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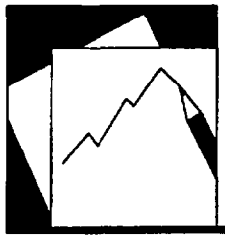

IMF Working Paper

On the Long and Short of Central Bank Independence, Policy Coordination, and Economic Performance

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On the Long and Short of Central Bank Independence, Policy Coordination, and Economic Performance

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Abstract

This paper examines the implications of central bank independence for equilibrium macroeconomic performance. The focus is on institutional arrangements governing financial relationships between central banks and ministries of finance, in the presence of competing objectives and constraints across institutions. Abstracting from long-run considerations, higher central bank independence increases fiscal discipline and results in lower inflation and growth, generating a short-run institutional Phillips curve. In the presence of sufficiently strong negative long-run externalities of inflation onto growth, higher CBI also increases fiscal discipline and generates lower inflation, however, it also yields higher growth and generates an inverted institutional Phillips curve. Strikingly, higher central bank independence is found to be frequently sub-optimal for a wide set of stylized economies. Whether these economies are empirically relevant is an open question.

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I. INTRODUCTION

Economic programs, whether IMF supported or not, contain statements about the joint behavior of key macroeconomic variables such as fiscal deficits, money and credit growth, output growth, and inflation. Among other things these variables depend on institutional factors underlying the interaction between ministries of finance (MOFs) and central banks (CBs). Very often central bank independence (CBI) is a driving factor behind these institutional arrangements. Operationally, for policy makers and IMF staff alike, prior knowledge about the degree of CBI is important for assessing the credibility of announcements relating to the joint behavior of fiscal, monetary, growth and inflation targets.

To varying degrees, nominal anchors require some form of CBI, regardless of whether they are based on exchange rates or inflation targeting. The degree of CBI will have implications for restrictions on deficit financing and for coordinating competing objectives and constraints across CBs and MOFs.[2]

Theoretically, the case for CBI has been built on two strands of literature. First, indirect arguments favoring CBI as a solution to the time inconsistency and inflationary bias of discretionary monetary policy presume that CBI is a necessary and sufficient condition for rules rather than discretion.[3] This strand of literature also presumes that CBI is equivalent to central bank conservatism, or aversion to inflation. Furthermore, it is not clear whether an independent CB will necessarily conduct monetary policy based on rules, nor that rules can only be implemented by an independent CB.[4] Second, a more direct approach to CBI focuses on improved inflation performance associated with the coordination of monetary and fiscal policies.[5] This strand of literature emphasizes the role of private sector constraints on deficit financing of a consolidated public sector (CB and MOF), in the presence of rational expectations.

This paper focuses on unconsolidating objectives and constraints across CBs and MOFs, to examine implications of CBI on intra-public sector deficit financing and equilibrium

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[2] See Laurens and de la Piedra (1998).

[3] See Kydland and Prescott (1977), Barro and Gordon (1983), Rogoff (1985) for arguments favoring rules rather than discretion.

[4] This point is also made in Debelle and Fischer (1994).

[5] See Sargent and Wallace (1981) for initial discussion of inflationary finance in a rational expectations setting. More recently empirical sutudies have suggested a link between CBI, deficit financing, and monetization. See Berument (1998), Fry (1998), and Sikken and de Haan (1998).

macroeconomic performance. The paper abstracts from market-imposed constraints on private sector deficit financing, by focusing instead on institutional arrangements governing financial relationships between CBs and MOFs in the presence of competing objectives and constraints across institutions.

This paper finds that abstracting from long-run considerations, higher CBI increases fiscal discipline and results in lower inflation and growth, generating a Phillips curve driven by institutional factors. In the presence of sufficiently strong negative long-run externalities of inflation onto growth, higher CBI also increases fiscal discipline and generates lower inflation, however, it also yields higher growth and generates an inverted institutional Phillips curve. Strikingly, higher central bank independence is found to be frequently sub-optimal for a wide set of stylized economies. Whether these economies are empirically relevant is an open question.

Empirical results suggest that higher CBI is associated with lower inflation, both in developing and industrialized countries, while the effects of CBI on growth are not yet conclusive.[6] [7] Empirical measures of *legal* CBI have been constructed on the basis of several CB characteristics including its objectives, financial linkages to the MOF, and procedures for the appointment of governors.[8] For developing countries, the rate of turnover for CB governors has been used as a proxy for legal CBI.

While on paper, a CB may appear to be *legally* independent, the true degree of CBI is ultimately reflected by economic performance rather than by statutory factors. The CB law may suggest a certain degree of independence, but ultimately fiscal deficits, their financing, growth and inflation, will reflect the true degree of CBI. To a large extent, and mostly in developing countries, persistent double digit inflation rates are supported by MOF reliance on CB financing, frequently owing to underdeveloped tax collection systems and the absence of markets for government paper.[9] By formalizing the effect of institutional arrangements on equilibrium macroeconomic performance, this paper takes the first step in constructing

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[6] Grilli, Machiandro, and Tabellini (1991) and Cukierman, Webb, and Neypati (1992).

[7] Cukiermant et. al. (1993) find a positive relationship between CBI and long term growth. Their findings are related to the negative relationship between inflation and growth when cases of hyperinflation are included in the sample. Conversely, Debelle and Fischer (1994) suggest that, based on the Bundesbank's and Fed's performance, CBI and growth are negatively related along the business cycle. Finanlly, Schaling and Hoeberichts (1998) confirm that CBI is negatively related to inflation while the effects of CBI on growth are at best ambiguous.

[8] Grilli, Machiandro, and Tabellini (1991) and Cukierman, Webb, and Neypati (1992).

[9] In countries with persistent double digit inflation, seigniorage accounts for between 2 and 3 percent of GDP and for a significant portion of government revenues, World Economic Outlook (October 1996). Also see, Berument (1998), Fry (1998), and Sikken and de Haan (1998).

performance-based measures of CBI which may eventually obtain by taking the model to the data.

