# Corruption and Monetary Policy[1]

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**Abstract**

The level of corruption varies widely across countries. This paper examines the consequence of corruption for the design of monetary policy. We employ an extended Barro-Gordon framework a la Alesina and Tabellini (1987) and model corruption as a leakage of tax revenue. There are several important implications from the model. First, the optimal inflation targeting for a high-corruption country is generally different from that for a low-corruption country. A mechanical inflation target (i.e., the 1-3% range typically advocated to most countries in the world) could reduce social welfare. Second, corruption can be viewed as one source of lack of commitment. Fixed exchange rates or currency boards are more difficult to sustain for high-corruption countries as the inflation rate (in the anchor country) may be too low from the viewpoint of the countries that adopt the exchange rate arrangements. Third, while inflation rate generally rises with the level of corruption under a commitment regime, it may fall or rise with corruption under a discretionary regime, depending on the initial level of corruption. Despite of this, a commitment regime generally generates a higher level of welfare than an ordinary discretionary regime. Fourth, a Rogoff-style conservative central banker can outperform a fixed exchange rate regime, a mechanical inflation target, currency board or dollarization. However, the optimal degree of conservatism is an inverse function of the corruption level. In

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the extreme case in which corruption is so severe that the tax system breaks down completely, the optimal degree of conservatism is zero.

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## 1. INTRODUCTION

The extent of bureaucratic corruption varies widely across countries. It is a particularly serious problem in many developing countries and transition economies, though developed countries are not immune to the disease. Surprisingly, the consequence of corruption on the design of monetary policy has not been systematically examined. The objective of this paper is to fill this void, and to demonstrate that the effect is non-trivial.

The literature on the design of monetary policy is too voluminous to be referenced completely here, but recent seminal contributions include Kydland and Prescott (1977), Calvo (1978), Barro and Gordon (1983), Backus and Driffill (1985), Rogoff (1985), Barro (1986), Walsh (1995), and Svensson (1997).[4] The literature acknowledges the importance of institutions in affecting inflation bias. However, a particular institutional feature that separates developing from developed countries is severity of bureaucratic corruption. As far as we know, the literature on inflation targeting, on comparing discretionary versus rule-based monetary regimes, and on conservative central banker, has not paid sufficient attention to this institutional feature.

For the purpose of our paper, we define corruption as the erosion of a government's ability to collect revenue through formal tax channels. This may arise through outright theft by tax officials, through hiding of taxable income by taxpayers, or through practices whereby tax inspectors collaborate with taxpayers to reduce the latter's tax obligation in exchange for a bribe.

Our theory combines useful ingredients from two different strands of the literature. The first literature is on the design of monetary policy. In addition to the papers cited above, we make use of a framework from Alesina and Tabellini (1987), where the government's objective function includes a provision for public goods in addition to minimizing inflation and output fluctuations. The second literature that helps to

[4] See Berger *et al* (2001) for a survey of both the theoretical and empirical literature in more recent years up to 2000.

inspire this paper studies the causes and consequences of corruption. The seminal works include Rose-Ackerman (1976, 1978), Shleifer and Vishny (1993), and Mauro (1995). Evans and Rauch (2000), Van Ricjkhem and Weder (2000), and Wei (2000a) examine the determinants of corruption. Wei (2000b, 2000c, and 2001) and Bai and Wei (2000) look at the consequence of corruption for international capital flows. As far as we know, none of the papers in these two strands of literature has examined the implication of corruption on monetary policy design.

In our simple model of a monetary policy game, the erosion of a government's fiscal ability might lead to a high inflation tax that is otherwise undesirable. We examine whether a commitment monetary regime still dominates a discretionary one when corruption is considered. Under an inflation targeting framework, we study whether the socially optimal level of an inflation target for a high-corruption country should be higher than for a low-corruption country. We further examine the implications of corruption for the design of several other monetary frameworks, including creating a currency board, dollarization and the Rogoff-type conservative central banker, and rank these monetary frameworks in terms of their social welfare.

With our framework, we have a number of results that can be previewed here. First, while corruption always raises the level of inflation under a commitment regime, its effect on inflation under a discretionary regime depends on the seriousness of corruption. Despite this qualification, the inflation rate under discretion is always higher than under commitment (except when corruption causes the tax system to collapse completely). Furthermore, the commitment regime unambiguously dominates the discretionary one for all levels of corruption.

Second, generally speaking, the optimal level of inflation targeting is higher for a high-corruption country than for a low-corruption country. So the uniform advice of an inflation target of 1-3%, that is commonly observed in the work by international financial institutions, is not optimal under our framework.

Third, our framework sheds light on the desirability of various exchange-rate-based monetary regimes. It provides one possible explanation for why a pegged exchange rate system in a developing country often fails. When a developing country announces an exchange rate system that pegs its currency to another anchor currency (e.g., the U.S. dollar) whose average inflation rate is lower than that of the developing country itself, there is a systematic incentive to deviate from the foreign inflation rate due to the corruption-induced fiscal problem. A currency board arrangement commits a country to adopt the level of inflation in the anchor currency's country. Assuming that the corruption level is higher in the currency-board country than in the anchor country, then the welfare under a currency board arrangement would be lower than an optimally designed inflation targeting regime. Since dollarization is equivalent to a currency board arrangement, except that it also gives up seignorage, its welfare is lower than that of a currency board. To sum up, these analyses suggest that the exchange-rate-based monetary regimes imply sub-optimal inflation rates for high-corruption countries and are under a greater stress to break than for low-corruption countries, unless they are compensated by some other policy or institution.

