Tax evasion and public investment in a time-inconsistency model: fiscal corruption may improve welfare

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Abstract

This paper examines the consequences of tax evasion within a dynamic fiscal and monetary policymaking framework that takes into account the beneficial effects of public investment on future economic performance. In the absence of time-inconsistency problems, tax evasion always harms welfare. On the contrary, in the presence of commitment problems, tax evasion may exert a credibility effect and improve welfare by reducing both intratemporal and intertemporal distortions. An increase in the degree of tax evasion may indeed stimulate economic activity and alleviate the inflation bias by leading authorities to cut distortionary taxes, hence lower intratemporal losses. Moreover, as the credibility problem of monetary policy makes that the public investment level is too high from a social point of view, tax evasion improves the intertemporal distribution of distortions if it brings about a cut in public investment spending.

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1. Introduction

Corruption is usually regarded as a plague in academic or public discussion. Basically, it is a violation of the rules supposed to govern the allocation of resources in market economies. Empirical studies suggest that corruption may seriously affect economic efficiency and restrain growth through a wide range of channels, as it can take many forms and be carried out at different levels. In particular, there is some evidence that corruption discourages private investment and alters the composition of government expenditure (Mauro, 1997). The opportunity to extort bribes from new infrastructure projects may indeed lead some politicians to make their decisions on a distorted basis and eventually increase public investment in unproductive projects, especially in developing countries, where widespread corruption negatively impacts on the quality and return rate of the existing infrastructure, too (Davoodi and Tanzi, 1998). Corruption is also likely to have adverse fiscal consequences, especially if it contributes to larger budget deficits when it takes the form of tax evasion (Tanzi, 1997).[1]

Such a phenomenon appears all the more detrimental as public investment spending on infrastructure or human capital is likely to sustain economic growth by enhancing overall productivity in the long run (see Aschauer, 1989a, b), and probably turns out to be as important as private investment.[2] Even if empirical research does not always succeed in drawing clear-cut conclusions about the precise magnitude of the impact of public investment on macroeconomic performance (see European Commission, 2003; Turrini, 2004), there is all the same a consensus according to which public capital expenditure and productivity growth are positively linked. In particular, public investment could play a leverage role in rendering private investment more productive and in stimulating more private investments in productive assets (Lloyd, 1999).

The present paper attempts to explore the consequences of corruption in the form of tax evasion for the composition of government expenditure between public consumption and public investment and for social welfare in general. In order to focus on the strategic aspects that are instrumental in determining the share of public investment in total government spending, I tackle this issue from a purely theoretical viewpoint, by means of a standard game-theoretic model of fiscal and monetary policymaking with commitment problems in a closed economy in the tradition of Barro and Gordon (1983). This model is particularly intended to describe in a very simplified way the situation in some developing countries, where corruption and the lack of credibility of government institutions are issues of major public concern.

For my purpose, I resort to useful ingredients from some recent papers. To my knowledge, Huang and Wei (2003) are the first to have combined the issue of corruption with that of time inconsistency. These two authors model corruption as an erosion in the government's capacity to collect tax receipts through formal channels and examine the consequences of such a problem for the design of monetary policy in developing countries. Here, I take up again their approach and use the same type of model, but extend it to two periods for considering the role of public investments in enhancing productivity and their implications for future economic out-

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[1] Of course, tax avoidance exists irrespective of corruption, whenever taxpayers seek for exemptions or manipulate their declarations with the aim of reducing their payment. The problem is that corrupt practices undertaken by officials in return for bribes may aggravate the leakage of tax revenues to a significant extent and contribute to weak tax administrations. Empirical evidence reveals that high corruption is generally associated with low tax receipts (Davoodi and Tanzi, 1998). The case of Peru and Uganda quoted by Tanzi (1997) is particularly revealing in this respect: the tax evasion problem was so important in those countries and corruption became so pervasive that the existing administrations were dismantled and replaced with new ones. Another well-known example is the failure to undertake efficient and equitable tax collection in Russia after the collapse of the Soviet bloc.

[2] Some other theoretical reasons, such as the supply of public goods or the presence of various market failures, also provide a rationale for public investment.

comes. In addition to their paper, I make use of the work by Ismihan and Ozkan (2003a, b, c), who utilize a similar policymaking framework and distinguish current spending, which does not affect output, from productivity-enhancing spending, which boosts economic activity in the long run. The important point is that the choice of the composition of public expenditure implies a strategic behavior from the incumbent since the favorable consequences of the volume of public investment committed today will only be realized in the future.

I start off by studying the optimal level of public investment and the implications of tax evasion in the case in which the policymaker can credibly commit to future inflation. Under this regime, social welfare always decreases as corruption increases, as already shown by Huang and Wei (2003) with their static model. The basic reason is that the equilibrium inflation rate goes up with tax evasion, given the social value of seigniorage in providing public revenues. In this dynamic version, I show in addition that corruption also increases the loss originating in the distribution of distortions across time by affecting the equilibrium public investment level. However, for any degree of tax evasion, the commitment regime always yields the highest welfare level and thus provides a natural benchmark for the analysis.

Next I drop the assumption of commitment and consider the discretionary case. The analysis of the discretionary regime allows me to derive the main result of this paper, which runs counter to conventional wisdom. I show that fiscal corruption can theoretically be welfare-improving when the decision-maker is no longer able to commit. Such a result suggests that the actual authorities' incentive to fight certain forms of corruption could depend, in part, on their anti-inflationary credibility. Thereby, this might contribute to explaining why bureaucratic corruption remains much more prevalent in developing economies. More specifically, in a country endowed with a populist political model in which the government puts more weight on output than on price stability, tax evasion might exert beneficial effects by reducing both intratemporal and intertemporal distortions. The basic reason for this apparently paradoxical result derives from the principle that the aggravation of a distortion (i.e. corruption) in an already distorted world (owing to the absence of commitment and the self-defeating incentive to boost activity through unanticipated inflation) may raise overall welfare, because the two distortions tend to offset each other.

In this dynamic framework, tax avoidance affects social welfare in two ways, in that it impacts on both the intratemporal and intertemporal loss components. The first source of welfare losses is intratemporal and rests in the familiar commitment problem leading authorities to attempt to alleviate distortions in the real economy by inflating. As the incentive to create surprise inflation is perceived by the private sector, the price level is higher under discretion than under commitment, but there is no gain in terms of output, except through the seigniorage channel, since the need for distortionary taxation is then reduced. It is shown that, provided that the government puts a sufficient weight on output and employment when implementing policies, an increase in the corruption level involves a decrease in the tax rate and thereby weakens the incentive to generate inflation. This is the first positive effect of fiscal corruption in the paper: tax evasion makes it possible to bring inflation down and acts, in a way, as a second-best mechanism that substitutes for commitment.

The second source of welfare losses stems from the intertemporal distribution of distortions across the two periods of the game and therefore depends on the equilibrium level of public investments. In this game-theoretic framework, the incumbent strategically chooses the public investment level in the current period in order to influence inflation expectations – and hence the inflation bias of monetary policy – in the next period. Devoting more resources to productive uses in period one makes it possible to boost activity in period two; accordingly, the incentive to inflate in the final period will be weakened. The problem is that this strategic behavior makes that the equilibrium level of productive spending in period one turns out to be too high from a social point of view; that is to say, the intertemporal allocation of distortionary losses is suboptimal. It can then be shown that an increase in tax evasion may involve a decrease in productive spending through its impact on the incumbent's effective discount factor. This is the second positive effect of fiscal corruption: tax avoidance lowers intertemporal welfare losses whenever it entails a cut in productive public spending.

The rest of the paper is as follows. Section 2 describes the two-period model with public investment spending. Section 3 shows that fiscal avoidance always worsens welfare under the commitment regime. Section 4 turns to the consequences of fiscal evasion for social welfare under the monetary discretionary regime and determines the formal conditions under which an increase in the degree of tax evasion permits both intratemporal and intertemporal distortions to be reduced. Finally, Section 5 concludes. The details of the calculations are contained in two technical appendices, available from the author upon request.

2. The model

The modeling framework is in the tradition of Barro and Gordon (1983) and Alesina and Tabellini (1987) in a closed economy and formulates a game between a centralized policy-making authority and workers representing the private sector. This standard framework is developed into a dynamic two-period model to incorporate the role of public investment in enhancing overall productivity and its consequences for economic performance in the long term (see Ismihan and Ozkan, 2003a, b, c). As in Huang and Wei (2003), corruption simply takes the form of tax evasion and is then assumed to cause a leakage of tax revenues.