The paper is organized as follows. Section II outlines the basic short-run model where higher CBI imparts fiscal discipline into the economy and generates lower growth and inflation. Section III builds on the basic model by allowing for long-run effects of inflation on growth. The implications of CBI on performance are again examined. Section IV discusses optimal CBI by considering how decentralized institutional arrangements would maximize social welfare. Derivations are relegated to the Appendix. Figures and numerical simulations are used to illustrate results.

II. CENTRAL BANK INDEPENDENCE AND SHORT-RUN ECONOMIC PERFORMANCE

This section considers a continuum of institutional arrangements underlying the financial relationship between CBs and MOFs in the presence of competing objectives and constraints. For simplicity and tractability the exercise is carried-out in a stylized economy.

A. Competing objectives and constraints across institutions

Both the CB and the MOF know the response of period growth and inflation (1.1) to variations in money and to the budget deficit. The joint contributions of monetary and fiscal policy to growth and inflation are assumed to be non-negative so that $\lambda_1 + \lambda_2 \geq 0$ and $\eta_1 + \eta_2 \geq 0$ respectively. The stationary term A_t is known at the beginning of each period and could be a function of predetermined variables and/or shocks. It is distributed with mean μ_A and variance σ_A^2.[10] In the simplest case A_t could be a constant over time.

$$\begin{aligned} \gamma(\Delta M_t, D_t) &= \lambda_1 \Delta M_t + \lambda_2 D_t + A_t \\ \pi(\Delta M_t, D_t) &= \eta_1 \Delta M_t + \eta_2 D_t + A_t \end{aligned} \tag{1.1}$$

At the beginning of every period the CB considers a monetary program based on preferences over growth and inflation, and a balance sheet constraint (1.2). According to the balance sheet constraint, variations in money are equivalent to segniorage.[11] [12] The parameter $\alpha \geq \frac{1}{2}$

[10] The same predetermined stochastic variable is used for growth and inflation because this greatly simplifies the algebra without changing the fundamental results.

[11] A more realistic economy would include other variables in the CB's balance sheet constraint such as net credit to the private sector and variations in net international reserves. However, for the purpose of capturing the interaction between monetization, CBI and economic performance, the simplest balance sheet constraint suffices.

determines the CB's aversion to inflation and also its preferences over growth. The higher α the more averse the CB is to inflation and the less importance it attaches to growth. When considering a monetary program, the CB takes as given the budget deficit chosen by the MOF. Capital letters denote parametric variables for the CB while small case letters denote choice variables.

$$\begin{aligned} &\Omega(\Delta m_t, D_t) = (1-\alpha)\gamma(\Delta m_t, D_t) - \alpha\pi(\Delta m_t, D_t) \\ &st: \Delta m_t = \Delta s_t \end{aligned} \tag{1.2}$$

Also at the beginning of every period the MOF considers a fiscal program based on its preferences over growth and inflation, and a financing constraint (1.3). According to the financing constraint, the deficit is entirely financed from segniorage.[13] [14] The parameter α is the MOF's preference for growth. The higher α the less averse the MOF is to inflation and the more it favors growth. When considering a fiscal program, the MOF takes as given variations in the money stock chosen by the CB. Capital letters denote parametric variables for the MOF while small case letters denote choice variables.

$$\begin{aligned} &\Psi(\Delta M_t, d_t) = \alpha\gamma(\Delta M_t, d_t) - (1-\alpha)\pi(\Delta M_t, d_t) \\ &st: d_t = \Delta s_t \end{aligned} \tag{1.3}$$

The CB and MOF have diametrically opposed preferences over economic performance, namely growth and inflation. These preferences capture the inherent conflict between a politically motivated MOF which prefers higher growth and inflation, and a more conservative CB which prefers lower growth and inflation.

Out of equilibrium, neither institution considers that its decisions will affect decisions by the other institution. The MOF does not consider that the budget deficit will ultimately affect variations in the money stock. Similarly, the CB does not consider that variations in the money stock will affect the budget deficit. There is a strategic element to the relationship between both institutions that needs to be solved by the equilibrium.

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[12] The simple balance sheet constraint could be thought of as capturing indirect deficit financing by way of liquidity injections of the CB to the banking system, which are ultimately used by banks to buy government debt.

[13] A more realistic economy would of course include other forms of deficit financing, namely bond issuance, external borrowing, or credit from the banking system.

[14] The simple financing constraint could be thought of as capturing indirect deficit financing coming from the banking system, but originating in liquidity injections by the CB.

B. Negotiating over financing

Given the inherent conflict between both institutions, segniorage has to be split in order to satisfy competing objectives and constraints. At the beginning of every period when the monetary and fiscal programs are simultaneously determined, MOFs and CBs negotiate over the amount of segniorage, or monetary financing of the budget deficit.

The negotiation process is represented by the Nash bargaining problem (1.4) which subsumes the preferences and constraints of both institutions in (1.2) and (1.3).[15] The bargaining power of the CB is given by $\theta \in [0,1]$ and is effectively the degree of CBI. The higher the bargaining power of the CB, the more independently it will be able to determine the amount of deficit financing, and the more direct bearing it will have on economic performance. As $\theta \to 1$, the CB becomes increasingly independent; in the limit the CB becomes fully independent from the fiscal priorities of a more politically motivated MOF. In order to ensure a mutually advantageous agreement, the bargaining process must also satisfy the two incentive compatibility constraints.[16]

$$
\begin{aligned}
&\Delta s_t\left(\Delta M_t, D_t\right) = \underset{\Delta m_t, d_t}{\arg\max}\, \Omega\left(\Delta m_t, D_t\right)^{\theta} \Psi\left(\Delta M_t, d_t\right)^{(1-\theta)} \\
&st: \\
&\Delta m_t = \Delta s_t \\
&d_t = \Delta s_t \\
&\Omega\left(\Delta m_t, D_t\right) \geq 0 \\
&\Psi\left(\Delta M_t, d_t\right) \geq 0
\end{aligned}
\qquad (1.4)
$$

