\right) \end{array} \right] \\ +\sum_{W=\{HW,LW\}} f_W\left(e_1^D, \theta_a\right) \sum_s f_s\left(e_2^*\left(q_1\right), \theta_a\right) L^s \end{array} \right\} \end{aligned} \tag{21}$$

The example below shows that inequality (19) can indeed be satisfied so that it is *individually rational* for a self-interested politician to delegate the management of the public good to an independent but accountable officeholder (the officeholder becomes the agent of the elected politician, who himself is the representative of citizens at large).

Example 2. Using the same parameter values and functional forms as those of Example 1 (with $R - c(e) \simeq 0 \ (= 1.10^{-6})$), and using the ex ante utilities (20) and (21),[36] the equilibrium payoffs of the elected politician under each regime are shown in Table 2 (the equilibrium levels of effort are those reported in Table 1).

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[35] We assume that, if the politician does not conduct monetary policy, he does not get any rent from office.

[36] The ex ante utility of a citizen under the Democratic regime is:

$$\begin{aligned} v^c(Dem.) &= -\sum_a \sum_s q_1^a f_s\left(e_1^D, \theta_a\right) L_1^s \\ &\quad -\sum_a q_1^a \left\{ \begin{array}{c} \sum_{R=\{HR,LR\}} f_R\left(e_1^D, \theta_a\right) \sum_s f_s\left(e_2^*\left(q_2^R\left(e_1^D\right)\right), \theta_a\right) L_2^s \\ +\sum_{W=\{HW,LW\}} f_W\left(e_1^D, \theta_a\right) \sum_s f_s\left(e_2^*\left(q_1\right), \theta_a\right) L_2^s \end{array} \right\} \end{aligned}$$

Table 2: Equilibrium Payoffs (Loss) of the Politician, the Appointee, and Citizens

Payoffs: $\backslash$	$v^c\,(Appoint.)$	$v^o\,(Dem.)$	$v^c\,(Dem.)$	$v^{cb}\,(Appoint.)$
$\theta_H - \theta_L$:				
0.50	-4.449	-4.448	-4.448	-4.449
1.00	-4.30	-4.29	-4.29	-4.29
1.58	-3.85	-3.90	-3.92	-3.84

So we can see that, under certain parameter values (when the ability uncertainty is large enough and the private rent from office is small), an elected politician has an incentive to delegate the management of the public good to an independent appointee rather than manage it himself, i.e., $v^c\,(Appointment) > v^o\,(Democracy)$.

The intuition for this result is the following. First, the private rent from holding office $(R - c(e))$ is relatively "small," thereby lowering the (private) benefit of being in charge of the public good. Second, since uncertainty regarding the true ability of the officeholder ($\theta_H - \theta_L$ is "large") is important, there is a strong experimentation motive, i.e., a strong benefit from rapidly discovering the officeholder's true type. However, speeding this discovering process (improving the quality of the posterior belief) can only occur by raising effort above its optimal no-experimentation level, which is costly in the short run (period 1) but beneficial in the long run (period 2). Since the appointee is given a *longer time horizon* than the politician can expect, he can *afford to pay the extra short-term cost.* (We can also notice that, when delegation does occur, the appointee is always the citizen with the highest equilibrium payoff.)

Another interesting result is that it is also possible to have the following equilibrium payoffs:[37]

$$v^{cb}\,(Appointment) > v^o\,(Democracy) > v^c\,(Appointment) > v^c\,(Democracy)$$

so that the privately optimal regime for the elected politician is for him to manage the public good even though all citizens (except the politician) would be better off with an independent appointee. In this case, Democracy is therefore inefficient, in the Pareto sense, since a social planner, having the same (incomplete symmetric) information as all citizens in this economy, could choose a feasible outcome that makes all citizens better off.

To summarize:

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[37]This is, for instance, the case when $L_t^{HW} = L_t^{LW} = 1$, $L_t^{HR} = L_t^{LR} = 1/2\ \forall t$, so that $L_t^{HW} - L_t^{HR} + L_t^{LW} - L_t^{LR} = 1\ \forall t, p = q_1 = 1/2$, $a = 0$, $\alpha = 4$, $R = 0.2$, $\theta_H = 1.59$, and $\theta_L = 0.01$. With these parameter values, the payoffs are

$$v^{cb}\,(App.) = -3.6 > v^o\,(Dem.) = -3.7 > v^c\,(App.) = -3.8 > v^c\,(Dem.) = -3.9$$

Proposition 4. (Endogenous central bank independence) *(For $p = 1/2$). (1) Provided the net rent from office is small enough and the uncertainty regarding the ability spread is large enough, then it can be optimal for an elected politician to delegate the production of the public good to an appointed agent who is guaranteed tenure. (2) When it occurs, delegation is always socially optimal. (3) The politician's (privately) optimal regime choice can be Pareto inefficient.*

C. Extensions

The model can be extended along several dimensions to make the policy environment more realistic (not least, in the monetary policy context, by having a broader interpretation of effort e and ability θ).

One extension that should also give rise to a benefit from delegation is to assume that there is learning by doing on the job. Suppose, for example, that effort in period 1 does not only enter in the conditional forecast in period 1 but also in period 2 (a "learning by doing" effect). This increases effort under appointment in period 1 even more relative to a democratic regime since a policymaker with a longer horizon has an incentive to *invest* effort in period 1. Note that this extensions would overturn part 2 of Proposition 3. The expected ability of the officeholder in period 2 may be higher under appointment than under democracy because ability in period 2 is now a function of effort supplied in the first period. One can also introduce a constant learning on the job that does not interact with effort in period 1. This would also tend to make the outcome under appointment in period 2 better relative to a democracy.

III. Central Bank Independence

As stressed by Milton Friedman, monetary policy operates with "long and variable lags." Monetary policy is therefore conducted on the basis of forecasts about the state of the economy. Indeed, central banks such as the U.S. Federal Reserve, the European Central Bank, or the Bank of England expend a large amount of resources into their forecasting divisions and these forecast are described to the public as the key underlying reason for monetary policy decisions. In this section, we capture this crucial aspect of the conduct of monetary policy by integrating our microfounded political agency framework with a standard dynamic "New Keynesian" stochastic general equilibrium model (e.g. Clarida et al. (1999); Rotemberg and Woodford (1999)).[38]

In Section III.A, we first show that there can be a rationale for delegating monetary policy to an independent central banker, where independence refers to instrument independence (agents have homogenous preferences so that there are no goal differences). In Section III.B, we allow

[38]In fact, from a technical viewpoint, integrating the two literatures amounts to endogenizing the loss function in the utility function of the representative citizen (it was assumed to be constant in our model of Section II.A).

for heterogeneity of preferences among citizens so as to address the issue of goal accountability of the (instrument) independent central banker. Finally, Section III.C draws and discusses some empirical predictions from our theory.

A. Instrument Independence

The structure of the game is the same as in Section II.A, except that we now also introduce a policy decision for the officeholder: setting the nominal interest rate. Thus, the conduct of monetary policy amounts to forecasting the future state of the economy and to setting the nominal interest rate accordingly. Again, at the beginning of the first period, the newly elected politician has to decide whether to perform monetary policy himself or to delegate it to an "independent (but accountable) central banker"; then, in each period, the official in charge of monetary policy supplies effort, receives a signal, and then chooses i_t, the nominal interest rate. After this the shock is observed and markets clear.

Interestingly, this decision process fits recent decisions to delegate monetary policy to independent central banks around the world. In the United Kingdom, for instance, the first major policy decision of the newly elected Prime Minister Tony Blair in May 1997 was to grant independence to the Bank of England.

We first present a simple macro framework that illustrates that an independent central bank delivers lower inflation and output *variability* in a fairly standard macro model. We then show that, in an extended version of the model, central bank independence also delivers lower *average* inflation.

Inflation and Output Variability

Macroeconomic Setup We analyze a macroeconomic model that has become (close to) standard in the literature. This model is often referred to as the New Keynesian model (see, e.g., Woodford, 2003). The model can be explicitly derived from micro foundations. For simplicity, we will follow much of the literature by using a linear approximation of the structural equations of the model and a quadratic approximation of the utility the representative household.