Fourth, if a commitment regime of any type is not feasible, a Rogoff-type conservative central banker has been advocated as an **imperfect** substitute under a discretionary regime. The degree of conservatism is defined as the difference between the weight on inflation stabilization placed by an independent central banker with discretion and that placed by a central planner. We show that the introduction of a public goods provision as one of the entries in the social loss function can lead to some surprising results. Unlike the Rogoff framework, the social planner is concerned about achieving a certain level of public expenditure as well, and thus the trade-off is between inflation and output as well as public expenditure. Although a conservative central banker can always lower inflation, in our framework this brings in an additional cost of increasing the tax rate. This additional cost helps to moderate the degree of conservatism relative to the original Rogoff framework. Moreover, the optimal degree of conservatism is inversely related to the level of corruption in the economy: the higher the level of corruption, the lower the optimal degree of conservatism. At the limit, when corruption makes collection of tax revenue infeasible, the optimal degree of central banker conservatism is zero. Somewhat surprisingly, under our assumptions, an optimally chosen central banker with discretion actually replicates perfectly the first-best solution under commitment.

Overall, an optimally chosen conservative central banker and an optimally designed inflation targeting both attain the first-best outcome, and are generally preferable to a mechanical inflation target of 1-3% and to all exchange-rate-based monetary arrangements.

The rest of the paper proceeds as follows. We set up the model and discuss the nature of the time inconsistency problem in section 2. In section 3, we analyze the commitment monetary policy regime and compare four popular frameworks that implement the commitment regime, namely inflation targeting, currency board arrangement and dollarization. We find that the introduction of corruption can help to think of a source of lack of credibility under these arrangements. In Section 4, we analyze how the choice of a Rogoff-type conservative central banker depends on corruption, and it may be better than a fixed exchange rate, currency board or dollarization. Section 5 concludes.

## 2. BASIC SETUP

Our model utilizes a framework developed in Alesina and Tabellini (1987), which we think has not been sufficiently appreciated in the literature. The government's objective function is to provide public goods in addition to stabilizing inflation and output:

$$V(\pi, \tau) = -\frac{1}{2}\left[\pi^2 + y^2 + (g - \overline{g})^2\right] . \tag{1}$$

In this objective function, the target levels for inflation and output are normalized to zero. In addition, the government aims to minimize the deviation of public goods provision from a non-negative target $\overline{g}$.[5]

[5] The government's objective function can be expressed more generally as

$$V(\pi, \tau) = -\frac{1}{2}\left[\pi^2 + \theta(y - y^*)^2 + \beta(g - \overline{g})^2\right],$$

In the original model by Barro and Gordon (1983) in which public goods provision was not considered, one has to assume that the government's targeted output level to be systematically above the long-run equilibrium in order to generate an inflation bias under a discretionary regime. As an interesting consequence of the Alesina-Tabellini reformulation, the need to provide public goods ($\overline{g} > 0$) is enough to generate an inflation bias. This will be demonstrated below. Therefore, we normalize the target output level to equal zero for simplicity. A more general formulation a la Barro and Gordon (1983) would generate some extra terms to carry in the subsequent discussion without yielding new insights.

For simplicity, we consider a deterministic economy with no shocks to aggregate demand. A modified Lucas supply curve governs the relationship between aggregate output and government policies: unexpected monetary growth increases aggregate demand, and a discretionary tax rate reduces aggregate supply.[6] Both monetary and fiscal policy choices are taken by the government. To be more precise, output is given by:

$$y = \alpha(\pi - \pi^e - \tau),\ \alpha > 0, \tag{2}$$

where $y$ is the log of real output; $\pi$ and $\pi^e$ are, respectively, the actual and expected inflation rates; and $\tau$ is the tax rate on the total revenue of firms.[7]

where $\theta > 0$ and $\beta > 0$ are the weights on output stability and public expenditure stability respectively, and $y*$ is the target level of output that is the source of the inflation bias in the original Barro-Gordon framework. Because public goods provision at the level $\overline{g} > 0$ already generates an inflation bias in our framework, without loss of generality, we choose to focus on the simpler objective function described by Equation (1), whereby $\theta = \beta = 1$, and $y^* = 0$. We will return to this issue in subsection 4.2.

[6] Our main result carries over to more complex settings including random supply shocks, which we will discuss when comparing the inflation targeting framework with the currency board arrangement. For the moment, we consider the simplest model we can think of that simultaneously captures the interactions between the monetary and fiscal authorities and allows us to address corruption. For further discussion of this model and, in particular, of its micro-foundations, see Alesina and Tabellini (1987).

[7] Equation (1) implicitly assumes that money demand is not affected by fiscal policy and, there-

Let $g$ denote the ratio of expenditure on public goods to output. To finance the public goods provision, the government has two sources of revenue: corporate tax $\tau$, and the inflation tax, $\pi$. A crucial assumption that we make is that corruption causes a leakage of the tax revenue: the greater the corruption, the greater the leakage. If the private sector pays a tax in the amount of $\tau$, only $\phi\tau$ amount of revenue is actually accrued to the government, where $0 \leq \phi \leq 1$. $\phi$ can be thought of as an index for lack of corruption. If $\phi = 1$, then there is no leakage of tax revenue to corruption. If $\phi = 0$, then there is complete leakage and the government cannot collect any revenue through the tax channel.

Following Alesina and Tabellini (1987) and after suitable approximations and simplifications, the government's budget constraint can be written as:[8]

$$g = \phi\tau + \pi. \tag{3}$$

Note that when $\phi = 1$, there is no corruption, and our model boils down to the set up in Alesina and Tabellini. Moreover, as in Alesina and Tabellini, our model abstracts from public debt.[9]

fore, that fiscal policy is not subject to time inconsistencies. Otherwise, an independent central bank could not directly control inflation, since it would be *jointly* determined by the money supply and the tax rate.

[8] Equation (3) can be obtained from a two-step derivation as in Alesina and Tabellini (1987). First, the government budget constraint in nominal terms is: $G_t = \phi\tau_t P_t X_t + M_t - M_{t-1}$, where $G$ denote public spending, $P$ price level, $X$ real output, and $M$ equilibrium money supply respectively. Second, dividing both sides by nominal income $P_t X_t$, we have $g_t = \phi\tau_t + (M_t - M_{t-1})/P_t X_t = \phi\tau_t + \pi_t$.

