Bureaucratic Corruption and the Dynamic Interaction between Monetary and Fiscal Policy

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Abstract

This paper analyses the dynamic interaction between fiscal and monetary policies under different levels of bureaucratic corruption. Building on the original Barro and Gordon (1983) model and explicitly formulating the fiscal authority, we find that all policy outcomes depend on the size of corruption the economy is faced with. Delegation of monetary policy to an independent central bank is attaining the second best solution only if there is no bureaucratic corruption. However, with suboptimal institutional quality, the government has the incentive to increase debt strategically and indirectly 'force' the central bank to pursue expansionary monetary policy, despite independence. This result is augmented by the size of bureaucratic corruption and poses difficulties on the achievement of both price stability and a balanced debt process. Bureaucratic corruption, 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. The implications of the theoretical model on debt accumulation are verified empirically using a cross-sectional setting of 77 developed and developing countries. Confirming the theoretical predictions we find that after central bank independence is granted, more corruption leads to higher debt accumulation. More importantly, this effect is augmented by the degree of independence each central bank reform gave.

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Introduction

The aim of this paper is to explore the impact of bureaucratic corruption on the interaction of monetary and fiscal policies under different levels of monetary authority independence. On a theoretical level, we readdress the time-inconsistency problem of monetary policy focusing on the driving forces of monetary and fiscal policymaking when the economy is faced with suboptimal institutional quality, materialised in the form of an inefficient tax collection system. The empirical analysis concentrates on the relationship between fiscal outcomes, and more precisely, debt accumulation and corruption after full or partial central bank independence (CBI) has been legislated.

There has been a general and intensively increasing trend towards central bank independence in the past couple of decades among both industrial and developing countries. During late 1980s and early 1990s many industrial countries have strengthened or established the independent legal status of their central banks, and developing countries followed their example soon afterwards. In the same context, many countries have opted for an inflation targeting framework, assigning price stability as the primary objective. Nonetheless, the monetary and fiscal performance of these countries has been very divert. Bureaucratic corruption provides an explanation for these observed differences.

Central bank independence has received considerable attention in both policy and academic circles. The main theoretical argument in favour of CBI, initiated by Barro and Gordon (1983), stresses the elimination of the time inconsistency problem of monetary policy; that is, the use of unanticipated monetary policy for a short-term boost of the economy. Hence, an independent central bank would 'tie the hands' of the government and eliminate the inflation bias.

With the recognition that the inflation bias is determined by the taxation policy and hence the financing structure of government spending (Alesina and Tabellini 1987)[1], the literature has also focused on the interactions among monetary and fiscal policy, by endogenising the latter. In this context, inflation also serves as a tool for government revenues (seignorage) and budgetary considerations play an important role in determining monetary policy. Among other things, quality of institutions can affect the government's fiscal decisions. In a recent paper, Huang and Wei (2005), incorporate bureaucratic corruption in the static Alesina and Tabellini (1987) framework and show the implications of corruption in the tax collection mechanism on the fiscal and in turn monetary policymaking.

Using a two period model this paper puts government debt into play considering the whole spectrum of government spending financing and allowing for dynamic effects

[1]The inflation bias has been motivated either by imperfections in the labour market (e.g. Rogoff (1985)) or by the existence of tax distortions (e.g. Barro and Gordon (1983)). However, as Alesina and Tabellini (1987) correctly point out everything boils down to taxation: If non-distortionary taxes existed, they could correct for the market imperfections induced 'output gap' by subsidising firms and obtain the socially desired outcome without excessive inflation. Hence, it is the nonexistence of non-distortionary taxation that creates the time-inconsistency problem.

to take place with crucial implications on the model.[2] With explicit fiscal policy, an independent central bank is also not fiscally dominated, setting monetary policy free of budgetary considerations. However, despite independence, past and current fiscal policy actions influence, and to an extent set, the environment in which monetary policy acts and hence can still constrain it. In this sense, the financing of government credit requirements can determine the extent of actual central bank autonomy. Lower quality of fiscal institutions is limiting government's ability to raise revenues through the tax system and with monetary policy no longer in its control, the debt's importance as a source of financing expenditure increases.

We find that the overall performance of an economy under different regimes depends on the level of institutional quality. Even if a commitment technology is available, corruption worsens the monetary and fiscal outcomes and results in decreased overall social welfare. Moreover, corruption still remains an obstacle when improvements are introduced in the monetary policy framework. Our main theoretical finding suggests that, with the presence of bureaucratic corruption, even if an independent central bank is legislatively constituted, the government has the incentive to use debt policy strategically to affect monetary policy.[3] Intuitively, an independent central bank is overcorrecting for the inflation bias, delivering too little inflation (and seigniorage revenues) from the government's perspective. At the same time, lower quality of institutions is also limiting government's tax revenues. Thus, the government has the incentive to increase debt in the first period in an attempt to increase second period inflation. The channel of transmission lies on the central bank's output considerations, which allows the government to indirectly 'force' an expansionary monetary policy. As a result of that, economies with lower institutional quality that set independent central banks should observe rising levels of debt and higher levels of inflation *vis à vis* their higher quality counterparts. Therefore, our model provides an explanation for the poorer inflation and debt accumulation performance of economies suffering from corruption issues.

On the empirical side, we attempt to explore these finding by concentrating on the response of debt policies after the introduction of independent central banks in countries faced with different levels of corruption. In a cross-sectional setting, CBI is approximated as a point in time, that is, as that central bank reform that gave a decisive step towards central bank autonomy, and then the impact of corruption after that point on debt is examined compared to before the reform for a set of 77 advanced and developing countries. Finally, we complement our analysis with a measure for the level of independence each reform gave. In this respect, our empirical approach bears more resemblance with event studies, which have been quite limited in the CBI literature.

[2]There is a series of papers, e.g. Beetsma and Bovenberg (1997), Jensen (1994) that examine the dynamics of the model, abstracting, however, from corruption considerations.

[3]This incentive is prominent unless a less conservative, regarding output considerations, central bank is delegated or unless the economy is faced with severe levels of corruption.

Our main results verify the theoretical implications and suggest that corruption plays a role in explaining debt accumulation with the introduction of independence. The effect of corruption after an important central bank reform on the on debt-to-GDP growth is both significant and sizeable. After controlling for a set of variables, we do find that more corruption leads to more debt accumulation. More importantly, after accounting for the level of independence the respective central bank reform gave, the effect of corruption on debt accumulation is bigger, the higher the CBI granted.

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, as well as the case where the centralised authority is behaving discretionary. In section 3, following Rogoff's argument, monetary policy is delegated to a weight-conservative central bank. Section 4 introduces central bank independence and assesses its impact on the solution outcome in the presence of corruption. The empirical analysis is conducted in Section 5. Section 6 concludes.

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 (τ_t) are incorporated in the model as a fraction on the firms' revenues and thus distort the behaviour of firms. 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.

