ISSN 1745-8587

School of Economics, Mathematics and Statistics

BWPEF 0607

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June 2006

Birkbeck Working Papers in Economics & Finance

▪ Birkbeck, University of London ▪ Malet Street ▪ London ▪ WC1E 7HX ▪

# Monetary and Fiscal Policy Interactions: The Role of the Quality of Institutions in a Dynamic Environment

Ourania Dimakou*

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**Abstract**

This paper analyses the interaction between fiscal and monetary policy using the original Barro and Gordon (1983) model extended to include fiscal policy, dynamics and the level of institutional quality, measured as bureaucratic corruption. It is found that delegating monetary policy to an independent central bank (i.e. not fiscally dominated) the second best solution of the model is achievable only if there is no bureaucratic corruption. Otherwise, when institutional quality is not optimal, unless a less conservative than the government, regarding output considerations, independent central bank is delegated, the second best is not restored. The government has the incentive to increase debt strategically in an attempt to increase second period inflation. This result is augmented by the quality of institutions and poses difficulties on the achievement of both price stability and a balanced debt process. Quality of institutions, hence, can provide an explanation for the poorer inflation performance, due to debt boosts, of countries with lower institutional quality despite the introduction of central bank independence.

*JEL Classification*: E58, E61, E63

*Keywords*: Monetary and Fiscal policy, time-inconsistency, independent central bank, corruption

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## Introduction

Following the seminal work of Kydland and Prescott (1977) and Barro and Gordon (1983) inflation has been explained as the result of lack of commitment from the monetary authority's side in a game where the monetary authority interacts with the private sector. The source of the excessive inflation in the absence of a commitment technology is due to the policymaker's incentive to stimulate activity through unanticipated inflation. However, as the private sector correctly foresee future policy incentives, at the equilibrium, any attempt to boost output (employment) is pointless and the economy ends up with an inflation bias. Consequently, the source of the inflation bias reduces to what drives the time-inconsistent behaviour of the policymaker.

The underlying feature for this problem is that the output goals of the private sector and the policymaker differ. The monetary authority considers the market-determined level of output without policy intervention to be 'too low' from a social perspective. Thus, since nominal contracts are set before the monetary policy is selected, the policymaker faces the incentive of generating unexpected monetary shocks and deviating ex post in order to stimulate output (and employment) and bring it closer to the socially optimum level.

The fact that the market-determined level of output is considered too low has been motivated in two major ways. A branch of the literature (for example Rogoff (1985), Canzoneri (1985)) assumes that imperfections in the labour market, due to unions' monopolistic power, keep the real wage too high at the expense of output. This explanation can also provide justification for the difference between the objective function[1] of the private sector (that is defined as the wage setters and thus the 'insiders') and the one of the policymaker (which includes both the 'insiders' and the 'outsiders', and thus corresponds to the social utility function). The second motivation for the output goal conflict among the private sector and the policymaker, initiated by Barro and Gordon (1983), is the existence of tax distortions that reduce the level of activity below its market clearing level. Moreover, distortions could also be derived from imperfections in the goods market (e.g. monopolistic competition).

Nonetheless, whatever the motivation for the output goal difference, as Alesina and Tabellini (1987) correctly point out, everything boils down to taxation. That is to say, if non-distortionary (i.e. lump-sum) taxes existed, then even if some market imperfections were driving output below the socially optimum level, the policymaker could correct this 'output gap' by subsidising firms and obtain the socially desired outcome without excessive

[1] From now on we will be referring to the objective function of the players as the utility function, which more precisely corresponds to the loss function with a negative sign.

inflation.

Therefore, it is the nonexistence of non-distortionary taxation that creates the time-inconsistency problem. The inflation bias is partially determined by the taxation policy and hence depends on the financing structure of government spending. In other words, the time-inconsistency of monetary policy is solidly linked with fiscal policymaking, and hence the distortionary nature of fiscal policy should not be considered exogenous.

Alesina and Tabellini (1987) introduce a third player, the fiscal authority (government), in the original static Barro and Gordon (1983) model and in this way taxes, and hence distortions and the monetary policy inflation bias, are endogenised. Interaction among the two 'big' players (the fiscal and the monetary authority) becomes a crucial determinant for every outcome. With the consideration of public goods provision in the social welfare function, and the introduction of the government budget constraint, inflation also serves as a tool for government revenues (seigniorage) and the discrepancy between the output goals of the private sector and the policymakers, and hence the incentive to use surprise inflation, is no longer regime invariant.

Alesina and Tabellini (1987) conclude that, in the absence of any commitment mechanism, starting from the case where both monetary and fiscal decisions are set by a centralised authority and reducing the relative weights on output and government spending for the monetary authority (i.e. delegating monetary policy to a Rogoff-type conservative central bank) improves upon the discretionary outcome, in line with Rogoff's (1985) result when fiscal policy is exogenous.

Recently, Huang and Wei (2005) incorporate quality of institutions in the static model of Alesina and Tabellini (1987). Quality of institutions is modelled as bureaucratic corruption, in the sense that the tax collection mechanism exhibits inefficiencies. This new element has crucial implications for the model, as it limits fiscal authority's formal tax channel of government revenues and hence increases the importance and reliance on inflation tax for the required government revenues to be raised.

Moreover, there is a series of papers[2] that examine the dynamics of the model by allowing for the government to issue public debt, abstracting, however, from corruption issues. With endogenous fiscal policy and dynamic considerations, tax, distortions and inflation biases are no longer time invariant. Debt policy affects the need for tax revenues and seigniorage.

This work attempts to bring together the above mentioned papers and readdress the time-inconsistency problem of monetary policy, focusing especially on the driving forces of monetary and fiscal policy making under different levels of institutional quality. We establish that the second best outcome of the model (given by a centralised authority that is able to pre-

[2]For example Beetsma and Bovenberg (1995), Beetsma and Bovenberg (1997), Jensen (1994).

commit) is a function of the quality of institutions. Lower quality results in higher optimal inflation levels, lower tax levels[3], government spending, output gap, as well as lower social welfare. In other words, the best an economy facing corruption issues can do, in a second best world, is worse compared to an economy with high quality of institutions.

Developing countries have traditionally higher seigniorage revenues and lower quality of institutions, compared to advanced economies. Thus, it is interesting to see how optimal monetary and fiscal policy can be achieved or what kind of institutional arrangements can improve upon the outcomes where a commitment technology is not available. More precisely, this paper focuses on the implications of central bank independence.

We find that without corruption limitations, an independent central bank (i.e. a central bank that is not fiscally dominated) can achieve the second best without the need for increased inflation aversion relative to output. However, with the introduction of tax inefficiencies, this result no longer holds. Unless a less conservative, regarding output considerations, independent central bank is delegated, the government will use debt strategically to affect monetary policy setting. More precisely, the government has the incentive to increase first period debt in an attempt to increase second period inflation. As a result of that, economies with low institutional quality that set independent central banks, losing seigniorage revenue, should observe rising levels of debt and higher levels of inflation *vis à vis* their more developed counterparts.

Hence we conclude that even if fiscal dominance phenomena are appropriately tackled, through central bank independence, fighting corruption is vital for sustainable disinflation, correction of intertemporal distortions and improved social welfare levels. With the introduction of central bank independence, concentrating on the quality of institutions could avoid debt boosts and consequently could enhance price stability.

The remaining of the paper proceeds as follows. Section 1 presents the model and the solution in a first best world. Section 2 determines the second best outcome, which corresponds to a centralised economy that is able to commit and it also refers to the case where the centralised authority is behaving discretionary. Section 3, following Rogoff's argument, presents the case where monetary policy is delegated to a weight-conservative central bank. After analysing a few special cases (Section 4) that provide the necessary background, in Section 5 we analyse the implications of constituting central bank independence in a dynamic environment under different levels of institutional quality. Section 6 concludes.

[3]Taxes are negatively related to quality of institutions, given that the structural parameters of the model satisfy a condition. The same applies to output gap.

# 1 The Model

There are three players in the economy that live for two periods; the private sector that sets inflation expectations, the government that is responsible for the fiscal policy and sets taxes, government spending and debt, and the central bank that deals with monetary policy by setting inflation directly.

## 1.1 Private Sector: *Production, wage setting and the aggregate supply function*

The economy is characterised by a continuum of firms that are both price and wage takers and seek to maximise their net of taxes profits,

$$max_{L_t}(1-\tau_t)P_tY_t - W_tL_t$$

Taxes are incorporated in the model as a fraction on the firms' revenues and thus distort the behaviour of firms.[4] The production function is given by $Y_t = L_t^{\eta},\ 0 < \eta < 1$. Solving the profit maximisation problem and taking logs, we can get the aggregate supply equation of the model,

$$y_t = a(p_t - w_t - \tau_t) + k$$

where $a = \frac{\eta}{1-\eta} > 0$ and $k = \frac{\eta}{1-\eta}\ \log\eta$. Lower-case letters denote logs of nominal variables and $\tau$ is the tax rate on the total revenue of firms.

The private sector (individuals) sets nominal wage contracts one period in advance, in a competitive labour market, which is thus populated by a continuum of uncoordinated small agents.

The public's objective function is assumed to be,

$$U^p = -\frac{1}{2}\sum_{t=1}^{2}\beta^{t-1}(w_t - p_t)^2 = -\frac{1}{2}\sum_{t=1}^{2}\beta^{t-1}(\pi_t - \pi_t^e)^2 \qquad (1)$$

which implies that since wages are set in advance, the best each individual can do is set $w_t = p_t^e$, or equivalently[5] $\pi_t^e = \pi_t$.

The assumption of a continuum of uncoordinated individuals that the best they can do is to predict inflation correct could be interpreted as individuals not acting strategically, but competitively by maximising always their objective. The model, thus, concentrates on the strategic interaction among the two 'big' players.

[4] Alternatively and leading to the same implications, an income tax could be considered.

[5] Alesina and Tabellini (1987) assume that the labour market is populated by a strong trade union who's utility is given by $U^u = -\frac{1}{2}E_0\sum_{t=0}^{\infty}\beta^t(w_t - p_t - v)^2$, where $v$ is the real wage target. Consequently, the aggregate supply specification becomes: $y_t = y_n + a(\pi_t - \pi_t^e - \tau_t - v)$. However, since monetary policy inconsistency can arise solely from distortionary taxation, we will assume that $v = 0$.

Using the best the private sector can do ($\pi_t = \pi_t^e$) the aggregate supply can be rewritten as

$$y_t = y_n + a(\pi_t - \pi_t^e - \tau_t) \tag{2}$$

where $y_n = k$ is the level of output that would prevail in the absence of monetary policy shocks and taxation (i.e. the natural level of output).

From equation (2) it becomes apparent that the private sector aims at the market-determined level of output ($y_n - a\tau_t$), which is distorted due to taxation.

Note that we abstract from imperfections in both the goods and the labour markets. These simplifying assumptions allow us to concentrate on the effects of the existence of distortionary taxation on the incentives of the policymakers and their policy decisions.

### 1.2 Fiscal Authority

The government is introduced in the model by controlling the fiscal instruments tax rate ($\tau_t$), government spending ($g_t$) and debt ($d_t$). The government budget constraint in nominal terms is given by:

$$P_t G_t = \phi \tau_t P_t Y_t + M_t - M_{t-1} + P_t D_t - (1+r) P_t D_{t-1}$$

where $G_t, D_t, D_{t-1}$ and $r$ are real variables, $0 < \phi < 1$ shows the degree of tax-collection inefficiency (i.e. the degree of bureaucratic corruption) and debt is indexed and matures after one period.

Following Canzoneri (1985), money demand is represented by a very simple quantity theory of money equation, which depends only on an output level that is independent of fiscal policy (taxes), $M_t = P_t \bar{Y}$. This implies that inflation is equivalent to money creation. Since money demand does not depend on distortionary output (i.e. taxes) or nominal interest rate (i.e. expected inflation), the fiscal authority is not subject to time-inconsistency problems.[6] The government has no incentive to change taxes after the public has set its expectations.