[9] In our view, regular tax collection is more prone to leakage due to corruption than inflation tax collection, partly because the former involves many more layers of government bureaucracy. We focus on this case in this paper and note that it is quite straightforward to extend the analysis to allow also for a leakage in the inflation tax collection.

# 3. COMMITMENT THROUGH INFLATION TARGETING, CURRENCY BOARD AND FIXED EXCHANGE RATE, AND DOLLARIZATION

## 3.1 The Commitment Regime

We consider an institutional setup in which monetary and fiscal authorities each control a single policy instrument (the inflation rate, $\pi$, by the central bank, and tax policy, $\tau$, by the fiscal authority), but share a common objective function defined by Equation (1). The two branches of the government solve a non-cooperative game. The equilibrium inflation and tax rates are given by the Nash equilibrium of the game.

In this sub-section, we focus on the case in which the central bank can credibly commit to a given inflation rate, i.e. $\pi = \pi^e$. It is easy to verify that, in this case, $y = -\alpha\tau$. The Nash equilibrium monetary and fiscal policies can be directly obtained from the first-order conditions associated with (1), where $y = -\alpha\tau$:[10]

$$\pi^C(\tau) = \frac{1}{2}(\overline{g} - \phi\tau), \tag{4}$$

$$\tau^C(\pi) = \frac{\phi}{\alpha^2 + \phi^2}(\overline{g} - \pi). \tag{5}$$

Solving these two reaction functions together, we obtain the Nash-equilibrium inflation and tax rates under commitment:

$$\pi^C = \frac{\alpha^2\overline{g}}{2\alpha^2 + \phi^2}, \tag{6}$$

$$\tau^C = \frac{\phi\overline{g}}{2\alpha^2 + \phi^2}. \tag{7}$$

A number of observations can be made. First, if there is no need to provide public goods ($\overline{g} = 0$), then the equilibrium inflation (and tax) rate under a commitment regime would be zero, consistent with the result from Barro and Gordon. Second,

[10] The second-order conditions associated with this problem (as well as those of the time-consistent problem below) are trivially satisfied since $V(\pi, \tau)$ is globally concave with respect to its arguments.

the effect of corruption on inflation and taxes can be examined by taking the partial derivatives from (6) and (7),

$$\begin{aligned}\frac{\partial \pi^C}{\partial \phi} &= -\frac{2\phi\alpha^2\overline{g}}{(2\alpha^2+\phi^2)^2} < 0;\\ \frac{\partial \tau^C}{\partial \phi} &= \frac{(2\alpha^2-\phi^2)\overline{g}}{(2\alpha^2+\phi^2)^2}.\end{aligned}$$

It is straightforward to see that the equilibrium inflation under a commitment regime goes up as corruption becomes more severe (or as $\phi$ goes down from one towards zero). The intuition is as follows: a rise in corruption essentially raises the shadow cost of raising revenue through regular tax channels *vis a vis* inflation tax. Consequently, more inflation tax should be raised.

Third, the effect of corruption on the equilibrium tax rate falls in two ranges. For moderate corruption (or $1 \geq \phi \geq \sqrt{2}\alpha$), the optimal response to a rise in corruption is to raise the tax rate. On the other hand, for severe corruption, ($\phi \leq \sqrt{2}\alpha$), the optimal response to a rise in corruption is to reduce the tax rate. The non-monotonicity of the effect can be understood as follows. When corruption is in the moderate range, in response to a small increase in the rate of leakage in tax revenue, the government has to tax more to compensate for the lost revenue. On the other hand, if corruption has already reached a very severe level, the marginal cost of collecting tax revenue in terms of foregone output becomes too high. As a result, the optimal response is to collect less revenue and to shift the revenue collection from regular tax to inflation tax.

From these two equations, we can also obtain the equilibrium values of output and public expenditure under commitment: $y^C = -\alpha\tau^C < 0$ and $g^C = \phi\tau^C + \pi^C < \overline{g}$. More precisely,

$$g^C = \phi\tau^C + \pi^C = \frac{(\alpha^2+\phi^2)\overline{g}}{2\alpha^2+\phi^2}, \tag{8}$$

$$y^C = -\alpha\tau^C = -\frac{\alpha\phi\overline{g}}{2\alpha^2+\phi^2}. \tag{9}$$

Substituting $\pi^C$, $y^C$ and $g^C$ in (3), we have:

$$V^C = -\frac{1}{2}\left[(\pi^C)^2 + (y^C)^2 + (g^C-\overline{g})^2\right] = -\frac{1}{2}\frac{\alpha^2\overline{g}^2}{2\alpha^2+\phi^2} = -\frac{1}{2}\overline{g}\pi^C. \tag{10}$$

The level of social welfare is a negative function of the inflation rate. Since more corruption leads to a higher inflation rate, more corruption reduces social welfare.

To summarize, we have:

**Proposition 1** *Under a commitment regime, (1) the inflation rate goes up as corruption becomes more serious; (2) the tax rate goes up (or down) with corruption if the initial level of corruption is moderate (or severe); and (3) social welfare decreases as corruption increases.*

Four popular frameworks have been developed to implement the commitment regime. They are inflation targeting, fixed exchange rate, currency board arrangement and dollarization. We will analyze and compare the desirability of these frameworks based on the insights from this model.

### 3.2 Mechanical vs. Optimal Inflation Targeting

Inflation targeting is a monetary arrangement in which the central bank announces (or is asked to follow) a target level (or a range) for the inflation rate. In principle, inflation targeting can be viewed as an institutional commitment to achieve the desirable outcome ($\pi^C$, $\tau^C$ and $g^C$).