Negotiated segniorage $\Delta s_t\left(\Delta M_t, D_t\right)$ is a function of variations in money and the budget deficit, and is characterized implicitly by the necessary and sufficient first order condition and incentive compatibility constraints (1.5).

$$
\begin{aligned}
&\theta \Psi\left(\Delta M_t, \Delta s_t\right) \frac{\partial \Omega\left(\Delta s_t, D_t\right)}{\partial \Delta m_t} + (1-\theta)\Omega\left(\Delta s_t, D_t\right) \frac{\partial \Psi\left(\Delta M_t, \Delta s_t\right)}{\partial d_t} = 0 \\
&\Omega\left(\Delta s_t, D_t\right) \geq 0 \\
&\Psi\left(\Delta M_t, \Delta s_t\right) \geq 0
\end{aligned}
\qquad (1.5)
$$

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[15] Nash (1950) and Osborne and Rubinstein (1990).

[16] If negotiations break-down and both parties agree to disagree, equilibrium is not attained and payoffs are normalized to zero.

In equilibrium, each institution's expectations about the other's choice must be validated. The CB's expectations about the budget deficit must be validated by the MOF's choice, and *vice-versa,* the MOF's expectation about the monetary program must be validated by the CB's choice. Consistency between expectations and choices implies that the budget deficit must be financeable in equilibrium. Equilibrium amounts to consolidating the MOF's financing constraint and the CB's balance sheet constraint into a single public sector financing constraint. The equilibrium condition is given by (1.6) .

$$D_t = d_t = \Delta s_t = \Delta m_t = \Delta M_t \tag{1.6}$$

Equilibrium segniorage Δs_t^* is implicitly fully characterized by using (1.6) to evaluate (1.5) as in (1.7) below.

$$\begin{aligned} &\theta \Psi\left(\Delta s_t^*\right) \frac{\partial \Omega\left(\Delta s_t^*\right)}{\partial \Delta m_t} + (1-\theta)\Omega\left(\Delta s_t^*\right) \frac{\partial \Psi\left(\Delta s_t^*\right)}{\partial d_t} = 0 \\ &\Omega\left(\Delta s_t^*\right) \geq 0 \\ &\Psi\left(\Delta s_t^*\right) \geq 0 \end{aligned} \tag{1.7}$$

The above equality can easily be solved for the candidate equilibrium segniorage as a function of CBI represented by θ. Under regularity conditions on the primitives of the economy, it can be shown that this candidate equilibrium solution is incentive compatible so that both inequalities are also satisfied and equilibrium is attained (Appendix).

It can also be shown that as θ increases, a higher degree of fiscal discipline is imparted into the economy. As CBs becomes more independent, the growth of money, segniorage, and deficit all decline because it is within the CB's interest to limit variations in the money stock, this reduces segniorage and ultimately the deficit (1.8). Moreover, CBs are able to impose their interests on MOFs.

$$\frac{\partial \Delta s_t^*}{\partial \theta} = \frac{\partial \Delta m_t^*}{\partial \theta} = \frac{\partial d_t^*}{\partial \theta} < 0 \tag{1.8}$$

Furthermore, there is an implied Phillips curve driven by institutional factors. As the degree of CBI increases, short-run growth and inflation decline (1.9). Equations (1.8) and (1.9) also

apply to expected growth and inflation. For completeness, it can also be shown that under some regularity conditions higher CBI also reduces the variability of growth and inflation.[17]

$$\frac{\partial \gamma}{\partial \theta} = (\lambda_1 + \lambda_2)\frac{\partial \Delta s_t^*}{\partial \theta} < 0$$
$$\frac{\partial \pi}{\partial \theta} = (\eta_1 + \eta_2)\frac{\partial \Delta s_t^*}{\partial \theta} < 0 \qquad (1.9)$$

These results emphasize the impact of institutional factors governing the financial relationship between the CB and MOF on economic performance. Furthermore, the results are consistent with empirical correlations between *legal* CBI and inflation. While empirical correlations between legal CBI and growth are ambiguous, results suggest a negative correlation between legal CBI and short-term growth.

In a departure from previous literature, CBI is formalized directly and decoupled from the degree of CB conservatism; a richer environment provides more insights about the interactions between conservatism and CBI.[18] The degree of CB conservatism is captured by α in this model, while institutional factors are instead driven by the central bank's bargaining power θ. One could imagine many situations in which the good intentions and conservatism of the CB (high α) may be eclipsed by an overbearing politically motivated MOF (low θ). In these instances, CBs will have little or no impact on monetary, and let alone fiscal policy.[19]

III. Central Bank Independence and Long-Run Economic Performance

In the literature, it has frequently been argued that higher inflation imparts a negative externality onto long-run economic growth, through uncertainty and distorted relative price movements.[20] This section formalizes such a negative externality and considers the implications of CBI for economic performance.

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[17] Because this paper focuses on CBI and expected economic performance, and considers the impact of CBI on the variability of performance to be of second order, the necessary and sufficient regularity conditions for CBI to yield lower variability are discussed in the Appendix.

[18] See Rogoff (1985) for original bundling of CBI into central bank conservatism.

[19] See Figure 5 for how expected growth and inflation depend on both conservatism and CBI, and for how conservatism may be undermined by a lack of CBI.

[20] Fischer (1993), Bruno and Easterly (1995), Judson and Orphanides (1996), Sarel (1996), Barro (1995), Ghosh and Phillips (1998).

The negative externality of inflation onto growth affects the long-run component of growth every period. A more general representation of growth obtains by expanding (1.1) to include a long-run component of growth X_t per-unit-time (1.10). The long-run component of growth is driven by the negative externality of inflation onto growth.

$$\gamma(\Delta M_t, D_t) = \lambda_1 \Delta M_t + \lambda_2 D_t + A_t + X_t \tag{1.10}$$

Because it is an externality, the deleterious effects of inflation on the long-run component of growth are not internalized in short-sighted negotiations between CBs and MOFs every period. Equivalently, X_t is taken as parametric during negotiations. However, the equilibrium must internalize the externality.