A representative firm faces the production function $Y_t = A_t(L_t)^{\alpha}$, where Y_t, L_t and A_t represent output, labor and the productivity level in period t, respectively, and $0 < \alpha < 1$. The firm is a price taker on every market and has to maximize $P_tY_t(1 - \tau_t) - W_tL_t$, where P_t and W_t respectively denote the price level and the nominal wage rate in period t, and where τ_t is the tax rate on the total revenue of the firm in period t. As in Alesina and Tabellini (1987), fiscal policy has distortionary effects: any increase in the tax rate leads to a fall in profitability and thus results in lower output.[3] Workers make rational expectations and have for sole objective to achieve a target real wage rate whose logarithm is normalized to zero; hence, the nominal wage rate in period t is set equal to the expected price level for period t: $w_t = (p_t)^e$, where lower case letters represent logs and where the superscript "e" denotes a rational expectation. It is easy to check that output is then given by $y_t = (\alpha/(1 - \alpha))[p_t - (p_t)^e - \tau_t + a_t/\alpha + \log(\alpha)]$, where $\log(1 - \tau_t)$ has been approximated by $(- \tau_t)$.

Following Ismihan and Ozkan (2003a, b, c), I simply assume that productivity in any period directly depends on the public investment level chosen by the policymaker in the previous period: $a_t = a_0 + \beta_0 g^{I}_{t-1}$, where g^{I} denotes public investment expenditure and $a_0, \beta_0 > 0$. Therefore, substituting a_t into the output equation above and setting $\beta \equiv \beta_0/\alpha$ for algebraic simplicity yields $y_t = (\alpha/(1 - \alpha))[p_t - (p_t)^e - \tau_t + \beta g^{I}_{t-1} + a_0/\alpha + \log(\alpha)]$.

Normalizing output by subtracting the constant sum $a_0/\alpha + \log(\alpha)$ from the equation above and setting $\alpha = ½$ for convenience finally gives:

$$x_t = \pi_t - \pi^{e}_t - \tau_t + \beta g^{I}_{t-1}, \qquad (1)$$

[3] The absence of lump-sum taxes implies that the first-best equilibrium cannot be attained here. The second best corresponds to the commitment equilibrium without any corruption. The tax evasion problem therefore makes that the solution with the highest welfare level that can be reached in this model is only a third best.

where x_t is normalized output and π_t stands for the inflation rate. The parameter β measures the productivity of public investment. Notice that corruption in the public sector may also affect the value taken by β. Davoodi and Tanzi (1998) provide empirical evidence that corruption is often associated with poor quality of infrastructure because of cutbacks on operation and maintenance expenditure and reduces the productivity of public investment in the end. According to this analysis, the higher the level of corruption in the economy, the lower the productivity parameter β.

I take up again the distinction made in Ismihan and Ozkan (2003a, b, c) between public consumption spending (g^C), which has no effect on economic activity but yields instant utility to authorities (on political and electoral grounds, for instance), and public investment spending (g^I), which has a positive impact on overall productivity and makes it possible to increase output in the next period, as seen above. Current (or non-productive) spending is made up of public sector wages, transfers and other government consumption expenditure. Public investment is here understood in a broad sense and notably consists of spending on infrastructure, such as transport and telecommunication networks, leading to changes in the stock of physical capital, and of spending on knowledge and human capital (education, training and research and development).

The government budget constraint creates a link both between fiscal and monetary policies within each period and between optimization decisions across different periods:

$$\begin{aligned} &g_t^C + g_t^I = \pi_t + \gamma\tau_t, \\ &0 \le \gamma \le 1. \end{aligned} \tag{2}$$

Borrowing as a source of financing is excluded for abstracting from the issue of strategic public debt accumulation.[4] The left-hand side of (2) represents the total government outlay. The right-hand side indicates the two sources of financing available to authorities: seigniorage revenues, π_t, and tax revenues, $\gamma\tau_t$.[5]

γ is the key parameter in the analysis. I resume the assumption of Huang and Wei (2003) concerning the connection between the degree of corruption and the amount of tax receipts, and model corruption as a diminution in the government's ability to collect tax revenues through formal channels. Corruption brings about a loss of public revenue when it takes the form of tax evasion. Hence, γ can be thought of as a fiscal capacity index: the lower γ, the lower the amount of tax receipts eventually accruing to the government. When $\gamma = 1$, there is no corruption at all. On the other hand, if $\gamma = 0$, so important is tax evasion that the tax collection system collapses, and the government cannot collect any revenue through the tax channel.

The government's loss function reflects the preferences of society, in that it accounts for the preferences of not only workers but also non-workers, and is increasing in the deviations of inflation, output (i.e. employment) and public consumption spending from their targets:

$$\begin{aligned} &V = L_1 + \rho L_2 = \frac{1}{2}\sum_{t=1}^{2}\rho^{t-1}\left[\pi_t^2 + s_x x_t^2 + s_g\left(g_t^C - g_t^*\right)^2\right], \\ &0 < \rho \le 1 \text{ and } s_x, s_g > 0. \end{aligned} \tag{3}$$

[4] Faure (2004) investigates this issue and the effects of corruption by means of a similar model. The introduction of public debt does not alter the qualitative nature of the results and would even reinforce the conclusion of the present paper: tax evasion may again improve welfare under the discretionary regime by reducing both intratemporal and intertemporal welfare losses if authorities put a sufficiently large weight on output.

[5] For convenience, I shall suppose throughout the rest of the paper that there is no public investment spending in t = 0 nor in t = 2, so $x_1 = \pi_1 - \pi_1^e - \tau_1$ and $g_2^C = \pi_2 + \tau_2$.

The targeted inflation rate is taken to be zero and corresponds to price stability. For convenience, without any consequence for the results, the output target is also set equal to zero, which is the level reached, in the absence of tax distortions (i.e. $\tau_t = 0$), in a rational expectations equilibrium whenever inflation is correctly anticipated (i.e. $\pi_t = (\pi_t)^e$). This normalization is possible seeing that the desired public consumption spending level, g_t^*, is strictly positive. In this model, the need to provide public goods and services in each period of the game is enough to generate the usual time-inconsistency problem and an inflation bias under discretion. Notice that public investment spending is not itself an economic policy objective, in that there is no targeted value for this variable, but it nevertheless enters in the determination of welfare through the budget constraint and the output supply function in period one and in period two, respectively. s_x and s_g are both positive and denote the weights of the output and current spending objectives, respectively, relative to the weight of the price stability objective (which is normalized to unity). Finally, ρ is the subjective discount factor of the government.

Unlike Huang and Wei (2003), the weights assigned to the various economic objectives are here allowed to differ from one another. As will be clear below, this assumption is crucial. In reality, there is no particular justification for supposing that the government would always attach the same importance to each of its objectives. The weight put on activity may indeed differ from those put on price stability and the desired level of public expenditure, depending on the economic and political features of the country, the ideological preferences of the different political parties, or even the probability for the incumbent of being out of office at the end of the first period. For instance, a populist government might place a very large weight on output and employment seeing that its re-election probability is rather low. On the other hand, a conservative policymaker should worry more about inflation. In a general way, I shall assume throughout the rest of the paper that the decision-maker is rather weight-liberal, and then particularly cares about the deviations of output from its target, but not much about inflation or public expenditure (i.e. $s_x \longrightarrow \infty$ and $s_g \longrightarrow 1$). This assumption is necessary for showing that an increase in the degree of tax avoidance can be welfare-enhancing.[6]

3. The commitment regime: when fiscal corruption does harm

I first consider the case in which the single policymaker can credibly commit to a given inflation rate (i.e. $\pi_t = (\pi_t)^e$ *ex ante* for t = 1, 2). This equilibrium corresponds to the third-best solution (if there is some tax evasion) and provides the benchmark as regards social welfare.[7]

3.1. Public investment and welfare losses

In this dynamic setup, the decision regarding how much to spend on infrastructure and other projects to improve productivity is made in the first period while taking into account the

[6] A possible justification for this assumption, apart from the fact that it contributes to explaining why the policymaker may come up against a commitment problem and be unable to set a time-inconsistent policy, is that corruption, though universal, is all the same more serious in countries whose environment is politically unstable, especially in the poorest, on account of wealth inequality, among other things. In such a context, authorities tend to discount future events at a higher rate and are more readily prone to adopt populist policies in an attempt to increase their re-election probability. In this stylized framework, that type of behavior is captured in a simple way by a marked aversion for the deviations of output from its target.

[7] The details of the derivations for the commitment case are contained in Appendix A (available upon request).

repercussions of these investments on future outcomes. Hence, when determining the productive expenditure level, the first-period player acts as a leader *vis-à-vis* the second-period player, since public investment can be employed strategically for influencing future decisions. The model is solved by backward induction: the second-period policy choices and welfare losses are derived for any value of g_1^{I} and under the condition $\pi_2 = (\pi_2)^{\mathrm{e}}$; subsequently, the first-period policies (including the equilibrium level of productive spending) are computed under the constraint $\pi_1 = (\pi_1)^{\mathrm{e}}$, given that the second-period policies will be set optimally.