There are quite a few developed countries that have adopted some version of inflation targeting. They include Australia, Canada, New Zealand, Norway, Sweden, United Kingdom, and Finland and Spain before the European Central Bank became operative. In practice, these countries target their inflation rates to a relatively narrow range, typically a 1-3% range. The fact that the inflation target is a range rather than a point is explained by the existence of unanticipated shocks, such as a temporary disturbance to money demand that the central bank ought to respond to. For simplicity, shocks are assumed away in this paper. It is thought that a similar type of inflation targeting would benefit developing countries as well. For example, the IMF has advised several transition and emerging market economies to adopt inflation targeting with a similarly narrow range.

The empirical evidence, however, by and large shows that inflation targeting has been less successful in developing economies than developed countries. In fact, many developing countries are quite reluctant to adopt this new monetary framework, even though lack of creditability is a clear concern for them. Are there any fundamental reasons for the difference in performance between developed and developing countries? We believe that the varying degree of corruption across countries provides one important reason.[11]

It may be useful to make a distinction between a mechanical inflation targeting and an optimal inflation targeting. A mechanical inflation targeting is a framework that advocates developing countries to do what developed countries have been doing, namely to target a low inflation rate like 3% (or a narrow range in that neighborhood). An optimal inflation targeting is an arrangement that conforms with the optimal solution under the commitment that we have discussed. More precisely, the optimal mix of monetary and fiscal policies should be (6) and (7) respectively, i.e.,

$$\pi^C = \frac{\alpha^2 \overline{g}}{2\alpha^2 + \phi^2},$$
$$\tau^C = \frac{\phi \overline{g}}{2\alpha^2 + \phi^2}.$$

In other words, the optimal inflation target for the central bank is:

$$\pi^{IT} = \pi^C = \frac{\alpha^2 \overline{g}}{2\alpha^2 + \phi^2}.$$

An immediate implication is that optimal inflation targeting should be a function of the corruption level. The higher the corruption level (or the greater the slope of the Phillip's curve or the higher the target level of public goods provision), the higher the optimal level of inflation target should be.

[11] Masson, Savastano and Sharma (1997) and Eichengree, Masson, Savastano and Sharma (1999) stated that a monetary authority "free of fiscal dominance" is a pre-condition for the success of a (narrow-range) inflation target. Our model can be viewed as a formalization of their argument. However, in our view, the existence of high corruption may doom any attempt to maintain a low-rate inflation target, it need not rule out an optimally chosen inflation target.

For the purpose of illustration, consider a comparison of a low-corruption country (e.g., Sweden) and a high-corruption country (e.g., Russia). Suppose that corruption is the only thing that is different between these two economies $\phi_{Sweden} = 1$ and $\phi_{Russia} = 1/4$, $\alpha_{Sweden} = \alpha_{Russia} = \alpha = 1/4$, and $\overline{g}_{Sweden} = \overline{g}_{Russia}$. In this case, it is easy to verify that

$$\pi^C_{Russia} = \frac{2\alpha^2 + \phi^2_{Sweden}}{2\alpha^2 + \phi^2_{Russia}} \pi^C_{Sweden} = 6\ \pi^C_{Sweden} \tag{11}$$

In this case, the optimal inflation target for Russia should be six times the level of what is optimal for Sweden. In other words, if a 3% inflation target is optimal for Sweden, then the optimal level of the inflation target for Russia should be 18% rather than 3%. This admittedly artificial example illustrates the quantitative significance of bringing corruption into the consideration of inflation targeting and shows that what is optimal for a high-corruption country is generally different from what is optimal for a low-corruption country. A mechanical program of inflation targeting in a high-corruption country that copies the low-inflation target from a low-corruption country could reduce social welfare.

### 3.3 Currency Board and Fixed Exchange Rate

A fixed exchange rate regime, by definition, fixes the rate of exchange between the domestic currency and an anchor currency. A currency board arrangement is a monetary framework whereby domestic money is rigidly pegged to a foreign currency and domestic high-powered money is completely backed up by foreign exchange reserves in hard currencies (or their equivalents). The single most popular choice of foreign anchor currency among countries that have adopted a fixed exchange rate or currency board system is the U.S. dollar. The German mark (and now the euro) is also chosen by some countries. In principle, a currency board can anchor to a basket of foreign currencies rather than a single currency. In reality, however, this is seldom done (except if one thinks of the euro as a basket of currencies).

By construction, under a fixed exchange rate or currency board arrangement, there is an implied inflation target which is the inflation rate in the anchor country's inflation rate. Suppose $\widehat{\pi}$ denotes the foreign inflation rate in the anchor country. Generally speaking, the anchor currency tends to come from a low-corruption country. We have already seen from the discussion on inflation targeting that the optimal level of inflation for a high-corruption country is different from a low-corruption one. Therefore, there is welfare loss associated with a fixed exchange rate or currency board arrangement for a high-corruption country. To put it differently, our discussion suggests that for a high-corruption country, there is tension under a fixed rate or currency board arrangement between the implied inflation target (i.e., a relatively lower level) and the inflation rate that the country finds optimal to pursue (i.e., a relatively higher level). The tension can be relieved if the country can effectively reduce corruption or adopt other compensating policies or institutions.