In equilibrium, the externality is given by (1.11) with $\varepsilon \geq 0$. If $\varepsilon = 0$ the externality vanishes and this economy collapses to the economy presented in section II, where inflation has no deleterious effects on the contemporaneous component of long-term growth. As ε increases, the long-run component of growth dominates the short-term component, and higher inflation induces progressively lower equilibrium growth. Conversely, the lower the inflation rate, the higher equilibrium growth.

$$X_t = -\varepsilon\pi(\Delta M_t, D_t) \tag{1.11}$$

Going through the same argumentation as in the previous section, imposing (1.11) as an equilibrium condition, and subject to some regularity conditions, equilibrium segniorage can be easily solved (Appendix).

Even with an externality of inflation onto growth, it is still the case that higher CBI imparts fiscal discipline and results in lower money growth, segniorage, and budged deficit (1.12). However, if the externality is large and the long-run component of growth dominant enough, the implied institutional Phillips curve may become negatively sloped with higher CBI resulting in lower inflation and higher growth. The same results (1.12) also apply to expected growth and inflation. As before and for completeness, it can also be shown that under some regularity conditions CBI reduces the variability of growth and inflation.[21]

[21] Because focus is on expected performance, please see Appendix for discussion of necessary and sufficient conditions for CBI to generate lower variability .

$$\frac{\partial \gamma}{\partial \theta} = \left[\lambda_1 + \lambda_2 - \varepsilon(\eta_1 + \eta_2)\right]\frac{\partial \Delta s_t^*}{\partial \theta}\begin{cases} < 0 if\ \varepsilon < \frac{\lambda_1+\lambda_2}{\eta_1+\eta_2} \\ = 0 if\ \varepsilon = \frac{\lambda_1+\lambda_2}{\eta_1+\eta_2} \\ > 0 if\ \varepsilon > \frac{\lambda_1+\lambda_2}{\eta_1+\eta_2} \end{cases} \qquad (1.12)$$

$$\frac{\partial \pi}{\partial \theta} = (\eta_1 + \eta_2)\frac{\partial \Delta s_t^*}{\partial \theta} < 0$$

The results are again consistent with empirical findings. Higher CBI imparts fiscal discipline and results in lower inflation. Whether higher CBI results in higher, or lower, growth depends on the intensity of the externality and this sheds some light on the ambiguous empirical correlations between CBI and growth.

The decision of whether to institute full CBI seems trivial under a strong negative externality of inflation onto growth because higher CBI generates less inflation and more growth. However, the choice of optimal institutional arrangements turns out not to be so simple.

IV. Optimal Central Bank Independence

The literature has also explored whether there is an optimal degree of CBI.[22] This line of inquiry is invariably a function of society's preferences over economic performance, and these preferences may differ to those of the CB and/or MOF. This section focuses on the optimal degree of CBI and shows that it is not always optimal to have higher CBI. In fact, in as many economies as it is optimal to have higher CBI, it is also optimal to have lower CBI. Higher CBI is not always, and very frequently, sub-optimal. Whether these economies are empirically relevant, or merely theoretical possibilities, is left as an open question.

Consider an economy with a continuum of agents indexed by their preferences δ over growth and inflation. For simplicity assume the population is normally distributed over the real line with mean μ. Owing to symmetry of the distribution, the weighted average of individual utilities collapses to a very simple social welfare function which does not depend on the dispersion of preferences, but rather only on their mean (1.13). Also note that a social welfare internalizes equilibrium conditions.[23]

$$W(\Delta s_t) = (1-\mu)\gamma(\Delta s_t) - \mu\pi(\Delta s_t) \qquad (1.13)$$

Optimal CBI is determined by maximizing social welfare subject to decentralized negotiations between CBs and MOFs. This is done by using $\Delta s_t^*(\theta)$ from section III in (1.13)

[22] See Debelle and Fischer (1994).

[23] Social welfare internalizes the feasibility condition (1.6) and the externality (1.11).

and optimizing with respect to $\theta \in [0,1]$. The marginal condition which determines optimal CBI represented by θ^*, stipulates that full CBI is optimal if and only if the marginal social cost of segniorage is larger than its marginal social benefit. The marginal social cost of segniorage is a function of social aversion to inflation, the negative externality of inflation on growth, and the contribution of segniorage to inflation. Conversely, the marginal social benefit of segniorage is a function of social preference for growth and the contribution of segniorage to growth.

$$(\varepsilon+\mu)(\eta_1+\eta_2)-(1-\mu)(\lambda_1+\lambda_2)\begin{cases}>0 \Leftrightarrow \theta^*=1\\ =0 \Leftrightarrow \theta^* \in [0,1]\\ <0 \Leftrightarrow \theta^*=0\end{cases} \tag{1.14}$$

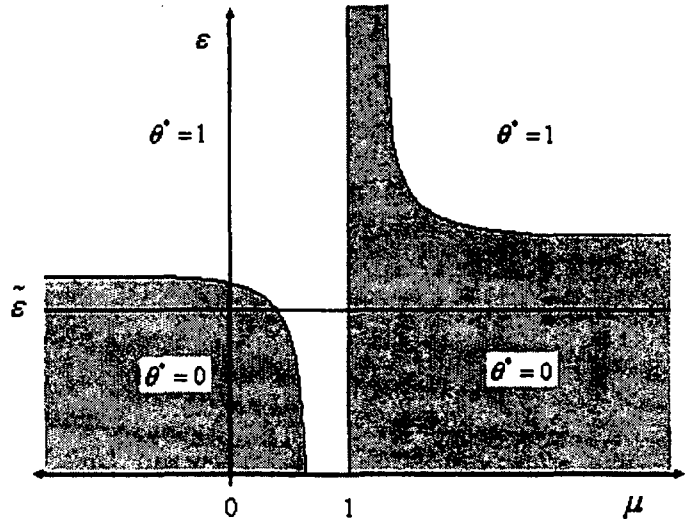
After rearranging, the marginal condition can equivalently be expressed in terms of the marginal social rate of substitution between growth and inflation relative to the marginal sacrifice ratio. Full CBI is optimal if and only if the marginal social rate of substitution between inflation and growth exceeds the marginal sacrifice ratio.