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,

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

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

The assumption of a continuum of uncoordinated individuals can be interpreted as individuals acting competitively, rather than strategically, by always maximising their objective. This way, the model concentrates on the strategic interaction among the two 'big' players. Using the best the private sector can do (predict inflation correctly, $\pi_t = \pi_t^e$) 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. Also, 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 (τ_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.[4] 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 π_t has been approximated by $\frac{P_t - P_{t-1}}{P_t}$.[5]

The 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

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

[4] 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.

[5] 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 $\bar{Y}$.

where $\lambda_i > 0$, for $i = 1, 2$, $0 < g^* < 1$ 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. The weights on the function's arguments are set relative to inflation, with inflation's weight normalised to unity. Hence, λ_i for $i = 1, 2$ correspond to the weights the government puts on output and government spending respectively relative to inflation. Note that the government shares the same discount factor and relative weights as society.

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. The difference in the output goals among the private sector $(y_n - a\tau_t)$ and the fiscal authority (y_n) is the source of the inflation bias. With no distortions $(\tau_t = 0)$ there is no output goal conflict, and hence no time-inconsistency problem. This makes for the Alesina and Tabellini (1987) point. 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:

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

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

nomic 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 a centralised authority, which is able to precommit in a world with non-distortionary taxes. 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.

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 (Beetsma and Bovenberg 1997). 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

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

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

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

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

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

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

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 ϕ) 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 ϕ. 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 $\tilde{\phi} < 1$. For plausible parameter values $\tilde{\phi}$ would be greater than unity, implying that corruption deterioration will cause an intratemporal shift away from taxes.[6]

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 similar to period 2 we have:

[6]The critical value of ϕ is $\tilde{\phi} = (\frac{a^2\lambda_1(1+\lambda_2)}{\lambda_2})^{1/2}$. $(1+\lambda_2)/\lambda_2 > 1$, and assuming that the share of labour in the production function is greater than 0.5, $a = \frac{\eta}{1-\eta} > 1$. Further, λ_1 should be a number in the vicinity of 1, hence, $\tilde{\phi}$ will be greater than unity.

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

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

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, ϕ. 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 π_1 and τ_1 to cover government expenditure (including debt repayment, d_0). Second period inflation and taxes, though, are positively related to d_1, for the same reasoning.[7] However, the size of ϕ is only affecting the shares of seigniorage and taxes in meeting the government expenditure and debt payment requirements.

Thus, in this model, debt is just reallocating the burden of raising revenues (through taxation or inflation) among the two periods, and with a committed centralised authority that faces the optimal policy mix debt does not depend on the corruption level.[8] Optimal debt is driven only from the subjective time preference of society relative to the rate of return on assets. From equation (8) 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 the rate of return on assets $(1+\rho)$ will determine whether society wishes to be a net debtor or a net borrower. Thus, if $\beta(1+\rho) > 1 \Rightarrow \frac{1}{\beta} < (1+\rho)$, 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.

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

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

Despite the fact that debt policy is independent of ϕ, 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. Table A.1 in Appendix A summarises the SB solution outcome.

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 present. In this case, first period debt policy is

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

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, λ_1, λ_2 and ϕ. 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.[9]

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. 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, although first period inflation expectations are taken as given, second period's 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.[10] 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 ϕ. Under some conditions, it holds that intratemporal imbalances are higher for higher levels of in-

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

[10] 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 $t = 2$.

stitutional quality and quality of institutions is negatively related to debt. Hence, $d_1^{SB} > d_{\phi_L}^d > d_{\phi_H}^d$, where ϕ_L, ϕ_H correspond to lower and higher quality respectively.[11]

Intuitively, since higher institutional quality leads to more intratemporal distortions, the incentive to correct them is higher. Hence, the higher quality 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 is nested in table A.2 of Appendix A.

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

Following Rogoff (1985) we now analyse the improvements that could be achieved by delegating monetary policy 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 and table A.2 in Appendix A summarises it.

- In the Second Period:

The government and the central bank maximise their objective functions with respect to τ_2 and π_2 respectively, for given d_1 and taking second period inflation expectations as given.

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

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

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

Then the private sector forms expectations according to the first order conditions of the policymakers and the optimal second period policies are obtained.

- Similarly, in the First Period:

The fiscal and monetary authorities maximise their objective functions with respect to τ_1, d_1 and π_1 respectively, taking first period inflation expectations and the optimal

[11] For more details see Dimakou (2006).

second period policies as given. 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 π_1 can only impact current period outcomes.

Discretionary debt policy is given by:

$$d_1^{\text{dmc}} = \frac{(1+\rho)d_0 + (1-\beta(1+\rho)M)g^*}{1+\beta(1+\rho)^2 M} \tag{8}$$

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.

The optimal delegated parameters can be obtained by maximising the optimised society's welfare under decentralisation,

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

which yields the optimality condition for ξ_1, ξ_2:

$$\lambda_1(\xi_2 - \lambda_2) + \xi_1\lambda_2\phi = 0 \Leftrightarrow \xi_2 = \lambda_2 - \frac{\lambda_2}{\lambda_1}\,\phi\,\xi_1 \tag{9}$$

This implies that optimal ξ_2 is a linear function of ξ_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, λ_1, λ_2, on the degree of corruption, ϕ, and on the optimal reduction of the central bank's weight on output, ξ_1. Hence, there are infinite combinations of ξ_1, ξ_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).[12] That is, setting ξ_i according to (9) yields $M = 1$, and hence, $d_1^{\text{dmc}} = d_1^{SB}$, and at the same time $U^{\text{dmc}} = U^{SB}$.

Note also, from equation (9), that both ξ_1, ξ_2 are inversely related to the quality of institutions. Lower fiscal capacity (smaller ϕ) requires higher ξ_i (i.e. less conservative

[12] 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, κ, and from the fact that they concentrate on coordinated monetary and fiscal policies by minimising a weighted average of the two policymakers' loss functions.

central banks). The reason for this result is that a low value for ϕ 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 need for seigniorage translates into higher values for ξ_1 (higher central bank's incentive to boost distorted output through unanticipated inflation) or ξ_2 (higher central bank's consideration for government spending when setting inflation) or any combination of the two, according to (9).

4 Central Bank Independence

Suppose that monetary policy is delegated to an independent central bank. This implies that $\xi_2 = 0$, since the central bank is not taking into account budgetary concerns, and hence is not fiscally dominated. From condition (9), the optimally delegated parameter for the relative weight on output should be

$$\text{With } \xi_2 = 0 \text{ optimal } \xi_1 \text{ is } \Rightarrow \xi_1 = \frac{\lambda_1}{\phi} > \lambda_1$$

That is, with an independent central bank, the SB is attained only if a less conservative regarding output considerations central bank is appointed. In other words, when the economy is faced with tax inefficiencies and $\xi_1 = \lambda_1$, then the optimal ξ_2 should be equal to $0 < \xi_2^* = \lambda_2(1-\phi) < \lambda_2$, hence, some level of fiscal dominance should be permitted.

Nonetheless, if ξ_1 is bounded by λ_1, whenever an independent central bank ($\xi_2 = 0$ 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:[13]

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

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

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

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, $d_1^{ICB} > d_1^{SB}$.