To see this in more precise terms, we can work out the welfare loss for a high-corruption country under a fixed rate or currency board arrangement. Given the monetary arrangement, the authority is left with only one independent instrument, tax rate $\tau$. Thus the fiscal policy can be directly obtained from the first-order condition of (3) with respect to $\tau$. This yields:

$$\tau^{CB}(\pi) = \frac{\phi}{\alpha^2 + \phi^2}(\overline{g} - \widehat{\pi}),$$

Assuming that the anchor country can effectively implement an inflation target that is optimal for its economy, then

$$\pi_j^C = \frac{\alpha_j^2 \overline{g}_j}{2\alpha_j^2 + \phi_j^2}.$$

But $\pi_j^C$ can also be mapped into the $(\alpha, \overline{g})$ space such that

$$\pi^{CB} = \frac{\alpha^2 \overline{g}}{2\alpha^2 + \widehat{\phi}_j^2} = \frac{\alpha_j^2 \overline{g}_j}{2\alpha_j^2 + \phi_j^2} = \pi_j^C. \tag{12}$$

Thus,

$$\tau^{CB} = \frac{\phi\left(\alpha^2 + \widehat{\phi}_j^2\right)\overline{g}}{\left(\alpha^2 + \phi^2\right)\left(2\alpha^2 + \widehat{\phi}_j^2\right)}. \tag{13}$$

The difference between the inflation levels is

$$\pi^{C}-\pi^{CB}=\frac{\widehat{\phi}_j^2-\phi^2}{2\alpha^2+\widehat{\phi}_j^2}\pi^{C}.$$

Once again, the more serious is the corruption in the country that adopts a currency board arrangement (a lower $\phi$), the higher is the difference between the levels of inflation under a currency board arrangement and under a commitment regime.

Moreover, the differences between the tax rate under currency board and under commitment is

$$\tau^{CB}-\tau^{C}=\frac{\left(\widehat{\phi}_j^2-\phi^2\right)\alpha^2\tau^{C}}{\left(\alpha^2+\phi^2\right)\left(2\alpha^2+\widehat{\phi}_j^2\right)}.$$

And the level of social welfare under a currency board is

$$V^{CB}=-\frac{\overline{g}\pi^{C}}{2}\frac{\left[\alpha^2\left(\alpha^2+\phi^2\right)+\left(\alpha^2+\widehat{\phi}_j^2\right)^2\right]\left(2\alpha^2+\phi^2\right)}{\left(\alpha^2+\phi^2\right)\left(2\alpha^2+\widehat{\phi}_j^2\right)^2}<-\frac{1}{2}\overline{g}\pi^{C}=V^{C}. \qquad (14)$$

Under the assumption that $\widehat{\phi}_j>\phi$, and thus $\pi^{CB}<\pi^{C}$ and $\tau^{CB}>\tau^{C}$. In other words, relative to an optimal commitment regime, a currency board arrangement implies too low an inflation rate but too high a tax rate.

So far, we have used the word "credibility" in our discussion. Of course, introducing credibility is considered one major motive for countries to adopt a fixed rate regime or a currency board. Our discussion in this sub-section can be viewed as pointing out corruption as a possible source of lack of credibility. A fixed rate regime or a currency board is more difficult to sustain in a high-corruption country because the inflation rate implied by the exchange rate regime is too low from the viewpoint of the country.

In the previous discussion, we assumed away stochastic shocks to the aggregate Phillips curve. With these shocks, a fixed exchange rate, a currency board arrangement and a mechanical inflation targeting (that targets to the level of inflation in the anchor country) are equivalent. However, we note parenthetically that if shocks are introduced, an inflation targeting framework can dominate a fixed-rate or currency board arrangement as it allows for the flexibility to respond to shocks that are specific to domestic economy.

### 3.4 Dollarization

Dollarization, or more generally, the adoption of a foreign currency as one's own currency, is a monetary arrangement that involves an even stronger commitment to low inflation – assuming the anchor country has low inflation – than a currency board arrangement. Unlike a currency board arrangement, the national currency disappears completely under dollarization.[12] The commitment is stronger because the cost to the government of reversing such an arrangement is higher. If the anchor country is the same for a currency board and for dollarization (e.g., the United States), the inflation rates of the two regimes are obviously the same. However, the government in a dollarization regime has to forego seignorage revenue associated with the insurance of domestic money. On this ground, (i.e., if we are not concerned with social loss due to lower credibility), the social welfare is lower under a dollarization regime than under a currency board arrangement.

To demonstrate the social loss more precisely, we start by noting that the loss of the inflation tax implies the following (3)

$$g = \phi\tau. \tag{15}$$

As in the currency board arrangement, under dollarization the authority is left with only one independent instrument, tax rate $\tau$. Using (15) in (3) and then taking the first-order condition of (1) with respect to $\tau$ yields:

$$\tau^{DO}(\pi) = \frac{\phi\overline{g}}{\alpha^2 + \phi^2}. \tag{16}$$

Denoting $\pi^{DO}$ as the rational expectations of the inflation rate of country $j$, where $j$ can be the U.S. or another country whose currency replaces the domestic currency

[12]See Fischer (1982), among others, for an analysis of seigniorage as a rationale for a national money.

in circulation, which is assumed to be under a commitment regime, and once again mapping $\pi_j^C$ into the $\left(\alpha,\, \overline{g}_j\right)$space, then we have

$$\pi^{DO} = \frac{\alpha^2 \overline{g}}{2\alpha^2 + \widehat{\phi}_j^2} = \frac{\alpha_j^2 \overline{g}_j}{2\alpha_j^2 + \phi_j^2} = \pi_j^C. \tag{17}$$

Once again, we should expect that $\pi^{DO} < \pi^C$. Obviously,

$$\pi^{DO} = \pi^{CB}.$$

Similar to a currency board arrangement, the more serious is its own corruption (a lower $\phi$), the higher is the difference between the levels of inflation under dollarization and under a commitment regime.