$$\frac{\varepsilon+\mu}{1-\mu}-\frac{\lambda_1+\lambda_2}{\eta_1+\eta_2}\begin{cases}>0 \Leftrightarrow \theta^*=1\\ =0 \Leftrightarrow \theta^* \in [0,1]\\ <0 \Leftrightarrow \theta^*=0\end{cases} \tag{1.15}$$

The optimality of CBI can also be characterize in the (μ,ε) plane (Figure 1), where social preferences are weighted against the negative externality of higher inflation onto long-run growth (Appendix).[24] Clearly it is not always optimal, and is frequently sub-optimal, to have higher CBI. Empirical distributions over the range of possible economies are not discussed, however, it is hard to imagine that no economy would fall in the regions where higher CBI is not optimal.

[24] Optimal CBI is unique, discrete, and binary owing to the linearity of social payoffs; optimal CBI is a boundary solution which generates a constrained social maximum. In a generalized environment with non-linear social payoffs, optimal CBI would be a unique interior solution yielding a continuous function of primitives, and generating an unconstrained maximum.

Figure 1. Optimal CBI



It is intuitively clear that proponents of full CBI ($\theta^*=1$) have in mind economies where social aversion to inflation is high (μ high) and the negative externality of lower inflation onto long-term growth is also high (ε high). In these economies it is optimal to have higher CBI because this generates lower short-run inflation and sufficient long-term growth to compensate for the lower short-term growth.

Perhaps a less intuitively clear case for higher CBI can be made if social aversion to inflation is low (μ low) but the negative long-run externality of inflation onto growth is high (ε high). In these economies it is optimal to have full CBI because sufficient long-term growth is generated to compensate for both lower short-term inflation and short-term growth.

Although not frequently touted, the case for no CBI ($\theta^*=0$) is also intuitively clear if social aversion to inflation is low (μ low) and the negative externality of inflation onto long-term growth is low (ε low). In these economies it is optimal to have lower CBI because this generates higher short-run inflation and growth, without sufficiently serious detrimental effects on long-run growth.

A less intuitive case for lower CBI can be made if social aversion to inflation is high (μ high) but the negative long-run externality of inflation onto growth is low (ε low). In these economies it is optimal to have no CBI because the deleterious effects of high inflation on long-term growth are not sufficiently serious, and enough long-term growth is generated to compensate for higher short-run inflation.

V. CONCLUDING REMARKS

An exploration of central bank independence and macroeconomic performance suggests that public announcements about monetary, fiscal, growth and inflation targets need to be checked for consistency against underlying institutional arrangements. Some announcements about the joint behavior of these key macroeconomic variables, whether in Fund supported programs or not, may not be consistent with the underlying degree of central bank subordination and implied deficit financing. Deficit financing from the CB may occur directly from CB to MOF, or indirectly through the banking system.

Consistent with empirical findings, higher CBI results in lower inflation, independently of whether the externality of inflation onto long-run growth is sufficiently strong. Also consistent with ambiguous empirical results, the effects of CBI on growth depend on long-run considerations. If the externality of inflation onto long-run growth is sufficiently strong, CBI increases growth, and the converse occurs if this externality is weak. A direct implication for empirical investigations is the need to control for the externality of inflation onto growth when attempting to correlate CBI and growth.

Surprisingly, there is a wide set of economies for which higher CBI is not optimal. In fact the case can be made for lower CBI in this wide set of economies. These economies may map into reality, or may only be theoretical possibilities. Nevertheless it is useful to learn that higher CBI may not always be the best recommendation.

A few extensions may shed further light on the effect of institutional arrangements on performance. First, the financial links across institutions and with the rest of the economy could be enriched. The balance sheet of CBs could include variations in credit to private sector and changes in international reserves, while the financing constraint of MOFs could include private sector financing and external financing. Second, the environment could be enriched to include private sector deficit financing constraints implied by rational expectations, with emphasis on the price of debt and interest rates. Third, the analysis could be turned on its head, and the model could be taken to the data in an effort to estimate parameters to extract performance-based measures of actual CBI which could then be compared to existing legal proxies.

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Figures

Panel (a) of Figures 2-5 correspond to an economy with a weak negative externality of inflation on long-term growth, while panel (b) correspond to an economy with a strong negative externality of inflation on long-term growth.