When determining the optimal level of productivity-enhancing public expenditure, the current decision-maker has to equate the marginal cost from increasing public investment (i.e. larges losses in period one) to the (discounted) marginal benefit (i.e. smaller losses in period two). Eq. (4) below illustrates this intertemporal trade-off:

$$g_1^* + g_1^{\mathrm{I}} = \rho\beta\gamma\left(g_2^* - \beta\gamma g_1^{\mathrm{I}}\right). \tag{4}$$

The left-hand side of (4) represents the loss sustained by society in period one in consequence of public investment spending. Expanding public investment inevitably takes place at the expense of lower public consumption $(\text{i.e.}\,(\partial g_1^{\mathrm{C}})/(\partial g_1^{\mathrm{I}}) < 0)$. Therefore, the higher the public investment level, the higher is the positive gap between the targeted level of current spending and the effective level. Moreover, any rise in productive expenditure implies both higher seigniorage and tax revenues given that they are the two means of financing available to authorities $(\text{i.e.}\,(\partial \pi_1)/(\partial g_1^{\mathrm{I}}) > 0 \text{ and } (\partial \tau_1)/(\partial g_1^{\mathrm{I}}) > 0)$, thereby lowering the current production level, which is always below its target in the equilibrium $(\text{i.e.}\,(\partial x_1)/(\partial g_1^{\mathrm{I}}) < 0)$.

The right-hand side of (4) represents the benefit in period two from undertaking public investments in period one. The higher the level of public investments, the better will be economic performance in the final period. The increase in productive spending results in higher output in period two $(\text{i.e.}\,(\partial x_2)/(\partial g_1^{\mathrm{I}}) > 0)$. Moreover, the favorable effects of public investment are not limited to economic activity. Public investment indeed expands the amount of tax receipts in period two thanks to production growth $(\text{i.e.}\,(\partial \tau_2)/(\partial g_1^{\mathrm{I}}) > 0)$, and thus improves the policymaker's leeway for reducing the deviation of current spending from its target value in period two $(\text{i.e.}\,(\partial g_2^{\mathrm{C}})/(\partial g_1^{\mathrm{I}}) > 0)$, which in addition makes it possible to have a lower inflation rate $(\text{i.e.}\,(\partial \pi_2)/(\partial g_1^{\mathrm{I}}) < 0)$.

From Eq. (4), the equilibrium level of productive spending under commitment is:

$$\left(g_1^{\mathrm{I}}\right)^{\mathrm{c}} = \frac{\rho^{\mathrm{c}} g_2^* - g_1^*}{1 + \rho^{\mathrm{c}}\beta\gamma}, \tag{5}$$

where $\rho^{\mathrm{c}} \equiv \rho\beta\gamma \geq 0$, and where the superscript "c" is used for commitment.

ρ^{c} is the government's *effective* subjective discount factor. This term varies in accordance with the nature of the policy game (i.e. the commitment technology available to authorities). A higher effective discount factor raises the marginal benefit of public investment and so leads to a rise in productive public expenditure $(\text{i.e.}\,(\partial (g_1^{\mathrm{I}})^{\mathrm{c}})/(\partial \rho^{\mathrm{c}}) > 0)$.[8]

[8] The effective discount factor is equal to zero only in the very particular case in which the government could not collect any revenue through the tax channel (i.e. $\gamma = 0$). In that case, the commitment and discretionary solutions merge into a single one, as will be clear below. Authorities would then only consider the current period when implementing their policies, and so would set their control variables so as to have a nil loss in the first period $(\text{i.e.}\ g_1^{\mathrm{I}} = -g_1^*, \pi_1 = 0 \text{ and } \tau_1 = 0, \text{hence } L_1 = 0, \text{ while } L_2 = [s_g (g_2^*)^2]/[2(1+s_g)])$.

The right-hand side of Eq. (5) reveals the determinants of public investment. The higher the second-period current spending target, the higher must be the level of productive spending (i.e. $(\partial(g_1^{\mathrm{I}})^{\mathrm{c}})/(\partial g_2^*) > 0$). Conversely, the higher the first-period public consumption spending target, the lower the optimal share of productive expenditure (i.e. $(\partial(g_1^{\mathrm{I}})^{\mathrm{c}})/(\partial g_1^*) < 0$).

The expression for society's equilibrium welfare loss can be decomposed into two terms so as to distinguish the intratemporal component from the intertemporal one:

$$V^{\mathrm{c}} = L_{\mathrm{intra}}^{\mathrm{c}} \times L_{\mathrm{inter}}^{\mathrm{c}}. \tag{6a}$$

The intratemporal loss factor (L_{intra}) represents the distribution of the existing distortions across the various available policy instruments within each period, and thus corresponds to the result that would be obtained in a simple one-shot game without any public investment. The intertemporal loss factor (L_{inter}) stems from the distribution of distortions across the two periods, and hence depends on the rate of time preference. After some algebra, one finally arrives at the following expressions (see Appendix A for the details of the calculations):

$$L_{\mathrm{intra}}^{\mathrm{c}} = \frac{s_x s_g}{2Z}, \tag{6b}$$

$$L_{\mathrm{inter}}^{\mathrm{c}} = \frac{\rho G^2}{1+\rho\beta^2\gamma^2}. \tag{6c}$$

where $Z \equiv s_x + s_x s_g + s_g \gamma^2 > 0$ and $G \equiv \beta\gamma g_1^* + g_2^* > 0$.

3.2. The negative consequences of tax evasion for social welfare

It is easy to demonstrate that fiscal corruption always harms welfare under commitment. Let us analyze the impact of a rise in the degree of tax evasion on each loss component successively.

According to (6b), as the intratemporal loss factor is strictly decreasing in Z, and as Z strictly increases with γ, any drop in γ involves larger intratemporal distortionary losses (i.e. $(\partial(L_{\mathrm{intra}}^{\mathrm{c}}))/(\partial\gamma) = (\partial(L_{\mathrm{intra}}^{\mathrm{c}}))/(\partial Z) \times (\partial Z)/(\partial\gamma) < 0$). This result, first shown by Huang and Wei (2003), is due to the fact that fiscal corruption then tends to call into question the anti-inflationary credibility of monetary policy. The equilibrium inflation rate under the commitment regime effectively goes up as fiscal corruption becomes more severe (i.e. $\gamma \longrightarrow 0$) because the recourse to taxation for financing public spending is more and more costly in terms of foregone output. Accordingly, authorities prefer to run a more expansionary monetary policy in order to obtain higher seigniorage revenues. As the social loss is a positive function of the inflation rate, more corruption inevitably reduces welfare.

The new point here concerns the impact of tax evasion on the distribution of distortionary losses across time:

$$\frac{\partial L_{\mathrm{inter}}^{\mathrm{c}}}{\partial\gamma} = \frac{2\rho\beta G\left(g_1^* - \rho^{\mathrm{c}} g_2^*\right)}{\left(1+\rho^{\mathrm{c}}\beta\gamma\right)^2}. \tag{7}$$

The equilibrium level of public investment is strictly positive if and only if $\rho^{c} g_2^* > g_1^*$ (see Eq. (5)). This condition makes that the partial derivative (7) is always negative. Thus, in this dynamic setup, the leakage of tax revenues exerts an additional negative effect through the distribution of distortions across time. A higher degree of fiscal corruption involves a cut in productive public spending that reduces the first-period loss but increases the second-period loss in return. To see this, let us calculate the partial derivative of $\left(g_1^{\mathrm{I}}\right)^{c}$ with respect to γ:

$$\frac{\partial\left(g_1^{\mathrm{I}}\right)^{c}}{\partial\gamma} = \frac{\rho\beta\left[2\beta\gamma g_1^* + \left(1-\rho^{c}\beta\gamma\right)g_2^*\right]}{\left(1+\rho^{c}\beta\gamma\right)^2}. \tag{8}$$

Notice that $L_1^{c} = \rho L_2^{c}$ if and only if $\rho^{c}\beta\gamma = 1$ (see Appendix A). Social losses are then equally distributed across the two periods of the game. Even in that case, a rise in tax evasion involves lower public investment spending (see (8)). The leakage of tax revenues increases the immediate cost of public investment, since the tax rate that has to be fixed for financing a given level of productive expenditure goes up with the degree of fiscal corruption, all other things being equal. The curtailment in productive expenditure in period one because of corruption will be still more pronounced in the more realistic case in which $\rho^{c}\beta\gamma < 1$ (i.e. when $L_1^{c} < \rho L_2^{c}$). Tax evasion then negatively impacts on the intertemporal distribution of distortions still further by leading authorities to trade off losses in the second period against additional gains in the first period.

To sum up, this setup shows that tax evasion always makes a country worse off under the commitment regime by increasing both intratemporal and intertemporal distortionary losses.

4. The discretionary regime: when fiscal corruption may be a good thing

Let us now consider the more interesting case in which authorities are no longer able to commit to their policy announcements. The discretionary case is more appropriate because the present model is especially intended to describe the situation in many developing countries, where corruption and the lack of credibility constitute a much more serious problem than in developed countries. The model also becomes more interesting on account of the theoretical conclusions to which it leads. Unlike the previous regime, tax evasion might indeed be welfare-improving under discretion. This result could thus contribute to explaining why bureaucratic corruption remains prevalent in developing economies and why authorities in those countries are not always encouraged to make significant efforts to fight the problem.