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

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 (i.e. ξ_1 is bounded by λ_1), 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 π_2 (and π_2^e) directly, presented in Section 3.[14]

This outcome suggests that more conservative monetary policymaking 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.[15] Note as well, that if there were no corruption issues, $\phi = 1$, the SB would be attained with $\xi_1 = \lambda_1$ and the government would have no incentive to use debt strategically. Hence, it is the existence of bureaucratic corruption in the tax collection mechanism that induces the government to indirectly 'force' an expansionary monetary policy with the use of fiscal policy, despite independence.

A direct implication that can be observed is that there is a range of ξ_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 fiscal institutions (smaller ϕ), 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.

Debt Behaviour

In order to analyse the debt behaviour and hence the 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, ξ_1.

The government's relative weight on government spending, λ_2, is always a negative function of the effective discount factor. Hence, the more the government cares about government spending relative to inflation, (higher λ_2), the more it is inclined to accumulated debt, (higher d_1^{ICB}). On the contrary, the government's relative weight

[14] The same applies to the solution of a discretionary centralised economy of Section 2.1. In general, whenever $\xi_2 > 0$, debt affects π_2 directly, since d_1 appears in the FOC_{π_2}. This is what we call the *direct channel*.

[15] 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 (κ), and not due to corruption.

on output is a non-linear function of N[16]. For relatively small values of λ_1 an increase in the relative weight of output induces the government to issue more debt. Note that the value of λ_1 that obtains the SB, given ξ_1, ϕ, is always on the negatively sloped part on $N(\lambda_1)$ (see Figure 1(c)). It is after λ_1 takes the value of twice the one that would obtain the SB that the opposite effect takes place. Nonetheless, in the subsequent analysis we will treat the government's weights, λ_1 and λ_2, as given since our focus is on the interaction between central bank conservatism (ξ_i) and quality of institutions (ϕ) and their impact on fiscal and monetary policy. We will assume that λ_1 is such that $\frac{\partial N}{\partial \lambda_1} < 0$.

The rest two parameters of the model, ξ_1, ϕ, are non-linear functions of N and there are critical values that switch their effect on N, the effective discount factor and first period debt policy. We will analyse each of them in more detail.

Table 1: **Effect of ξ_1, ϕ on N**

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

- Central bank's relative weight on output: ξ_1

Regarding the degree of central bank's conservatism, there is a critical value of ξ_1 that provides the global minimum for N as a function of ξ_1, keeping the other parameters fixed.

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

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

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

For relatively small values of ξ_1, $0 < \xi_1 < \xi_1^*$, a further increase in the central bank's degree of conservatism (lower ξ_1), increases N and hence the effective discount factor. Since the future matters more, the government reduces debt.[17] Further reduction

[16]For λ_2, since $\xi_2 = 0$ it is only the government that cares about government spending, so irrespective of the initial value of λ_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 λ_1 will partially depend on the weight the central bank attaches to output given the efficiency of the tax system.

[17]Note that in this interval, ξ_1 could be greater than λ_1, depending of ϕ. Actually, for small values of ϕ (with certainty for $\phi < 1/2$), it is the case that $\xi_1 > \lambda_1$. However, the smaller is ϕ the more loose

in ξ_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. 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 ξ_1, namely, $\xi_1^* < \xi_1 < \lambda_1/\phi$, delegating a more conservative independent central bank (reducing ξ_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 that lowering ξ_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: ϕ

Regarding the quality of institutions, again, there is a critical value of ϕ that gives the global minimum of N as a function of ϕ. 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 ϕ, $\phi \in (0, \phi^*)$, a further deterioration in fiscal capacity 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 ϕ 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.

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.

However, for $\phi > \phi^*$, given that $\phi^* \leq 1$, more corruption (lower ϕ) 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 fiscal institutions.

Figure 1 summarises the previous discussion by depicting the effects of ξ_1, ϕ and λ_1 on N. We can pinpoint only one sufficient condition under which a further increase in the central bank's conservatism (lower ξ_1) or a further deterioration in quality of institutions (lower ϕ) would lead to higher debt accumulation.

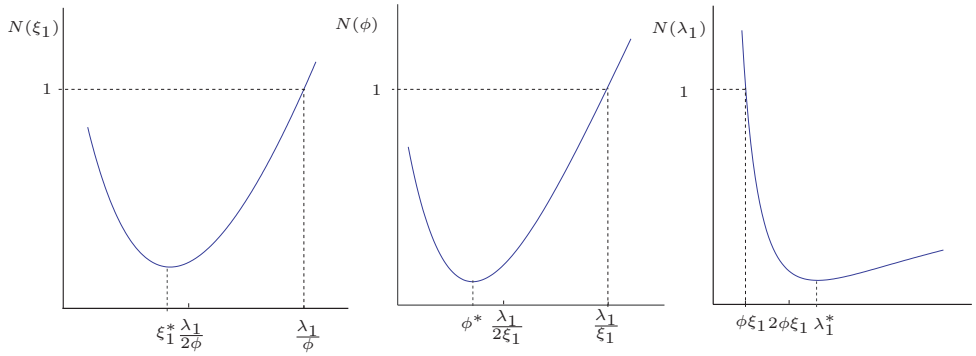

Figure 1: $N(\xi_1)$, $N(\phi)$ and $N(\lambda_1)$ respectively

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:[18]

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

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[19] (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 independent central bank , $\frac{\partial N}{\partial \xi_1}_{|\xi_1=\lambda_1} > 0$

[18]It also holds that $\frac{\partial N}{\partial \lambda_1} < 0$. However, we concentrate only on the effects of ξ_1 and ϕ assuming that the government's relative weights (λ_1, λ_2) are given.

[19]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 in the first place.

5 Empirical Model

The empirical analysis concentrates on the impact of bureaucratic corruption on debt accumulation given that full or partial central bank independence has been legislated. Central bank independence is primarily identified as a point in time, rather than a level. Hence, we concentrate on the time that an important central bank reform took place providing a decisive step towards independence and observe the evolution of debt accumulation from that point onwards compared to before. The timing of an institutional reform has been a widely neglected piece of information on how a commitment by the policymakers to a more independent central bank -materialised in the form of a legislation- can affect macroeconomic performance. Event studies in this area of economic literature have been limited. There are some exceptions, the majority of which concentrate on time-series approaches and on inflation targeting (IT) adoption only.[20] Conventionally, central bank independence has been measured in the form of an index identifying the degree of independence based on a set of common legal criteria as provided in the Central Bank Act. The Grilli, Masciandaro, and Tabellini (1991) (GMT-index) and Cukierman, Webb, and Neyapti (1992) (CWN-index) are two of the most widely known such indexes. Nonetheless, during the 1990s and beginning of 2000s the legal independence of most central banks has been updated without a generalised follow-up by the CBI-indexes. Our time approach to CBI is complemented by the GMT-index, for which most available information exists, as assessed by a series of studies[21], as well as own calculations when updated data did not exist. Such an approach allows for a wider country sample to be used, and more interestingly for exploring the impact of central bank reforms in countries that has not been possible in the past.