Figure 2a. CBI and expected performance

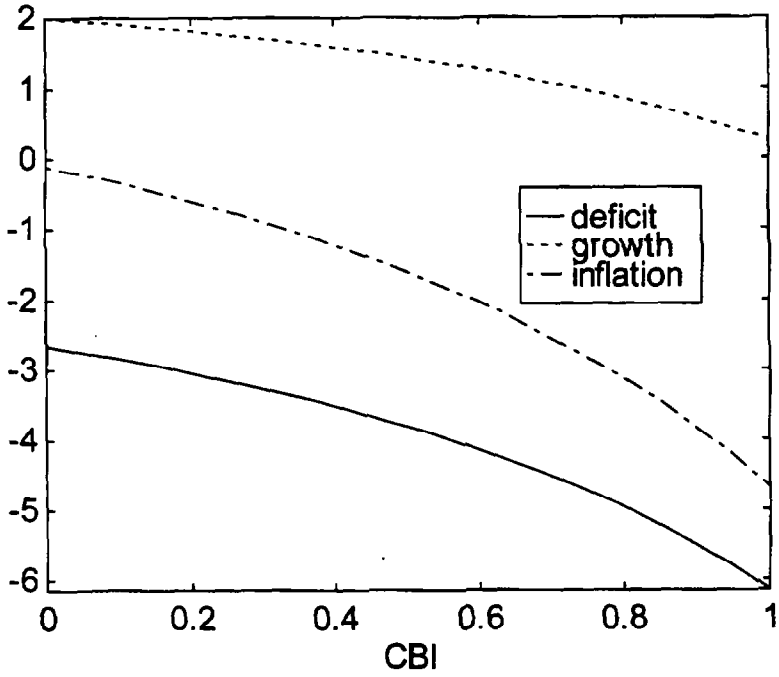


Figure 2b. CBI and expected performance

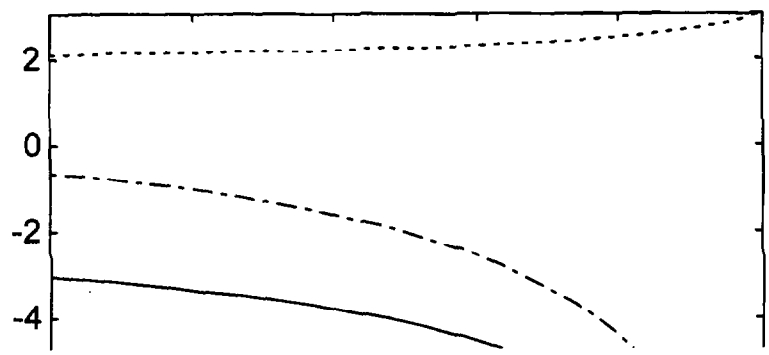


Figure 3a. Implied expected institutional Phillips curve

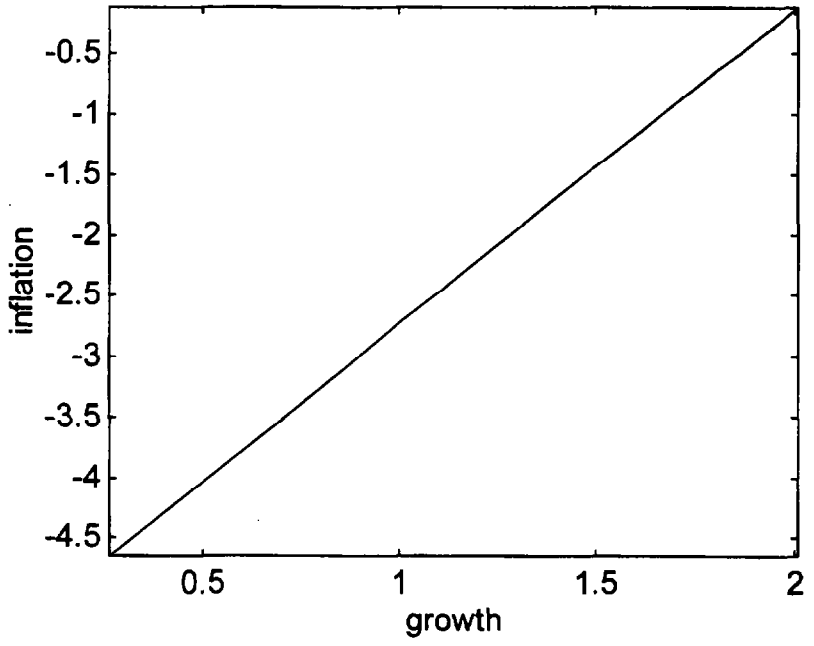


Figure 3b. Implied expected institutional Phillips curve

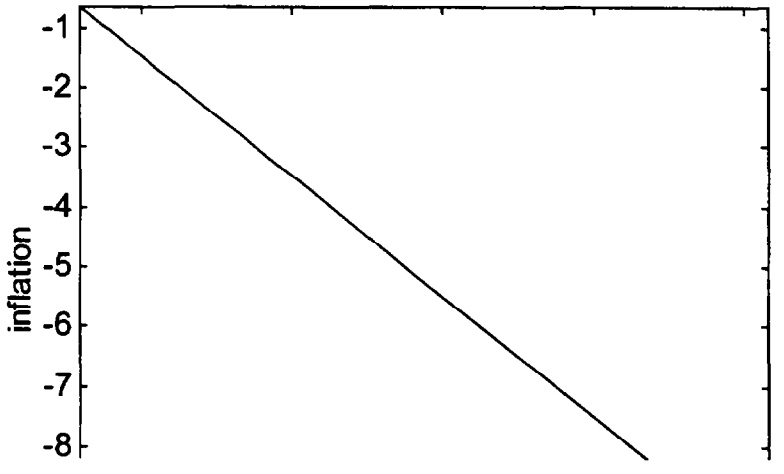


Figure 4a. Simulated performance

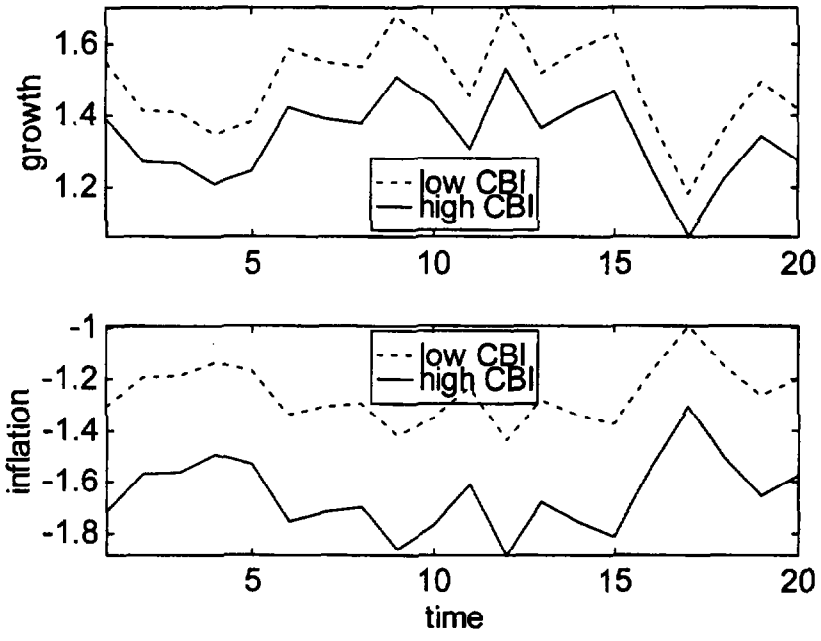


Figure 4b. Simulated performance

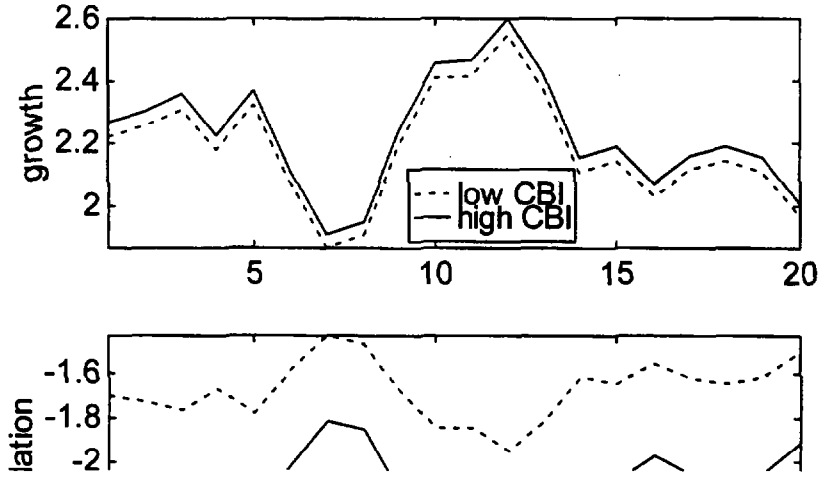


Figure 5a. CBI vs CB conservatism

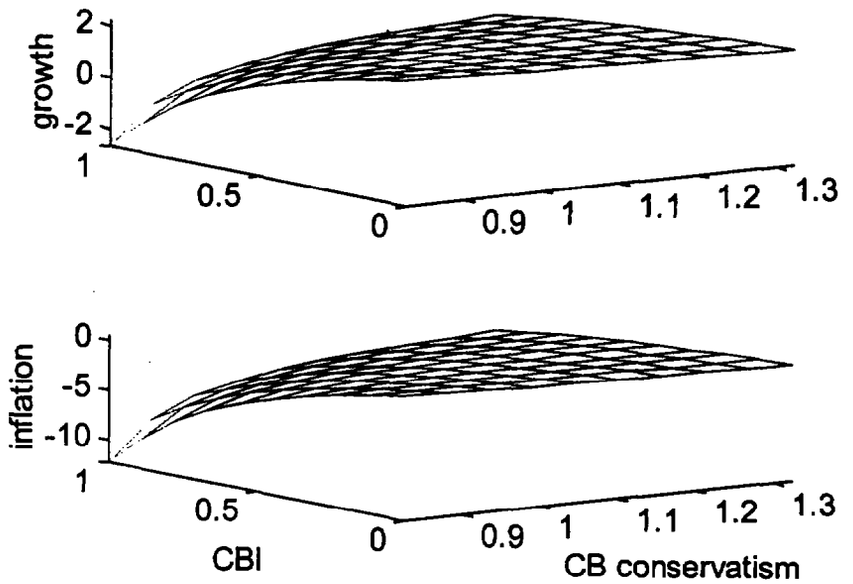
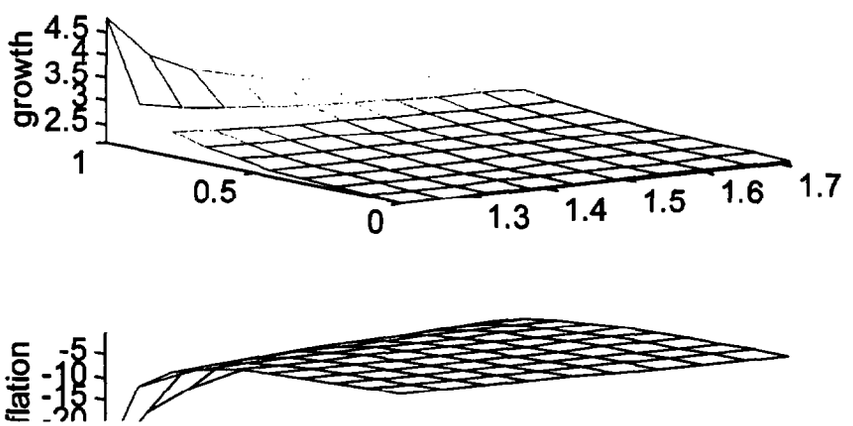


Figure 5b. CBI vs CB conservatism



Some regularity conditions must be imposed on primitives for the equilibrium to be incentive compatible and for CBI to generate fiscal discipline. All conditions are derived for a generalized environment with a negative externality of inflation per-unit-time on long-run growth. Regularity conditions for the short-run obtain when the externality of inflation onto long-run growth vanishes $\varepsilon \to 0$.

Optimal segniorage:

Solving the analogous equality to that in (1.7) after generalizing for externality of inflation onto long-term growth:

$$\Delta s_t^* = K(\theta, \varepsilon, \alpha, \lambda_1, \lambda_2, \eta_1, \eta_2) A_t$$
$$with \qquad (1.16)$$
$$K(.) = \frac{\theta[1+\alpha(\varepsilon-2)][(1-\alpha)\lambda_1 - \alpha\eta_1] - (1-\theta)[1+\alpha(\varepsilon-2)-\varepsilon][\alpha\lambda_2 - (1-\alpha)\eta_2]}{\theta\{\alpha[\lambda_1+\lambda_2-\varepsilon(\eta_1+\eta_2)]-(1-\alpha)(\eta_1+\eta_2)\}[(1-\alpha)\lambda_1-\alpha\eta_1] + (1-\theta)\{(1-\alpha)[\lambda_1+\lambda_2-\varepsilon(\eta_1+\eta_2)]-\alpha(\eta_1+\eta_2)\}[\alpha\lambda_2-(1-\alpha)\eta_2]}$$

Regularity conditions:

Regularity conditions (1.17), (1.19), and (1.21) below, ensure equilibrium deficit financing is incentive compatible.