The utility function of a (representative) citizen is given by:

$$v_t^c = -L_t^c = -E_t \sum_{t=1}^{2} \beta^t \left[\frac{1}{2}\pi_t^2 + \frac{1}{2}\lambda x_t^2 \right] \tag{22}$$

where π_t is inflation and x_t is the output gap, i.e., the deviation of output from the natural rate of output.

The aggregate supply (AS) equation can be derived from the optimal pricing decision of firms:

$$\pi_t = kx_t + \beta E_t \pi_{t+1} + u_t \tag{23}$$

where E_t denotes expectations formed at time t. u_t is an i.i.d. shock ($E[u] = 0$). Variation in u_t represent a "cost push shock" that can, for example, be modeled as an exogenous variation in the markup of firms (see, e.g., Woodford, 2003).

The IS equation can be derived by a linear approximation of the consumption Euler equation of the representative household:

$$x_t = E_t x_{t+1} - \varepsilon(i_t - E_t \pi_{t+1} - r_t^n) \tag{24}$$

where i_t is the nominal interest rate and r_t^n is the natural rate of interest. In this model the natural rate of interest is only a function of exogenous shocks. It is the real rate of interest that would "clear the market", i.e., it is the real interest rate that is consistent with output being at the natural rate of output at all times. We assume that the central bank chooses i_t in each period before the shock is realized so that the policy problem is exactly the same as discussed in Section II (but here the loss function L_t is endogenous since it is a function of π_t and x_t). We first consider a case where the only exogenous shock is r_t^n. In terms of our notation from last sections $S_t = r_t^n$ and we assume that r_t^n is equal to r^H with probability p and r^L with probability $1 - p$. For simplicity we limit ourselves to analyzing the equilibrium for two periods, as in previous sections. We can think of the economy as being an infinite repetition of the two periods we analyze.[39] Accordingly we shall suppose that equation (23) and (24) refer to periods of fairly long duration.[40]

If the central bank could perfectly forecast the natural rate of interest, it would set $i_t = r_t^n$, resulting in zero inflation and output gap. This minimizes the bank's loss function. If the central bank cannot perfectly forecast the natural rate of output, this equilibrium may not be feasible. For example, if the central bank misses the target for the natural rate of interest so that $i_t < r_t^n$, there will be excessive inflation and output will be above its natural level. By contrast, if $i_t > r_t^n$ there will be deflation and output slump. Since the central bank sets the nominal interest rate before observing r_t^n, its problem is to predict the future value of r_t^n in order to minimize its losses. Since monetary policy operates with long and variable lags we believe this feature of our framework captures, albeit in a crude fashion, a realistic and basic problem facing modern central banks.

Equilibrium and Welfare We solve the officeholder's decision problem with the usual dynamic programming approach.

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[39]For this interpretation to be valid we need to assume that each democratically elected politician can only sit for two terms, e.g., as is the case for American presidents.

[40]It is possible, using the methods we illustrate, to generalize the model and allow for the game to evolve over several periods of shorter duration, without changing the basic insights.

Myopic Policy and Effort Choices. In the last (second) period, the maximization problem of the officeholder is to

$$\max_{\{e,i,\pi\}} E^{\theta} E^{S} [v^{o}] \tag{25}$$

We analyze the Markov equilibria. Since there are no state variables in period 2, the government treats expectations as constants and this reduces the problem to a one-period model.

From (23) and (24), we get

$$\pi = kx + \beta\tilde{\pi} + u \tag{26}$$

$$x = \tilde{x} - \varepsilon(i - \tilde{\pi} - r^{n}) = \tilde{x} + \varepsilon\tilde{\pi} + \varepsilon r^{n} - \varepsilon i \tag{27}$$

After substitution of (26) and (27) into (25), the maximization problem of the officeholder becomes $\max_{\{e,i,\pi\}} -\sum_{a}\sum_{s} q^{a} f_{s}(e,\theta_{a}) L^{s} + R - c(e)$, where

$$L^{S\sigma} = \frac{1}{2}\pi_{S\sigma}^{2} + \frac{1}{2}\lambda \begin{pmatrix} \tilde{x} + \varepsilon\tilde{\pi} \\ +\varepsilon r^{S} - \varepsilon i^{\sigma} \end{pmatrix}^{2} + \gamma_{S\sigma} \begin{pmatrix} \pi_{S\sigma} - k\tilde{x} - k\varepsilon r^{S} - u \\ +k\varepsilon i^{\sigma} - (\beta + k\varepsilon)\tilde{\pi} \end{pmatrix} \tag{28}$$

and, as in Section II.A, the subscript $S\sigma \in \{HR, LR, HW, LW\}$ refers to the combination of the shock $S \in \{H, L\}$ and the forecast $\sigma \in \{H, L\}$, i.e., whether σ turns out to be a correct forecast about S or not. For simplicity, we assume that $\tilde{x} = \tilde{\pi} = 0$, which is consistent with a loss function with no inflation bias.

After rearranging the first-order conditions (w.r.t. e, i^{H}, i^{L}, π_{HR}, π_{HW}, π_{LR}, π_{LW}), the equilibrium values of i^{H}, i^{L}, π_{HR}, π_{HW}, π_{LR}, π_{LW} are:

$$i^{H} = (p + E[\theta]e) r^{H} + (1 - p - E[\theta]e) r^{L} + \frac{k}{\varepsilon(\lambda + k^{2})} u \tag{29}$$

$$i^{L} = (p - E[\theta]e) r^{H} + (1 - p + E[\theta]e) r^{L} + \frac{k}{\varepsilon(\lambda + k^{2})} u \tag{30}$$

$$\pi_{HR} = \varepsilon k (1 - p - E[\theta]e) \left(r^{H} - r^{L}\right) + \frac{\lambda}{\lambda + k^{2}} u \tag{31}$$

$$\pi_{HW} = -\varepsilon k (p + E[\theta]e) \left(r^{H} - r^{L}\right) + \frac{\lambda}{\lambda + k^{2}} u \tag{32}$$

$$\pi_{LR} = -\varepsilon k (p - E[\theta]e) \left(r^{H} - r^{L}\right) + \frac{\lambda}{\lambda + k^{2}} u \tag{33}$$

$$\pi_{LW} = \varepsilon k (1 - p + E[\theta]e) \left(r^{H} - r^{L}\right) + \frac{\lambda}{\lambda + k^{2}} u \tag{34}$$

$$x_{s} = k^{-1}(\pi_{s} - u); \quad s \in \{HR, LR, HW, LW\} \tag{35}$$

where $E[\theta] = q\theta_{H} + (1 - q)\theta_{L}$. The equilibrium values are all functions of the expected ability of the officeholder, i.e., $e = e^{*}(q) > 0$, $i^{H} = i^{H*}(q)$, $i^{L} = i^{L*}(q)$, $\pi_{s} = \pi_{s}^{*}(q)$, and $x_{s} = x_{s}^{*}(q)$. To find the value for e we again obtain condition (6) (terms that involve $\frac{\partial L^{S}(w)}{\partial e}$ cancel out in equilibrium) where we can substitute the endogenous values of π_{s} and x_{s} into the loss function.

In this case the first-order condition with respect to effort can be written as:

$$2(k^2+\lambda)\varepsilon^2(r^H-r^L)^2)(q\theta_H+(1-q)\theta_L)^2e=c'(e)=\alpha_1+\alpha_2e \tag{36}$$

where we assume that the cost function $c(e)$ is linear quadratic. Note that we need $\alpha_1 \neq 0$ for nonzero solution of e to exist which we will assume in our numerical example.

The first-period allocation, as far as the macroeconomic variables is concerned (i.e., i^H, i^L, π_s, x_s), will be the same as those derived in (29)-(35) since there are no state variables. The derivation of the first-period equilibrium effort level follows directly from the analysis of Section II.A with the added analytical complication that the loss function is endogenous.