4.1. Public investment and welfare losses

The method of solving the game is the same as before, except that the constraint $\pi_t = (\pi_t)^{e}$ applies *ex post* now.[9] Monetary policy is time consistent and the solution of the non-cooperative game between the policymaker and the private sector is the Nash equilibrium. Note that if authorities consider inflation expectations in period one as exogenously given, the

[9] The details of the calculations for the discretionary case are provided in Appendix B (available from the author upon request).

second-period expectations, in contrast, still need to be formed and are affected by the first-period policy decisions. The level of public investment is consequently selected in a strategic way in order to influence future outcomes.

The equilibrium level of productive expenditure results from the equalization of the marginal cost from reducing the amount of available resources for current spending in period one and the (discounted) marginal gain in period two, as seen before. Under discretion, this intertemporal trade-off is given by the following equation:

$$g_1^* + g_1^{\mathrm{I}} = \frac{\rho\beta\gamma N}{D}\left(g_2^* - \beta\gamma g_1^{\mathrm{I}}\right), \tag{9}$$

where $N \equiv s_x + s_x s_g (1+\gamma)^2 + s_g \gamma^2 > 0$ and $D \equiv s_x + s_x s_g (1+\gamma) + s_g \gamma^2 > 0$.

Hence:

$$\left(g_1^{\mathrm{I}}\right)^{\mathrm{d}} = \frac{\rho^{\mathrm{d}} g_2^* - g_1^*}{1+\rho^{\mathrm{d}}\beta\gamma}, \tag{10}$$

where $\rho^{\mathrm{d}} \equiv \frac{\rho\beta\gamma N}{D} \geq 0,$ and where the superscript “d” stands for discretion.

ρ^{d} is the effective subjective discount factor of authorities under discretion. In contrast with the commitment case, the effective discount factor now also depends on the government’s relative preferences among the various economic objectives, as measured by s_x and s_g, through the ratio N/D. An increase in this factor leads to a rise in productive public expenditure, as seen before (i.e. $(\partial (g_1^{\mathrm{I}})^{\mathrm{d}})/(\partial \rho^{\mathrm{d}}) > 0$).

The comparison of (10) with the corresponding expression (5) from the commitment regime shows that the lack of reputation leads to an increase in productive expenditure as long as $\gamma > 0$ (i.e. as long as $N > D$). This rise represents a *credibility-improving effect* captured by the ratio N/D. The presence of this ratio raises the effective discount factor and thus the second-period gains associated with additional public investment.

The higher productive public expenditure level in the discretionary regime is due to the fact that the current decision-maker can affect inflation expectations, and therefore the inflation bias of monetary policy, in the next period. Spending more on infrastructure and human capital enables authorities to enhance overall productivity and stimulate economic activity in the second period, which will automatically weaken the incentive to create surprise inflation to try to protect employment. Thus, by increasing public investment, the government trade-offs additional distortionary losses in period one (i.e. higher inflation and taxes and lower output and current spending) against gains in the credibility of monetary policy in period two.

Just like in the commitment case, the expression for society’s welfare loss is split into two terms for considering the intratemporal factor and the intertemporal factor separately:

$$V^{\mathrm{d}} = L_{\mathrm{intra}}^{\mathrm{d}} \times L_{\mathrm{inter}}^{\mathrm{d}}. \tag{11a}$$

After some algebra one finds (see Appendix B for details):

$$L_{\mathrm{intra}}^{\mathrm{d}} = \frac{s_x s_g N}{2D^2}, \tag{11b}$$

$$L^{\mathrm{d}}_{\mathrm{inter}} = \frac{\left(\rho + \left(\rho^{\mathrm{d}}\right)^2\right)G^2}{\left(1+\rho^{\mathrm{d}}\beta\gamma\right)^2}. \tag{11c}$$

4.2. The effect of tax evasion on intratemporal losses

Let us first examine the effect of fiscal corruption on intratemporal losses. According to (11b), the impact of a change in the value of γ on the intratemporal loss factor is given by:

$$\frac{\partial L^{\mathrm{d}}_{\mathrm{intra}}}{\partial \gamma} = \frac{s_x s_g^2 \gamma}{D^3}\left[(s_x - 1)\left(s_x + s_g\gamma^2\right) - s_x s_g (1+\gamma)(1+2\gamma)\right]. \tag{12}$$

Moreover, as the intratemporal loss factor coincides with that of a static game in which there is no public investment (i.e. $g_1^{\mathrm{I}} = 0$), the effect of fiscal corruption on both inflation and taxation in any period t is given by the following partial derivatives (see Appendix B):

$$\frac{\partial \pi^{\mathrm{d}}_{\mathrm{t}}}{\partial \gamma} = \frac{s_x s_g g^*_{\mathrm{t}}}{D^2}\left[s_x - s_g\gamma(2+\gamma)\right], \tag{13}$$

$$\frac{\partial \tau^{\mathrm{d}}_{\mathrm{t}}}{\partial \gamma} = \frac{s_g g^*_{\mathrm{t}}}{D^2}\left[s_x\left(1+s_g\right) - s_g\gamma^2\right]. \tag{14}$$

The sign of the derivative $(\partial L^{\mathrm{d}}_{\mathrm{intra}})/(\partial\gamma)$ may be either positive or negative, depending on the relative importance attached to the output and public consumption spending objectives and the degree of tax evasion. However, it is obvious that the sign must be positive in the case of a government that cares about employment above all and nearly assigns the same weight to price stability and current spending (i.e. $s_x \longrightarrow \infty$ and $s_g \longrightarrow 1$). In that case, a rise in the degree of fiscal corruption has favorable consequences and allows intratemporal distortionary losses to be reduced.

The intuition for the positive effects of tax evasion in the discretionary equilibrium is the following. Corruption in the form of tax evasion automatically increases the cost of using the fiscal instrument for collecting revenue. All other things being equal, the tax rate that has to be fixed to obtain a given amount of tax receipts goes up with the degree of tax evasion, so much so that the cost sustained by society in terms of foregone output and employment rises. If the objective of reaching the output target highly prevails, compared to the price stability and current spending objectives, the optimal reaction of the decision-maker to a rise in the corruption level consists in cutting distortionary taxes (see (14): $(\partial\tau^{\mathrm{d}}_{\mathrm{t}})/(\partial\gamma) > 0$ if $s_x \longrightarrow \infty$ and $s_g \longrightarrow 1$). Consequently, the impact of corruption on activity turns out to be positive (i.e. $(\partial x^{\mathrm{d}}_{\mathrm{t}})/(\partial\gamma) = -(\partial\tau^{\mathrm{d}}_{\mathrm{t}})/(\partial\gamma) < 0$). Moreover, when the policymaker primarily focuses upon economic activity, the equilibrium inflation rate is also lower in consequence of corruption, because the gain in terms of higher output lessens the incentive to generate surprise inflation (see (13): $(\partial\pi^{\mathrm{d}}_{\mathrm{t}})/(\partial\gamma) > 0$ if $s_x \longrightarrow \infty$ and $s_g \longrightarrow 1$). Thus, another beneficial effect of tax avoidance is to mitigate the inflation bias associated with discretionary policymaking, provided that the weight put on output is large enough. In that case, tax evasion acts, in a way, as a second-best mechanism that substitutes for commitment.

In fact, the government is no longer encouraged to undertake anti-corruption reforms beyond a critical degree of tax evasion. To see this, let us examine the polynomial of degree two in γ within the partial derivative $(\partial L^{\mathrm{d}}_{\mathrm{intra}})/(\partial\gamma)$. Rearranging the terms in square brackets in (12), $(\partial L^{\mathrm{d}}_{\mathrm{intra}})/(\partial\gamma)=0$ if and only if:

$$-(s_x+1)s_g\gamma^2-3s_xs_g\gamma+s_x(s_x-s_g-1)=0. \qquad (15)$$

The discriminant Δ of the polynomial (15) in γ equals $9s_x^2s_g^2+4s_xs_g(s_x+1)(s_x-s_g-1)$. A sufficient condition to have $\Delta>0$ is $s_x>s_g+1$, which must hold when the government attaches much more importance to employment than to its other objectives, hence two real roots: $\gamma_1=(\sqrt{\Delta}-3s_xs_g)/[2(s_x+1)s_g]$ and $\gamma_2=-(\sqrt{\Delta}+3s_xs_g)/[2(s_x+1)s_g]$. Notice that the root γ_2 is of no interest here since it is always negative for $\sqrt{\Delta}>0$. It is also easy to check that $0\le\gamma_1\le 1$ if $3s_xs_g\le\sqrt{\Delta}\le 5s_xs_g+2s_g$. Accordingly, tax evasion has damaging effects (i.e. $(\partial L^{\mathrm{d}}_{\mathrm{intra}})/(\partial\gamma)<0$) if γ falls into the interval $](\sqrt{\Delta}-3s_xs_g)/[2(s_x+1)s_g],1]$. The intratemporal welfare loss reaches a maximum (i.e. $(\partial L^{\mathrm{d}}_{\mathrm{intra}})/(\partial\gamma)=0$) at $\gamma=\gamma_1$. Corruption then improves welfare (i.e. $(\partial L^{\mathrm{d}}_{\mathrm{intra}})/(\partial\gamma)>0$) if γ falls into the interval $[0,(\sqrt{\Delta}-3s_xs_g)/[2(s_x+1)s_g[$. However, for sufficiently large values of s_x, the intratemporal welfare component is always decreasing in γ in the range between 0 and 1 because $\gamma_1>1$.