The equilibrium preferences of MOF and CB need to be well behaved. The CB prefers less segniorage to more, while the MOF prefers more segniorage to less.

$$\begin{aligned} &\frac{\partial\Omega(\Delta s_t)}{\partial \Delta s_t} \le 0 \Leftrightarrow (1-\alpha)\left[\lambda_1+\lambda_2-\varepsilon(\eta_1+\eta_2)\right]-\alpha(\eta_1+\eta_2) \le 0 \\ &\frac{\partial\Psi(\Delta s_t)}{\partial \Delta s_t} \ge 0 \Leftrightarrow \alpha\left[\lambda_1+\lambda_2-\varepsilon(\eta_1+\eta_2)\right]-(1-\alpha)(\eta_1+\eta_2) \ge 0 \end{aligned} \qquad (1.17)$$

Fiscal discipline occurs across extreme cases. Extremes are defined when either player has entire bargaining power. Together with (1.17) this ensures the feasible set is non-empty.

$$\begin{aligned} &\Delta s_t^*\big|_{\theta=1} - \Delta s_t^*\big|_{\theta=0} < 0 \\ &\Leftrightarrow \frac{(1-2\alpha)(\eta_1+\eta_2-\lambda_1-\lambda_2)A_t}{\{(1-\alpha)[\lambda_1+\lambda_2-\varepsilon(\eta_1+\eta_2)]-\alpha(\eta_1+\eta_2)\}\{(1-\alpha)(\eta_1+\eta_2)-\alpha[\lambda_1+\lambda_2-\varepsilon(\eta_1+\eta_2)]\}} < 0 \end{aligned} \qquad (1.18)$$

But using (1.17) and $\alpha \ge \frac{1}{2}$:

$$\Leftrightarrow (\lambda_1+\lambda_2-\eta_1-\eta_2)A_t < 0 \qquad (1.19)$$

Fiscal discipline is increasing in CBI. This ensures regular behavior between extremes so that optimal deficit financing lies within the non-empty feasible set.

$$\begin{aligned} &\tfrac{\partial \Delta s_t^*}{\partial \theta} < 0 \\ &\Leftrightarrow (1-2\alpha)\left[(1-\alpha)\lambda_1 - \alpha\eta_1\right]\left[\alpha\lambda_2 + (1-\alpha)\eta_2\right](\lambda_1 + \lambda_2 - \eta_1 - \eta_2)A_t < 0 \end{aligned} \tag{1.20}$$

But using (1.19) and $\alpha \geq \frac{1}{2}$:

$$\left[(1-\alpha)\lambda_1 - \alpha\eta_1\right]\left[\alpha\lambda_2 - (1-\alpha)\eta_2\right] < 0 \tag{1.21}$$

Variability of performance:

Higher CBI reduces the variability of growth and inflation if and only if the following regularity conditions are satisfied. Note that they depend on θ so that the effect of CBI on variability is a local concept affected by the intensity of CBI.

$$\begin{aligned} &\frac{\partial \sigma_y}{\partial \theta} < 0 \Leftrightarrow \left[\lambda_1 + \lambda_2 - \varepsilon(\eta_1 + \eta_2)\right]K(\theta,.) + 1 - \varepsilon > 0 \\ &\frac{\partial \sigma_\pi}{\partial \theta} < 0 \Leftrightarrow (\eta_1 + \eta_2)K(\theta,.) + 1 > 0 \end{aligned} \tag{1.22}$$

Welfare and optimal CBI:

Because $\frac{\partial \Delta s_t^*}{\partial \theta} < 0$, the linearity of social welfare in segniorage (but not in θ) results in a constrained maximum and a boundary solution for optimal CBI (1.23). If welfare is strictly increasing in θ, then it is optimal to have full CBI ($\theta^* = 1$). Conversely, if welfare is strictly decreasing in θ, it is optimal to have no CBI ($\theta^* = 0$). Lastly, if welfare in not a function of θ, then any degree of CBI will be optimal. In a non-linear setting, optimal CBI would be a continuous function of primitives, generating an interior solution and an unconstrained maximum.

$$\frac{\partial W(\Delta s_t^*)}{\partial \theta} = \left\{(1-\mu)\left[\lambda_1 + \lambda_2 - \varepsilon(\eta_1 + \eta_2)\right] - \mu(\eta_1 + \eta_2)\right\}\frac{\partial \Delta s_t^*}{\partial \theta}\begin{cases} > 0 \Rightarrow \theta^* = 1 \\ = 0 \Rightarrow \theta^* \in [0,1] \\ < 0 \Rightarrow \theta^* = 0 \end{cases} \tag{1.23}$$

Optimal CBI can be characterized over the (μ, ε) plane where social preferences over economic performance are weighted against the negative long-run externality of inflation onto growth.

$$\tilde{\varepsilon} = \frac{(1-\mu)(\lambda_1+\lambda_2)-\mu(\eta_1+\eta_2)}{(1-\mu)(\eta_1+\eta_2)} \; with \frac{\partial\tilde{\varepsilon}}{\partial\mu} = \frac{-1}{(1-\mu)^2} < 0$$

$$\varepsilon \begin{cases} > \tilde{\varepsilon} \Rightarrow \theta^* = 1 \\ = \tilde{\varepsilon} \Rightarrow \theta^* \in [0,1] \\ < \tilde{\varepsilon} \Rightarrow \theta^* = 0 \end{cases} \qquad (1.24)$$