5.1 Methodology

The empirical investigation of our argument involves estimating the effect of bureaucratic corruption on debt after an important central bank reform in a cross-sectional setting. This is conducted as follows. Firstly, time is transformed so that τ refers to the central bank Act reform or the inflation targeting adoption date for each country. We then construct an average of the variables of interest, for the three years before (including the year τ) and 3 years after τ for all of our country sample. For instance, for the dependent variable, debt-to-GDP ratio, we have,

$$DB = \frac{D_{\tau-2} + D_{\tau-1} + D_{\tau}}{3}$$

[20] For instance, see Daunfeldt and de Luna (2002), Diana, Papadopoulos, and Sidiropoulos (2005), Ball and Sheridan (2003).

[21] Grilli, Masciandaro, and Tabellini (1991), Tavelli, Tullio, and Spinelli (1998), Arnone, Laurens, and Segalotto (2006), Maliszewski (2000) and Jácome and Vázquez (2005).

$$DA = \frac{D_{\tau+1} + D_{\tau+2} + D_{\tau+3}}{3}$$

where D_t corresponds to the debt-to-GDP ratio and DB and DA correspond to averages of 3 years before and after respectively. Then based on the theoretical implication that more corruption leads to more debt accumulation we have the following empirical model:

$$GD_i = a + bQUAL_i + cX_i + \varepsilon_i \tag{10}$$

where GD is the percentage change in the average 3 years before and after debt-to-GDP ratio, calculated as $GD = \frac{DA-DB}{DB} \times 100$. $QUAL$ reflects the level of corruption (quality) of each country and X consists of a set of control variables. Subscript i refers to each observation (country and reform) in our sample, thus countries with two central bank reforms are treated as different observations. The choice of 3 years averaging was merely driven by debt data availability. Although not presented here, using 4 and 5 years averages does not qualitatively affect our results, but increases the cases with missing data.

5.2 Data

Our country sample consists of 77 countries, 23 advanced economies, and 54 developing. Central bank reform dates span from 1989 to 2002. 29 countries had two reforms during the examined period which raises the number of observations in the model to 106. Developing countries come from all geo-economic regions and provide for a very diverge sample. Country selection was largely based on data availability- either public debt or corruption index data. Countries are classified into geo-economic and income groups according to Jaimovich and Panizza (2006) who, themselves, follow the World Bank classification. Appendix B presents the country sample.

Debt

Collecting public debt data for a big set of countries over a balanced time period is a cumbersome task. Most available debt data sets are incomplete (e.g. International Financial Statistics (IFS),World Bank Indicators (WBI)), both in terms of cross-sectional and time series coverage. A more extensive data set on external debt is available. However, as we are interested in total, domestic and external, public debt and the evolution of external debt might not be a good indicator for overall debt we cannot use this data set.

To our knowledge, the most complete publicly available data set, which we use in this study, is provided by Jaimovich and Panizza (2006) (hereafter JP). Their debt data set refers to central government debt (both external and domestic) as a share of GDP. A separate GDP column is available, measured in current billion USD. JP data refer to gross central government debt. For more information regarding JP data and

their methodology see Jaimovich and Panizza (2006).

Bureaucratic Corruption

As a proxy for bureaucratic corruption ($QUAL$), we use the most widely known index, the Corruption Perception Index (CPI) of Transparency International (TI) as of 2005. This is the only year that we have data for the whole country sample. Notwhithstanding, since corruption is a feature that changes very sluggishly over time this is not a major drawback. In this index, corruption is defined as the abuse of public office for private gain and it does not distinguish between administrative and political corruption. CPI-TI assesses and ranks countries in terms of the degree to which corruption is perceived to exist among public officials and politicians, drawing on different polls and different surveys among business people, academics and risk analysts. The index is computed as the simple average of the number of different surveys. It ranges from 0 (absolute corruption) to 10 (perfect institutional quality). More information regarding the methodology of CPI-TI is provided by in their web-site (www.transparency.org).

Central Bank Independence

Typically, central bank independence is measured as the degree of legal central bank autonomy identified in the central bank Act of different countries at the same point in time. Based on a set of legal criteria, each Act is assessed and graded to form an index. As already discussed, in our model, CBI is primarily proxied as a point in time. During the 1990s and beginning of 2000s many developed and developing countries reviewed the status of their central bank legislation towards increased independence. Data on central bank reforms have been collected from official Central Bank websites, legal databases, and a set of reference papers.[22] Inflation Targeting (IT) adoption dates are treated as central bank reforms as well.

Despite the fact that a central bank reform is undisputable, each reform gave a different level of independence, and it is in high levels of CBI that the government has a higher incentive to strategically accumulate more debt. We accommodate for this feature with the introduction of a dummy variable that categorises the reformed countries according to the level of independence given by the new Act, as measured by the GMT-index. We use a dummy, instead of the actual level of CBI, to ameliorate the subjectivity biases created by combining many different sources, as well as own calculations. We then interact this dummy with the level of corruption (quality) of each country, allowing us to investigate the effect of corruption on debt at different stages of central bank independence. Our CBI dummy is grouped in 4 categories for high, upper medium, lower medium and low independence ($IHIGH_i, IUMED_i, ILMED_i, ILOW_i$). The GMT-index is measured in a 0 (no CBI) to 16 (full CBI) scale, by adding up its two components (political and economic autonomy). The categorisation of the countries

[22] A list of the central bank reforms and the GMT-scores for our country sample and their sources can be provided by the author upon request.

into the 4 classes was mainly based on deriving somehow equal size groups, while keeping the level of CBI as coherent as possible. The majority of the countries fall into the middle category, which triggered a further split into upper medium ($IUMED$) and lower medium ($ILMED$). There is no country with a 0 score (the least independent is Qatar with a score of 3) nor with 16. More precisely,

$$IHIGH = \begin{cases} 1 & \text{if CBI} \geq 13 \\ 0 & \text{otherwise} \end{cases} \qquad IUMED = \begin{cases} 1 & \text{if } 11 \leq \text{CBI} \geq 12 \\ 0 & \text{otherwise} \end{cases}$$

$$ILMED = \begin{cases} 1 & \text{if } 8 \leq \text{CBI} \geq 10 \\ 0 & \text{otherwise} \end{cases} \qquad ILOW = \begin{cases} 1 & \text{if CBI} \leq 7 \\ 0 & \text{otherwise} \end{cases}$$

Control Variables

The vector X includes a set of control variables that could be affecting the evolution of the debt-to-GDP ratio, other than corruption. Since our dependent variables refer to debt as a share of GDP, variations in nominal GDP could be affecting GD_i negatively. Hence, we construct a control variable, $GGDP_i$, as the percentage change of average GDP between 3 years before and after the CB reform for each country, following the same process as with GD_i. For comparability reasons GDP data are from Jaimovich and Panizza (2006). They refer to nominal GDP measured in USD. Following the same reasoning, inflation could be impacting the dependent variable. However, the effect of inflation in different countries' debt growth is unclear. Some countries have indexed debt, so inflation is already accounted for, though for others with non-indexed debt, we would expect variations in the rate of inflation to be affecting debt accumulation (as a share of GDP) negatively. INF_i is constructed the same way as $GGDP_i$. Inflation is based on CPI data from the IFS series of the IMF.