Proposition 5. (Lower Output and Inflation Variability under Central Bank Independence). *If (i)* $e\prime \geq e$ *and (ii)* $E[\theta'] \geq E[\theta]$ *then* $VAR(x') \leq VAR(x)$ and $VAR(\pi) \leq VAR(\pi)$.

Proof: Obvious from equations (29)-(35). □

As we saw in the last section, conditions (i) and (ii) are satisfied in period 1 under the Appointment regime for certain parameter values. The policymaker has an incentive to invest more effort in period 1 (this was shown in Proposition 3) under Appointment than Democracy for the same level of ability. We have, however, not established this for the case when the loss function is endogenous. This is what we show in the next subsection in a numerical example.

The conditions of Proposition 5, however, fail to hold under Appointment in period 2. Since under Democracy an incompetent first-period officeholder is fired, the expected ability of the policymaker in a Democracy in period 2 is higher than under Appointment. It would be tempting to conclude that this implies that expected output and inflation variability in period 2 is lower under Democracy than Appointment. Although this was the case in our previous example when the loss function was constant it is not the case when the loss function is endogenous. This can be seen by condition (36). This condition reveals that effort is decreasing in ability in the myopic equilibrium. Lower expected ability makes the policymaker work even harder to compensate for his lack of ability. This positive effect under delegation more than offsets the loss in expected ability in period 2. Thus we find that the variability of inflation and the output gap is lower when the central bank is independent in *both* periods. It is worth stressing that there may be several other benefits of central bank independence added into the model, such as learning on the job, so that effort in period 1 may serve as forecasting "capital" in period 2 as discussed in Section II.C. These additional benefits may increases the ability of the officeholder in period 2 and make the outcome under independence even better.[41]

[41] We choose not to include these effects here, simply to emphasize that we do not even need them to show that Appointment can be better than Democracy. It should be obvious that by abstracting from learning by doing we are stacking the cards against the result we obtain.

Our results resolve what has sometimes been considered as a major limitation of the literature on central bank independence. This literature implies (see, e.g., Rogoff, 1985) that society delegates policy to achieve lower inflation variability, but at the cost of inducing higher variability in output. This prediction is not, as discussed in our empirical section, consistent with the data. In the data lower output and inflation variability usually go hand in hand. Contrary to much of the theoretical literature, but consistent with the data, this is exactly what our model implies, an independent central bank delivers both lower inflation and output variability.[42]

Welfare Across Regimes Following the insights from Section II.B.4, we investigate whether and under what circumstances (namely, if the private net rent from office is small and the uncertainty regarding ability is large) the politician endogenously prefers to delegate monetary policy to an independent but accountable central banker. As Example 3 below shows, the circumstances highlighted in Section II.B.4 still lead to endogenous delegation of monetary policy.

Example 3. Following Rotemberg and Woodford (1997), we calibrate k, ε, and β as $k = 0.0227$, $\varepsilon = 6$, $\beta = 0.99$, and $\lambda = 0.0029$. These calibration parameters apply to quarterly data and we change them to imply that each period is 4 years. Furthermore we assume that $x^* = 0$, $\pi^* = 0$, $r^H = 0.10$, $r^L = 0.02$ in one-year units, $p = 0.5$, $q_1 = 0.5$, $\theta_L = 0.01$, and $u = 0$. The functional form $c(e)$ is $c(e) = \alpha_1 e + \alpha_2 e^2/2$ with $\alpha_1 = -1$, and $\alpha_2 = 10$. The ex ante utilities are given by (20) and (21), with the proviso that the loss function is now endogenous. The resulting equilibrium payoffs of the different agents in this economy, and under each regime, are shown in Table 3 below.

Table 3: Equilibrium Payoffs of the Politician, the Central Banker and Citizens.

\ Payoffs:*	$v^c\,(Appt.)$	$v^o\,(Dem.)$	$v^c\,(Dem.)$	$v^{cb}\,(Appt.)$
Scenario 1	−8.52	37.7	−8.51	51.5
Scenario 2	−8.52	−8.33	−8.55	−8.22
Scenario 3	−6.33	−6.63	−6.80	−6.14

where $R - c\left(e^*\left(q_1\right)\right) \simeq 0 = 1.10^{-6}$. *: payoffs are expressed in thousands. Scenario 1: $R - c(.) = 0.02$, $\theta_H = 3$ (i.e., "large" ego rent, "medium" $\theta_H - \theta_L$). Scenario 2: $R - c(.) \simeq 0$, $\theta_H = 3$ (i.e., "small" ego rent, "medium" $\theta_H - \theta_L$). Scenario 3: $R - c(.) \simeq 0$, $\theta_H = 5$ (i.e., "small" ego rent, "large" $\theta_H - \theta_L$).

Table 3 confirms the insights obtained in Section II.B.4 (when the loss function was exogenous). In particular, the following points are noticeable. First, Scenario 1 shows that, with a sufficiently

[42]For exceptions to this trade-off see, for example, Alesina and Gatti (1995) and Schellekens (2002).

high private rent from office, the equilibrium payoff of the politician is far higher if he retains monetary policy than if he delegates it and receives the payoff of a representative citizen ($v^o\,(Dem.) = 37.7 > v^c\,(Appt.) = -8.52$). Second, Scenario 2 shows that a Pareto inefficient equilibrium is again possible: the politician's private value from office biases his regime choice against that preferred by citizens (delegation to an independent central bank yields higher payoffs to citizens than political conduct of monetary policy but this regime choice is not incentive compatible for the politician: $v^c\,(Appt.) = -8.52 > v^c\,(Dem.) = -8.55$ but $v^c\,(Appt.) = -8.52 < v^o\,(Dem.) = -8.33$). Third, as shown in Scenario 3, when the uncertainty about ability is large enough, both the politician and the representative voter benefit by delegating monetary policy ($v^c\,(Appt.) = -6.33 > v^o\,(Dem.) = -6.63$, $v^c\,(Dem.) = -6.80$). Finally, comparing Scenarios 2 and 3, we can see that payoffs are increasing in $\theta_H - \theta_L$.

Average Inflation

The model derived in the previous section implies that average inflation is zero across regimes. This can be seen from equations (29)-(35). Here we show how the model can be extended to imply that central bank independence also implies lower average inflation. We now assume that society's loss function given by (22) is modified to:

$$v_t^c = -L_t^c = -E_t \sum_{t=1}^{2} \sum_{s\in\{HR,LR,HW,LW\}} \beta^t \mu(s) \left[\frac{1}{2}\pi_t^2 + \frac{1}{2}\lambda x_t^2\right] \tag{37}$$

This is a generalization of the previous loss function since we now allow the loss function to depend on the state of the economy so that $\mu(s)$ can take four values, i.e., $s \in \{HR, LR, HW, LW\}$. This loss function allows for asymmetry across states of the economy. In particular, we consider the possibility that society attaches higher losses to a recession (i.e., a negative output gap and deflation) than to an expansion (i.e., a positive output gap and inflation). Thus we assume that $\mu^{HR} < \mu^{LR}$ and $\mu^{HW} < \mu^{LW}$ *in equilibrium.* An asymmetry between a recession and a boom would indeed arise from the microfoundation of the underlying model, although we assume a somewhat simpler analytical form here so as to abstract from an inflationary bias.[43]

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[43]In the microfounded model the loss function takes the form $\pi_t^2 + \lambda(x_t - x^*)^2$ as shown in Woodford (2003) where $x^* \geq 0$ for appropriately chosen taxes and monopoly distortions. If $x^* > 0$, in an equilibrium where the output gap is zero, this loss function implies that the marginal loss of a positive output gap (or inflation) is lower than the marginal loss of a negative output gap (or deflation) because the economy is operating at production that is below x^* (and the loss function is convex). Our point could thus be made with the microfounded loss function with the additional complication that we would need to make an assumption about the central bank's ability to commit to future policy. To abstract from the issue of whether the central bank can commit or not, we choose to introduce an asymmetry by attaching different weights to the loss function. This simplifies our discussion and makes our central point clearer: we emphasize a rationale for delegating policy even if there is no "inflation bias" – no difference between the equilibrium when the central bank can and cannot commit to future policy. It should be clear that

For a given level of effort, we can now solve for the optimal level of inflation, output and interest rate following the same steps as in the previous section. The only difference is that now $\tilde{\pi} \neq 0$ and $\tilde{x} \neq 0$. The resulting expressions for π_s and x_s are somewhat more complicated than before and are shown in the Mathematical Appendix, Section C. What they illustrate is that a higher level of effort does not only reduce inflation and output variability but also the average *level* of inflation. The reason for this is simple. When the central bank weighs recessions and booms differently, average inflation is different from zero. Since the central bank puts a lower weight on an economic boom than on a recession, it sets the nominal interest rate as if it is giving a higher probability on the recessionary state relative to the solution derived in the previous section. This causes an average inflation bias that is *unrelated* to the standard inflation bias.[44] What is immediately clear, however, is that a higher level of effort decreases average inflation since a higher level of effort improves the accuracy of the central bank's forecast. Since central bank independence, when it (endogenously) occurs, is associated with higher effort, central bank independence leads, not only to lower variability in output and inflation, but it can also reduce the average level of inflation.