The government budget constraint at $t$ can be rewritten in real terms as:

$$g_t = \pi_t + \phi \tau_t + d_t - (1+\rho) d_{t-1} \quad \text{for} \quad t = 1, 2 \tag{3}$$

where $g_t$, $d_t$, $d_{t-1}$ are expressed as shares of the non-distortionary output ($\bar{Y}$) and $\pi_t$ has been approximated by $\frac{P_t - P_{t-1}}{P_t}$.[7]

[6] If money demand depended on output, which is a function of taxes, then inflation would be determined partially through money growth and partially through tax growth ($\pi_t = \Delta m_t + a\Delta\tau_t$) and the government would be facing time-inconsistent incentives. Further, if money demand depended on inflation expectations as well, then expected inflation could alter people's money holdings, and in this case it would be expected as well as unexpected inflation having real effects.

[7] Equation (3) is derived by dividing the government budget constraint by $P_t \bar{Y}$ and represents a good approximation if $Y_t$ is close to $\bar{Y}$.

The intertemporal government budget constraint is given by:

$$\sum_{t=1}^{2}\left(\frac{1}{1+\rho}\right)^{t-1} g_t = \sum_{t=1}^{2}\left(\frac{1}{1+\rho}\right)^{t-1} [\tau_t + \pi_t] - (1+\rho)d_0$$

Government finances its spending and debt payments through taxes, seigniorage, and newly issued debt. In our two-period model, the government cannot issue new debt in period 2 (i.e. $d_2 = 0$) and the only benefit from positive inflation is seigniorage.

The government's objective function is given by

$$U^g = -\frac{1}{2}\sum_{t=1}^{2}\beta^{t-1}u_t = -\frac{1}{2}\sum_{t=1}^{2}\beta^{t-1}\left[\pi_t^2 + \lambda_1(y_t - y_n)^2 + \lambda_2(g_t - g^*)^2\right] \quad (4)$$

where $\lambda_i > 0$, for $i = 1, 2$, and $0 < g^* < 1$ and
$u_t = \pi_t^2 + \lambda_1(y_t - y_n)^2 + \lambda_2(g_t - g^*)^2$ is the instantaneous loss function.

The government faces the conventional loss function, with a negative sign in order to represent social welfare. In this utility function specification the weights on the function's arguments are set relative to inflation, with inflation's weight normalised to unity. In that sense, the government shares the same discount factor and relative weights as society, and $\lambda_i$ for $i = 1, 2$ correspond to the weights the government (society) puts on output and government spending respectively relative to inflation.

Despite the benefits of inflation on government revenues, society's inflation target corresponds to price stability, since society would be better off with zero inflation. The output target is the natural level of output, $y_n$, implying that the policymakers aim at achieving a non-distortionary level of output. Hence, with no distortions ($\tau_t = 0$) there is no output goal conflict among the policymakers and the private sector. Finally, following Debelle and Fischer's (1994) interpretation, the government spending target ($g^*$) represents the optimal share of non-distortionary output ($\bar{Y}$) to be allocated on public goods provision, if non-distortionary taxes were available.

### 1.3 Monetary Authority

The central bank is responsible for monetary policy and controls inflation perfectly, since from the money demand specification $\pi_t = \Delta m_t$. The monetary authority is subject to time-inconsistency problems, since from (2) it can use surprise inflation to stimulate output, which is considered 'too low' due to distortionary taxation.

The objective function of the central bank would generally be of the form:

$$V^{cb} = -\frac{1}{2}\sum_{t=1}^{2}\beta^{t-1}v_t = -\frac{1}{2}\sum_{t=1}^{2}\beta^{t-1}[\pi_t^2 + \xi_1(y_t - y_n)^2 + \xi_2(g_t - g^*)^2] \quad (5)$$

where $v_t = \pi_t^2 + \xi_1(y_t - y_n)^2 + \xi_2(g_t - g^*)^2$ and $\xi_i$ for $i = 1, 2$ represent the central bank's relative weights and need not be equal to $\lambda_i$ for $i = 1, 2$.

If $\xi_i = \lambda_i$ for $i = 1, 2$, both authorities share the same objective function, and hence we have a centralised authority (the government) being responsible for both monetary and fiscal policy. Clearly, under this framework, the policymaker is facing the optimal policy mix and there is no disagreement regarding the conflicting objectives.

In the case where $\xi_i < \lambda_i$ for $i = 1, 2$ monetary policy is delegated to a weight-conservative (Rogoff-type) central bank that is more averse to inflation. With the explicit incorporation of fiscal policy, $\xi_2$ represents the degree of fiscal dominance and thus the extent in which the delegated central bank is 'forced' to take fiscal considerations into account when setting its monetary policy. Thus, the case where the appointed central bank has $\xi_2 = 0$ may be interpreted as the decentralisation of economic policies with the appointment of an independent central bank. In line with the literature on central bank independence, $\xi_2 = 0$ corresponds to instrument independence, as opposed to goal independence since the central bank shares the same goals as the government.

### 1.4 First Best

The first best outcome in this framework is given by the centralised authority, which is able to precommit in a world where taxes are not distortionary. In this case, the aggregate supply is no longer distorted by taxes ($y_t - y_n = a(\pi_t - \pi_t^e)$), and the government budget constraint is the same as equation (3), but now the tax rate represents lump-sum taxes as a share of non-distortionary output ($\tau_t = T_t/\bar{Y}$). The first best outcome results in zero inflation, $y_t = y_n$ and $g_t = g^*$ in both periods. Regarding optimal tax and debt policy, since those two fiscal instruments are non-distortionary they turn out to be interchangeable. Any of the two could be used to cover the desired level of government spending including outstanding debt payments. Also note that even if the first best world is facing tax-collection inefficiencies (i.e. $\phi < 1$), corruption only raises the tax level needed to cover the government financial requirement of every period. A detailed presentation of this outcome is given in Appendix A.

## 2 Second Best

With nonexistent lump-sum taxes, the first best outcome is infeasible. The second best (SB) of the model can be derived from a centralised authority that is able to commit when distortionary taxes are apparent. In a two period model, the commitment outcome of maximising the intertemporal society's utility function under the intertemporal constraints is equivalent to solving the model backwards. Hence, starting from the second period,

setting $\pi_2 = \pi_2^e$ and taking $d_1$ as given, second period policy decisions are optimally chosen, $\pi_2 = f(d_1, g^*)$ and $\tau_2 = g(d_1, g^*)$. Then, first period policy decisions are chosen (including $d_1$), given $\pi_1 = \pi_1^e$ and given that the optimal second period decisions will be followed.

- In the Second Period,

The centralised authority is maximising

$$\max_{\tau_2,\pi_2} u_2 = -\frac{1}{2}\left[\pi_2^2 + \lambda_1(y_2 - y_n)^2 + \lambda_2(g_2 - g^*)^2\right]$$

$$\begin{aligned} \text{Subject to} \quad & \pi_2 = \pi_2^e \\ & y_2 = y_n - a\tau_2 \\ & g_2 = \pi_2 + \phi\tau_2 - (1+\rho)d_1 \quad \text{i.e.} \quad d_2 = 0 \\ \text{and} \quad & d_1 \quad \text{predetermined} \end{aligned}$$

Thus,

$$\max_{\tau_2,\pi_2} u_2 = -\frac{1}{2}\left[\pi_2^2 + \lambda_1(-a\tau_2)^2 + \lambda_2(\pi_2 + \phi\tau_2 - (1+\rho)d_1 - g^*)^2\right]$$

The optimal monetary and fiscal instruments for the second period will be chosen according to:

$$\tau_2 = \frac{\phi\lambda_2}{a^2\lambda_1(1+\lambda_2) + \phi^2\lambda_2}\left[(1+\rho)d_1 + g^*\right]$$

$$\pi_2 = \frac{a^2\lambda_1\lambda_2}{a^2\lambda_1(1+\lambda_2) + \phi^2\lambda_2}\left[(1+\rho)d_1 + g^*\right]$$

$$u_2 = -\frac{1}{2}\frac{a^2\lambda_1\lambda_2}{a^2\lambda_1(1+\lambda_2) + \phi^2\lambda_2}\left[(1+\rho)d_1 + g^*\right]^2 = u_2(d_1, g^*) \tag{6}$$

Social welfare in $t = 2$ is a negative function of $d_1$ (and $g^*$), since a higher debt accumulation in the previous period requires higher debt servicing costs this period. Second period inflation is negatively related to the degree of corruption, as higher corruption (lower $\phi$) leads to higher intratemporal inflation due to greater reliance on inflation tax revenues. Social welfare is reduced when corruption increases.

The effect of corruption on second period taxes depends on the size of $\phi$. If $0 < \phi < \tilde{\phi}$, then $\frac{\partial\tau_2}{\partial\phi} > 0$, and a reduction in the quality of institutions will lead to less taxes. The opposite effect occurs if $\tilde{\phi} < \phi < 1$, assuming that $\tilde{\phi} < 1$. In other words, depending on the structure of the economy, there is a critical value of $\phi$ that inverses the effects of corruption on taxes. Nonetheless, for plausible parameter values $\tilde{\phi}$ would be greater than unity,

implying that corruption deterioration will cause an intratemporal shift away from taxes.[8]

Note that the static version of the model is the second period optimal values with $d_1 = 0$. So, with $\phi = 1$ the outcomes reduce to the Alesina and Tabellini's (1987) SB and with $\phi < 1$ to Huang and Wei's (2005).

- In the First Period,

The centralised authority maximises $U^g$ given that second period polices will be followed, that is, given that $u_2$ is equal to its maximised value according to (6).

$$\max_{\tau_1,\ \pi_1,\ d_1} U^g = \sum_{t=1}^{2} \beta^{t-1} u_t = -\frac{1}{2}\Big[[\pi_1^2 + \lambda_1(y_1 - y_n)^2 + \lambda_2(g_1 - g^*)^2] + \beta \frac{a^2\lambda_1\lambda_2}{a^2\lambda_1(1+\lambda_2) + \phi^2\lambda_2}\ [(1+\rho)d_1 + g^*]^2\Big]$$

$$\begin{aligned} \text{Subject to} \qquad & \pi_1 = \pi_1^e \\ & y_1 = y_n - a\tau_1 \\ & g_1 = \pi_1 + \phi\tau_1 + d_1 - (1+\rho)d_0 \end{aligned}$$

So similarly to period 2 we have:

$$\tau_1 = \frac{\phi\lambda_2}{a^2\lambda_1(1+\lambda_2) + \phi^2\lambda_2}\ [(1+\rho)d_0 + g^* - d_1]$$

$$\pi_1 = \frac{a^2\lambda_1\lambda_2}{a^2\lambda_1(1+\lambda_2) + \phi^2\lambda_2}\ [(1+\rho)d_0 + g^* - d_1]$$

And optimal debt policy is given by:

$$d_1^{SB} = \frac{(1+\rho)d_0 + (1 - \beta(1+\rho))g^*}{1 + \beta(1+\rho)^2} \tag{7}$$

In the SB, the choice of $d_1$ is independent of the structural parameter values of the model $(a, \lambda_1, \lambda_2)$, including the level of corruption, $\phi$.

Debt is a policy instrument only in one period that has to be repaid in the next one. First period inflation and taxes are negative functions of $d_1$, i.e. more $d_1$ implies less $\pi_1$ and $\tau_1$ to cover government expenditure (including debt repayment, $d_0$). Second period inflation and taxes, though,

[8] The critical value of $\phi$ is $\tilde{\phi} = (\frac{a^2\lambda_1(1+\lambda_2)}{\lambda_2})^{1/2}$. For $\tilde{\phi} < 1$, since $\lambda_2/(1+\lambda_2) < 1$ it should hold that either $a$ or $\lambda_1$ are less than 1. However, assuming that the share of labour in the production function is greater than 0.5, so that $a > 1$, and that $\lambda_1$ should be a number very close to 1, $\tilde{\phi}$ will be greater than unity.

are positively related to $d_1$, for the same reasoning.[9] However, the size of $\phi$ is only affecting the shares of seigniorage and taxes in meeting the government expenditure requirements (plus debt interest and principal payments).