Furthermore, we control for the exchange rate regime of each country, since the more rigid the regime, the less scope for discretionary monetary policy. In this case, a strategic manipulation of debt by the government will not affect monetary policy, i.e. it will not induce the CB to respond. The government being aware of that, will not necessarily use debt policy in such a way. The exchange rate regime of each country was drawn by the de facto classification of Bubula and Ötker Robe (2002). Firstly, we include an exchange rate dummy ($EX_j, j = 1, 2, 3, 4, 5$) identifying 5 different exchange rate regimes that were in place or were introduced at the time of the CB reform; Namely, $EX1$ for fixed pegs, $EX2$ for horizontal bands, $EX3$ for crawling pegs and crawling bands, $EX4$ for tightly managed floats, and $EX5$ for managed and independent floats. In cases where a central bank reform was accompanied by an exchange rate regime shift, we categorise the country according to the new regime. The majority of countries fall into the last category, with some of the intermediate cases having a small number of countries. Hence, we also try a broader categorisation of regimes, $EXFIXED, EXINTER, EXFLOAT$, for fixed, intermediate and floating ones.

Financial or currency crises are also accounted for, since they have sizeable effects on the debt accumulation of the affected countries. For instance, the Asian financial crisis of 1997 caused Indonesia's debt-to-GDP to increase by 235% between 1997-1998. The crisis dummy ($CRISIS_i$) gives a value of 1 to those countries which experienced a financial or currency crisis during the years of interest, that is, around the time of the central bank reform, and a value of 0 otherwise. This dummy variable is capturing all the major crises that occurred during the 1990s and beginning of 2000, since, in the majority of the cases, the aftermath of the crisis initiated the introduction of a new monetary policy framework, usually accompanied by an exchange rate regime shift. The monetary policy change was verified with a new or amended Central Bank Act, or with a move to an inflation targeting regime. We would expect the effect of this variable on GD_i to be positive.

Furthermore, we also control for the initial debt level of each country by introducing a dummy for countries that are highly indebted. $HIGHDB_i$ takes the value 1 if the country's 3 years before the CB reform average debt-to-GDP ratio exceeds 80%. Countries with excessive debt-to-GDP ratios are facing a set of different challenges; due to credit or other constraints, they might not be able to issue more debt, but at the same time it could be difficult to implement a drastic debt disaccumulation policy. Overall, countries with high starting debt/GDP levels experienced small decreases after the reforms. A similar control variable accounts for the Heavily Indebted Poor Countries initiatives, initiated in 1996 and further enhanced in 1999. This is a scheme of debt relief launched by the IMF and World Bank, to ensure sustainability of (external) debt for Heavily Indebted Poor Countries (HIPC). After eligibility for this scheme (decision point) is granted to a country, usually it takes some time until the creditors start providing the full size of the decided debt relief (completion point). We introduce the $HIPC_i$ dummy for countries that have their decision or completion points under the two HIPC-initiatives included in the period examined. This dummy variable, although an almost perfect subset of $HIGHDB_i$, reflects a very different feature that impacts debt growth rates.

5.3 Estimation Results

Under all specifications, the effect of $QUAL$ is significant at the 1% level and ranges between 2.5 and 3.5%. This implies that a decrease in quality (more corruption) by 1 unit will increase the rate of growth of (3-years average) debt-to-GDP ratio by approximately 3 percentage points. Given that average GD in our sample is 5.8%, the impact of corruption on debt accumulation is sizeable.

$GGDP$ and INF both have a negative impact on GD but they are quantitatively very small. The dummies for $HIGHDB$, $CRISIS$ and $HIPC$ are always significant both statistically and quantitatively. As expected, $HIGHDB$ and $HIPC$ reduce GD considerably, though $CRISIS$ increases it. Their sizeable effects are attributable to

the fact that they include countries with very different debt processes compared to the average. In most countries hit by a crisis, there were marked increases in their debt-to-GDP ratios, in others where GD was not largely affected the impact of the crisis is noticed in either their GDP growth or inflation. Highly indebted countries are experiencing debt decreases after the reforms, a phenomenon observed even more among the Heavily Indebt Poor Countries ($HIPC$).

Columns *(2)* and *(3)* of Table 2 include two different types of exchange rate regime dummies, but they all turn out to be insignificant. A number of reasons could explain this result. Firstly, we have excluded all currency board arrangements or currency unions (apart from the EMU and some countries in the Rand zone), in which cases there is no scope for discretionary monetary policy.[23] Secondly, regarding the first classification of exchange rates, each regime dummy includes a very different sample both in terms of individual countries and in terms of size. For instance, EX2 refers to horizontal bands and accounts only for 10 countries, the majority of which were in the ERM system, however, EX5 includes 52 much more diverged observations. Nonetheless, a more general categorisation of regimes, where $EXFIXED = EX1 + EX2$, $EXINTER = EX3 + EX4$ and $EXFLOAT = EX5$, is not alleviating the results.

Finally, in column *(5)* we control for 3 of the most exceptional cases in our country sample, namely for Nicaragua (NIC1 1992) where despite a huge 3 years-average debt-to-GDP ratio for before 1992 (227%), debt/GDP further increased after the reform, Sierra Leone (SLE 2000) which apart from becoming a HIPC, it went out of a civil war on that year, and both effects contributed to a sizeable debt/GDP decrease, and Kyrgyz Republic, which experienced the highest increase in GD due to the negative spill-over of the Russian financial crisis. Despite the exclusion of those countries, the results remain robust with the impact of $QUAL$ in the same range as before.

In general terms, our results are in line with the theoretical implications of the model; more corruption can explain a part of the higher debt-to-GDP accumulation of different countries after more CBI is granted. However, up to now our empirical investigation does not account for the level of independence. The individual Act reforms, although being viewed as reforms in the direction of improved autonomy, gave different degrees of independence to their central banks. Our theoretical model suggests that we would expect the effect of quality to be stronger when high levels of CBI are legislated, rather than when a monetary policy regime shift is only partial. From an empirical point of view, we account for this feature of the model by interacting the quality of institutions with a dummy variable reflecting the level of independence the central bank reform in question gave. This way we can establish the impact of quality on GD for 4 levels of CBI. Results are presented in Table 3.

Our empirical results verify this conjecture. The impact of quality on debt-to-GDP

[23] Countries of the Euro Area are considered as independent floaters. Alternative specifications in which they are classified as a separate group, does not alter the empirical findings.