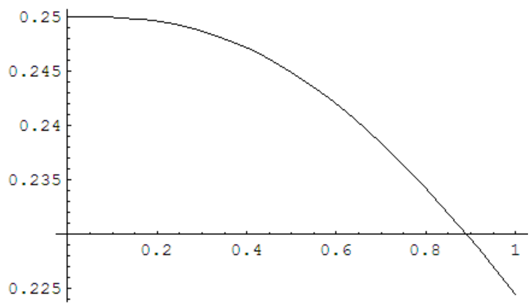

Figure 1. Intratemporal losses for $s_x=2$ and $s_g=1$

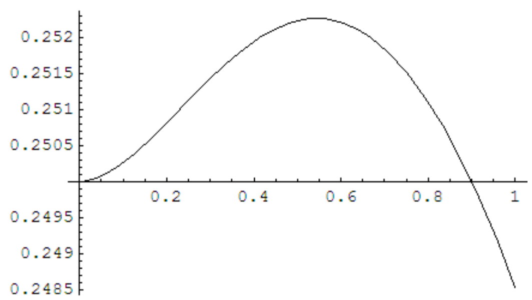

Figure 2. Intratemporal losses for $s_x=4$ and $s_g=1$

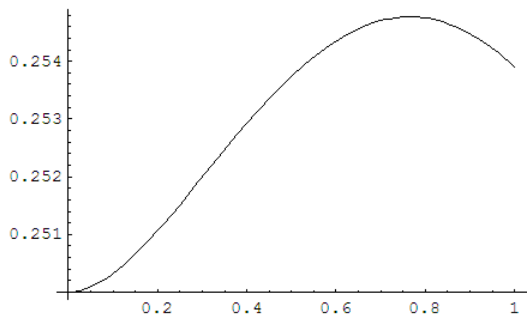

Figure 3. Intratemporal losses for $s_x=5$ and $s_g=1$

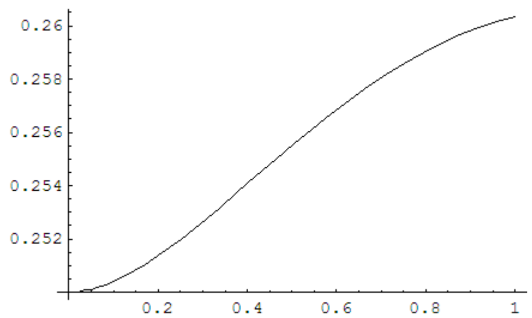

Figure 4. Intratemporal losses for $s_x=7$ and $s_g=1$

As an illustration, the four figures above show the evolution of the intratemporal loss component according to the fiscal capacity index, γ, for several values of s_x (with $s_g=1$ in every case). The larger the value taken by s_x, the higher the government's aversion to unemployment. If $s_x = 2$, the intratemporal loss reaches a maximum at $\gamma = 0$, so that any increase in tax evasion is always harmful (see Fig. 1). When $s_x = 4$, the critical value of γ for which the intratemporal loss factor reaches a maximum within the interval [0, 1] is around 0.54 (see Fig. 2). In other words, corruption begins to be beneficial in that case when the rate of leakage of tax receipts exceeds 50%. If the relative preference for employment continues to rise, the degree of tax evasion from which welfare gains can be reaped is getting weaker and weaker. Thus, the value of γ for which the intratemporal loss reaches a maximum rises to about 0.76 if $s_x = 5$ (see Fig. 3); that is to say, tax evasion theoretically begins to be beneficial when it borders on 25% now. When s_x goes up to 7, the intratemporal component is decreasing in γ in the entire interval [0, 1], and corruption is then always welfare-improving (see Fig. 4). In sum, these results suggest that a country attaching more and more importance to employment will be less and less prone to make efforts to lower tax evasion.

An interesting consequence of tax evasion, first highlighted by Huang and Wei (2003), is that the commitment problem vanishes in the extreme case of a tax collection system completely destroyed by corruption, so much so that the government can no longer collect revenue through the tax channel (i.e. $\gamma = 0$). In such a case, since the total amount of public resources does not depend anymore on the choice of the tax rate, fiscal policy is set only according to the output objective. Consequently, the output target is always attained (i.e. $\tau_t = x_t = 0$), so the incentive to resort to unanticipated inflation for stimulating economic activity vanishes, and monetary policy is then selected on the basis of the trade-off between the price stability objective and the benefits of inflation in terms of seigniorage. It follows that the commitment solution and the discretionary solution merge into a single one in that case. As long as $\gamma > 0$, the intratemporal loss factor is always greater under discretion than under commitment: although output and current public expenditure are higher in the discretionary equilibrium, the aggravation of the inflation bias problem makes that the loss incurred by society is greater in the absence of commitment.

4.3. The effect of tax evasion on intertemporal losses

I now investigate the implications of fiscal corruption for the distribution of distortionary losses across the two periods of the game, and consequently for the equilibrium level of productive expenditure. The partial derivative of the intertemporal factor with respect to γ is computed from (11b):

$$\frac{\partial L_{\text{inter}}^{\text{d}}}{\partial \gamma} = \frac{2G}{\left(1+\rho^{\text{d}}\beta\gamma\right)^3}\left[\frac{\partial \rho^{\text{d}}}{\partial \gamma}\left(\rho^{\text{d}}-\rho\beta\gamma\right)G-\beta\left(\rho+\left(\rho^{\text{d}}\right)^2\right)\left(\rho^{\text{d}}g_2^*-g_1^*\right)\right]. \tag{16}$$

The examination of the expression above shows that a change in the degree of tax evasion affects intertemporal distortionary losses in two distinct ways, with both positive and negative consequences. The first term in square brackets on the right-hand side of (16), $[(\partial\rho^{\text{d}})/(\partial\gamma)](\rho^{\text{d}}-\rho\beta\gamma)G,$ captures the effect of corruption on the public investment level through the variation of the decision-maker's effective discount factor, ρ^{d}. The second term, $\beta(\rho+(\rho^{\text{d}})^2)(\rho^{\text{d}}g_2^*-g_1^*),$ captures the impact of tax evasion on the government's trade-off between the current and future public consumption spending targets. Both these terms are positive as soon as the equilibrium amount of productive spending is strictly positive (i.e. $\rho^{\mathrm{d}} g_2^* > g_1^*$). Therefore, the former corresponds to a *welfare-enhancing effect* of fiscal corruption, whereas the latter corresponds to a *welfare-worsening effect*. The overall effect of fiscal corruption on the intertemporal loss component is thus ambiguous.

The first term represents a beneficial effect due to the fact that the effective discount factor turns out to be too high in the discretionary equilibrium from a social point of view. To see this, let us compute the partial derivative of $L_{\mathrm{inter}}^{\mathrm{d}}$ with respect to ρ^{d} from (11b):

$$\frac{\partial L_{\mathrm{inter}}^{\mathrm{d}}}{\partial \rho^{\mathrm{d}}} = \frac{2G^2\left(\rho^{\mathrm{d}} - \rho\beta\gamma\right)}{\left(1+\rho^{\mathrm{d}}\beta\gamma\right)^3}. \tag{17}$$

Moreover, one finds after some algebra:

$$\frac{\partial \rho^{\mathrm{d}}}{\partial \gamma} = \frac{\rho\beta}{D^2}\left[Ns_x\left(1+s_g\right) + 2Ds_x s_g \gamma(1+\gamma) + s_g\gamma^2\left(2D-N\right)\right] \tag{18}$$

The partial derivative (17) indicates that the intertemporal allocation of distortionary losses is optimal if and only if $\rho^{\mathrm{d}} = \rho\beta\gamma$. This equality holds only in the extreme case in which tax evasion is complete (i.e. $\gamma = 0$); the commitment and discretionary regimes then merge into a single one. In all other cases (i.e. $0 < \gamma \leq 1$), $\rho^{\mathrm{d}} > \rho\beta\gamma$. Thus, the intertemporal component is strictly increasing in ρ^{d} as long as $\gamma > 0$, which means that the effective discount factor and so the amount of productive expenditure are too high in the discretionary equilibrium from a social standpoint, provided that the leakage of tax revenues is not complete. In addition, the partial derivative (18) is always positive, since $2D > N$, and indicates that any increase in tax evasion entails a decrease in the effective discount factor. Consequently, a rise in the corruption level can exert a positive effect as regards welfare by tilting the balance in the composition of government spending towards current non-productive expenditure.