Thus, in this model, debt is just reallocating the burden of raising revenues (through taxation or inflation) among the two periods, and with a centralised authority that faces the optimal policy mix and has no output boost incentives, debt does not depend on the corruption level.[10] Optimal debt is driven only from the subjective time preference of society relative to the rate of return on assets. From equation (9) if for a moment we ignore $d_0$ (either because is close to zero or just an exogenous constant), we see that the degree of society's impatience $(1/\beta)$ relative to rate of return on assets $(1+\rho)$ will determine whether society wishes to be a net debtor or a net borrower. Thus, if $\beta(1+\rho) > 1 \Rightarrow \frac{1}{\beta} < (1+\rho)$, then society is better off accumulating assets and vice versa. If $\beta(1+\rho) = 1$, no debt is issued and the model reduces to the static one-shot game, where current policy instruments cover current revenue requirements. The effective discount factor, $\beta(1+\rho)$, is inversely related to debt, and in the SB is assumed to be optimal.

Also note that in the SB world inflation is non-zero, unlike the deterministic Barro and Gordon (1983) model with exogenous fiscal policy. Positive inflation arises solely because of government spending considerations and the incorporation of the government budget constraint in the maximisation problem. That is, the centralised authority is willing to tolerate some positive inflation (seigniorage), as it is trading-off among providing more of public goods and incurring the cost of positive inflation.

Despite the fact the debt policy is independent of $\phi$, all other policy instruments are not. That is, the SB outcome an economy can achieve is different for different corruption levels. Hence, an economy that faces lower quality of institutions will have a SB outcome characterised by higher inflation, lower taxes (if $\tilde{\phi} > 1$), lower government spending and lower overall social welfare. Appendix B summarises the SB solution outcome and the main results.

### 2.1 Centralised Economic Policy without Commitment

Suppose that the centralised authority is unable to precommit, and thus the output boost channel of unanticipated inflation is apparent. In this case, first period debt policy is

$$d_1^d = \frac{(1+\rho)d_0 + (1-\beta(1+\rho)K)g^*}{1+\beta(1+\rho)^2K}$$

[9] Note that first period debt policy can affect second period policies, and this is the link between the two periods under dynamic considerations.

[10] If the corruption level $\phi$ is time-variant, then optimal debt would depend on $\phi_t$ for $t = 1, 2$. However, in this two period model we assume that $\phi$ is time-invariant reflecting the fact that corruption levels change very sluggishly over time.

where

$$K = \frac{a^2\lambda_1\lambda_2(1+\phi)^2 + \phi^2\lambda_2 + a^2\lambda_1}{a^2\lambda_1(1+\lambda_2) + \phi\lambda_2(a^2\lambda_1 + \phi)} > 1 \quad \text{for every } \phi$$

Discretionary debt depends on the structural parameters of the model $a, \lambda_1, \lambda_2$ and $\phi$ . Furthermore, $d_1^d < d_1^{SB}$, since $K$ is always greater than unity. The effective discount factor under discretion $(\beta(1+\rho)K)$ is greater compared to the SB, which implies that second period costs of servicing debt are increased, and consequently, the centralised authority issues less debt in the first period.[11]

The intuition behind this result is that in the static version of the model, the economy ends up with higher inflation and lower taxes compared to the (static) SB in both periods.[12] Due to time-inconsistent monetary policy, the government is collecting too much revenue in the form of inflation and too little in the form of taxes (intratemporal imbalance). In the dynamic version of the model with discretion, however, though first period inflation expectations are taken as given, second period inflation expectations are not; they can still be affected by first period debt policy. The same applies to second period inflation and taxes. Thus, $\pi_2^e = h(d_1)$, and $\pi_2 = f(d_1)$, $\tau_2 = g(d_1)$. In other words, the centralised authority will use first period debt policy to affect second period outcomes and try and 'correct' the intratemporal imbalance of the second period. It uses debt to restrict itself from delivering too much inflation in the second period. That is why, discretionary debt depends on society's time preference relative to not only the rate of returns on assets but also $K$, which reflects intratemporal considerations.[13] In doing so, centralised discretionary policies result in both intratemporal and intertemporal imbalances (or distortions) compared to the SB.

The discretionary outcome under a centralised authority is again depending on the quality of institutions, since all choice variables are a function of $\phi$. Under some conditions, it holds that intratemporal imbalances are higher for higher levels of institutional quality. Furthermore, quality of institutions is negatively related to debt. Lower institutional quality increases debt and it is the higher institutional quality economies that restrict themselves more (and are further away from SB debt). For more details refer to Appendix D.2. Hence,

$$d_1^{SB} > d_{\phi_L}^d > d_{\phi_H}^d$$

where $\phi_L, \phi_H$ correspond to lower and higher quality respectively.

Intuitively, since higher institutional quality leads to more intratemporal distortions, the incentive to correct them is higher. Hence, the higher qual-

[11] See also Obstfeld (1991), Jensen (1994), Beetsma and Bovenberg (1997).

[12] The two period model without dynamic considerations, i.e. without debt, is equivalent to the one-shot game's outcome in both periods.

[13] Recall that $K$ summarises the intratemporal effects of inflation, tax and government spending on social welfare, according to the maximised value of equation (4) for $t = 2$.

ity economy accumulates more assets. This result is further motivated by the fact that high quality translates into more efficient tax systems, giving the opportunity for lowering debt further down but still having adequate revenues.

Note however that our model could be overstating the disaccumulation of debt since reputational issues and private sector's strategic behaviour are ignored. A summary of the discretionary outcome and the main findings is presented in Appendix C.

## 3 Delegation of monetary policy to a more conservative (Rogoff-type) central bank

According to Alesina and Tabellini (1987), in line with Rogoff (1985), decentralising economic policies and delegating monetary policy to a more conservative central bank can improve upon the (static) discretionary equilibrium, when a commitment mechanism is not available.[14]

Suppose that monetary policy is delegated to a more conservative central bank. Due to the objective function specification, this translates into lower weights on the output and government spending arguments relative to inflation (i.e. $\xi_i < \lambda_i$, $i = 1, 2$). None of the policymakers is able to precommit. The solution is again obtained backwards.

- In the Second Period:

The government and the central bank maximise their objective functions with respect to $\tau_2$ and $\pi_2$ respectively, for given $d_1$ and taking second period inflation expectations as given.

$$\max_{\tau_2} u_2 = -\frac{1}{2}\left[\pi_2^2 + \lambda_1(y_2 - y_n)^2 + \lambda_2(g_2 - g^*)^2\right]$$

$$\max_{\pi_2} v_2 = -\frac{1}{2}\left[\pi_2^2 + \xi_1(y_2 - y_n)^2 + \xi_2(g_2 - g^*)^2\right]$$

$$\begin{aligned} \text{Subject to} \quad & y_2 - y_n = a(\pi_2 - \pi_2^e - \tau_2) \\ & g_2 = \pi_2 + \phi\tau_2 - (1+\rho)d_1 \end{aligned}$$

The private sector forms expectations according to the first order conditions of the policymakers, which results in the following optimal second period policies:

$$\tau_2 = \frac{\phi\lambda_2}{a^2\lambda_1(1+\xi_2) + \phi\lambda_2(\phi + a^2\xi_1)}\left[(1+\rho)d_1 + g^*\right]$$

[14] The discretionary equilibrium in Alesina and Tabellini (1987) is exhibiting only intratemporal distortions.

$$\pi_2 = \pi_2^e = \frac{a^2\lambda_1\xi_2 + a^2\xi_1\phi\lambda_2}{a^2\lambda_1(1+\xi_2) + \phi\lambda_2(\phi + a^2\xi_1)}\ [(1+\rho)d_1 + g^*]$$

$$u_2 = -\frac{1}{2}\frac{(a^2\lambda_1\xi_2 + a^2\xi_1\phi\lambda_2)^2 + a^2\lambda_1\lambda_2(\phi^2\lambda_2 + a^2\lambda_1)}{[a^2\lambda_1(1+\xi_2) + \phi\lambda_2(\phi + a^2\xi_1]^2}\ [(1+\rho)d_1 + g^*]^2 = u_2(d_1, g^*) \tag{8}$$

- Similarly, in the First Period:

The fiscal and monetary authorities maximise their objective functions with respect to $\tau_1, d_1$ and $\pi_1$ respectively, taking first period inflation expectations and the optimal second period policies as given.

$$\max_{\tau_1,\, d_1} U^g = \sum_{t=1}^{2} \beta^{t-1} u_t = -\frac{1}{2}\Big[[\pi_1^2 + \lambda_1(y_1 - y_n)^2 + \lambda_2(g_1 - g^*)^2] + \beta u_2(d_1, g^*)\Big]$$

$$\max_{\pi_1} V^{cb} = \sum_{t=1}^{2} \beta^{t-1} v_t = -\frac{1}{2}\Big[[\pi_1^2 + \xi_1(y_1 - y_n)^2 + \xi_2(g_1 - g^*)^2] + \beta v_2(d_1, g^*)\Big]$$

$$\begin{aligned} \text{Subject to} \qquad & y_1 - y_n = a(\pi_1 - \pi_1^e - \tau_1) \\ & g_1 = \pi_1 + \phi\tau_1 + d_1 - (1+\rho)d_0 \end{aligned}$$

where $u_2$ is given by equation (8).

Note that it is only the fiscal authority that can affect second period policies (including second period inflation expectations and society's utility) through $d_1$. In contrast, the monetary authority cannot affect the second period, since $\pi_1$ can only affect current period outcomes, hence $v_2(d_1, g^*)$ need not be derived.

Solving the maximisation problems simultaneously, and after the private sector forms its inflation expectations, we get:

$$\tau_1 = \frac{\phi\lambda_2}{a^2\lambda_1(1+\xi_2) + \phi\lambda_2(\phi + a^2\xi_1)}\ [(1+\rho)d_0 + g^* - d_1]$$

$$\pi_1 = \pi_1^e = \frac{a^2\lambda_1\xi_2 + a^2\xi_1\phi\lambda_2}{a^2\lambda_1(1+\xi_2) + \phi\lambda_2(\phi + a^2\xi_1)}\ [(1+\rho)d_0 + g^* - d_1]$$

And discretionary debt policy is given by:

$$d_1^{\text{dmc}} = \frac{(1+\rho)d_0 + (1 - \beta(1+\rho)M)g^*}{1 + \beta(1+\rho)^2 M} \tag{9}$$

where the superstrict 'dmc' stands for 'discretion with a more conservative central bank' and

$$M = \frac{(a^2\lambda_1\xi_2 + a^2\xi_1\phi\lambda_2)^2 + a^2\lambda_1\lambda_2(\phi^2\lambda_2 + a^2\lambda_1)}{a^2\lambda_1\lambda_2[a^2\lambda_1(1+\xi_2) + \phi\lambda_2(\phi + a^2\xi_1)]}$$

Under decentralised and discretionary policymakers, optimal debt policy depends on intertemporal ($\beta(1+\rho)$) and intratemporal ($M$) considerations. The magnitude of $M$ (compared to unity) will depend on the central bank's weights (i.e. degree of conservatism) relative to government's weights and the level of corruption.

To find the optimal degree of conservatism, one needs to find the $\xi_i,\ i = 1, 2$ that maximise society's welfare under decentralisation. Thus setting,

$$\frac{\partial U^{\text{dmc},g}}{\partial \xi_i} = 0 \text{ for } i = 1, 2$$

yields the optimality condition for $\xi_1, \xi_2$:

$$\lambda_1(\xi_2 - \lambda_2) + \xi_1\lambda_2\phi = 0 \Leftrightarrow \xi_2 = \lambda_2 - \frac{\lambda_2}{\lambda_1}\ \phi\ \xi_1 \tag{10}$$

This implies that optimal $\xi_2$ is a linear function of $\xi_1$, due to the quadratic specification of the policymakers objective function. In other words, the optimal reduction of the weight the central bank puts on government spending depends on society's initial weights, $\lambda_1, \lambda_2$, on the degree of corruption, $\phi$, and on the optimal reduction of the central bank's weight on output, $\xi_1$. Hence, there are infinite combinations of $\xi_1, \xi_2$ that can maximise $U^{\text{dmc},g}$, which are bounded by $0 \leq \xi_i \leq \lambda_i,\ i = 1, 2$.