Table 2: Estimation Results for Equation (2): GD (No. of observations 106)

	(1)	*(2)*	*(3)*	*(4)*	*(5)*
Const.	29.643	27.639	29.211	21.524	29.910
	(4.178)***	(3.239)***	(3.803)***	(3.468)***	(4.295)***
QUAL	-3.439	-3.218	-3.310	-2.480	-3.341
	(-3.569)***	(-2.906)***	(-3.356)***	(-2.756)***	(-3.464)***
GGDP	-0.211	-0.215	-0.220	-0.221	-0.240
	(-1.972)*	(-1.886)*	(-1.922)*	(-2.083)**	(-2.410)**
INF	-0.097	-0.121	-0.109		-0.116
	(-1.951)*	(-2.008)**	(-1.980)*		(-2.327)**
HIGHDB	-14.144	-14.051	-14.109	-12.859	-16.091
	(-2.868)***	(-2.702)***	(-2.814)***	(-2.820)***	(-3.633)***
CRISIS	29.863	32.117	30.495	27.572	28.366
	(6.449)***	(6.585)***	(6.550)***	(5.083)***	(6.237)***
HIPC	-20.567	-21.230	-20.689	-19.648	-9.716
	(-2.276)**	(-2.188)**	(-2.210)**	(-2.297)**	(-1.814)*
EX1		3.183			
		(0.500)			
EX2		-3.200			
		(-0.576)			
EX3		6.165			
		(0.875)			
EX4		1.085			
		(0.108)			
EXINTER			2.843		
			(0.451)		
EXFLOAT			-0.971		
			(-0.190)		
NIC1					48.804
					(5.557)***
SLE					-48.339
					(-12.882)***
KGZ					42.108
					(7.280)***
R-square	*0.430*	*0.437*	*0.432*	*0.401*	*0.507*
Adj. R-square	*0.395*	*0.377*	*0.385*	*0.371*	*0.460*
SER	*20.711*	*21.015*	*20.880*	*21.117*	*19.563*
F-stat	*12.433*	*7.361*	*9.225*	*13.396*	*10.951*
Prob(F-stat)	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*

Note: t-ratios in parenthesis
* = 10%, ** = 5%, and *** = 1% levels of significance

accumulation is the highest for the countries that shifted to very high levels of CBI, and gradually decreases as the level of CBI introduced by the central bank reform lessens. The interaction variables of quality with high, upper medium and low CBI are significant under all specifications. According to our results, within the reforms that gave high degree of independence, a unit rise in corruption (lower *QUAL*), increases the change of the debt/GDP ratio by 4.5 percentage points. Within the group of upper medium CBI, the impact of corruption on debt-to-GDP is around 3.5 points and among the countries that their reforms gave very little independence, the impact of corruption is lower and equal to 2.5. However, the interaction variable QUAL*ILMED turns out to be insignificant and of lower magnitude than expected.

The ILMED and ILOW clusters include economies from all geo-economic regions,

although the majority comes from low-income countries. Hence, unlike the two higher independence groups, they incorporate very diverse cases also in terms of the timing of the reform. The ILMED group includes very few Industrial (IND) countries, which correspond to older Act amendments. Reformed central banks from Latin America and Caribbean (LAC) and Europe and Central Asia (ECA) are scattered throughout the 1990s, and most of these countries exhibit high corruption levels. The last four countries in the group come from Subsaharan Africa (SSA) and Middle East and North Africa (MENA). The ILOW group is dominated by SSA, MENA and EAP (East Asia and Pacific) countries. The few IND countries refer to either older reforms or to more recent Nordic cases. All the Asian crisis hit and HIPC countries are distributed in those two groups. Concentrating on the level of independence given to the reformed central banks, the ILMED group is characterised overall by low political autonomy and its main improvements compared to ILOW come from economic autonomy aspects. In that sense, and considering that a certain level of political autonomy is also required for economic autonomy to be more relevant, those two groups that exhibit lower levels of CBI do not differ so much. For this reason, in column *(2)* of Table 3 we add the last two groups of CBI and the lack of significance is no longer observed. With three categorisations, all interaction variables are significant and the impact of worsening quality as the level of CBI is higher on the rate of debt accumulation increases.

In order to identify the underlying reasons for the insignificance of the ILMED dummy, we examine closely the composition of countries in this group. The lower medium CBI group is the group with the lowest standard deviation in quality levels, a feature driven by the lack of high quality countries relative to the other groups. Australia (AUS 1993) and Malta (MLT1 1994) have the highest and fourth highest quality in the ILMED group, though they rank 9th and 23rd in the overall sample respectively. At the same time, both countries experienced sizeable increases in their debt-to-GDP-ratio after their central bank reforms, which are not accounted for in the $CRISIS$ dummy. They both suffered from severe recessions around the time of their reforms which caused substantial debt increases.[24] In the last two columns of Table 3 we control for those two countries with the use of separate country dummies and we do observe that the effect of quality within the lower medium levels of CBI gets significant both statistically and quantitatively. Note that the coefficients of the ILMED and ILOW clusters are very close, which certifies the similarities between the two groups.

Nicaragua (NIC1 1992) and Sierra Leone (SLE), countries we have been controlling for in all previous regressions, are in the ILMED group. In the last column of Table 3 we control for these (as well as Kyrgyz), and conclude that the effect of quality in all levels of independence remains significant. The effect and significance of all

[24]In the case of Australia, the reform date, although widely accepted as the IT date, refers to the unilateral decision of the Reserve Bank to follow an inflation targeting regime. Another widely accepted view is that the recession was responsible for the drop of inflation and hence for the success of the IT regime, which followed the recession.

Table 3: Estimation Results for Equation (2) using CBI levels (No. of observations 106)

	(1)	*(2)*	*(3)*	*(4)*	*(5)*
Const.	28.117	28.612	28.062	30.166	30.391
	(3.761)***	(3.960)***	(3.619)***	(4.192)***	(4.341)***
GGDP	-0.281	-0.265	-0.265	-0.272	-0.313
	(-2.542)**	(-2.384)**	(-2.277)**	(-2.385)**	(-3.030)***
INF	-0.093	-0.090	-0.102	-0.093	-0.113
	(-1.726)*	(-1.724)*	(-1.772)*	(-1.756)*	(-2.156)**
HIGHDB	-14.907	-15.623	-15.339	-14.364	-16.485
	(-2.933)***	(-3.025)***	(-2.897)***	(-2.741)***	(-3.631)***
CRISIS	28.350	28.936	29.493	29.400	27.560
	(5.926)***	(6.380)***	(6.523)***	(6.297)***	(6.086)***
HIPC	-20.340	-19.438	-20.258	-19.865	-8.656
	(-2.268)**	(-2.158)**	(-2.159)**	(-2.173)**	(-1.817)*
QUAL*IHIGH	-4.304	-4.387	-4.297	-4.619	-4.638
	(-4.354)***	(-4.593)***	(-4.356)***	(-4.862)***	(-4.888)***
QUAL*IUMED	-3.053	-3.207	-3.123	-3.448	-3.174
	(-2.755)***	(-3.049)***	(-2.981)***	(-3.231)***	(-2.988)***
QUAL*ILMED	-1.247			-2.881	-2.623
	(-0.762)			(-2.107)**	(-1.930)*
QUAL*ILOW	-2.475			-2.850	-2.681
	(-2.369)**			(-2.831)***	(-2.726)***
QUAL*ILMED+		-2.130	-2.027		
QUAL*ILOW		(-1.959)*	(-1.829)*		
EXFIXED			-1.092		
			(-0.222)		
EXFLOAT			2.583		
			(0.410)		
AUS				38.845	45.158
				(6.258)***	(5.220)***
MLT1				46.644	38.162
				(5.521)***	(5.945)***
NIC1					52.721
					(5.932)***
SLE					-48.424
					(-14.882)***
KGZ					43.830
					(7.347)***
R-square	*0.477*	*0.470*	*0.472*	*0.514*	*0.597*
Adj. R-square	*0.428*	*0.426*	*0.416*	*0.457*	*0.535*
SER	*20.147*	*20.171*	*20.347*	*19.618*	*18.158*
F-stat	*9.717*	*10.752*	*8.486*	*9.043*	*9.631*
Prob(F-stat)	*0.000*	*0.000*	*0.000*	*0.000*	*0.000*