Proposition 6. (Lower Average Inflation under Central Bank Independence). *If* $e' \geq e$ *and* $E[\theta'] \geq E[\theta]$ *then* $E[\pi'] \leq E[\pi]$.

Proof: see the Mathematical Appendix.

Again one should be careful to note that in period 2 expected ability is lower under Appointment than under Democracy. Again, though, for some parameter values this is more than compensated by an increase in effort under Appointment in period 2. Thus central bank independence can lead to lower average inflation in both period 1 and 2 in our model.

B. Goal and Instrument Independence

The assumption of homogenous preferences precludes us from addressing an important issue related to CBI: namely whether to give the central bank *instrument* and *goal* independence as opposed to purely instrument independence (following Debelle and Fischer's (1994) terminology). In simpler terms: should the central bank be independent but accountable? To address this issue, we now relax the homogeneity of preferences assumption.

The structure of the game remains the same as in Section III.A, except that we now assume that two possible types of citizens exist in the population (e.g. Democrat D, or Republican R), each

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we could always replicate the *equilibrium values* of the microfounded asymmetric loss function by choosing the correct weights in (37).

[44]Using the word "bias" here may be somewhat misleading, since higher average inflation is *optimal* for this social loss function (as opposed to the standard inflation bias that is suboptimal and is due to inefficient lack of credibility).

with different preferences regarding the inflation-output trade-off: i.e. $\lambda_D > \lambda_R > 0$ in (22). These preferences are common knowledge and constant over time for all but one individual, the median voter. The preferences of the median voter are varying over time according to a random walk process. Let us index by m_t $(-m_t)$ the group of citizen that shares the same preferences as that of the median voter at time $t = 1, 2$, i.e., the majority (the opposition); The (potential) shift in the preferences of the median voter occur at the same time as q_2 is formed (i.e., before the election).

Myopic Equilibrium

Two cases need to be analyzed: (1) the officeholder is a member of the majority ($o = m \in \{D, R\}$); and (2) the officeholder has different preferences than the majority ($o = -m$).

The Officeholder Belongs to the Majority ($o = m$). In this case, the officeholder's maximization problem is the same as in Section III.A, "Equilibrium and Welfare," namely: $\max_{\{e,i,\pi\}} -\sum_a \sum_s q^a f_s(e, \theta_a) L_m^{S\sigma} + R - c(e)$. The associated equilibrium level of effort and of the macroeconomic variables is therefore the same as in Section III.A, "Equilibrium and Welfare." However, the expected utility of a citizen c ($c \in \{D, R\}$ and $c \in \{m, -m\}$) now depends on his preferences and that of the officeholder o:

$$v^c(o = m) = -\sum_a \sum_s q^a f_s(e^*(q), \theta_a) L_c^s(q, \lambda_m) \tag{38}$$

where

$$L_c^{S\sigma}(q, \lambda_m) = \frac{\pi^*_{S\sigma}(q, \lambda_m)}{2} + \frac{\lambda_c}{2} \begin{pmatrix} \tilde{x} + \varepsilon r_S^*(q, \lambda_m) \\ +\varepsilon\tilde{\pi} - \varepsilon i_\sigma^*(q, \lambda_m) \end{pmatrix}^2 + \gamma_{S\sigma} \begin{pmatrix} \pi^*_{S\sigma}(q, \lambda_m) - k\tilde{x} \\ -k\varepsilon r_S^*(q, \lambda_m) \\ +k\varepsilon i_\sigma^*(q, \lambda_m) - (\beta + k\varepsilon)\tilde{\pi} \end{pmatrix} \tag{39}$$

so that $v^{c=m}(o = m) > v^{c=-m}(o = m)$.

The Officeholder Does Not Belong to the Majority($o = -m$).[45] This is the interesting case since there is then a *conflict of interest* between the central banker and the majority of the population. Two cases can potentially exist: (1) the central banker is both instrument and goal independent, and (2) the central banker is instrument independent but goal dependent.

The analysis of the first case is trivial from our previous analysis and is omitted. As for the second case, in our setup, a simple and feasible mechanism that holds the central banker goal dependent is to alter his private net rent from office from $R - c(e)$ to $R + \omega^s - c(e)$, where ω^s is a state

[45] This case only occurs in the Appointment regime.

contingent transfer[46] determined by the second-period politician.[47] An obvious choice is to have $\omega^s = \sum_s q^a f_s(e,\theta_a)\left[-\frac{1}{2}\lambda_m (x^s)^2 + \frac{1}{2}\lambda_{-m}(x^s)^2\right]$, since, in that case, the officeholder's problem becomes: $\max_{\{e,i,\pi\}} -\sum_a \sum_s q^a f_s(e,\theta_a) L^s_{-m} + R + \omega^s - c(e)$, which is equivalent to $\max_{\{e,i,\pi\}} -\sum_a \sum_s q^a f_s(e,\theta_a) L^s_m + R - c(e)$: i.e. the same problem as when the officeholder shares the majority's preferences. The equilibrium allocations are therefore the same as in Section III.A, "Equilibrium and Welfare," while the expected utilities of the various players differ depending on whether they belong to the majority or not:

$$v^c(o=-m) = -\sum_a \sum_s q^a f_s(e^*(q,\lambda_m),\theta_a) L^s_c(q,\lambda_m) \tag{40}$$

Therefore, $v^o(o=-m) > v^{c=m}(o=-m) > v^{c=-m}(o=-m)$.

Dynamic Equilibrium

Under Appointment. There is a probability $1-m$ that the median voter's preferences shift in the second period (which leads to the election of a politician with preferences that differ from those of the central banker). For illustration purposes, let us assume that the central banker is of type $c=D$, as is the first-period majority. Then, the central banker's first-period problem now becomes: $\max_{\{e_1,i_1,\pi_1\}} E^\theta_1 E^S_1[v^o_1] + E^m_1 E^\theta_1 E^S_1[v^o_2(q_2(e_1))]$, or

$$\begin{aligned}
&\max_{e_1,i_1,\pi_1} -\sum_a \sum_{s_1} q^a_1 f_{s_1}(e_1,\theta_a) L^{s_1}_D(q_1,\lambda_D) + R - c(e_1) \\
&-m\sum_a \sum_{s_1} q^a_1 f_{s_1}(e_1,\theta_a) \sum_{s_2} f_{s_2}(e_2(q_2^{s_1}(e_1)),\theta_a) \begin{bmatrix} L^{s_2}_D(q_2^{s_1}(e_1),\lambda_D) \\ -R + c(e_2(q_2^{s_1}(e_1))) \end{bmatrix} \\
&-(1-m)\sum_a \sum_{s_1} q^a_1 f_{s_1}(e_1,\theta_a) \sum_{s_2} f_{s_2}(e_2(q_2^{s_1}(e_1)),\theta_a) \begin{bmatrix} L^{s_2}_G(q_2^{s_1}(e_1),\lambda_G) \\ -R + c(e_2(q_2^{s_1}(e_1))) \end{bmatrix}
\end{aligned} \tag{41}$$

where the second-period loss function $L^{s_2}_G(q,\lambda_G)$, $G \in \{D,R\}$ depends on whether or not the central banker is goal dependent or not. If the majority shifts and the central banker of type D is goal independent then $L^{s_2}_G(q,\lambda_G) = L^{s_2}_D(q,\lambda_D)$; however, if the central banker is goal dependent, then he is offered a contract ω^s that aligns his preferences to that of a citizen $c=R$ (the new majority) so that $L^{s_2}_G(q,\lambda_G) = L^{s_2}_R(q,\lambda_R)$.