The optimality condition for $\xi_i,\ i = 1, 2$ manages to correct for both the intertemporal and intratemporal imbalances of discretionary policy and hence attain the SB, unlike in Beetsma and Bovenberg (1997).[15] That is, setting $\xi_i$ according to (10) yields $M = 1$, and hence, $d_1^{\text{dmc},g} = d_1^{SB}$, and at the same time $U^{\text{dmc},g} = U^{SB}$.

Note also, from equation (10), that both $\xi_1, \xi_2$ are inversely related to the quality of institutions. Lower quality (smaller $\phi$) requires higher $\xi_i$ (i.e. less conservative central banks). The reason for this result is that a low value for $\phi$ implies more costly tax collection, and hence a less effective tax system. Thus, the government would like to rely more on seigniorage. However, since monetary policy is no longer controlled by the government, this increased

[15] Beetsma and Bovenberg (1997) using a slightly different loss function and abstracting from corruption issues, end up with a value for $M$ that is always greater than unity. Consequently, their optimal degree of conservatism corrects only for the intratemporal misallocations. This result is driven by the money demand specification, $M_t/P_t = \kappa\bar{Y}$ that incorporates a velocity of money term, $\kappa$, and from the fact that they concentrate on coordinated monetary and fiscal policies by minimising a weighted average of the two policymakers' loss functions.

need for seigniorage translates into higher values for $\xi_1$ (higher central bank's incentive to boost distorted output through unanticipated inflation) or $\xi_2$ (higher central bank's consideration for government spending when setting inflation) or any combination of the two, according to (10).

## 4 Some special static cases

### 4.1 Static model without corruption

As mentioned above, with $d_1 = 0$ and $\phi = 1$ the model becomes static and reduces to Alesina and Tabellini's (1987) paper. According to their main argument, starting from the situation where both authorities share the same weights (i.e. $\xi_i = \lambda_i$) and decreasing the weights for the central bank results in higher discretionary utility. In other words,

$$\frac{\partial U^d}{\partial \xi_i}_{|\xi_i=\lambda_i} < 0, \quad \text{for} \quad i = 1, 2$$

Nonetheless, this differentiation outcome holds for $\xi_j,\ j \neq i,\ j = 1, 2$ constant and utility is increased when $\xi_i$ decreases locally.

Following and extending this finding, we can actually find the optimal $\xi_1, \xi_2$ that maximise $U^{\mathrm{dmc},g}$ and attain the SB. Equation (10) for $\phi = 1$ gives:

$$\xi_i = \lambda_i - \frac{\lambda_i}{\lambda_j}\xi_j, \quad \text{for} \quad i = 1, 2,\ j = 1, 2 \text{ and } j \neq i \tag{11}$$

If it is further assumed that a more conservative central bank translates into increasing the absolute weight on inflation, while the absolute weights on output and government spending remain constant, then both $\xi_1$ and $\xi_2$ would be reduced by the same amount. In other words, if we directly increase the weight on inflation from 1 to $(1 + s)$, $s > 0$, keeping the relative weights on the other two arguments of the objective function the same, we would have $\hat{U} = -\frac{1}{2}[(1 + s)\pi^2 + \lambda_1(y - y_n)^2 + \lambda_2(g - g^*)^2]$ so that $\xi_i = \frac{\lambda_i}{1+s}$, $i = 1, 2$. From the optimality condition,

$$\frac{\lambda_i}{1 + s} = \lambda_i - \frac{\lambda_i}{\lambda_j}\frac{\lambda_j}{1 + s} \Rightarrow s = 1$$

Thus, the optimal aversion to inflation should be doubled, and consequently, the relative weights on output and government spending that the central bank attaches to should be reduced by half. Thus, optimal $\xi_i$, $i = 1, 2$ are $\xi_i = \lambda_i/2$.

#### 4.1.1 Independent Central Bank

Suppose monetary policy is delegated to an independent central bank. This would imply that $\xi_2 = 0$, since the central bank is not taking into account

budgetary concerns, and hence is not fiscally dominated. From the optimality condition, equation (11), optimal relative weight on output would be $\xi_1 = \lambda_1$, and the SB outcome would again be obtained.

Thus, in the static model with $\phi = 1$, when monetary policy is delegated to an independent central bank ($\xi_2 = 0$), the SB outcome is achieved, without the need for delegating a more conservative central banker; the independent central bank should share society's relative weight on output ($\xi_1 = \lambda_1$).

The intuition for the limiting case of ($\xi_2 = 0, \xi_1 = \lambda_1$) is as follows. With $\xi_2 = 0$ the central bank is not internalising the government budget constraint in its policy decisions and completely ignores seigniorage benefits. The monetary authority still faces the incentive to cause surprise inflation so as to stimulate distorted output ($\xi_1 \neq 0$). Hence, the setting of inflation depends only on the level of taxes (i.e. distortions) and on how important the effect of these distortions on output relative to inflation are perceived to be (i.e. level of $\xi_1$). However, with endogenous fiscal policy, the degree of distorted output depends on the level of taxes set and the government still considers seigniorage revenues important ($\lambda_2 > 0$). Consequently, the government delegates an independent central bank with such a weight on output considerations ($\xi_1 = \lambda_1$) that its choice of SB taxes ($\tau^{SB}$) would induce the SB level of inflation.

The maximisation problem an independent central bank faces yields a first order condition for inflation, after private sector expectations are formed, according to: $\pi = a^2 \xi_1 \tau$, which is the same result when monetary policy is considered alone and $\tau$ is an exogenous constant (Barro and Gordon 1983). However, when $\tau$ is a choice variable, delegating an independent central bank such that $\xi_1 = \lambda_1$, and setting $\tau = \tau^{SB}$ will induce

$$\pi = a^2 \lambda_1 \tau^{SB} = \frac{a^2 \lambda_1 \lambda_2 g^*}{a^2 \lambda_1 (1 + \lambda_2) + \lambda_2} = \pi^{SB}$$

### 4.2 Introduce corruption to the static model

When the issue of the quality of institutions is introduced in the static case, the model reduces to Huang and Wei (2005). In this case, we established that optimal monetary and fiscal policy are functions of $\phi$, and this could provide a justification for countries with higher levels of corruption to be targeting higher inflation levels, unlike advanced countries that face better quality of institutions, according to one of their main arguments.

Extending on their work, this paper establishes that delegating an independent central bank no longer attains the SB, unless, according to (10) $\xi_1 = \lambda_1/\phi > \lambda_1$, that is, unless a less conservative than society central bank is chosen. The reason for this different result stems from the fact that now an independent central bank is also ignoring the capability of the tax-collection

mechanism in raising revenues through the formal tax channel. In other words, it is not taking into account that a lower $\phi$ implies a more costly tax system and a higher reliance on inflation tax from the perspective of the government. That is why, with the introduction of tax-collection leakages and a non-fiscally dominated central bank, for the SB to be achieved, the government wishes to appoint monetary policy to an independent central bank with a negative degree of conservatism on output considerations relative to its own.

## 5 Dynamics and Corruption

In the dynamic case with $\phi < 1$, again for the SB to be achieved with an independent central bank, a less conservative central bank regarding output considerations should be appointed. Thus, the introduction of debt is not qualitatively altering the outcome of the static case.

When the economy is facing tax inefficiencies and $\xi_1 = \lambda_1$, then the optimal $\xi_2$ should be equal to $0 < \xi_2^* = \lambda_2(1-\phi) < \lambda_2$, according to the optimality condition, stated in equation (10). Hence, some level of fiscal dominance should be permitted.

However, whenever an independent central bank with $\xi_2 = 0$ and $\xi_1 \leq \lambda_1$ (or $\xi_1 < \lambda_1/\phi$) is legislatively constituted, a new aspect emerges in a dynamic environment; the government faces the incentive to use debt strategically, since first period debt relates to second period monetary and fiscal setting.

In this case, $M$ with $\xi_2 = 0$ becomes[16]:

$$M_{|\xi_2=0} = N = \frac{(a^2\xi_1\phi\lambda_2)^2 + a^2\lambda_1\lambda_2(\phi^2\lambda_2 + a^2\lambda_1)}{a^2\lambda_1\lambda_2\left[a^2\lambda_1 + \phi\lambda_2(\phi + a^2\xi_1)\right]} < 1,$$

$$\text{for every} \quad \xi_1 < \frac{\lambda_1}{\phi} \quad \text{and hence for every} \quad \xi_1 \leq \lambda_1$$

$$\text{And} \quad d_1^{ICB} = \frac{(1+\rho)d_0 + (1-\beta(1+\rho)N)g^*}{1+\beta(1+\rho)^2N}$$

where *'ICB'* stands for discretion under an independent central bank.

For $\xi_1 < \lambda_1/\phi$, the effective discount factor of the government, $\beta(1+\rho)N$, is smaller compared to the SB one ($\beta(1+\rho)$) and society values less the costs of servicing debt. Hence, the effective discount factor is such that the government intertemporally shifts its financial requirements away from the first and towards the second period, by issuing more debt compared to the SB. Therefore, $d_1^{ICB} > d_1^{SB}$ by

$$d_1^{ICB} - d_1^{SB} = \frac{(1-N)\beta(1+\rho)^2}{(1+\beta)(1+\rho)^2N)(1+\beta(1+\rho)^2)} \left[(1+\rho)d_0 + g^* + \frac{g^*}{1+\rho}\right]$$

[16]Recall that $M$ is one component of the effective discount factor, $\beta(1+\rho)M$, according to which the government sets its debt policy.

Thus, if the government is unable to affect the degree of conservatism of the central bank or it cannot appoint such a less conservative central bank as to obtain the SB due to political reasons, it can use debt in order to affect second period monetary policy because monetary policy is considered too conservative from the ex ante perspective of the government, delivering too little inflation in both periods. More precisely, the government strategically accumulates debt so as to increase second period taxes, which in turn distort output further and hence induce the central bank to increase second period inflation (indirect channel). Note that in this case (with $\xi_2 = 0$) the channel through which debt affects second period inflation is different from the case of a more conservative central bank where both $\xi_i > 0$ and $d_1$ affects $\pi_2$ (and $\pi_2^e$) directly, presented in Section 3.[17]

This outcome suggests that more conservative monetary policy induces the government to use debt in order to increase second period inflation, despite the fact that monetary policy is free from any fiscal dominance phenomena.[18]

A direct implication that can be observed is that there is a range of $\xi_1$, namely, $\lambda_1 < \xi_1 < \lambda_1/\phi$, that even if a less conservative independent central bank is appointed, the government finds it optimal to accumulate debt in order to increase second period inflation. The lower is the quality of institutions (smaller $\phi$), the greater is this range. Higher levels of tax inefficiency imply more costly tax revenues and higher SB inflation levels. Hence, the government requires more and more loose monetary policy in order to cover its spending requirements through seigniorage.

### 5.1 Debt Behaviour

In order to analyse the debt behaviour and hence inflation dynamics of an economy that faces tax inefficiencies we should explore the factors that decrease $N$ further from unity. $N$ and hence the effective discount factor of the government, $(\beta(1+\rho)N)$, is a function of all the structural parameters of the model $(\lambda_1, \lambda_2, \phi)$, as well as the degree of central bank conservatism, $\xi_1$.

The government's relative weight on government spending, $\lambda_2$, is always a negative function of the effective discount factor. Hence, the more the government cares about government spending relative to inflation, (higher $\lambda_2$), the more it is inclined to accumulated debt, (higher $d_1^{\text{ICB}}$).

$\lambda_1, \xi_1, \phi$ are non-linear functions of $N$ and there are critical values of the

[17] The same applies to the solution of a discretionary centralised economy of Section 2.1 In general, whenever $\xi_2 > 0$, debt affects $\pi_2$ directly, since $d_1$ appears in the $\text{FOC}_{\pi_2}$. This is what we call the direct channel.

[18] This is one of the possibilities that arise in Beetsma and Bovenberg (1997). However, their outcome is driven from restrictions on the velocity of money, parameter $(\kappa)$, and not due to corruption.

variables that switch their effect on $N$, and consequently on the effective discount factor and first period debt policy. We will analyse each of them in more detail.