Such a result, which seems quite surprising at first sight because of the detrimental consequences for the second-period macroeconomic performance, can be explained as follows. Remember that public investment policy is employed strategically here. Whereas they take as given inflation expectations in period one, the first-period authorities can influence inflation expectations and economic outcomes in period two by means of public investment spending. The lack of commitment implies that the (endogenous) second-period inflation expectations are too high from the *ex ante* perspective of these authorities. By devoting more public resources to productive uses, they have the capacity to alleviate the inflation bias in period two, since output will be higher. As a consequence, the incentive to generate unexpected monetary shocks to boost activity will be weakened, resulting in lower equilibrium inflation. As explained before, this strategic behavior from the first-period authorities is formally captured by the ratio N/D in the expression for the effective discount factor. The problem is that such a behavior involves a suboptimal intertemporal allocation because it leads the first-period authorities to rely more heavily on unanticipated inflation for financing additional spending. In the discretionary equilibrium, inflation expectations are endogenous in the first period, too, since the private sector correctly anticipates the first-period policymaker's incentives. Hence, the discretionary equilibrium is characterized by an excessive reliance on the first-period sources of financing. Therefore, tax evasion positively impacts on the intertemporal distribution since it deters authorities from undertaking additional public investments by reducing their effective discount factor.

The second term in square brackets on the right-hand side of (16) captures the effect of a change in the fiscal corruption level on the trade-off between the current and future current spending targets. That term represents the decision-maker's incentive to increase public investment in order to raise the amount of available resources in the future and to set a higher tax rate (remember that $(\partial \tau_2)/(\partial g_1^{\mathrm{I}}) > 0$), thereby making it possible to get closer to the second-period current spending target. When $\gamma \longrightarrow 0$, resorting to taxation to finance current public expenditure becomes more costly in terms of foregone output. So authorities are induced to spend more on productive projects with the aim of increasing the future financing capacity. Accordingly, in contrast with the first effect of tax evasion, that second effect is damaging as regards welfare since it corresponds to an additional deterioration in the intertemporal allocation of distortions. The higher the second-period public consumption target, the larger the negative impact of tax evasion will be.

It follows that the net impact of tax evasion on the equilibrium level of public investment theoretically appears to be uncertain:

$$\frac{\partial \left(g_1^{\mathrm{I}}\right)^{\mathrm{d}}}{\partial \gamma} = \frac{\frac{\partial \rho^{\mathrm{d}}}{\partial \gamma} G - \rho^{\mathrm{d}} \beta \left(\rho^{\mathrm{d}} g_2^* - g_1^*\right)}{\left(1 + \rho^{\mathrm{d}} \beta \gamma\right)^2}. \tag{19}$$

It is easy to make the bringing together between the expression above and Eq. (16). The first term in the numerator on the right-hand side of (19), $[(\partial \rho^{\mathrm{d}})/(\partial \gamma)]G$, corresponds to the first effect of tax evasion on the intertemporal component through the variation of the effective discount factor, while the second term, $\rho^{\mathrm{d}} \beta (\rho^{\mathrm{d}} g_2^* - g_1^*)$, corresponds to the effect associated with the trade-off between the current and future government spending targets. A higher corruption level is welfare-enhancing if $(\partial (g_1^{\mathrm{I}})^{\mathrm{d}})/(\partial \gamma) > 0$ (i.e. tax evasion leads to a decrease in the effective discount factor, and thus to lower productive expenditure), but increases the intertemporal loss component if $(\partial (g_1^{\mathrm{I}})^{\mathrm{d}})/(\partial \gamma) < 0$ (i.e. tax evasion increases public investment and damages the intertemporal distribution of distortions).

The partial derivative above reveals the importance of both the productivity parameter of public investment expenditure, β, and the second-period government spending target, g_2^*, in the determination of the implications of fiscal corruption for intertemporal losses. With the aim of illustration, the four figures hereafter show the evolution of the intertemporal component according to the fiscal capacity index, γ, for two distinct values of β (0.3 and 0.6) and g_2^* (10 and 20), with $s_x = 5, s_g = 1, \rho = 0.9$ and $g_1^* = 2$ in every case.[10] Generally speaking, to observe a damaging effect of corruption, one must have a large value for the government spending target in period two in comparison with that of the first period), so much so that authori-

[10] Notice that these values are arbitrary and have been selected above all to illustrate both the positive and negative aspects of fiscal corruption. The estimations of the output elasticity with respect to public capital differ quite noticeably according to empirical studies and remain a controversial and debated issue. In particular, the results obtained for the United States by Aschauer (1989a, b) in his pioneering work have been criticized on various econometric grounds and as being implausible on account of an elasticity near to 0.4, which would correspond to "pretty stratospheric estimates of the marginal product of government capital" in the words of Gramlich (1994). Many subsequent analyses following alternative approaches have been carried out with the aim of measuring the contribution of public investment expenditure towards economic growth for different countries and periods. Eventually, much of the literature tends to corroborate Aschauer's views as to the crucial role played by public investment for explaining growth, but the estimated impact of public capital on output is nevertheless often weaker than that found by Aschauer (1989a, b). Thus, according to the findings in the empirical literature, a value of 0.6 for β here may appear to be overoptimistic, whereas the value of 0.3 at first glance seems a better approximation; these two values have been, however, retained for bringing out the differences in the consequences of tax evasion more distinctly.

ties are forced to increase public investment in order to raise the future financing capacity (compare Figs. 5 and 6), and/or a significant rise in the value taken by β, because the higher productivity of public capital leads them to invest more (compare Figs. 5 and 7). When both β and g_2^* are large enough, the negative effect of tax evasion in (16) and (19) becomes the biggest and the intertemporal loss factor is decreasing in γ over most of the interval [0, 1] (see Fig. 8). However, with such values, it is rather an extreme theoretical case (see footnote 10). A value of 0.6 for the parameter β is, in fact, hardly credible; empirically, the positive output elasticity of public investment found in many studies is not so high (see, among others, Sturm, de Haan and Kuper, 1998; Hénin and Hurlin, 1999; European Commission, 2003). Generally speaking, for smaller (and probably more realistic) values of β, and/or for smaller gaps between the government spending targets, the positive effect of fiscal corruption on the intertemporal allocation of distortions is much more pronounced; that is to say, the intertemporal loss is increasing in γ over all the interval of definition, as in Fig. 5.[11]

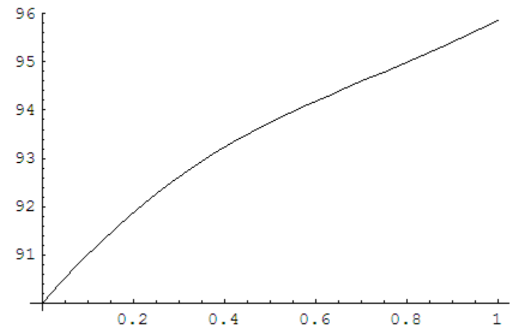

Figure 5. Intertemporal losses for $\beta = 0.3$ and $g_2^* = 10$

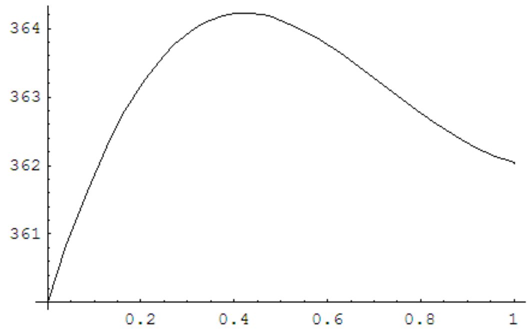

Figure 6. Intertemporal losses for $\beta = 0.3$ and $g_2^* = 20$

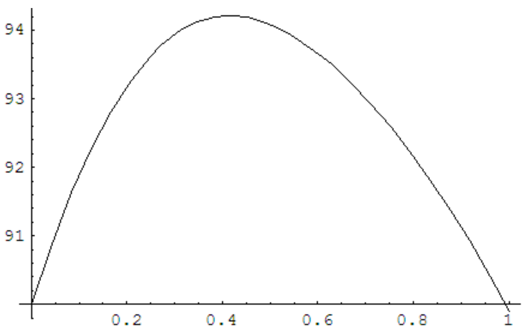

Figure 7. Intertemporal losses for $\beta = 0.6$ and $g_2^* = 10$

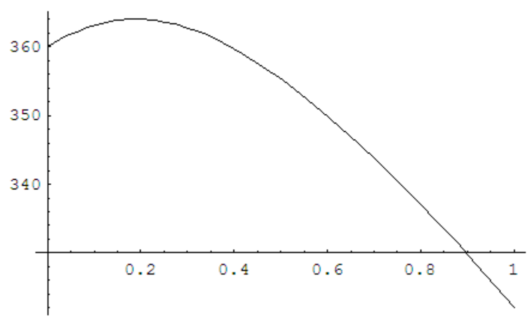

Figure 8. Intertemporal losses for $\beta = 0.6$ and $g_2^* = 20$

To sum up, tax evasion might make a country better off in the discretionary case by reducing intertemporal distortionary losses, too, in consequence of a fall in the effective discount factor. In the extreme, if tax evasion becomes complete (i.e. $\gamma = 0$), the effective discount factor equates zero, so that the intertemporal component is the same under discretion as under commitment (i.e. the two regimes then merge; see footnote 8).