Under Democracy. Compared to the game analyzed in Section II.B "Dynamic Effort Level Under Democracy," the politician can now be fired for two reasons: (1) a majority shift, and (2)

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[46]The state-contingent transfer is only one way through which a new majority can alter the behavior of the central banker. Arguably this is not a very realistic one but is made here only for the sake of simplicity of exposition. A more realistic approach would be to have the new majority / politician choose an inflation target for the central banker.

[47]The state-contingent benefit is financed by taxing the n citizens in the economy an amount ω^s/n. However, if n is large, this tax becomes infinitesimal and can be neglected. This is our working assumption.

incompetence, which we analyze in turn.

First, assuming again that the initial majority is $m = D$, if a majority shift arises (an event occurring with probability $1 - m = 1/2$), provided $A.2.$ below holds, the incumbent $l \in D$ is replaced with an opponent $k \in R$ in the second period of the game. The expected utility to any citizen $R \neq k$ from electing the opponent is $v_2^{c=R}(q_1, o = R)$, while the expected utility of any citizen D is $v_2^{c=D}(q_1, o = R) < v_2^{c=R}(q_1, o = R)$.

A.2. $v_2^{c,m_2}(q_1, o = m_2) > v_2^{c,m_2}(q_2, o = -m_2)$.

which just says that, if a new majority arises in period 2, its members always prefer to have an officeholder who shares their own preferences, regardless of the current incumbent's expected ability q_2 (an officeholder's "ideology" is a more salient issue than his "ability" for voters).

Second, provided the majority does not change from period 1 to 2, if the politician $l \in D$ does not appear to be competent enough (specifically $q_2 < q_1$), he is replaced by an opponent $k \in D$ in period 2 (as in Section II.B "Dynamic Effort Level Under Democracy"). The expected utility to any citizen $D \neq k$ from electing the opponent is $v_2^{c=D}(q_1, o = D)$, while the expected utility of any citizen R is $v_2^{c=R}(q_1, o = D) < v_2^{c=D}(q_1, o = D)$.

The second-period equilibrium continuation payoff of the incumbent $l \in m_1$ conditional on S_1, σ_1, e_1 and m_2 is

$$w(S_1, \sigma_1, m_2, e_1) = \begin{cases} v_2^o(q_2, o = m_1), & \text{if } (S_1, \sigma_1) = \{HR, LR\} \text{ and } m_2 = m_1 \\ v_2^c(q_1, o = m_2), & \text{if } m_2 = -m_1 \end{cases} \tag{42}$$

So, the expected second-period continuation payoff of the incumbent $l \in m_1$, conditional on first-period effort, $E[w(.)]$ is equal to

$$\begin{aligned} &-m \sum_a q_1^a \left\{ \begin{array}{r} \sum_R f_R(e_1, \theta_a) \sum_s f_s\left(e_2\left(q_2^R(e_1), o = m_1\right), \theta_a\right) \left[\begin{array}{c} L_{m_1}^s - R \\ +c\left(e_2\left(q_2^R(e_1)\right)\right) \end{array} \right] \\ + \sum_W f_W(e_1, \theta_a) \sum_s f_s\left(e_2(q_1, o = m_1), \theta_a\right) L_{m_1}^s \end{array} \right\} \\ &-(1-m) \sum_a q_1^a \sum_s f_s(e_1, \theta_a) \sum_s f_s\left(e_2(q_1, o = m_2), \theta_a\right) L_{m_1}^s(o = m_2) \end{aligned} \tag{43}$$

Given the continuation payoff (43), the choice of first-period policies and effort of the incumbent solves $\max_{e_1} E_1^\theta E_1^S [v_1^o] + E_1^\theta E_1^m E_1^S [w(.)]$.

Goal (In)Dependence and Welfare

We can now analyze the pros and cons of goal independence, both from the politician's viewpoint and from society's.

From Section III.A, "Equilibrium and Welfare," we know that a politician only finds delegation

of monetary policy worthwhile if the appointed central banker is given a long-term employment contract (which we assume to be legally binding). With homogenous citizen preferences, the only relevant term of this contract is the length of employment. Now, with heterogenous preferences, it is easy to see that the politician who is writing the initial contract with the central banker has a *private incentive*[48] to give the central banker a fixed goal/ fixed preferences, i.e., to have a central bank that is *both instrument and goal independent*. Arguably, such a regime could describe the U.S. Federal Reserve Board. The Board is clearly instrument independent and, given that its mandate is cast in very broad terms and covers conflicting tasks (to pursue both "maximum employment" and "stable prices"), its governing body is de facto the one that interprets and assigns relative weights among those objectives: i.e. it is goal independent.

Having established that goal independence is *privately optimal* for a politician (should he decide to delegate monetary policy), Proposition 7 analyzes whether it is also *socially optimal*:

Proposition 7. (Goal independence and social welfare). *Compared to a regime where the tenured central banker is goal dependent, granting goal independence to a tenured central banker (1) lowers welfare of the future majority of the population to the benefit of the future minority (if there is a majority change from period 1 to 2); (2) always decreases expected social welfare if the gains and losses are symmetric.*

Proof. Assuming the first-period majority is $m_1 = D$, expected total utility W^c of the two types of citizens is the following: (1) with a goal independent central bank, $W^{c=D} = E\left[v_1^{c=D}(o=D)\right] + mE\left[v_2^{c=D}(o=D)\right] + (1-m)E\left[v_2^{c=D}(o=D)\right]$ and $W^{c=R} = E\left[v_1^{c=R}(o=D)\right] + mE\left[v_2^{c=R}(o=D)\right] + (1-m)E\left[v_2^{c=R}(o=D)\right]$; (2) With a goal dependent central bank: $W^{c=D} = E\left[v_1^{c=D}(o=D)\right] + mE\left[v_2^{c=D}(o=D)\right] + (1-m)E\left[v_2^{c=D}(o=R)\right]$ and $W^{c=R} = E\left[v_1^{c=R}(o=D)\right] + mE\left[v_2^{c=R}(o=D)\right] + (1-m)E\left[v_2^{c=R}(o=R)\right]$. So, the only difference across the two regimes concerns the case where there is a majority change in the second period, an event occurring with probability $1-m$: i.e. $E\left[v_2^{c=D}(o=D)\right] + E\left[v_2^{c=R}(o=D)\right]$ versus $E\left[v_2^{c=D}(o=R)\right] + E\left[v_2^{c=R}(o=R)\right]$, where, given *A.2.*, $E\left[v_2^{c=D}(o=D)\right] > E\left[v_2^{c=D}(o=R)\right]$ and $E\left[v_2^{c=R}(o=D)\right] < E\left[v_2^{c=R}(o=R)\right]$. However, since in that case type-D citizens now belong to the minority, with symmetric loss functions, goal independence increases the expected utility of the minority while decreases that of the majority compared to goal dependence. □

The intuition for Proposition 7 is that when delegation occurs, the majority of the time appoints a central banker who shares its goals/preferences; if the next majority does not share these

[48]It also seems that, ceteris paribus, the politician also has an incentive to marginally increase the length of the central banker's contract (although, given our simple two-period structure, we cannot directly address this (interesting) issue.

preferences, with a goal independent and tenured central banker, this majority's welfare is lower than if it could set the goal of the central banker. For the first-period politician and his supporting majority, a goal independent central bank has clear benefits: it *constrain the policy decisions of the future majority.*

Since goal independence is privately optimal for a politician but is not socially optimal, can society establish a mechanism (which constrains the private incentive of the partisan politician) and which is Pareto improving? One feature that is widespread in representative democracies is the following:

A.3. *A constitution exists and states that institutional regime changes (such as central bank independence) require a supermajority of the voting population.*

which we take as given in our model.[49] (Recall that the politician only has a simple majority of the population: he is elected by the median voter.) The politician however retains the initiative, i.e., he decides whether to propose delegation or not. Given $A.3$, institutional changes can only occur in our model if the two types of agents (D and R) agree on the regime change.