Table 1: **Effect of $\xi_1, \lambda_1, \phi$ on $N$**

| | | |
|---|---|---|
| $\frac{\partial N}{\partial \xi_1}$ | $=$ | $\frac{a^2\lambda_2\phi}{\lambda_1 D^2}\left[(a^2\lambda_1+\phi^2\lambda_2)(2\phi\xi_1-\lambda_1)+a^2\xi_1^2\phi^2\lambda_2\right]$ |
| $\frac{\partial N}{\partial \phi}$ | $=$ | $\frac{a^2\xi_1\lambda_2}{\lambda_1 D^2}\left[a^2\lambda_1(2\phi\xi_1-\lambda_1)+\phi^2\lambda_2(\lambda_1+a^2\xi_1^2)\right]$ |
| $\frac{\partial N}{\partial \lambda_1}$ | $=$ | $-\frac{a^2\phi\xi_1\lambda_2}{\lambda_1^2 D^2}\left[a^2\lambda_1(2\phi\xi_1-\lambda_1)+\phi^2\xi_1\lambda_2(\phi+a^2\xi_1)\right]$ |

where $\quad D = a^2\lambda_1 + \phi\lambda_2(\phi + a^2\xi_1)$

- Government's relative weight on output: $\lambda_1$

Unlike $\lambda_2$, the relative weight the government attaches to output considerations ($\lambda_1$) is a non-linear function of $N$. The reason for this is that the intertemporal shift towards or away from debt accumulation depends on the government's weight on output relative to the central bank's conservatism ($\xi_1$) and the quality of institutions.[19]

$$\frac{\partial N}{\partial \lambda_1} = 0 \Rightarrow \lambda_1^* = \frac{a^2\xi_1\phi + \phi[a^2\xi_1(a^2\xi_1 + \lambda_2(a^2\xi_1+\phi))]^{1/2}}{a^2} > 2\phi\xi_1$$

$$\text{For} \quad 0 < \lambda_1 < \lambda_1^* \Rightarrow \frac{\partial N}{\partial \lambda_1} < 0, \quad \text{and for} \quad \lambda_1 > \lambda_1^* \Rightarrow \frac{\partial N}{\partial \lambda_1} > 0$$

For values of $\lambda_1$ up to $\lambda_1^*$, $N$ is negatively related to $\lambda_1$. For relatively small values of $\lambda_1$, an increase in the relative weight of output induces the government to issue more debt. That is, despite the increased government's aversion to output distortions, it still finds it optimal to increase debt, so as to increase second period taxes, and distort output, which would in turn put upward pressure on inflation in the second period. The value of $\lambda_1$ that

[19] This is not the case, though, for $\lambda_2$ because $\xi_2 = 0$. In other words, since $\xi_2 = 0$ it is only the government that cares about government spending, so irrespective of the initial value of $\lambda_2$, the more weight attached to government spending, the more the revenues the government wants to raise through both tax and inflation tax. However, since $\xi_1 > 0$, the response of the government to changes in $\lambda_1$ will partially depend on the weight the central bank attaches to output given the efficiency of the tax system.

obtains the SB, given $\xi_1, \phi$, is always on the negatively sloped part on $N(\lambda_1)$, as it can be seen in Figure 1(c).

It is after $\lambda_1$ takes the value of twice the one that would obtain the SB that the opposite effect takes place. That is, for $\lambda_1 > \lambda_1^* > 2\phi\xi_1$, $\lambda_1$ is positively related to $N$ and the government, caring more about output distortions, is not engaging in debt accumulation.

Nonetheless, in the subsequent analysis we will consider $\lambda_1$ (and $\lambda_2$) as given and try to see how different degrees of central bank conservatism ($\xi_1$), and more importantly how different levels of quality of institutions ($\phi$), lead to different debt policies. We will assume that $\lambda_1$ is such that $\frac{\partial N}{\partial \lambda_1} < 0$.

- Central bank's relative weight on output: $\xi_1$

Regarding the degree of central bank's conservatism, there is a critical value of $\xi_1$ that provides the global minimum for $N$ as a function of $\xi_1$, keeping the other parameters fixed.

$$\frac{\partial N}{\partial \xi_1} = 0 \Rightarrow \xi_1^* = \frac{[(a^2\lambda_1 + \phi^2\lambda_2)(a^2\lambda_1(1+\lambda_2) + \phi^2\lambda_2)]^{1/2} - (a^2\lambda_1 + \phi^2\lambda_2)}{a^2\lambda_2\phi}$$

$$\text{and } 0 < \xi_1^* < \frac{\lambda_1}{2\phi}$$

$$\text{For } 0 < \xi_1 < \xi_1^* \Rightarrow \frac{\partial N}{\partial \xi_1} < 0 \text{ and for } \xi_1^* < \xi_1 < \frac{\lambda_1}{\phi} \Rightarrow \frac{\partial N}{\partial \xi_1} > 0$$

That is, for relatively small values of $\xi_1$, $0 < \xi_1 < \xi_1^*$, a further increase in the central bank's degree of conservatism (lower $\xi_1$), increases $N$ and hence the effective discount factor. Since the future matters more, the government reduces debt.[20] Further reduction in $\xi_1$ does not engage the government in debt accumulation, since the government knows that the central bank (being very inflation averse) will barely raise inflation in response to higher debt repayment in the second period and refrains from issuing debt. In other words, the costs of increased debt (higher second period taxes) outweigh the benefits (higher second period inflation) and hence first period debt is reduced.

For relatively higher values of $\xi_1$, namely, $\xi_1^* < \xi_1 < \lambda_1/\phi$, delegating a more conservative independent central bank (reducing $\xi_1$), decreases the effective discount factor and induces the government to accumulate debt, in an attempt to increase second period seigniorage revenues. That is, given the other structural parameters $(a, \lambda_1, \lambda_2, \phi)$, the degree of conservatism is such

[20]Note that in this interval, $\xi_1$ could actually be greater than $\lambda_1$, depending of $\phi$. Actually, for small values of $\phi$ (with certainty for $\phi < 1/2$), it is the case that $\xi_1 > \lambda_1$. However, the smaller is $\phi$ the more loose monetary policy is required for the SB to be attained, which implies that even if $\lambda_1 < \xi_1 < \lambda_1/\phi$, the central bank is too conservative from the government's point of view.

that lowering $\xi_1$ in the region of $(\xi_1^*, \lambda_1/\phi)$ induces the government to shift its financial requirements towards the second period by increasing debt in the first period. Here the cost of increasing debt is lower than the benefit as the central bank cares enough about output distortions for the government to use the debt mechanism in order to push second period inflation up.

- Quality of institutions: $\phi$

Regarding the quality of institutions, again, there is a critical value of $\phi$ that gives the global minimum of $N$ as a function of $\phi$. Quality of institutions is non-linear in $N$ and the effective discount factor. There are, hence, levels of corruption that do not result in debt accumulation.

$$\frac{\partial N}{\partial \phi} = 0 \Rightarrow \phi^* = \frac{a\lambda_1[(\lambda_2(\lambda_1 + a^2\xi_1^2) + a^2\xi_1^2)^{1/2} - a\xi_1]}{\lambda_2(\lambda_1 + a^2\xi_1^2)}$$

$$\text{and} \quad 0 < \phi^* < \frac{\lambda_1}{2\xi_1}$$

$$\text{For } 0 < \phi < \phi^* \Rightarrow \frac{\partial N}{\partial \phi} < 0 \quad \text{and for } \phi > \phi^* \Rightarrow \frac{\partial N}{\partial \phi} > 0$$

For relatively small values of $\phi$, $\phi \in (0, \phi^*)$, a further deterioration in the quality of institutions is increasing the costs of servicing debt beyond the benefits, which results in asset accumulation. The intuition behind this outcome is as follows. With $0 < \phi < \phi^*$ a further reduction in $\phi$ is making taxes even more inefficient in the sense that, despite their distortionary effect on output and the subsequent positive response of inflation, overall revenues get smaller due to the negative impact of tax revenues. Consequently, taxes become a too costly tool to be used by the government so as to induce the central bank to deliver higher inflation by increasing first period debt. In other words, there is a range of poor quality of institutions (relative to the other parameters) that a further deterioration makes the potential mechanism the government has in affecting second period monetary policy prohibitively costly.

However, for $\phi > \phi^*$, given that $\phi^* \leq 1$, more corruption (lower $\phi$) reduces the effective discount factor, which results in higher first period debt. This result suggests that for $\phi > \phi^*$, we would expect economies with lower quality of institutions to exhibit higher increasing public debt levels with the introduction of central bank independence, and higher debt levels compared to economies that exhibit better quality of institutions.

Figure 1 summarises the previous discussion by depicting the effects of $\xi_1, \lambda_1$ and $\phi$ on $N$ graphically.

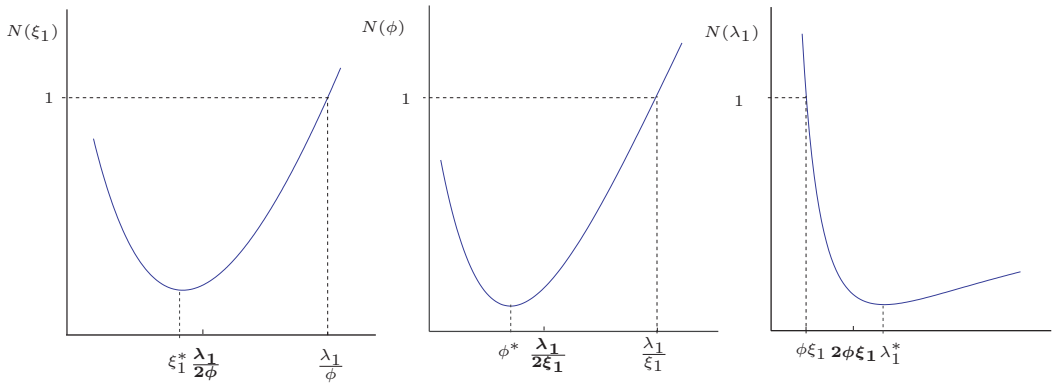


Figure 1: $N(\xi_1)$, $N(\phi)$ and $N(\lambda_1)$ respectively

Despite the non-linearities of the above parameters on $N$ one can observe, either from Table 1 or Figure 1, that whenever $2\phi\xi_1 - \lambda_1 > 0 \Rightarrow \phi > \lambda_1/2\xi_1$ (or equivalently $\xi_1 > \lambda_1/2\phi$) it holds that:[21]

$$\frac{\partial N}{\partial \xi_1} > 0, \quad \frac{\partial N}{\partial \phi} > 0$$

That is, we can pinpoint only one sufficient condition under which a further increase in the central bank's conservatism (lower $\xi_1$) or a further deterioration in quality of institutions (lower $\phi$) would lead to higher debt accumulation.

Furthermore, starting from the point where an independent central bank with $\xi_1 = \lambda_1$ has been in place and concentrating on reasonably realistic levels of corruption[22] (i.e. for $\phi > 1/2$) it holds that an economy would be accumulating more debt if

- it faces lower quality of institutions, $\frac{\partial N}{\partial \phi}_{|\xi_1=\lambda_1} > 0$
- it appoints a more conservative central bank , $\frac{\partial N}{\partial \xi_1}_{|\xi_1=\lambda_1} > 0$

[21] It also holds that $\frac{\partial N}{\partial \lambda_1} < 0$. However, we concentrate only on the effects of $\xi_1$ and $\phi$ assuming that the government's relative weights $(\lambda_1, \lambda_2)$ are given.

[22] Having a $\phi < 1/2$ would imply that more than half of the tax revenues never reach the treasury and would correspond to severe levels of corruption. We abstract from such severe levels of corruption. However, even if they do apply in reality, such countries are more likely to be also facing debt constraints and underdeveloped financial systems and would be more reluctant to give up seigniorage revenues by introducing independent monetary policy regimes.