Moreover,

$$\begin{aligned} \tau^{DO} - \tau^C &= \frac{\phi \alpha^2 \overline{g}}{\left(\alpha^2 + \phi^2\right)\left(2\alpha^2 + \phi^2\right)} > 0, \\ \tau^{DO} - \tau^{CB} &= \frac{\phi \alpha^2 \overline{g}}{\left(\alpha^2 + \phi^2\right)\left(2\alpha^2 + \widehat{\phi}_j^2\right)} > 0. \end{aligned}$$

Evaluating $V\left(\pi^{DO},\, \tau^{DO}\right)$, we get

$$V^{DO} = -\frac{\overline{g}\pi^C}{2}\left[\frac{\alpha^2\left(2\alpha^2 + \phi^2\right)}{\left(2\alpha^2 + \widehat{\phi}_j^2\right)^2} + \frac{\phi^2\left(2\alpha^2 + \phi^2\right)}{\alpha^2\left(\alpha^2 + \phi^2\right)}\right] < -\frac{1}{2}\overline{g}\pi^C = V^C. \tag{18}$$

Moreover,

$$\frac{V^{DO}}{V^{CB}} = \frac{\alpha^4\left(\alpha^2 + \phi^2\right) + \phi^2\left(2\alpha^2 + \widehat{\phi}_j^2\right)^2}{\alpha^4\left(\alpha^2 + \phi^2\right) + \alpha^2\left(\alpha^2 + \widehat{\phi}^2\right)^2} > 1,$$

if

$$\phi \geq \alpha,$$

which is a weaker condition than $\phi \geq \sqrt{2}\alpha$, and thus will likely hold unless corruption is very serious. If $\phi \geq \alpha$, then $V^{DO} < V^{CB} < 0$.

At this point, we can rank the various monetary frameworks.

**Proposition 2** *Generally speaking, the optimal commitment regime dominates a mechanical inflation targeting regime, which (weakly) dominates a fixed rate or currency board arrangement, which in turn dominates a dollarization regime.*

## 4. DISCRETION AND CONSERVATIVE CENTRAL BANKER

### 4.1 A Conventional Discretionary Regime

If the central bank cannot pre-commit, the inflation rate (and correspondingly the tax rate) derived for a commitment regime would not be time consistent. As is well-known in the literature, if the expected inflation were at the level under commitment ($\pi^e = \pi^C$), the central bank would always find it optimal to raise inflation unexpectedly. Hence, such an expectation of inflation level cannot be rational. The time-consistent policy mix, $(\pi^D, \tau^D)$, is the Nash equilibrium solution to the non-coordinated game played by the central bank and fiscal authority, who take expected inflation rate as given.

The solution is characterized by the first-order conditions associated with (1), where, in addition, we require that the expected inflation rate equals its equilibrium value. More precisely, $(\pi^D, \tau^D)$ solves the following pair of equations:

$$\pi^D(\tau) = \frac{1}{2}(\overline{g} - \phi\tau) + \frac{\alpha^2}{2}\tau, \tag{19}$$

$$\tau^D(\pi) = \frac{\phi}{\alpha^2 + \phi^2}(\overline{g} - \pi). \tag{20}$$

Solving (19) and (20) for $\pi^D$ and $\tau^D$, we have the Nash equilibrium policy mix:

$$\pi^D = \frac{(1+\phi)\alpha^2\overline{g}}{(2+\phi)\alpha^2 + \phi^2}, \tag{21}$$

$$\tau^D = \frac{\phi\overline{g}}{(2+\phi)\alpha^2 + \phi^2}. \tag{22}$$

We can examine how monetary and fiscal policies would optimally respond to a rise in the corruption level and compare it with the case when the central bank is able to commit. In contrast to the commitment regime, the optimal response of both monetary and fiscal policies to a rise in corruption depends on how severe corruption is. More precisely, from (21) and (22), we can show that

$$\frac{\partial \pi^D}{\partial \phi} = \frac{[\alpha^2 + 1 - (1+\phi)^2]\alpha^2 \overline{g}}{[(2+\phi)\alpha^2 + \phi^2]^2},$$
$$\frac{\partial \tau^D}{\partial \phi} = \frac{(2\alpha^2 - \phi^2)\overline{g}}{[(2+\phi)\alpha^2 + \phi^2]^2}.$$

If corruption is relatively modest (e.g., $\phi \geq \sqrt{\alpha^2+1} - 1$), then the optimal response to a rise in corruption is to raise the inflation rate ($\partial \pi^D / \partial \phi < 0$). On the other hand, if the corruption level is already serious ($\phi \leq \sqrt{\alpha^2+1} - 1$), then the opposite response (lowering the inflation tax) to a rise in corruption would be optimal. The optimal response of the fiscal policy, $\tau^D$, also has a similar non-monotonicity. For moderate corruption ($\sqrt{2}\alpha < \phi$), an optimal response to a rise in corruption is to raise the tax rate. But at a more serious level of corruption ($\sqrt{2}\alpha \geq \phi$), the optimal response would be to lower the tax rate.

This makes an interesting comparison with the commitment case. For example, starting at a high level of corruption (e.g., $\phi \leq \sqrt{\alpha^2+1} - 1$), the optimal monetary policy response to a rise in corruption is to lower the inflation rate under a discretionary regime, but to raise the inflation rate under a commitment regime. A natural question to ask is whether the "excessive" level of inflation under a discretionary regime relative to a commitment regime could disappear at a very high level of corruption. A related question is whether the welfare ordering of a commitment versus a discretionary regime could be switched at a high level of corruption.

To see the answer to the first question, we can work out the difference between the inflation rate (and the tax rate) between the two regimes:

$$\pi^D - \pi^C = \frac{\alpha^2 \phi \left(\alpha^2 + \phi^2\right) \overline{g}}{\left(2\alpha^2 + \phi^2\right) [(2+\phi)\alpha^2 + \phi^2]},$$
$$\tau^D - \tau^C = -\frac{\alpha^2 \phi^2 \overline{g}}{\left(2\alpha^2 + \phi^2\right) [(2+\phi)\alpha^2 + \phi^2]}.$$

It can be seen clearly that, as long as $\phi > 0$, the inflation level under discretion is always higher than under commitment (whereas the tax rate under discretion is always lower than under commitment). In the extreme case in which corruption makes tax collection infeasible ($\phi = 0$), the differences in the monetary and fiscal policies under the two regimes ($\pi^D - \pi^C$ and $\tau^D - \tau^C$, respectively) tend to disappear.