Given the assumed constitution ($A.3$), we can now answer the issue of the socially optimal type of independence that the central bank should be given.[50]

Proposition 8. *Given A2-A3 and that the conditions for delegation are satisfied, goal independence is not a politically feasible outcome, whereas goal dependence is both politically achievable and socially optimal.*

Proof. From Proposition 7, it is clear that, in period 1, the opposition group (minority) will never vote for a regime where monetary policy is delegated to a goal independent central bank since,

[49]This could easily be endogenized by adding a "constitutional" stage prior to the beginning of the game but does not add any benefit.

[50]The following example shows that it is possible to find parameter values under which a *partisan* politician endogenously decides to delegate monetary policy to a central banker even though the next majority might have different preferences than the current politician and would impose its *goal* (preferences) onto the central banker. The payoffs of the various players are (expressed in thousands)

$$v^{cb}\left(Appoint.\right) = 16.6 > v^{c=D}\left(Appoint.\right) = 13.8 > v^{o=D}\left(Demo.\right) = v^{c=D}\left(Demo.\right) = 13.7$$

where the parameters are: $k = 0.0908$, $\varepsilon = 6$, $\beta = 0.9605$, $\lambda_D = 1.3 * 0.0464$, $\lambda_R = 0.7 * 0.0464$, $x^* = 0$, $\pi^* = 0$, $r^H = 0.10$, $r^L = 0.02$, $p = q_1 = m = 0.5$, $\theta_H = 1$, $\theta_L = 0.01$, and $u = -0.1$. $R - c\left(e^*\left(q_1\right)\right) \simeq 0 = 1.10^{-6}$.The functional form $c(e)$ is $c(e) = \alpha_1 e + \alpha_2 e^2/2$ with $\alpha_1 = -1$, and $\alpha_2 = 3$. We assume that the first-period majority is D.

compared to the alternative (a goal dependent central bank), its expected utility is lower. But, given $A.3$, for a regime proposal to be accepted, it needs to gain the support of both types of agents (D and R); a goal independent central bank is therefore not a feasible political outcome. From Proposition 4 , we know that, when it is incentive compatible for the first-period politician to have instrument independence, the benefits arising from high effort (better forecasts) outweigh the cost of reduced expected ability of the officeholder. It is also trivial to see that both groups of citizens (D and R) also get higher welfare from an instrument independent but goal dependent central banker than from a politician as the officeholder. □

C. Empirical Predictions and Evidence

We now turn to the key predictions of our political agency theory of central bank independence:

- Independent central banks produce, on average, lower inflation, both in terms of level and variability.[51]
- Independent central banks generate, on average, lower output variability.
- The longer the tenure of central bank governors, the lower are the first two moments of inflation and the volatility of the output gap.
- Central bank independence should only occur in situations where the governing body of the central bank has a longer job contract than elected politicians.[52]
- The more corrupt a country, the less independent its central bank should be (since politicians can extract more rent from office).

The first two predictions have been extensively tested in the literature since the existing inflation-bias-based models of CBI also give predictions regarding the correlation between central bank independence and macroeconomic variables such as inflation and output. From these empirical studies, a consensus has emerged on a few "stylized facts," even though some of these are still disputed and their robustness questioned (see, e.g., Drazen (2000), Persson and Tabellini (2000), and Berger et al. (2002) for a review of this literature). With this caveat in mind, we now confront our theoretical predictions with these "stylized facts."

The first prediction of our model, the link between inflation's first two moments and CBI, is supported by the data. In fact this relationship is a key stylized fact of the empirical literature (see, e.g., Grilli et al. (1991); and Alesina and Summers (1993) for early studies on the mean of inflation and Cukierman (1992) on its variance).

The second prediction has not been widely tested in the literature since existing inflation-bias-

[51]This arises in our model because, when monetary policy is delegated, the central banker supplies more effort in forecasting shocks, thereby getting more accurate forecasts and less policy errors.

[52]Since otherwise, according to our theory, the politician, and society, would be better off with the politician setting monetary policy.

based theories either predict higher or no output variability associated with CBI.[53] The data strongly reject the former prediction and seem to accept the latter. Recent studies, however, (e.g., Lippi, 1998) find evidence of a statistically significant negative correlation between CBI and output variability. A result that we confirm below. We also present supportive evidence on our other predictions.

To test our predictions, we use a cross-country data set on central bank governors' turnover ("Turnover" variable) over the period 1980-89 first developed by Cukierman (1992) and later extended to 82 developing countries by de Haan and Kooi (2000).[54] Our sample then covers 100 developed and developing countries. The frequency of elections data come from the Database on Political Institutions from the World Bank (Beck et al., 1999).[55] From the turnover rate of governors and the frequency of elections, we construct a variable, "TurnElec," which is the difference between the former and the latter, i.e., how long is the tenure of a central bank governor compared to the electoral cycle. Our theory predicts that this variable is indicative of the degree of independence of a central bank. Indeed, while the turnover of the monetary policy decision maker is crucial in our model to explain a better (or worse) macroeconomic performance, the cross-country data on the turnover of central bank governor that we have are silent about where the real monetary policy decision making rests (i.e., governor or treasury). The difference between the turnover of the governor and the frequency of the electoral cycle is, according to our theory, an indicator of this *real authority* and therefore a better indicator of central bank independence than the simple turnover of central bank governors. Another important variable, according to our theory, is a politician's rent from office. One aspect of this rent[56] is the degree of "corruption within the political system" (Corrupt variable) as evaluated by the International Country Risk Guide (2002), a private international risk service company. Corrupt is a dummy variable taking a value of 0 (1) for countries without (with) important corruption problems.

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[53]An exception is Schellekens (2002), which is based on Rogoff (1985). Schellekens shows that Rogoff's prediction of a positive correlation between CBI and output volatility can be overturned by relaxing assumptions about uncertainty and preferences.

[54]As shown by Cukierman (1992) the turnover of central bank governors is a good indicator of actual central bank independence in developing countries (as opposed to a legal indicator of independence) since the enforcement of the law might be weak. In our model, the Turnover variable is *not* a proxy for actual independence but a key factor *directly affecting* the macroeconomic variables.

[55]This database reports all national elections that take place in a country, but since we are only interested in elections of the executive, we use DPI's classification of countries' political systems (presidential or parliamentary regime) and retain only the relevant elections (executive or legislative) to calculate the frequency of elections in a given country.

[56]This view of the rents from office abstain from the "ego" rents that an officeholder might derive because of the sheer prestige/status of being in office. These are certainly important but difficult to quantify. Hence our focus on corruption.

Finally, the macroeconomic variables (inflation—the change in the CPI: π—and unemployment as a percentage of the labor force (U)—our measure of the output gap) come from the IMF's *International Financial Statistics*.

Table 4 reports some cross-country regressions (similar to those that exist in the empirical literature on central bank independence).

Table 4: OLS Regression Results

	D	D	D	D	$Sd\pi$	$Sd\pi$	$Sd\pi$	$Sd\pi$	SdU	SdU	SdU	SdU	TurnElec
Turnover	0.10	0.10			11.9	11.3			3.2	2.1			
	[.00]	[.00]			[.00]	[.00]			[.02]	[.11]			
TurnElec			0.10	0.09			13.3	12.0			2.7	1.3	
			[.00]	[.00]			[.00]	[.00]			[.02]	[.25]	
Corrupt		0.05		0.04		5.5		3.7		0.64		0.53	0.24
		[.00]		[.00]		[.00]		[.07]		[.34]		[.46]	[.00]
Adj. R^2	0.10	0.21	0.15	0.22	0.09	0.18	0.17	0.22	0.07	0.03	0.06	0.01	0.14
Nb. obs.	100	87	100	87	100	87	100	87	72	68	72	68	87

where $D = \pi/(1+\pi)$ follows from Cukierman (1992); D is a transformed inflation rate (π) so as to reduce potential heteroskedasticity problems.[57] $Sd\pi$ and SdU refer to the standard deviation of inflation and unemployment, respectively. p-values in brackets.