### 5.2 Inflation Dynamics

In the previous section we established that for $\xi_1 < \lambda_1/\phi$, $N < 1$ and hence there are both intratemporal and intertemporal distortions that do not allow for the SB the be restored. Given the delegated parameters $(\xi_2 = 0, \xi_1 < \lambda_1/\phi)$ the monetary authority is intratemporally overcorrecting for inflation and consequently the fiscal authority is taxing too much and government spending is too low. Hence, an intratemporal distortion appears with inflation being too low in both periods, which is augmented by lower quality of institutions.[23]

In this situation, $N < 1$ and the government has the incentive to use debt in an attempt to correct this intratemporal imbalance, generating an intertemporal one. However, the intertemporal shift of the government towards second period inflation makes price stability ambiguous in a dynamic environment with an independent central bank in contrast to the static case.

Therefore, we will now turn our attention to the effects of debt policy on second period inflation setting by concentrating on changes on the central bank's delegated parameter $\xi_1$, since it raises the possibility of the unpleasant monetarist arithmetics of Sargent and Wallace (1981) to take place.

We have established that there is a range of $\xi_1$, $\xi_1 \in (\xi_1^*, \lambda_1/\phi)$ in which a further reduction in $\xi_1$ leads to more debt. This result implies that there is scope for the unpleasant monetarist arithmetics to emerge, in the case where a decline in $\xi_1$ results in an increase in second period inflation. Inflation is driven from both intertemporal and intratemporal factors. Recall that

$$\pi_2^{\text{ICB}} = \left(\frac{a^2\xi_1\phi\lambda_2}{a^2\lambda_1 + \phi\lambda_2(\phi + a^2\xi_1)}\right)\left(\frac{(1+\rho)}{1+\beta(1+\rho)^2N}\right)\left[(1+\rho)d_0 + g^* + \frac{g^*}{1+\rho}\right]$$

$$= (T_1)\ (T_2)\ \left[(1+\rho)d_0 + g^* + \frac{g^*}{1+\rho}\right]$$

The intratemporal factor $(T_1)$ is always positively related to $\xi_1$; A more conservative central bank reduces $T_1$, which tends to reduce inflation in both periods. The effect of the intertemporal factor $(T_2)$ on inflation, though, depends on the value of $\xi_1$. For relatively small values of $\xi_1$, $\xi_1 \in (0, \xi_1^*)$, a further decrease in $\xi_1$ shifts the intertemporal factor away from second period inflation and towards first period inflation. In this case the two effects reinforce each other. However, for $\xi_1 \in (\xi_1^*, \lambda_1/\phi)$, decreasing $\xi_1$ induces the government to accumulate debt, which tends to increase second period inflation (and reduce first period inflation). Hence, for relatively higher values of $\xi_1$, the intertemporal and intratemporal effects move to different directions.

[23] Actually, for a given $\xi_1 < \lambda_1/\phi$ lower quality of institutions (smaller $\phi$) leads the central bank to overcorrecting inflation even more if $a^2\lambda_1/\lambda_2 > 1$ or alternatively if $\phi < \sqrt{\frac{a^2\lambda_1}{\lambda_2}}$.

Therefore, if with a decrease in $\xi_1$ the intertemporal effect ($T_2$) dominates the intratemporal one ($T_1$), then the appointment of a more conservative independent central bank results in inflation boosts in the longer run (Sargent and Wallace 1981). This will take place if

$$\xi_1 > \tilde{\xi_1} = \left( \frac{\lambda_1(1+\beta(1+\rho)^2)(a^2\lambda_1+\phi^2\lambda_2)}{a^2\phi^2\lambda_2\beta(1+\rho)^2} \right)^{1/2}$$

because in this case $\frac{\partial \pi_2^{ICB}}{\partial \xi_1} < 0$. Also note that $\tilde{\xi_1} > \xi_1^*$.

For $\xi_1 > \tilde{\xi_1}$, delegating a more conservative independent central bank (lower $\xi_1$) results in higher second period inflation, because the government is issuing so much debt that the intertemporal shift towards second period inflation outweighs the intratemporal shift away from it.

### 5.3 An example

In this section we use a numerical example so as to visualise better the results stated in the previous sections. We parallel two cases in which the only difference lies on the level of the quality of institutions.

We assume that $\lambda_1 = 1.2$ and $\lambda_2 = 1.7$. That is, $1 < \lambda_1 < \lambda_2$, and the weights in the social welfare function are such that the government values output and government spending a bit more relative to inflation deviations from their targets. Furthermore, consistent with empirical findings, the share of labour in production, $\eta$, is set equal to 0.6, which implies that $a = 1.5 > 1$. Appendix D explains the implications of the chosen parameter values for the SB, the centralised discretionary and the central bank independence regime in more detail.

We distinguish two cases with different levels of corruption. In the first case the economy faces high quality of institutions, $\phi_{_H} = 0.95$ and the inefficiency of the tax system is minor, since it is only a small portion (5%) of tax revenues that goes wasted. In contrast, in the second case the economy suffers from a very high level of bureaucratic corruption, since $\phi_{_L} = 0.60$ and 40% of the tax revenues do not reach the treasury.

Regarding the SB outcome the two economies can achieve, since in both cases $\phi < 1$, a less conservative than society central bank should be delegated (assuming $\xi_2 = 0$). Nonetheless, in the case with low quality of institutions ($\phi = 0.6$) for the SB to be obtained a much less conservative independent central bank ($\xi_1^{SB} = 2$) is required, compared to the case with high quality, where $\xi_1^{SB} = 1.26$.

Lower quality of institutions translates into a SB solution with higher inflation, lower taxes, lower output gap, lower government spending and lower overall social welfare. In other words, the best an economy can achieve in a SB world is restricted by the quality of institutions it is subject to. Furthermore, since in this framework inflation is equivalent to seigniorage

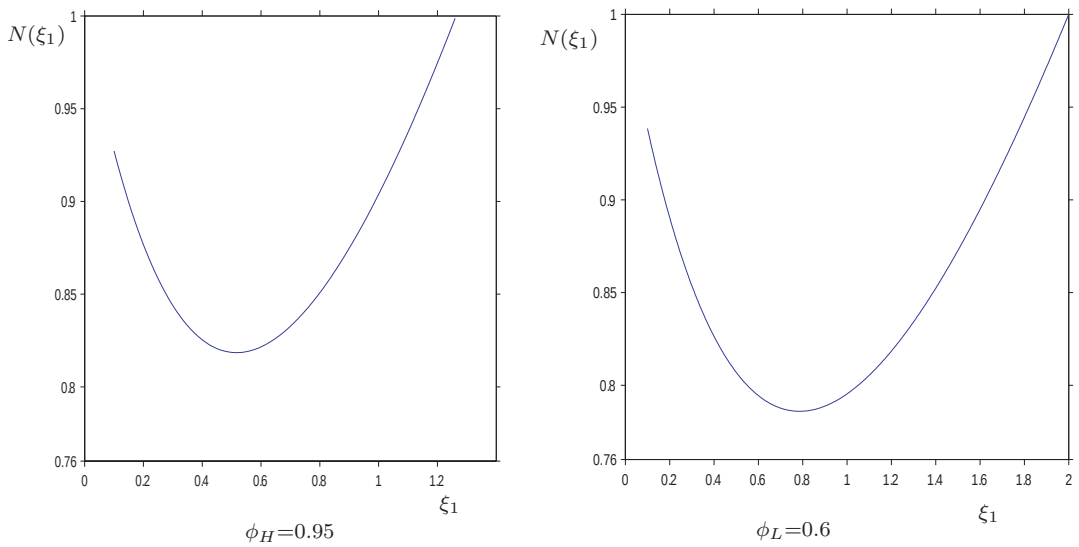


Figure 2: $N(\xi_1)$ and different qualities of institutions

our analysis suggests that the reliance on seigniorage is very limited for economies with small levels of corruption, contrary to cases with severer tax inefficiencies.

Comparing the case where both economies have delegated independent central banks with $\xi_2 = 0$ and $\xi_1 = \lambda_1$ it is established that the low institutional quality economy accumulates more debt compared to the high quality one.

Table 2 Independent Central Banks with $\xi_1 = \lambda_1$

| | | Level Comparison | | |
|---|---|---|---|---|
| $\phi$ | $\xi_1^{SB}$ | $N(\xi_1^{SB})$ | $\xi_1$ | $N(\xi_1 = \lambda_1)$ |
| $\phi_{_H} = 0.95$ | 1.2632 | 1 | $\xi_1 = \lambda_1 = 1.2$ | 0.9746 |
| $\phi_{_L} = 0.6$ | 2 | 1 | | 0.8184 |

As shown in Table 2 for economies which face high quality of institutions, as it is expected in many advanced economies, delegating an independent central bank gives a value of $N(= 0.9746)$ very close to unity. On the contrary, when $\phi_{_L} = 0.6$, $N(= 0.8184)$ is smaller, which implies higher debt accumulation. This is so because when an economy is facing large tax inefficiency issues it stands further away from its SB position when $\xi_1 = \lambda_1$ and hence issues more debt in an attempt to achieve its higher SB level of second period inflation. This result is enhanced by the fact that the

low quality economy is overcorrecting for inflation even more than the high quality economy delivering even lower inflation in both periods compared to the optimal level. For more details regarding how $\phi$ affects intratemporal distortions under central bank independence see Appendix D.3.

Another way of analysing debt dynamics under different levels of corruption is through a comparative statics exercise. Here, we focus on a comparison in which $\xi_1$ is reduced (from its respective SB level) by the same percentage and compare the percentage increase in debt for the two cases. The result is that the economy with low quality of institutions exhibits a higher debt increase. Suppose that both economies are at their SB so that $\xi_1 = \lambda_1/\phi$, for $\phi = \phi_H, \phi_L$. However, due to political pressures or due to an attempt to enhance the credibility of the newly introduced independent central bank, $\xi_1$ is considered 'too high'. Therefore, the government decides to appoint a central bank with a higher degree of conservatism (smaller $\xi_1$) and more precisely, with a $\xi_1$ that is 20% lower than the SB one.

Table 4: A percentage comparison

| $\phi$ | $\xi_1$ | $N(\xi_1)$ |
|---|---|---|
| $\phi_H = 0.95$ | $\xi_1^{SB} = 1.26$ | 1 |
| | $\acute{\xi_1} = 80\%\xi_1^{SB} = 1.0106$ | 0.9071 |
| $\phi_L = 0.6$ | $\xi_1^{SB} = 2$ | 1 |
| | $\acute{\xi_1} = 80\%\xi_1^{SB} = 1.6$ | 0.8948 |

Thus, for the high quality of institutions economy $\xi_1$ reduces to 1.01 and for the low quality economy to 1.6, and $N$ reduces by 9% and 10.5% respectively, as shown in Table 4. Consequently, the economy with low institutional quality will experience a higher debt increase.

Furthermore, though not presented here, the lower quality economy will experience a higher increase in inflation relative to the case where the government decides to continue behaving optimally and issuing no debt despite the non-optimal delegated parameter. Hence, the low institutional quality economy will also be facing higher difficulties in lowering inflation.

Finally, we will analyse the effects of a change in the monetary policy regime, from discretionary monetary and fiscal policy under a centralised economy to the appointment of an independent central bank with $\xi_2 = 0$ and $\xi_1 = \lambda_1$. Such a regime shift induces the the low quality economy to accumulate more debt.

Suppose that initially in both economies monetary and fiscal policy are determined by a centralised authority that is unable to precommit. This regime results in the outcomes presented in Section 2.1. In this case, we have established that the effective discount factor of the centralised economy,

$K\beta(1+\rho)$, is greater than the SB and the economy is accumulating less debt, since $K > 1\ \forall\phi$.

In our example, for the case where $\phi_{_H} = 0.95$, $K = 1.64$, though for $\phi_{_L} = 0.6, K = 1.41$. That is, the economy facing high institutional quality issues less debt (i.e. accumulates more assets) than the economy with high corruption issues. Given the chosen parameters, the intratemporal distortion of excessive inflation is higher in the high institutional quality economy. For more details refer to Appendix D.2.

Note that the simple model incorporated here abstracts from reputational issues and the private sector does not behave strategically. Hence, the centralised discretionary policies overstate the disaccumulation of debt. In other words, the centralised economy regime results in a debt policy setting that is not very realistic. Allowing for reputational issues would result in lower intratemporal inflation and consequently lower asset accumulation.