To find out the answer to the second question, it would be useful to first work out the amount of public goods provision and the level of output. Using $\pi^D$ and $\tau^D$ in $g^D = \phi\tau^D + \pi^D$, we have

$$g^D = \frac{[(1+\phi)\alpha^2 + \phi^2]\overline{g}}{(2+\phi)\alpha^2 + \phi^2}. \tag{23}$$

Using $\tau^D$ in $y^D = -\alpha\tau^D$ under the discretionary regime, we have

$$y^D = -\alpha\tau^D = -\frac{\alpha\phi\overline{g}}{(2+\phi)\alpha^2 + \phi^2}. \tag{24}$$

Therefore, $V(\pi^D, \tau^D)$ becomes

$$V^D = -\frac{1}{2}\frac{\alpha^2\left[(2+2\phi+\phi^2)\alpha^2 + \phi^2\right]\overline{g}^2}{\left[(2+\phi)\alpha^2 + \phi^2\right]^2}. \tag{25}$$

Comparing $V^D$ with $V^C$, we have

$$\frac{V^D}{V^C} \geq 1,$$

where the equality sign holds when $\phi = 0$.

To summarize, we have:

**Proposition 3** *The optimal commitment regime generates a higher social welfare than the discretionary regime.*

Only in the extreme case when corruption completely destroys the tax collection system ($\phi = 0$) would the difference between the two regimes disappear.

### 4.2 A Rogoff-type Conservative Central Banker

The discussion in Section 4.1 suggests that the optimal commitment regime strictly dominates the discretionary regime for every level of corruption except for the extreme case in which corruption renders the regular tax collection completely infeasible. This is a relatively modest generalization of the result in Kydland and Prescott (1978) and Barro and Gordon (1983).

If, for whatever reason, a commitment regime of any sort is not available, then, as proved by Rogoff (1985), delegating the monetary policy to a more conservative central banker (still with discretion) can improve upon the social welfare relative to a straightforward discretionary regime discussed in Section 4.1. Here, "more conservative" means the weight in the loss function on inflation placed by the central banker is higher than by the social planner.

In this section, we examine whether and how the optimal degree of central banker conservatism is affected by the presence of corruption. As a by-product, we also examine how the inclusion of public goods provision in the social welfare function may modify our understanding of the role of a conservative central banker.

Consider a modified central banker's problem. Let $S$ denote the weight on the inflation rate placed by the central banker. The central banker's objective function is given by,

$$V^{CC}(\pi, \tau) = -\frac{1}{2}\left[S\pi^2 + y^2 + (g - \overline{g})^2\right]. \tag{26}$$

If the central banker cares about inflation as much as the social planner, then $S = 1$. If the central banker is more conservative than the social planner, then $S \geq 1$.

The central banker and the fiscal authority still play a non-cooperative Nash game. The time-consistent policy mix in this case, labeled as $(\pi^{CC}, \tau^{CC})$, is characterized by the first-order conditions associated to (26), where, in addition, we require that the expected inflation rate equals its equilibrium value. Thus, $(\pi^{CC}, \tau^{CC})$ solves the following pair of equations:

$$\pi^{CC}(\tau) = \frac{1}{1+S}(\overline{g} - \phi\tau) + \frac{\alpha^2}{1+S}\tau, \tag{27}$$

$$\tau^{CC}(\pi) = \frac{\phi}{\alpha^2 + \phi^2}(\overline{g} - \pi). \tag{28}$$

Solving (27) and (28) for $\pi^{CC}$ and $\tau^{CC}$, we have:

$$\pi^{CC} = \frac{(1+\phi)\alpha^2\overline{g}}{(1+S+\phi)\alpha^2 + S\phi^2}, \tag{29}$$

$$\tau^{CC} = \frac{S\phi\overline{g}}{(1+S+\phi)\alpha^2 + S\phi^2}. \tag{30}$$

Obviously, at $S = 1$, the regime of a conservative central banker collapses to the discretionary regime without a conservative central banker. When $S > 1$, we can show easily that

$$\begin{cases} \pi^{CC} < \pi^D, \\ \tau^{CC} > \tau^D. \end{cases}$$

In fact, $\partial\pi^{CC}/\partial S < 0$ and $\partial\tau^{CC}/\partial S > 0$. Therefore, the more conservative is the central banker, the lower the equilibrium inflation rate is, but the higher the tax rate becomes.

The effect of a rise in corruption on the inflation rate (or tax rate) is non-monotonic. From (29) and (30), it is clear that

$$\begin{aligned} \frac{\partial\pi^{CC}}{\partial\phi} &= \frac{S[\alpha^2 + 1 - (1+\phi)^2]\alpha^2\overline{g}}{[(1+S+\phi)\alpha^2 + S\phi^2]^2}, \\ \frac{\partial\tau^{CC}}{\partial\phi} &= \frac{S[(1+S)\alpha^2 - S\phi^2)\overline{g}}{[(2+\phi)\alpha^2 + \phi^2]^2}. \end{aligned}$$

As in a conventional discretionary regime, $\partial\pi^{CC}/\partial\phi > 0$ if and only if $\phi \leq \sqrt{\alpha^2+1} - 1$. That is, when corruption is very serious, the optimal response to a rise in corruption is to lower inflation. On the other hand, if $\phi > \sqrt{\alpha^2+1} - 1$, i.e., when corruption is relatively modest, then $\partial\pi^{CC}/\partial\phi < 0$, which means that an optimal response to a rise in corruption is to raise inflation.

There is a similar asymmetry for the response of fiscal policy. When corruption is sufficiently serious, i.e., $\phi \leq \alpha\sqrt{1+S}/\sqrt{S}$, the optimal response to a rise in corruption is to lower the tax, $\partial\tau^{CC}/\partial\phi \geq 0$. On the other hand, when corruption is relatively modest, i.e., $\phi > \alpha\sqrt{1+S}/\sqrt{S}$, then the opposite adjustment in the fiscal policy is appropriate, since $\partial\tau^{CC}/\partial\phi < 0$.