[11] Moreover, as other forms of corruption may also reduce the productivity of public investments and result in poor-quality infrastructure (Davoodi and Tanzi, 1998), the value taken by β could, in fact, turn out to be very small, so much so that the whole effect on intertemporal distortionary losses would be even stronger!

5. Conclusion

This paper has explored how corruption in the form of tax evasion might impact on both the setting of macroeconomic policies and social welfare by means of a game-theoretic model with time-inconsistency problems. It appears that the commitment technology available to authorities could be a key factor in the fight against corruption. More precisely, when the government is able to commit to policy announcements, tax evasion always harms welfare. Therefore, under a commitment regime, authorities are induced to reduce fiscal corruption, as already shown by Huang and Wei (2003) in their static model. On the other hand, in the more realistic case with discretionary policies, an increase in the degree of tax evasion could be welfare-improving, especially in a country where the government gives a large weight to output deviations but worries very little about inflation. Thus, this result may contribute to explaining, in part, why corruption remains much more prevalent in some developing counties.

The basic theoretical reason for such a result is that the introduction of a distortion into an already distorted world may enhance welfare in the end. Within the present framework, the distortion associated with tax avoidance tends to offset the distortion originating in the inability to commit and resulting in both excessive inflation and public investment. Indeed, in the presence of tax distortions that restrain economic activity, corruption may both alleviate the inflation bias associated with a discretionary monetary policy and boost output thanks to a cut in taxation, thereby lowering intratemporal losses. Moreover, the lack of credibility makes that the equilibrium level of public investment spending turns out to be too high and involves a suboptimal distribution of distortions across time. It has been shown that tax evasion can then exert another positive effect by leading authorities to spend less on productive projects and thus reduce intertemporal losses, too.

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Appendix A. Derivation of public investment and welfare losses in the commitment regime

In the absence of lump-sum taxes, the highest welfare level is attained when the policymaker is able to commit and then adopts the monetary policy that is announced at the beginning of each period, before wages are set. Formally, the constraint $\pi_t = (\pi_t)^e$ applies *ex ante* for each period t = 1, 2.

Public investment policy is selected in period one while taking into account its consequences on the second-period welfare loss. The solution is found by backward induction and solving for optimal policies given the current value of the state variable (public investment expenditure) and given that future policies are optimally chosen. The policymaker's objective function in t = 2 can be written as:

$$L_2 = \frac{1}{2}\left\{\pi_2^2 + s_x\left(-\tau_2 + \beta g_1^{\mathrm{I}}\right)^2 + s_g\left(\pi_2 + \gamma\tau_2 - g_2^*\right)^2\right\} \tag{A.1}$$

The government has to minimize the loss above with respect to π_2 and τ_2. The first-order conditions are:

$$\pi_2 = \frac{s_g\left(g_2^* - \gamma\tau_2\right)}{1 + s_g}, \tag{A.2}$$

$$\tau_2 = \frac{s_x\beta g_1^{\mathrm{I}} + s_g\gamma\left(g_2^* - \pi_2\right)}{s_x + s_g\gamma^2}. \tag{A.3}$$

Solving the system (A.2)-(A.3) for π_2 and τ_2 yields:

$$\pi_2 = \frac{s_x s_g\left(g_2^* - \beta\gamma g_1^{\mathrm{I}}\right)}{Z}, \tag{A.4}$$

$$\tau_2 = \frac{s_x\left(1 + s_g\right)\beta g_1^{\mathrm{I}} + s_g\gamma g_2^*}{Z}, \tag{A.5}$$

where $Z \equiv s_x + s_x s_g + s_g\gamma^2 > 0,$ as defined in the main text.

Make use of Eqs. (1) and (2) in the main text to obtain the second-period levels of output and current spending for a given value of public investments:

$$x_2 = -\frac{s_g\gamma\left(g_2^* - \beta\gamma g_1^{\mathrm{I}}\right)}{Z}, \tag{A.6}$$

$$g_2^{\mathrm{C}} - g_2^* = -\frac{s_x\left(g_2^* - \beta\gamma g_1^{\mathrm{I}}\right)}{Z}. \tag{A.7}$$

Substituting (A.4), (A.6) and (A.7) into (A.1) yields the second-period loss for a given level of public investments:

$$L_2 = \frac{s_x s_g \left(g_2^* - \beta\gamma g_1^{\mathrm{I}}\right)^2}{2Z}. \qquad \text{(A.8)}$$

In period one, the decision-maker considers the following optimization problem:

$$L_1 + \rho L_2 = \frac{1}{2}\left\{\pi_1^2 + s_x \tau_1^2 + s_g \left(\pi_1 + \gamma\tau_1 - g_1^{\mathrm{I}} - g_1^*\right)^2\right\} + \frac{\rho s_x s_g \left(g_2^* - \beta\gamma g_1^{\mathrm{I}}\right)^2}{2Z}. \qquad \text{(A.9)}$$

The first-order conditions for π_1 and τ_1 are, respectively, given by:

$$\pi_1 = \frac{s_g \left(g_1^* + g_1^{\mathrm{I}} - \gamma\tau_1\right)}{1 + s_g}, \qquad \text{(A.10)}$$

$$\tau_1 = \frac{s_g \gamma \left(g_1^* + g_1^{\mathrm{I}} - \pi_1\right)}{s_x + s_g \gamma^2}. \qquad \text{(A.11)}$$

Solving the system (A.10)-(A.11) for π_1 and τ_1 yields:

$$\pi_1 = \frac{s_x s_g \left(g_1^* + g_1^{\mathrm{I}}\right)}{Z}, \qquad \text{(A.12)}$$

$$\tau_1 = \frac{s_g \gamma \left(g_1^* + g_1^{\mathrm{I}}\right)}{Z}. \qquad \text{(A.13)}$$

Combine the two equations above with (1) and (2) in the main text to obtain the levels of output and current spending in the first period for a given value of public investments:

$$x_1 = -\frac{s_g \gamma \left(g_1^* + g_1^{\mathrm{I}}\right)}{Z}, \qquad \text{(A.14)}$$

$$g_1^{\mathrm{C}} - g_1^* = -\frac{s_x \left(g_1^* + g_1^{\mathrm{I}}\right)}{Z}. \qquad \text{(A.15)}$$

Therefore, the social loss in period one is a positive function of public investment:

$$L_1 = \frac{s_x s_g \left(g_1^* + g_1^{\mathrm{I}}\right)^2}{2Z}. \qquad \text{(A.16)}$$

The first-period authorities have to determine the optimal level of productivity-enhancing public expenditure. The first-order condition from (A.9) is $\left(\frac{\partial L_1}{\partial g_1^{\mathrm{I}}}\right) + \rho\left(\frac{\partial L_2}{\partial g_1^{\mathrm{I}}}\right) = 0.$ One finds:

$$g_1^{\mathrm{C}} - g_1^* + \frac{s_x \rho\beta\gamma \left(g_2^* - \beta\gamma g_1^{\mathrm{I}}\right)}{Z} = 0. \qquad \text{(A.17)}$$

By making use of Eq. (A.15), this first-order condition can be rewritten as:

$$g_1^* + g_1^{\mathrm{I}} = \rho\beta\gamma\left(g_2^* - \beta\gamma g_1^{\mathrm{I}}\right), \tag{A.18}$$

which is (4) in the main text.

It is straightforward to solve for public investment in the commitment regime from (A.18):

$$\left(g_1^{\mathrm{I}}\right)^{\mathrm{c}} = \frac{\rho^{\mathrm{c}} g_2^* - g_1^*}{1 + \rho^{\mathrm{c}}\beta\gamma}, \tag{A.19}$$

which is (5) in the main text, and where $\rho^{\mathrm{c}} \equiv \rho\beta\gamma \geq 0$, with the superscript "c" indicating the commitment regime.

Substituting (A.19) for the public investment variable into (A.4)-(A.7) gives the second-period policy and economic outcomes. Combining the expression for public investment above with (A.12)-(A.15) then yields the first-period equilibrium values. One finds:

$$\pi_1^{\mathrm{c}} = \frac{s_x s_g \rho^{\mathrm{c}} G}{Z\left(1 + \rho^{\mathrm{c}}\beta\gamma\right)}, \tag{A.20}$$

$$x_1^{\mathrm{c}} = -\frac{s_g \rho^{\mathrm{c}} \gamma G}{Z\left(1 + \rho^{\mathrm{c}}\beta\gamma\right)}, \tag{A.21}$$

$$\left(g_1^{\mathrm{C}}\right)^{\mathrm{c}} - g_1^* = -\frac{s_x \rho^{\mathrm{c}} G}{Z\left(1 + \rho^{\mathrm{c}}\beta\gamma\right)}, \tag{A.22}$$

$$\pi_2^{\mathrm{c}} = \frac{s_x s_g G}{Z\left(1 + \rho^{\mathrm{c}}\beta\gamma\right)}, \tag{A.23}$$

$$x_2^{\mathrm{c}} = -\frac{s_g \gamma G}{Z\left(1 + \rho^{\mathrm{c}}\beta\gamma\right)}, \tag{A.24}$$

$$\left(g_2^{\mathrm{C}}\right)^{\mathrm{c}} - g_2^* = -\frac{s_x G}{Z\left(1 + \rho^{\mathrm{c}}\beta\gamma\right)}, \tag{A.25}$$

where $G \equiv \beta\gamma g_1^* + g_2^* > 0,$ as defined in the main text.