Table 5: Regime Shift Comparison

| Discretion Under a Centralised Economy | | |
|---|---|---|
| $\xi_1, \xi_2$ | $\phi$ | $K$ |
| | $\phi_H = 0.95$ | 1.64 |
| $\xi_1 = \lambda_1 = 1.2$ | | |
| $\xi_2 = \lambda_2 = 1.7$ | $\phi_L = 0.6$ | 1.41 |
| **Delegation of Monetary policy** | | |
| $\xi_1, \xi_2$ | $\phi$ | $N$ |
| | $\phi_H = 0.95$ | 0.9746 |
| $\xi_1 = \lambda_1 = 1.2$ | | |
| $\xi_2 = 0$ | $\phi_L = 0.6$ | 0.8184 |

Starting from the situation of a centralised economy and delegating monetary policy to an independent central bank that shares the same weight on output considerations as the government will result in different debt policies for different institutional qualities. This monetary policy regime shift would result in a sizable, but not equal, reduction in the effective discount factor and essentially in $N$ in both cases. However, a considerable part of the debt increase is attributable to the fact that under a centralised authority debt is much lower from its SB value. Consequently, the debt increase implied by the reduction of the effective discount factor from $K\beta(1+\rho)$ to $\beta(1+\rho)$ (or equivalently from $K$ to 1) is necessary for the correction of the intertemporal distortions the centralised economy has been generating.

We see from table 5 that the regime reform from a discretionary centralised policymaking to the delegation of monetary policy to an independent central bank results in an overall reduction in the effective discount factor of

40.5% for the high quality economy and of 42% for the low quality economy. However, concentrating on that part of the debt increase attributable to the introduction of the independent central bank that overcorrects for inflation beyond the SB point (or equivalently isolating that part of the debt increase that is attributable to the correction of the intratemporal distortions of the centralised economy) we observe that for the high quality economy the effective discount factor is reduced further from the SB by only 1.55%, though for the low quality economy by 12%. Hence, the low quality economy will experience a much higher debt increase with the introduction of an independent central bank.

It becomes apparent that high quality of institutions has two major advantages. Firstly, it corresponds to a better SB solution, compared to cases with lower $\phi$. Secondly, and equally important, the delegation of an independent central bank (with $\xi_1 = \lambda_1$) provides a solution to the lack of a commitment technology very close to the SB. The small debt accumulation can be easily corrected by a marginal increase in $\xi_1 = \lambda_1/\phi$.

In contrast, low institutional quality limits the economy's situation in a second best world. SB inflation is higher and this could pose difficulties in controlling and lowering inflation, unless the quality of institutions is improved. Even if monetary policy is delegated to an independent central bank, the government has a higher incentive to use first period debt policy in an attempt to increase second period inflation, the higher corruption is. Hence, economies facing higher corruption issues will experience higher debt increases and consequently increased upward pressure in inflation with the introduction of central bank independence. This result could provide an explanation for the divergent and generally poorer inflation performance of emerging market economies that have introduced central bank independence, and, at the same time, it poses difficulties for a balanced debt process.

## 6 Conclusion

We have presented a deterministic model where fiscal policy is endogenised; the new player, the government, is allowed to issue public debt and the quality of the tax system is allowed to differ from optimal, modelling this way bureaucratic corruption. Thus, the objective function of the policymakers is augmented to incorporate a government spending argument, and the government budget constraint is augmented with a tax inefficiency parameter, $\phi$. We abstract, however, from stochastic issues and any labour or goods market imperfections, since distortionary taxes alone can induce monetary policy time-inconsistency problems. Consequently, distortions and hence monetary policy inflation bias are endogenised, and the monetary authority is fiscally dominated. Setting up a two period model, dynamic considerations are introduced and with $0 < \phi < 1$ quality of institutions is considered.

In this environment, the second best (SB) is given by the commitment outcome under a centralised authority. The SB solution is a function of the quality of institutions, and lower quality (i.e. more corruption) results in higher SB inflation, lower taxes (under some conditions), lower SB provision of public goods and lower social welfare. Nonetheless, if a commitment mechanism is not available, centralised policies will be discretionary and lead to both intertemporal and intratemporal misallocations compared to the SB.

We find that if the tax system is purely efficient ($\phi = 1$), delegating an independent central bank (i.e. not fiscally dominated, $\xi_2 = 0$) achieves the SB without the need of a more conservative central bank, in terms of the relative weight attached to output stabilisation (i.e. $\xi_1 = \lambda_1$). This result stresses the importance of constituting an independent central bank, which is also one of the main prerequisites for successful monetary policy.

However, when corruption ($\phi < 1$) is introduced, the government's ability to raise revenues through the formal tax system is restricted and an independent central bank can no longer achieve the SB, unless it becomes less conservative towards output considerations than society ($\xi_1 = \frac{\lambda_1}{\phi} > \lambda_1$). Nonetheless, if, due to political or central bank credibility reasons, an independent central bank with $\xi_1 < \lambda_1/\phi$ has been legislatively constituted, the government has the incentive to strategically accumulate debt in order to increase second period inflation. Thus, despite the fact that the central bank is free from fiscal dominance phenomena, the government can still affect second period monetary policy, putting upward pressure on long-run price stability, by increasing debt accumulation. This result is augmented by the quality of institutions.[24]

Countries that are faced with low institutional quality (high corruption indexes), as is the problem with many emerging market economies, even if they constitute an independent central bank, which has been a general trend in the past decade, could experience lower performances in terms of controlling inflation compared to countries with high quality of institutions, due to the higher incentive of the government to rely on borrowing. In other words, our model suggests that a higher level of bureaucratic corruption could be responsible for lower inflation performances and increasing debt processes of economies that constitute an independent central bank.

This may provide one explanation for the divergent performance of emerging market economies that have introduced inflation-targeting regimes, though it is too early to make decisive conclusions. Nonetheless, using a very simple model, it has been demonstrated that corruption indexes can interact with fiscal policy by shifting the financing of government spending towards increased debts, which in turn interact with monetary policy and obstacle the

[24]This is the case under some conditions regarding the structural parameters of the model. See footnote 23.

efforts for price stabilisation and disinflation. This is in line with a number of empirical studies (see Eijffinger and de Haan (1996) for a survey) claiming that the negative relation between legal central bank independence and average inflation is not uniformly observed in developing countries.

Thus, improving the quality of institutions is vital in order to avoid sharp increases of debt after monetary policy reforms, and consequently for the independent central bank to avoid budgetary pressures in achieving its primary goal of price stability. Hence, an interesting future research project is to connect the empirical evidence of lower inflation performance of emerging market economies with the status of institutional quality and the response of debt policy after monetary policy reforms.

## Appendix A: First Best

In a First Best World, distortions are removed and the centralised authority is able to commit. Therefore, taxes are non-distortionary and there is no corruption, that is $\phi = 1$. However, we will allow $\phi$ to differ from unity and show its effect on optimal monetary and fiscal setting.

Since taxes are non-distortionary the aggregate supply function becomes: $y_t - y_n = a(\pi_t - \pi_t^e)$ and the government budget constraint: $g_t = \pi_t + \phi\tau_t + d_t - (1+\rho)d_{t-1}$, where $\tau_t = T_t/\bar{Y}$ represents lump-sum taxes as a share of non-distortionary output. The problem is solved backwards.

- In the Second Period,

the centralised authority maximises

$$\max_{\tau_2,\pi_2} u_2 = -\frac{1}{2}\left[\pi_2^2 + \lambda_1(y_2 - y_n)^2 + \lambda_2(g_2 - g^*)^2\right]$$

$$\begin{aligned} \text{Subject to} \qquad & \pi_2 = \pi_2^e \\ & y_2 = y_n \\ & g_2 = \pi_2 + \phi\tau_2 - (1+\rho)d_1 \quad \text{i.e.} \quad d_2 = 0 \end{aligned}$$

Thus, $\max_{\tau_2,\pi_2} u_2 = -\frac{1}{2}\left[\pi_2^2 + \lambda_2(\pi_2 + \phi\tau_2 - (1+\rho)d_1 - g^*)^2\right]$

The optimal monetary and fiscal instruments for the second period will be chosen according to:

$$\tau_2 = \frac{1}{\phi}\left[(1+\rho)d_1 + g^*\right] \quad \text{and} \quad \pi_2 = 0$$

If $\phi = 1$, then taxes would be covering current government spending and the debt burden of the first period. In a first best world, corruption is just changing the intertemporal amount of taxes to be collected in each period. Optimal inflation is zero. Consequently, $u_2 = 0$, and second period welfare is independent of $d_1$.

- In the first period,

since $u_2 = 0$ there is nothing connecting the two periods, and the government similarly maximises,

$$\max_{\tau_1,\pi_1,d_1} U^g = u_1 = -\frac{1}{2}\left[\pi_1^2 + \lambda_2(\pi_1 + \phi\tau_1 + d_1 - (1+\rho)d_0 - g^*)^2\right]$$

Thus,

$$\tau_1 = \frac{1}{\phi}\left[(1+\rho)d_0 + g^* - d_1\right] \quad \text{and} \quad \pi_1 = 0$$

And the $\text{FOC}_{d_1}$ holds for every $d_1$,

$$\lambda_2(\pi_1 + \phi\tau_1 + d_1 - (1+\rho)d_0 - g^*) = 0$$

$$d_1 = (1+\rho)d_0 + g^* - \phi\tau_1 \quad \forall d_1$$

since first period taxes are set according to $\tau_1 = \frac{1}{\phi}\left[(1+\rho)d_0 + g^* - d_1\right]$. In other words, one of the two fiscal instruments is redundant. Since taxes are non-distortionary, taxes and debt and equivalent in both their use and effects and hence interchangeable. For instance, if $\tau_1 = 0$, then all the first period required revenues are raised through debt, $d_1 = (1+\rho)d_0 + g^*$ and second period ones through second period taxes, $\tau_2 = \frac{(1+\rho)}{\phi}[(1+\rho)d_0 + g^* + \frac{g^*}{1+\rho}]$. Alternatively, if $d_1 = 0$, then $\tau_1 = \frac{1}{\phi}[(1+\rho)d_0 + g^*]$ and $\tau_2 = \frac{1}{\phi}g^*$.

In a first best world $\pi_t = 0$, $y_t = y_n$, $U^g = 0$ and taxes and debt are interchangeable. The level of corruption, $\phi$, just increases the required amount of tax revenues to be raised in each period.

## Appendix B: Second Best

Second Best Solution

| | | |
|---|---|---|
| $\tau_1^{SB}$ | $=$ | $\frac{\phi\lambda_2}{a^2\lambda_1(1+\lambda_2)+\phi^2\lambda_2}\left(\frac{\beta(1+\rho)^2}{1+\beta(1+\rho)^2}\right)\left[(1+\rho)d_0+g^*+\frac{g^*}{1+\rho}\right]$ |
| $\pi_1^{SB}$ | $=$ | $\frac{a^2\lambda_1\lambda_2}{a^2\lambda_1(1+\lambda_2)+\phi^2\lambda_2}\left(\frac{\beta(1+\rho)^2}{1+\beta(1+\rho)^2}\right)\left[(1+\rho)d_0+g^*+\frac{g^*}{1+\rho}\right]$ |
| $d_1^{SB}$ | $=$ | $\frac{(1+\rho)d_0+(1-\beta(1+\rho))\,g^*}{1+\beta(1+\rho)^2}$ |
| $\tau_2^{SB}$ | $=$ | $\frac{\phi\lambda_2}{a^2\lambda_1(1+\lambda_2)+\phi^2\lambda_2}\left(\frac{(1+\rho)}{1+\beta(1+\rho)^2}\right)\left[(1+\rho)d_0+g^*+\frac{g^*}{1+\rho}\right]$ |
| $\pi_2^{SB}$ | $=$ | $\frac{a^2\lambda_1\lambda_2}{a^2\lambda_1(1+\lambda_2)+\phi^2\lambda_2}\left(\frac{(1+\rho)}{1+\beta(1+\rho)^2}\right)\left[(1+\rho)d_0+g^*+\frac{g^*}{1+\rho}\right]$ |
| $U^{SB}$ | $=$ | $-\frac{1}{2}\left[\frac{a^2\lambda_1\lambda_2}{a^2\lambda_1(1+\lambda_2)+\phi^2\lambda_2}\right]\left(\frac{\beta(1+\rho)^2}{1+\beta(1+\rho)^2}\right)\left[(1+\rho)d_0+g^*+\frac{g^*}{1+\rho}\right]^2$ |

Summary of results:

- With endogenous fiscal policy SB inflation is non-zero. Positive inflation arises solely due to government spending considerations. Hence, it reflects the benefits from seigniorage which arise not due to debt constraints but due to distortionary taxation.
- SB debt policy in independent of $\phi$. It is driven by the subjective time preference of society $(1/\beta)$ relative to the rate of returns on assets $(1+\rho)$.
- Apart from debt, all other policy variables depend on $\phi$. Quality of institutions affects the SB outcome as follows. Lower quality gives rise to a worse SB, with higher SB inflation levels, lower taxes and output gap (if $\tilde{\phi} > 1$), lower government spending and lower social welfare.