Note: t-ratios in parenthesis
* = 10%, ** = 5%, and *** = 1% levels of significance

other control variables does not change from the regressions of Table 2. Exchange rate regime dummies are again insignificant without altering the main findings, as it can be observed from column *(3)*. On the other hand, $GGDP$ and INF are significant, albeit of very small size. The rest three dummies, $HIGHDB$, $CRISIS$ and $HIPC$, are in all specifications significant quantitatively and statistically.

Although not presented here, we perform different robustness checks and the results remain unchanged. We exclude all the countries that were hit by a currency crisis ($CRISIS$) and the ones that were accepted in the Heavily Indebted Poor Coun-

tries initiatives ($HIPC$), and we find similar results. Furthermore, regressions are run excluding the observations where residuals were above (below) 1.5 and 2 standard deviations from the regression line. This way we isolate the effect of outliers or extraordinary individual cases. Again, the results remain robust.

6 Conclusion

Using a two period model with explicit monetary and fiscal policy, we identify their interactions when an economy is faced with bureaucratic corruption in the tax collection mechanism. 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 achieves the SB. 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 present, 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 indirectly induce an expansionary monetary policy, putting upward pressure on long-run price stability, by increasing debt accumulation. This result is augmented by the quality of institutions.

Countries that are faced with low institutional quality, as is the problem with many emerging market economies, even if they constitute an independent central bank, 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. Corruption can interact with fiscal policy by shifting the financing of government spending and can be responsible for expanding debt processes of economies that constitute independent central banks.

On the empirical side, we concentrate on the impact of different levels of corruption on the debt accumulation process of countries that have constituted, at least partially, independent central banks. We investigate this in a cross-sectional setting using a large country sample, with both advanced and developing economies. The empirical results

verify the theoretical implications of the model. Quality of institutions is an important factor in explaining cross-country debt-to-GDP growth. After an important central bank reform and controlling for a set of other factors, we find that more corruption leads to higher debt accumulation. More importantly, accounting for the level of independence the respective central bank reform gave, indicates that the effect of corruption on debt accumulation is bigger, the higher the central bank independence granted.

The results prescribe a set of important policy implications. Firstly, it can be suggested that, since even under the Second Best regime, policy outcomes depend on the level of bureaucratic corruption the definition of price stability to the achieved need not be as universal as is empirically observed across different countries. Secondly, and most importantly, improving the quality of fiscal 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. Since, corruption impacts on fiscal policy decisions, which in turn can indirectly influence monetary policy, despite independence, attention should be directed to improving the quality of both the monetary and the fiscal institutions and not the one or the other alone.

An on-going research project concentrates on this last suggestion and explores not only the monetary and fiscal policy outcomes under different regimes, but also on the investment decisions in improving the quality of both monetary and fiscal institutions. This approaches enables the investigation of the interactions between monetary (optimal delegation of monetary policy) and fiscal (bureaucratic corruption reduction) reforms.

A Appendix

Table A.1: **Second Best Solution**

τ_1^{SB}	$=$	$\frac{\phi\lambda_2}{a^2\lambda_1(1+\lambda_2)+\phi^2\lambda_2}\left(\frac{\beta(1+\rho)^2}{1+\beta(1+\rho)^2}\right)\ \left[(1+\rho)d_0+g^*+\frac{g^*}{1+\rho}\right]$
π_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}	$=$	$\frac{(1+\rho)d_0+(1-\beta(1+\rho))\,g^*}{1+\beta(1+\rho)^2}$
τ_2^{SB}	$=$	$\frac{\phi\lambda_2}{a^2\lambda_1(1+\lambda_2)+\phi^2\lambda_2}\left(\frac{(1+\rho)}{1+\beta(1+\rho)^2}\right)\ \left[(1+\rho)d_0+g^*+\frac{g^*}{1+\rho}\right]$
π_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 ϕ. 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 ϕ. 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.

Table A.2: **Solution under a more conservative central bank**

τ_1^{dmc}	$=$	$\dfrac{\phi\lambda_2}{a^2\lambda_1(1+\xi_2)+\phi\lambda_2(\phi+a^2\xi_1)}\left(\dfrac{\beta(1+\rho)^2M}{1+\beta(1+\rho)^2M}\right)\ \left[(1+\rho)d_0+g^*+\dfrac{g^*}{1+\rho}\right]$
π_1^{dmc}	$=$	$\dfrac{a^2\lambda_1\xi_2+a^2\xi_1\phi\lambda_2}{a^2\lambda_1(1+\xi_2)+\phi\lambda_2(\phi+a^2\xi_1)}\left(\dfrac{\beta(1+\rho)^2M}{1+\beta(1+\rho)^2M}\right)\left[(1+\rho)d_0+g^*+\dfrac{g^*}{1+\rho}\right]$
d_1^{dmc}	$=$	$\dfrac{(1+\rho)d_0+(1-\beta(1+\rho)M)\,g^*}{1+\beta(1+\rho)^2M}$, where $\quad M=\dfrac{(a^2\lambda_1\xi_2+a^2\xi_1\phi\lambda_2)^2+a^2\lambda_1\lambda_2(\phi^2\lambda_2+a^2\lambda_1)}{a^2\lambda_1\lambda_2[a^2\lambda_1(1+\xi_2)+\phi\lambda_2(\phi+a^2\xi_1)]}$
τ_2^{dmc}	$=$	$\dfrac{\phi\lambda_2}{a^2\lambda_1(1+\xi_2)+\phi\lambda_2(\phi+a^2\xi_1)}\left(\dfrac{(1+\rho)}{1+\beta(1+\rho)^2M}\right)\ \left[(1+\rho)d_0+g^*+\dfrac{g^*}{1+\rho}\right]$
π_2^{dmc}	$=$	$\dfrac{a^2\lambda_1\xi_2+a^2\xi_1\phi\lambda_2}{a^2\lambda_1(1+\xi_2)+\phi\lambda_2(\phi+a^2\xi_1)}\left(\dfrac{(1+\rho)}{1+\beta(1+\rho)^2M}\right)\ \left[(1+\rho)d_0+g^*+\dfrac{g^*}{1+\rho}\right]$
U^{dmc}	$=$	$-\dfrac{1}{2}\left[\dfrac{(a^2\lambda_1\xi_2+a^2\xi_1\phi\lambda_2)^2+a^2\lambda_1\lambda_2(\phi^2\lambda_2+a^2\lambda_1)}{[a^2\lambda_1(1+\xi_2)+\phi\lambda_2(\phi+a^2\xi_1)]^2}\right]$ $\left(\dfrac{\beta(1+\rho)^2(1+\beta(1+\rho)^2M^2)}{[1+\beta(1+\rho)^2M]^2}\right)\ \left[(1+\rho)d_0+g^*+\dfrac{g^*}{1+\rho}\right]^2$

1. With $\xi_i=\lambda_i,\ i=1,2$ the solution in table A.2 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.

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

   - d_1^d is no longer independent of ϕ. 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.