As can be seen, the above regressions confirm the predictions of the model: both the level and the variability (standard deviation) of inflation are positively and significantly affected by the turnover of central bank governors, and also by the difference between governors' turnover and the frequency of elections (which, as argued, better captures the true degree of independence of a central bank). Interestingly, this latter variable is significantly better at explaining the level and variability than the central bank governor tenure variable (see adjusted R^2). Controlling for corruption, which our theory predicts affects the incentive to delegate monetary policy, does not change these results. Finally, the last column shows that, as predicted, the higher corruption within the political system, the lower the incentive to establish an independent central bank (as measured by TurnElec).

We now finish our look at the data by noting that our baseline model of Section III.A (i.e., with homogenous preferences and only an experimentation motive as a rationale for CBI) can replicate the inflation variability that is observed across regimes (politically dependent and independent

[57]Note that, to avoid having our results being driven by hyperinflation episodes, observations where the level and variability of the inflation rate are above 100 percent have been dropped. Alternative thresholds do not noticeably change our results

monetary policy regimes). Following Cukierman (1992), we use the turnover of central bank governors as our measure of central bank independence. In particular, we classify countries as having an independent (dependent) central bank if the governor's turnover is lower (higher) than the sample mean. Once hyperinflation episodes are dropped from the sample, inflation variability across regimes is between 10 to 25 percent (depending on how strictly one defines high-inflation countries). Our calibration is the following example:

Example 4. (Matching the inflation volatility observed in the data across regimes.) Following Rotemberg and Woodford (1997), we calibrate the parameters of the model of Section III.A as $k = 0.0227$, $\varepsilon = 6$, $\beta = 0.99$, and $\lambda = 0.0029$. These calibration parameters apply to quarterly data and we change them to imply that each period is 4 years. Furthermore we assume that $x^* = 0$, $\pi^* = 0$, $r^H = 0.10$, $r^L = 0.02$ in one year units, $R = 0.14$, $p = 0.5$, $q_1 = 0.5$, $\theta_H = 1.39$, $\theta_L = 0.36$, and $u = 0$. The functional form $c(e)$ is $c(e) = \alpha_1 e + \alpha_2 e^2/2$ with $\alpha_1 = 0.5$, and $\alpha_2 = 0.5$. With this calibration, we find that the average volatility (of periods one and two) is 24.6 percent higher in the regime where monetary policy is not independent than in the regime where it is delegated to an independent central banker with a long term of office.[58]

IV. Conclusion

Why would an office-motivated politician spontaneously decide to delegate his monetary policy prerogative to an independent but accountable central bank? In this paper we have developed a theory of central bank independence that provides an answer to this question, and does so in a framework that is radically different from existing theories of CBI (which all rely on the presence of an inflation bias in monetary policy as the underlying reason for delegation). Our theory does not rely on the existence of an inflation bias: all agents have the same (imperfect) information;[59] no citizen is ever fooled, even to his own benefit.

The proposed rationale for delegating monetary policy to an independent central banker is that he is given a long term job contract; this, in turn, enables the central banker to commit more effort into the conduct of monetary policy than an elected politician could ever afford to. This extra effort translates, in expectations, in better forecasts and fewer policy mistakes, which increases social welfare.

We find that, when the conditions for delegation are satisfied, a politician's *private* incentive is to delegate monetary policy to a central bank that is both instrument and goal independent. Although

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[58]For this particular calibration, the equilibrium payoffs of the different agents in this economy, and under each regime are $v^o\,(Dem.) = -1.81 < v^{cb}\,(Appt.) = -1.74$, and $v^c\,(Appt.) = -1.74$, $v^c\,(Dem.) = -1.99$; Delegation is therefore in the politician's interest.

[59]The office-holder's choice of effort is his private information but, in equilibrium, voters perfectly infer this level. So, in equilibrium, all citizens in this economy have the same information set.

instrument independence is welfare enhancing for society, goal independence is not (it benefits the current majority of the population at the expense of the future majority). A goal dependent central bank can however arise if the politician is constrained by a constitution requiring a supermajority of the population/parliament to agree on institutional changes.

The advantages of our novel approach are the following. First, it is consistent with Alan Blinder's (1998) description of the rationale for delegating monetary policy to an independent agency, namely that "monetary policy, by its very nature, requires a *long time horizon*"; a crucial feature of our model. Second, our model is also immune to the critiques on the foundation of existing CBI theories: the existence of an inflation bias as a rationale for independence.

Third, our political agency framework offers a new view on the debate between *goal* and *instrument* independence. Scholars of central banking have repeatedly emphasized this difference (e.g. Debelle and Fischer (1994), Blinder (1998)), stressing that CBI and democracy are not antagonistic; Our model accords with this view (as does most of the contracting approach CBI literature). The advantage of our framework, we believe, is a contracting environment that better describes the types of incentives available in the public sector; whereas existing theories rely on *explicit* incentive contracts (financial rewards or penalties for achieving a target) in alleviating/eliminating the inflation bias and therefore providing a rationale for CBI, our approach relies on *implicit* incentives (i.e. concerns for you future career prospects). It is well known that explicit incentives are relatively low powered in public organizations but that implicit incentives play a prominent role (Wilson, 1989). We have also shown why goal independent central banks can emerge even though a goal dependent central bank leads to higher social welfare.[60]

Fourth, it enables us to address the *endogeneity criticism* highlighted by Posen (1993, 1995): namely, (1) that independent central banks reflect the preferences of society (independence can only occur, in our model, if an elected politician decides it is in society's (or at least the majority's) welfare; moreover, the central banker remains accountable to an elected representative); and (2) that the effectiveness of laws and institutions in providing for a truly independent central bank depends on the political support given to its goal(s).

Our alternative rationale for CBI could help explain why, in recent years, many economies have been actively increasing the independence of their central bank. According to our model, the sharp increase in the frequency of elections across the world during the 1990s compared to previous decades played a major role. Other key variables, despite being difficult to quantify, would be an increase in the complexity of conducting monetary policy, and a decrease in the rent that politicians derive from running monetary policy themselves.

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[60]It increases the welfare of the politician (and those that share his preferences) that establishes the initial contract with the central banker.

MATHEMATICAL APPENDIX

A. Properties of the Myopic Equilibrium

From (6), we can derive some useful properties of e^* and the associated value functions $v^o(.)$, $v^c(.)$. First, e^* :

$$\frac{\partial e^*}{\partial q} = \frac{(\theta_H - \theta_L)\left[L^{HW} - L^{HR} + L^{LW} - L^{LR}\right]}{c''(e^*)} > 0 \tag{44}$$

So e^* is strictly increasing in q. Now, turning to the value functions, by direct application of the envelope theorem to $v^o(e(q), q)$ we have

$$\frac{\partial v^o(e(q), q)}{\partial q} = e^*(q)(\theta_H - \theta_L)\left[L^{HW} - L^{HR} + L^{LW} - L^{LR}\right] > 0 \tag{45}$$

So v^o is strictly increasing in q. By inspection of (44), v^c is also increasing in q. Moreover, as $R > 0$, and by the properties of $c(.)$, $v^o(q) > 0$, and by inspection, $v^c(q) > 0$.