Using $\pi^{CC}$ and $\tau^{CC}$ in $g^{CC} = \phi\tau^{CC} + \pi^{CC}$, we can compute the level of public goods provision:

$$g^{CC} = \frac{[(1+\phi)\alpha^2 + S\phi^2]\overline{g}}{(1+S+\phi)\alpha^2 + S\phi^2}. \tag{31}$$

Using $\tau^{CC}$ in $y^{CC} = -\alpha\tau^{CC}$ under a conservative central banker, we have

$$y^{CC} = -\alpha\tau^{CC} = -\frac{S\alpha\phi\overline{g}}{(1+S+\phi)\alpha^2 + S\phi^2}. \tag{32}$$

Accordingly, the level of social welfare (26) becomes

$$V^{CC}(\pi^{CC}, \tau^{CC}) = -\frac{1}{2}\frac{\alpha^2\left[[S^2 + (1+\phi)^2]\alpha^2 + S^2\phi^2\right]\overline{g}^2}{\left[(1+S+\phi)\alpha^2 + S\phi^2\right]^2}. \tag{33}$$

Suppose the social planner can choose any value of $S$, then what is the optimal degree of conservatism of the central banker that would maximize the social welfare? To find out the answer, we maximize the social welfare function described by (33) with respect to $S$. The first-order condition leads to[13]

**Proposition 4** $S^* = 1 + \phi$.

Let us measure the conservatism of the central banker by the excess weight she places on the inflation term relative to the social planner, i.e., conservatism $= S - 1$. The above equation suggests that the optimal degree of conservatism is given by $S^* - 1 = \phi$. A number of observations can be made. First, for $0 < \phi \leq 1$, a central banker that is more conservative than the social planner should be appointed to improve upon the social welfare under a discretionary regime. Second, the optimal degree of conservatism depends on the degree of corruption in the economy. The greater the level of corruption (i.e., a lower value of $\phi$), the less conservative the central banker should be. Third, in the extreme case in which corruption prevents the working of the tax system completely (i.e., when $\phi = 0$), the optimal degree of conservatism is zero. That is, the social planner would choose a central banker who has the same preference as herself.

When the central banker is optimally chosen (i.e., $S^* = 1 + \phi$), we can compute the level of inflation, taxes, and social welfare. It can easily be verified that

$$\pi^{CC} = \frac{\alpha^2\overline{g}}{2\alpha^2 + \phi^2} = \pi^C,$$

[13] It is easy to verify that (33) is indeed convex in $S$.

$$
\begin{aligned}
\tau^{CC} &= \frac{\phi\overline{g}}{2\alpha^2+\phi^2} = \tau^C, \\
V^{CC} &= -\frac{1}{2}\frac{\alpha^2\overline{g}^2}{2\alpha^2+\phi^2} = V^C.
\end{aligned}
$$

**Proposition 5** *When the conservatism of the central banker is optimally determined, this (modified) discretionary regime restores the first-best solution under commitment.*

This proposition is somewhat surprising and worth some further elaboration. There are a number of differences between our framework and that of the original Rogoff framework. First, in Rogoff (1985), the social planner is only concerned with inflation and output stabilization. In contrast, we have added public goods provision as part of the objective function. Although a more conservative central banker can lower inflation further, it would not be optimal to do that given the increasing costs of collecting taxes. Second, we do not have stochastic shocks to the aggregate supply/demand. Third, we do not have the equivalent of the labor market distortion that causes the social planner to attempt to stabilize output at a level above its natural rate.

It is clear that the welfare in the Rogoff-style conservative central banker framework dominates that in a currency board arrangement or dollarization. One may think that installing a conservative central banker requires fewer technical preconditions than implementing an inflation target framework due to the principle of contract implementation (Maskin and Moore (1999), Moore and Repullo (1988 and 1990))[14]. If that is true, the conservative central banker framework may also be better than an inflation targeting framework, though it is beyond the scope of this paper to have a full discussion on this issue.

In the absence of public goods provision (and hence fiscal policy), the Walsh (1995) contract implements the commitment solution under a discretionary regime. However, once fiscal policy is introduced, strategic manipulation by the fiscal authority could make the Walsh contract sub-optimal (Huang and Paddila (1995)). As a result,

[14]See Moore (1992) for an excellent survey of this literature.

the discretionary tax can be too high while the inflation rate may be too low. By this logic, the Rogoff-type conservative central banker arrangement may outperform the Walsh-type incentive contract.

## 5. CONCLUDING REMARKS

Taking into account corruption can have important implications for the design of an optimal monetary policy. We employ an extended Barro-Gordon framework a la Alesina and Tabellini (1987) and model corruption as a leakage of tax revenue.

There are several important implications from the model. First, the optimal inflation targeting for a high-corruption country is generally different from that for a low-corruption country. A mechanical inflation target (i.e., the 1-3% range typically advocated to most countries in the world) could reduce social welfare.

Second, corruption can be viewed as one source of lack of commitment. Fixed exchange rates or currency boards are more difficult to sustain for high-corruption countries as the inflation rate (in the anchor country) may be too low from the viewpoint of the countries that adopt the exchange rate arrangements.

Third, while inflation rate generally rises with the level of corruption under a commitment regime, it may fall or rise with corruption under a discretionary regime, depending on the initial level of corruption. Despite of this, a commitment regime generally generates a higher level of welfare than an ordinary discretionary regime.

Fourth, a Rogoff-style conservative central banker can outperform a fixed exchange rate regime, a mechanical inflation target, currency board or dollarization. However, the optimal degree of conservatism is an inverse function of the corruption level. In the extreme case in which corruption is so severe that the tax system breaks down completely, the optimal degree of conservatism is zero.

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