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 ϕ (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 and attain the SB, are given by $\xi_2 = \lambda_2 - \frac{\lambda_2}{\lambda_1}\phi\xi_1$ and correct for both intratemporal and intertemporal distortions.
- 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 ϕ 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.

B Appendix: Country Sample

Industrial (IND)		Latin America and the Carribean (LAC)	
AUSTRALIA	JAPAN	BARBADOS	HONDURAS
AUSTRIA	LUXEMBOURG	BOLIVIA	MEXICO
BELGIUM	MALTA	BRAZIL	NICARAGUA
CANADA	NETHERLANDS	CHILE	PARAGUAY
DENMARK	NEW ZEALAND	COLOMBIA	PERU
FINLAND	NORWAY	COSTA RICA	TRINIDAD AND TOBAGO
FRANCE	PORTUGAL	ECUADOR	URUGUAY
GERMANY	SPAIN	EL SALVADOR	VENEZUELA, R. B.
GREECE	SWEDEN		
ICELAND	SWITZERLAND		
IRELAND	UNITED KINGDOM		
ITALY			

Europe and Central Asia (ECA)		East Asia and Pacific (EAP)	
ALBANIA	LATVIA	CHINA,P.R.	PHILIPPINES
CYPRUS	MOLDOVA	INDONESIA	SINGAPORE
CZECH REPUBLIC	POLAND	KOREA	THAILAND
GEORGIA	RUSSIA	MALAYSIA	
HUNGARY	SLOVAK REPUBLIC		
HUNGARY	SLOVENIA		
KYRGYZ REPUBLIC	TURKEY		

Subsaharan Africa (SSA)		Middle East and North Africa (MENA)	
BURUNDI	NIGERIA	EGYPT	OMAN
ETHIOPIA	RWANDA	ISRAEL	QATAR
GHANA	SIERRA LEONE	JORDAN	TUNISIA
KENYA	SOUTH AFRICA	MOROCCO	
LESOTHO	UGANDA		
NAMIBIA			

References

Ahsan, A., M. Skully, and J. Wickramanayake (2006b): "Central Bank Independence and Governance and Inflation in Asia Pacific," Discussion paper, Monash University, Australia.

Alesina, A., and G. Tabellini (1987): "Rules and Discretion with Noncoordinated Monetary and Fiscal Policies," *Economic Inquiry*, 25(4), 619–30.

Arnone, M., B. Laurens, and J.-F. Segalotto (2006): "The Measurement of Central Bank Autonomy: Survey of Models, Indicators, and Empirical Evidence," IMF Working Papers 06/227, International Monetary Fund.

Ball, L., and N. Sheridan (2003): "Does Inflation Targeting Matter?," Working Paper 9577, National Bureau of Economic Research.

Barro, R. J., and D. Gordon (1983): "Rules, discretion, and reputation in a model of monetary policy," *Journal of Mathematical Economics*, 12, 101–121.

Beetsma, R. M. W. J., and A. L. Bovenberg (1997): "Central bank independence and public debt policy," *Journal of Economic Dynamics and Control*, 21(4-5), 873–894.

Bubula, A., and I. Ötker Robe (2002): "The Evolution of Exchange Rate Regimes Since 1990: Evidence From De Facto Policies," IMF Working Papers 02/155, International Monetary Fund, available at http://ideas.repec.org/p/imf/imfwpa/02-155.html.

Cukierman, A., S. B. Webb, and B. Neyapti (1992): "Measuring the Independence of Central Banks and Its Effect on Policy Outcomes," *World Bank Economic Review*, 6(3), 353–98.

Daunfeldt, S.-O., and X. de Luna (2002): "Central Bank Independence and Price Stability: Evidence from 23 OECD-countries," Umea Economic Studies 589, Umea University, Department of Economics.

Debelle, G., and S. Fischer (1994): "How independent should a central bank be?," Working papers in applied economic theory, Federal Reserve Bank of San Francisco.

Diana, G., A. Papadopoulos, and M. Sidiropoulos (2005): "Central Bank Reform and Inflation Dynamics in the Transition Economies theory and some evidence," Money Macro and Finance (MMF) Research Group Conference 2005 58, Money Macro and Finance Research Group.

Dimakou, O. (2006): "Monetary and Fiscal Policy Interactions: The Role of Quality of Institutions in a Dynamic Environment," Birkbeck Working Papers in Economics & Finance BWPEF 0607, Birkbeck, University of London.

Grilli, V., D. Masciandaro, and G. Tabellini (1991): "Political and Monetary Institutions and Public Financial Policies in the Industrial Countries," *Economic Policy*, 6-2, 341–92.

Huang, H., and S.-J. Wei (2005): "Monetary Policies for Developing Countries: The Role of Institutional Quality," CEPR Discussion Papers No 4911, C.E.P.R. Discussion Papers.

Jácome, L. I., and F. Vázquez (2005): "Any Link Between Legal Central Bank Independence and Inflation? Evidence from Latin America and the Caribbean," IMF Working Papers 05/75, International Monetary Fund.

Jaimovich, D., and U. Panizza (2006): "Public Debt around the World: A New Dataset of Central Government Debt," RES Working Papers 1019, Inter-American Development Bank, Research Department.

Jensen, H. (1994): "Loss of monetary discretion in a simple dynamic policy game," *Journal of Economic Dynamics and Control*, 18(3-4), 763–779.

Maliszewski, W. (2000): "Central Bank Independence in Transition Economies," Centre for Social and Economic Research No 519, London School of Economics and Political Science.

Mehran, H., P. Ugolini, J.-P. Briffaut, G. Iden, T. Lybek, S. Swaray, and P. C. Hayward (1998): "Financial Sector Development in Sub-Saharan African Countries," IMF Occasional Papers 169, International Monetary Fund.

Obstfeld, M. (1991): "Dynamic Seigniorage Theory: An exploration," CEPR Discussion Papers No 519, C.E.P.R. Discussion Papers.

Rogoff, K. (1985): "The Optimal Degree of Commitment to an Intermediate Monetary Target," *Quarterly Journal of Economics*, 100(4), 1169–89.

Tavelli, H., G. Tullio, and F. Spinelli (1998): "The Evolution of European Central Bank Independence: An Updating of the Masciandaro and Spinelli Index," *Scottish Journal of Political Economy*, 45(3), 341–44.