B. Posterior Beliefs

Before turning to the derivation of the posteriors beliefs themselves, we need the following assumption: $\Pr(\sigma_t = \sigma^H \mid e_t, \theta, S_t = S^H) = \Pr(S_t = S^H \mid e_t, \theta, \sigma_t = \sigma^H) \equiv f_{HR}(e_t)$, $\Pr(\sigma_t = \sigma^H \mid e_t, \theta, S_t = S^L) = \Pr(S_t = S^L \mid e_t, \theta, \sigma_t = \sigma^H) \equiv f_{HW}(e_t)$, $\Pr(\sigma_t = \sigma^L \mid e_t, \theta, S_t = S^L) = \Pr(S_t = S^L \mid e_t, \theta, \sigma_t = \sigma^L) \equiv f_{LR}(e_t)$, and that $\Pr(\sigma_t = \sigma^L \mid e_t, \theta, S_t = S^H) = \Pr(S_t = S^H \mid e_t, \theta, \sigma_t = \sigma^L) \equiv f_{LW}(e_t)$. These assumptions require that $\Pr(\sigma_t = \sigma^H) = \Pr(S_t = S^H) = p$ which is not unreasonable.

Using Bayes rule, we can now derive the four posteriors associated with the four possible states $s \in \{HR, LR, HW, LW\}$, i.e.

$$\begin{aligned}
q_2^{HR} &\equiv \Pr(\theta = \theta_H \mid e_1, S_1 = S^H, \sigma^H) = \frac{q_1}{q_1 + (1-q_1)\frac{p+\theta_L e_1}{p+\theta_H e_1}} \\
q_2^{HW} &= \Pr(\theta = \theta_H \mid e_1, S_1 = S^H, \sigma_1 = \sigma^L) = \frac{q_1}{q_1 + (1-q_1)\frac{1-p-\theta_L e_t}{1-p-\theta_H e_t}} \\
q_2^{LR} &= \Pr(\theta = \theta_H \mid e_1, S_1 = S^L, \sigma_1 = \sigma^L) = \frac{q_1}{q_1 + (1-q_1)\frac{1-p+\theta_L e_t}{1-p+\theta_H e_t}} \\
q_2^{LW} &= \Pr(\theta = \theta_H \mid e_1, S_1 = S^L, \sigma_1 = \sigma^H) = \frac{q_1}{q_1 + (1-q_1)\frac{p-\theta_L e_t}{p-\theta_H e_t}}
\end{aligned}$$

It is also useful to derive $\partial q_2^s(e_1)/\partial e_1$:

$$\frac{\partial q_2^{S^iR}(e_1)}{\partial e_1} = \frac{\Pr(S=S^i)\,q_1(1-q_1)(\theta_H-\theta_L)}{\{\Pr(S=S^i)+e_1[q_1\theta_H+(1-q_1)\theta_L]\}^2};\quad i\in\{H,L\}$$
$$\frac{\partial q_2^{S^iW}(e_1)}{\partial e_1} = -\frac{\Pr(S=S^i)\,q_1(1-q_1)(\theta_H-\theta_L)}{\{\Pr(S=S^i)-e_1[q_1\theta_H+(1-q_1)\theta_L]\}^2};\quad i\in\{H,L\}$$

It is easy to see that $\partial q_2^W(e_1)/\partial e_1 \leq 0$, $\partial q_2^R(e_1)/\partial e_1 \geq 0$, and that, with $p=1/2$,

$$\left|\frac{\partial q_2^R(e_1)}{\partial e_1}\right| = \left|\frac{\frac{1}{2}q_1(1-q_1)(\theta_H-\theta_L)}{\left\{\frac{1}{2}+e_1E_1[\theta]\right\}^2}\right| < \left|\frac{\partial q_2^W(e_1)}{\partial e_1}\right| = \left|\frac{-\frac{1}{2}q_1(1-q_1)(\theta_H-\theta_L)}{\left\{\frac{1}{2}-e_1E_1[\theta]\right\}^2}\right|$$

where $E_1[\theta]=q_1\theta_H+(1-q_1)\theta_L$.

C. Proof of Proposition 6 (Derivation of the Inflation Bias)

From the first order condition, after some direct manipulations, we find that

$$\begin{aligned} i^H = {} & \frac{(f_{HR}\mu^{HR}k^2\varepsilon + f_{HR}\varepsilon\mu^{HR}\lambda)}{f_{HR}\mu^{HR}k^2\varepsilon + f_{HW}\mu^{HW}k^2\varepsilon + f_{HR}\varepsilon\mu^{HR}\lambda + f_{HW}\varepsilon\mu^{HW}\lambda}r^H \\ & + \frac{f_{HW}\mu^{HW}k^2\varepsilon + f_{HW}\varepsilon\mu^{HW}\lambda}{f_{HR}\mu^{HR}k^2\varepsilon + f_{HW}\mu^{HW}k^2\varepsilon + f_{HR}\varepsilon\mu^{HR}\lambda + f_{HW}\varepsilon\mu^{HW}\lambda}r^L \\ & + \frac{\left\{\begin{array}{c}(f_{HR}\mu^{HR}k^2\varepsilon + f_{HW}\mu^{HW}k^2\varepsilon + f_{HR}\varepsilon\mu^{HR}\lambda + f_{HW}\varepsilon\mu^{HW}\lambda)(\tilde{x}+\varepsilon\tilde{\pi}) \\ -(f_{HR}\mu^{HR}k\varepsilon + f_{HW}\mu^{HW}k\varepsilon)((\beta+k\varepsilon)\tilde{\pi}+u)\end{array}\right\}}{f_{HR}\mu^{HR}k^2\varepsilon + f_{HW}\mu^{HW}k^2\varepsilon + f_{HR}\varepsilon\mu^{HR}\lambda + f_{HW}\varepsilon\mu^{HW}\lambda} \end{aligned}$$

and

$$\begin{aligned} i^L = {} & \frac{(f_{LR}\mu^{LR}k^2\varepsilon + f_{LR}\varepsilon\mu^{LR}\lambda)}{f_{LR}\mu^{LR}k^2\varepsilon + f_{LW}\mu^{LW}k^2\varepsilon + f_{LR}\varepsilon\mu^{LR}\lambda + f_{LW}\varepsilon\mu^{LW}\lambda}r^L \\ & + \frac{f_{LW}\mu^{LW}k^2\varepsilon + f_{LW}\varepsilon\mu^{LW}\lambda}{f_{LR}\mu^{LR}k^2\varepsilon + f_{LW}\mu^{LW}k^2\varepsilon + f_{LR}\varepsilon\mu^{LR}\lambda + f_{LW}\varepsilon\mu^{LW}\lambda}r^H \\ & + \frac{\left\{\begin{array}{c}(f_{LR}\mu^{LR}k^2\varepsilon + f_{LW}\mu^{LW}k^2\varepsilon + f_{LR}\varepsilon\mu^{LR}\lambda + f_{LW}\varepsilon\mu^{LW}\lambda)(\tilde{x}+\varepsilon\tilde{\pi}) \\ -(f_{LR}\mu^{LR}k\varepsilon + f_{LW}\mu^{LW}k\varepsilon)((\beta+k\varepsilon)\tilde{\pi}+u)\end{array}\right\}}{f_{LR}\mu^{LR}k^2\varepsilon + f_{LW}\mu^{LW}k^2\varepsilon + f_{LR}\varepsilon\mu^{LR}\lambda + f_{LW}\varepsilon\mu^{LW}\lambda} \end{aligned}$$

The values for inflation are:

$$\begin{aligned} \pi^{HR} &= k\tilde{x} + k\varepsilon r^H + u - k\varepsilon i^H + (\beta+k\varepsilon)\tilde{\pi} \\ \pi^{HW} &= k\tilde{x} + k\varepsilon r^L + u - k\varepsilon i^H + (\beta+k\varepsilon)\tilde{\pi} \\ \pi^{LR} &= k\tilde{x} + k\varepsilon r^L + u - k\varepsilon i^L + (\beta+k\varepsilon)\tilde{\pi} \\ \pi^{LW} &= k\tilde{x} + k\varepsilon r^H + u - k\varepsilon i^L + (\beta+k\varepsilon)\tilde{\pi} \end{aligned}$$

which leads to the following value for expected inflation

$$E[\pi] = f_{HR}\pi^{HR} + f_{HW}\pi^{HW} + f_{LR}\pi^{LR} + f_{LW}\pi^{LW}$$

The proposition can be proved by taking a partial derivative of this expectation with respect to e and show that it is negative. This can be verified to be the case by inspecting the equations above.

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