The total loss for the two periods of the game can finally be computed from (3) in the main text:

$$V^{\mathrm{C}} = \frac{s_x s_g}{2Z} \times \frac{\rho G^2}{1 + \rho\beta^2\gamma^2}, \tag{A.26}$$

where the first term on the right-hand side is the intratemporal loss component and the second term is the intertemporal loss component.

Appendix B. Derivation of public investment and welfare losses in the discretionary regime

It is now assumed that authorities cannot commit and take as given inflation expectations in each period (that is, the policymaker and the private sector play a Nash game). The method of solving the game is the same as before, except that the constraint $\pi_t = (\pi_t)^e$ applies *ex post*. The objective function in period two can be written as:

$$L_2 = \frac{1}{2}\left\{\pi_2^2 + s_x\left(\pi_2 - \pi_2^e - \tau_2 + \beta g_1^I\right)^2 + s_g\left(\pi_2 + \gamma\tau_2 - g_2^*\right)^2\right\} \tag{B.1}$$

The government minimizes the loss above with respect to π_2 and τ_2. Taking into account that rational expectations imply $\pi_2 = (\pi_2)^e$ *ex post*, the first-order conditions are:

$$\pi_2 = \frac{s_g g_2^* - s_x\beta g_1^I + \left(s_x - s_g\gamma\right)\tau_2}{1 + s_g}, \tag{B.2}$$

$$\tau_2 = \frac{s_g\gamma\left(g_2^* - \pi_2\right) + s_x\beta g_1^I}{s_x + s_g\gamma^2}. \tag{B.3}$$

Solving the system (B.2)-(B.3) for π_2 and τ_2 yields:

$$\pi_2 = \frac{s_x s_g\left(1+\gamma\right)\left(g_2^* - \beta\gamma g_1^I\right)}{D}, \tag{B.4}$$

$$\tau_2 = \frac{s_g\gamma g_2^* + s_x\left(1 + s_g\left(1+\gamma\right)\right)\beta g_1^I}{D}, \tag{B.5}$$

where $D \equiv s_x + s_x s_g\left(1+\gamma\right) + s_g\gamma^2 > 0,$ as defined in the main text.

Make use of Eqs. (1) and (2) in the main text to obtain the second-period levels of output and current spending for a given value of public investments:

$$x_2 = -\frac{s_g\gamma\left(g_2^* - \beta\gamma g_1^I\right)}{D}, \tag{B.6}$$

$$g_2^C - g_2^* = -\frac{s_x\left(g_2^* - \beta\gamma g_1^I\right)}{D}. \tag{B.7}$$

The substitution of (B.4), (B.6) and (B.7) into (B.1) yields the second-period loss for a given level of public investments:

$$L_2 = \frac{s_x s_g N\left(g_2^* - \beta\gamma g_1^I\right)^2}{2D^2}, \tag{B.8}$$

where $N \equiv s_x + s_x s_g (1+\gamma)^2 + s_g \gamma^2 > 0,$ as defined in the main text.

In period one, the decision-maker considers the following objective function:

$$L_1 + \rho L_2 = \frac{1}{2}\left\{\pi_1^2 + s_x\left(\pi_1 - \pi_1^{\mathrm{e}} - \tau_1\right)^2 + s_g\left(\pi_1 + \gamma\tau_1 - g_1^{\mathrm{I}} - g_1^*\right)^2\right\} + \frac{\rho s_x s_g N\left(g_2^* - \beta\gamma g_1^{\mathrm{I}}\right)^2}{2D^2}. \tag{B.9}$$

Given that $\pi_1 = (\pi_1)^{\mathrm{e}}$ *ex post*, the first-order conditions for π_1 and τ_1 are:

$$\pi_1 = \frac{s_g\left(g_1^* + g_1^{\mathrm{I}}\right) + \left(s_x - s_g\gamma\right)\tau_1}{1+s_g}, \tag{B.10}$$

$$\tau_1 = \frac{s_g\gamma\left(g_1^* + g_1^{\mathrm{I}} - \pi_1\right)}{s_x + s_g\gamma^2}. \tag{B.11}$$

Solving the system (B.10)-(B.11) for π_1 and τ_1 yields:

$$\pi_1 = \frac{s_x s_g (1+\gamma)\left(g_1^* + g_1^{\mathrm{I}}\right)}{D}, \tag{B.12}$$

$$\tau_1 = \frac{s_g\gamma\left(g_1^* + g_1^{\mathrm{I}}\right)}{D}. \tag{B.13}$$

Combine the two equations above with (1) and (2) in the main text to obtain the first-period equilibrium values for output and current spending for a given level of public investments:

$$x_1 = -\frac{s_g\gamma\left(g_1^* + g_1^{\mathrm{I}}\right)}{D}, \tag{B.14}$$

$$g_1^{\mathrm{C}} - g_1^* = -\frac{s_x\left(g_1^* + g_1^{\mathrm{I}}\right)}{D}. \tag{B.15}$$

Accordingly, the first-period loss is a positive function of public investment:

$$L_1 = \frac{s_x s_g N\left(g_1^* + g_1^{\mathrm{I}}\right)^2}{2D^2}. \tag{B.16}$$

As in the previous case, the optimal productive spending level is selected in t = 1. From (B.9).the first-order condition is $\left(\frac{\partial L_1}{\partial g_1^{\mathrm{I}}}\right) + \rho\left(\frac{\partial L_2}{\partial g_1^{\mathrm{I}}}\right) = 0.$ Hence:

$$g_1^* + g_1^{\mathrm{I}} = \rho\beta\gamma N D^{-1}\left(g_2^* - \beta\gamma g_1^{\mathrm{I}}\right), \tag{B.17}$$

which is (9) in the main text.

Let us note $\rho^{\mathrm{d}} \equiv \dfrac{\rho\beta\gamma N}{D}$, where the superscript "d" stands for discretion. The level of productive expenditure in the discretionary equilibrium is deduced from Eq. (B.17):

$$\left(g_1^{\mathrm{I}}\right)^{\mathrm{d}} = \frac{\rho^{\mathrm{d}} g_2^* - g_1^*}{1+\rho^{\mathrm{d}}\beta\gamma}, \tag{B.18}$$

which is (10) in the main text.

Substituting (B.18) into (B.4)-(B.7) gives the second-period policy and economic outcomes. Combining the expression for public investment above with (B.12)-(B.15) then yields the first-period equilibrium values. After some algebra one finds:

$$\pi_1^{\mathrm{d}} = \frac{s_x s_g (1+\gamma)\rho^{\mathrm{d}} G}{D\left(1+\rho^{\mathrm{d}}\beta\gamma\right)}, \tag{B.19}$$

$$x_1^{\mathrm{d}} = -\frac{s_g \rho^{\mathrm{d}} \gamma G}{D\left(1+\rho^{\mathrm{d}}\beta\gamma\right)}, \tag{B.20}$$

$$\left(g_1^{\mathrm{C}}\right)^{\mathrm{d}} - g_1^* = -\frac{s_x \rho^{\mathrm{d}} G}{D\left(1+\rho^{\mathrm{d}}\beta\gamma\right)}, \tag{B.21}$$

$$\pi_2^{\mathrm{d}} = \frac{s_x s_g (1+\gamma) G}{D\left(1+\rho^{\mathrm{d}}\beta\gamma\right)}, \tag{B.22}$$

$$x_2^{\mathrm{d}} = -\frac{s_g \gamma G}{D\left(1+\rho^{\mathrm{d}}\beta\gamma\right)}, \tag{B.23}$$

$$\left(g_2^{\mathrm{C}}\right)^{\mathrm{d}} - g_2^* = -\frac{s_x G}{D\left(1+\rho^{\mathrm{d}}\beta\gamma\right)}. \tag{B.24}$$

Substituting the results (B.19)-(B.24) into (3) in the main text gives the social loss for the two periods of the game:

$$V^{\mathrm{d}} = \frac{s_x s_g N}{2D^2} \times \frac{\left(\rho + \left(\rho^{\mathrm{d}}\right)^2\right) G^2}{\left(1+\rho^{\mathrm{d}}\beta\gamma\right)^2}, \tag{B.25}$$

where the first term on the right-hand side is the intratemporal welfare loss component, while the second term is the intertemporal loss factor, as before.

The comparison of (B.25) with (A.26) shows that both intratemporal and intertemporal distortionary losses are higher under discretion than under commitment as long as $\gamma > 0$.