## Appendix C: Delegation of Monetary Policy

Solution under a more conservative central bank

$$\tau_1^{\text{dmc}} = \frac{\phi\lambda_2}{a^2\lambda_1(1+\xi_2)+\phi\lambda_2(\phi+a^2\xi_1)}\left(\frac{\beta(1+\rho)^2M}{1+\beta(1+\rho)^2M}\right)\left[(1+\rho)d_0+g^*+\frac{g^*}{1+\rho}\right]$$

$$\pi_1^{\text{dmc}} = \frac{a^2\lambda_1\xi_2+a^2\xi_1\phi\lambda_2}{a^2\lambda_1(1+\xi_2)+\phi\lambda_2(\phi+a^2\xi_1)}\left(\frac{\beta(1+\rho)^2M}{1+\beta(1+\rho)^2M}\right)\left[(1+\rho)d_0+g^*+\frac{g^*}{1+\rho}\right]$$

$$d_1^{\text{dmc}} = \frac{(1+\rho)d_0+(1-\beta(1+\rho)M)\,g^*}{1+\beta(1+\rho)^2M},$$

$$\text{where} \quad M=\frac{(a^2\lambda_1\xi_2+a^2\xi_1\phi\lambda_2)^2+a^2\lambda_1\lambda_2(\phi^2\lambda_2+a^2\lambda_1)}{a^2\lambda_1\lambda_2[a^2\lambda_1(1+\xi_2)+\phi\lambda_2(\phi+a^2\xi_1)]}$$

$$\tau_2^{\text{dmc}} = \frac{\phi\lambda_2}{a^2\lambda_1(1+\xi_2)+\phi\lambda_2(\phi+a^2\xi_1)}\left(\frac{(1+\rho)}{1+\beta(1+\rho)^2M}\right)\left[(1+\rho)d_0+g^*+\frac{g^*}{1+\rho}\right]$$

$$\pi_2^{\text{dmc}} = \frac{a^2\lambda_1\xi_2+a^2\xi_1\phi\lambda_2}{a^2\lambda_1(1+\xi_2)+\phi\lambda_2(\phi+a^2\xi_1)}\left(\frac{(1+\rho)}{1+\beta(1+\rho)^2M}\right)\left[(1+\rho)d_0+g^*+\frac{g^*}{1+\rho}\right]$$

$$U^{\text{dmc}} = -\frac{1}{2}\left[\frac{(a^2\lambda_1\xi_2+a^2\xi_1\phi\lambda_2)^2+a^2\lambda_1\lambda_2(\phi^2\lambda_2+a^2\lambda_1)}{[a^2\lambda_1(1+\xi_2)+\phi\lambda_2(\phi+a^2\xi_1)]^2}\right]$$
$$\left(\frac{\beta(1+\rho)^2(1+\beta(1+\rho)^2M^2)}{[1+\beta(1+\rho)^2M]^2}\right)\left[(1+\rho)d_0+g^*+\frac{g^*}{1+\rho}\right]^2$$

The solution outcome presented in the Table above nests three special cases.

1. With $\xi_i = \lambda_i,\ i = 1,2$ it reduces to the outcome obtained under discretionary centralised policies (Section 2.1). In this case $M = K > 1\ \forall\phi$.

   - Since monetary policy is inconsistent, intratemporal distortions arise.

     $\tau^d < \tau^{SB},\ \pi^d > \pi^{SB},\ g^d > g^{SB}, U^d < U^{SB}\ \forall\phi$ in both periods

- $d_1^d$ is no longer independent of $\phi$. Debt policy is partially driven by intratemporal considerations ($K$) in an attempt to correct for them. Hence, $d_1^d > d_1^{SB}$.
- Regarding the effect of the quality of institutions on the discretionary outcome, under some conditions lower quality results in increased debt and in less intratemporal distortions. See D.2.

2. With $\xi_i \leq \lambda_i,\ i = 1, 2$ it reduces to the case where monetary policy has been delegated to a more conservative central bank.

   - Debt policy is still depending on $\phi$ (and the relative weights of both policymakers)
   - Whether the economy accumulates more or less debt compared to the SB will depend on the degree of central bank conservatism (relative to government's preferences) and the level of corruption.
   - The delegated parameters that maximise government's utility, are given by
     $$\xi_2 = \lambda_2 - \frac{\lambda_2}{\lambda_1}\phi\xi_1$$
     The optimal delegated parameters correct for both intratemporal and intertemporal distortions and attain the SB.
   - Both delegated parameters are inversely related to the quality of institutions. Lower quality requires less conservative central banks for the SB to be obtained.

3. With $\xi_2 = 0$ (and $\xi_1 \neq \lambda_1$) it reduces to the outcome under an independent central bank and $M_{|\xi_2=0} = N$.

   - If $\xi_1 = \lambda_1/\phi > \lambda_1$ the SB is again restored.
   - However, if $\xi_1 \leq \lambda_1/\phi$, then $N < 1$ and both intratemporal and intertemporal distortions arise. The independent central bank is overconservative and hence overcorrecting for inflation in both periods. Hence,
     $$\pi^{ICB} < \pi^{SB}, \tau^{ICB} > \tau^{SB}, U^{ICB} < U^{SB}\ \forall\phi \text{ in both periods}$$
   - Debt depends on $\phi$ and the government accumulates debt in an attempt to correct the intratemporal imbalances. Thus, $d_1^{ICB} > d_1^{SB}$. Upward pressure on second period inflation is placed and the price stability the independent central bank is trying to establish is obstacled at the cost of more debt.
   - Under some conditions, lower quality results in higher intratemporal distortions and higher debt accumulation. See D.3.

## Appendix D

Suppose we have two economies in which their only difference lies on the level of institutional quality. The structural parameters are set according to:

| | |
|---|---|
| $\lambda_1 = 1.2$ | $\lambda_2 = 1.7$ |
| $\eta = 0.6$ | $a = 1.5$ |
| $\phi_{_H} = 0.95$ | $\phi_{_L} = 0.60$ |

### D.1

For the SB outcome (Section 2) the chosen parameter values imply that

$$\tilde{\phi} = \left(\frac{a^2\lambda_1(1+\lambda_2)}{\lambda_2}\right)^{1/2} > 1$$

Hence, more corruption (lower $\phi$) is always resulting in a shift away from SB tax for both periods, as presented in Section 2 (page 9). Therefore, lower quality of institutions translates into a SB solution with higher inflation, lower taxes, output gap, government spending and overall social welfare.

### D.2

In the discretionary outcome under a centralised authority (Section 2.1) if $a^2\lambda_1 > \phi$, then $\frac{\partial d_1^d}{\partial \phi} < 0$. The chosen parameters assure that $a^2\lambda_1 > 1$, hence lower institutional quality results in higher debt. This is to say that, though discretionary debt setting is always below the SB level of debt, the lower quality economy's debt is closer the SB one.

$$d_1^{SB} > d_{\phi_L}^d > d_{\phi_H}^d$$

To assess the magnitude of the intratemporal distortions under different levels of institutional quality we need to identify the effect of $\phi$ on the absolute difference of inflation and taxes from their SB levels respectively. If $\phi < \left(\frac{a^2\lambda_1(1+\lambda_2)}{\lambda_2}\right)^{1/2}$ it holds that

$$\frac{\partial|\pi^d - \pi^{SB}|}{\partial\phi} > 0, \ \frac{\partial|\tau^d - \tau^{SB}|}{\partial\phi} > 0$$

In our example, $\frac{a^2\lambda_1(1+\lambda_2)}{\lambda_2} > 1$, hence it always holds that intratemporal distortions are higher for higher levels of institutional quality. This is one reason why economies will higher levels of quality are using debt to restrict themselves even more.

**D.3**

Regarding the central bank independence regime, the chosen parameters assure that $2\phi\xi_1 - \lambda_1 > 0$. Therefore,

$$\frac{\partial N}{\partial \lambda_1} < 0, \ \frac{\partial N}{\partial \xi_1} > 0$$

for both levels of corruption.

In addition, starting from the point where $\xi_1 = \lambda_1$ it still holds that

$$\frac{\partial N}{\partial \xi_1}_{|\xi_1=\lambda_1} > 0$$

for the two chosen levels of corruption, since they are both greater than 1/2.

How are the intratemporal distortions affected by $\phi$ is this case? Similarly to D.2 one should analyse the effect of $\phi$ on the difference between central bank independece and SB levels of inflation and taxes respectively. If $\phi < \left(\frac{a^2\lambda_1}{\lambda_2}\right)^{1/2}$ it holds

$$\frac{\partial|\pi^{ICB} - \pi^{SB}|}{\partial\phi} < 0, \ \frac{\partial|\tau^{ICB} - \tau^{SB}|}{\partial\phi} < 0$$

The chosen parameter values satisfy $\frac{a^2\lambda_1}{\lambda_2} > 1$. So, it is the lower quality economy that ends up with more intratemporal distortions. Hence, the need to increase debt in order to correct for them is higher.

Comparing the minimum value of the central bank's conservatism, $\xi_1^*$, that shifts the effect of $\xi_1$ on $N(\xi_1)$ from positive to negative, for lower quality of institutions, $\xi_1^*$ corresponds to a higher value of $\xi_1$ and a lower value of $N$. That is, for greater corruption levels, the range of $\xi_1$ $(0, \xi_1^*)$ that is restraining the government from using the debt channel to affect second period monetary policy is larger. The reasoning behind this outcome is that with higher corruption levels the tax system is very inefficient and the reliance on seigniorage revenues is greater. Consequently, for the government to use the debt mechanism, $\xi_1$ must also be greater for the central bank's response to a higher financial requirement to result to the preferred outcome.

Table 3

| $\phi$ | $\xi_1^*$ | $N(\xi_1^*)$ | $\tilde{\xi_1}$ | $N(\tilde{\xi_1})$ |
|---|---|---|---|---|
| $\phi_{_H} = 0.95$ | 0.5169 | 0.8185 | 1.6803 | 1.1950 |
| $\phi_{_L} = 0.6$ | 0.7860 | 0.7860 | 2.3530 | 1.1094 |

Also note that for severe (and somehow not very plausible) levels of corruption ($\phi < 0.5$) it could be the case that $\xi_1 = \lambda_1$ lies on the negatively sloped part of $N(\xi_1)$. In our example this happens for $\phi < 0.4$, in which cases $\xi_1^* > \xi_1 = \lambda_1 = 1.2$.

Recalling from Section 5.2 (page 25) there is scope for the unpleasant monetarist arithmetics to take place for high values of $\xi_1$ ($\xi_1 > \tilde{\xi_1}$). Nonetheless, in our example there is no need to worry about this phenomenon because in both cases of high and low quality of institutions, the value of $\xi_1$ after which a more conservative central bank results in higher inflation lies above the SB value[25], i.e. $\tilde{\xi_1} > \xi_1^{SB} = \lambda_1/\phi$.

[25] Actually, given the chosen parameters, for any $0 < \phi < 1$, $\tilde{\xi_1} > \xi_1^{SB}$. However, this is not a general result. For the unpleasant monetarist arithmetics to emerge before the SB, $\lambda_2$ ($\lambda_1$) should be large (small), relative to each other and the level of corruption.

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