Corrupt Bureaucracy and Growth

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2006

MONASH University
Business and Economics

DEPARTMENT OF ECONOMICS

ISSN 1441-5429

DISCUSSION PAPER 15/06

PUBLIC GOODS, CORRUPTION AND GROWTH*

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In this paper, we analyse implications of corruption on growth. We extend existing growth models by incorporating ubiquitous corruption as a by-product of the public sector. Corruption affects both taxation and public good provision, and therefore causes income redistribution and inefficiencies in the public sector. These effects of corruption lead to lower growth through distortions of investment incentives and resources allocation.

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Key words: Corruption, growth, public goods, tax evasion

JEL code: D92, D72, E20, E60, H26, H41, O17, O41

* Acknowledgement: I thank Prof. Yew-Kwang Ng for his invaluable guidance and motivation. I wish to thank David Lavine, Vai-Lam Mui, Daniel Mulino, Svetlana Maslyuk, and Stephen Miller for their helpful comments.
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1. Introduction

A large body of literature has shown that the services and infrastructure provided by the public sector play an important role in private production. Corruption distorts the purpose and functionality of the public sector. For that reason, corruption emerges as a significant factor determining the growth potential of the economy. Here we define corruption as an illicit rent-seeking activity of public agents using their public position. The rent-seeking capacity of bureaucracy stems from the scope and quality of the underlying institutions, so that the level of corruption also depends on the quality of institutions. Consequently, productivity of private production depends on the quality of the institutions and the level of corruption. Based on this rationale, this paper aims to study how corruption distorts the interactions between the private and public sectors; and how these distortions affect growth potential of the economy.

The distortions caused by corruption are well known in the literature. Nevertheless, the overall effect of these distortions on growth is yet not well understood. While some findings claim that corruption improves efficiency, others see it as the biggest obstacle in the way of development. The existing theoretical conclusions about the growth impact of corruption are conflicting. Thus, the issue is still far from being completely explored and explained.

To overcome the ambiguity in conclusions about the growth impact of corruption we need to view corruption from a broader perspective. Since corruption always involves the public sector, it is reasonable to suppose that corruption is just one possible feature of the public sector. We treat corruption simply as a side-effect of the public sector being supplied along with the public services. Corruption is driven by rent-seeking, but the rent-seeking capacity of the corrupt bureaucrats depends on the quality of the institutions. Corruption distorts the interactions between the public and private sectors and the inner functioning of the public sector. As we know these interactions take place in the form of taxation and public service provision. Therefore, we adopt a setting that incorporates corruption in the main public activities such as taxation and public service provision. This setting allows us to capture how corruption affects government's regulative burden and its productive input to private production in a broader way.

We consider a Ramsey-type growth model with an extension incorporating corruption in the public sector. In the model, the public sector is assumed to be engaged in two main activities: taxation and public good provision. Both activities are carried out by public servants, who are corruptible and rent-seeking that is manifested as:

- Corrupt tax inspectors conceal tax evasion for bribes paid by detected tax evaders. This type of corruption decreases tax revenue and limits the scope of public services available to the private sector. At the same time tax evasion reduces the tax burden on taxpayers.

- Corrupt public officials abuse the authority given to them by attaching excessive red tape to the public services they are supposed to provide. It is assumed that excessive red tape is a set of unnecessary procedures that has no productive value for firms. The firms have to incur the burden of excessive red tape in order to obtain the essential public services. The corrupt officials can rescind the excessive red tape for bribes paid by the firms. As a result, the corrupt officials capture a part of firms' profits as rent. This income redistribution from the firms to the corrupt officials effectively imposes an illegal tax on the firms. In addition, the rent-seeking wastes a part of public funds reducing the amount of public goods provided by the government.

This work contributes to the literature in the following ways:

- We combine the literature on growth, tax evasion and corruption within one framework.
- We develop a general model that incorporates both income redistribution and inefficiency in public good provision caused by corruption. The model represents main effects of corruption. Namely, the corruption leads to income redistribution and inefficiency in public good provision. The former distorts the saving and investment decisions, the latter changes the relative burden of the public sector and reduces productive public input provision.
- We provide a new mechanism that explains the deviation of the optimal tax rate from the degree of public sector externality by incorporating corruption into the dynamic general-equilibrium framework.
- We demonstrate that corruption can never be growth enhancing if considered holistically.

The paper is structured as follows: first we present a literature review, followed by Section 3, where we present the assumptions of the model and the implications stemming from those assumptions. In Section 4, we consider a household's optimization problem in choosing intertemporal consumption level and tax evasion rates. Further in Section 5 we examine the government growth optimization, by choosing the tax rate and penalty rate for tax evasion. Section 6 concludes the paper.

2. Literature Review

The role of the public sector in determining the productive capacity of the private sector has attracted much interested in the growth theory literature. The seminal papers Barro (1990) and Barro and Sala-i-Martin (1992) propose that government services can be treated as a productive input. The efficient supply of government services can increase returns on private capital offsetting the adverse effect of taxation. Therefore, it is logical to pose the question whether corruption affects growth by impeding the provision of public services. In developing and transitional economies, government operations are often entangled with corruption. The issue is initially considered by Leff (1964), who suggests that corruption that decreases red tape still can be beneficial for economic growth. Similar views are shared by Huntington (1968) and Lui (1996; 1985). They find corruption as an optimal response to market distortions that lessens the burden of regulations that improves efficiency. The results obtained by Mauro (1995) and Barreto (2000) show that the effect of corruption on growth is indeed controversial and multi-pronged. Therefore, the existing explanations about the growth effects of corruption are inconclusive.

With few exceptions, the dependence between corruption and red tape has largely been overlooked in the literature. In general, it is accepted that corruption might decrease the regulatory burden and red tape. On the other hand, we also need to take into account the relationship between corruption and the regulatory burden. Excessive red tape can be created by corrupt bureaucrats in order to create rents. Therefore, the perceived decrease in red tape by corruption is in fact just mere reduction of the intentionally created excessive red tape. On the contrary, corruption should result in higher public sector burden. The reason is that excessive red tape can be surmounted by paying bribes, while the legitimate red tape usually is not reduced by corruption. For example, Kaufman and Wei (1999) reject the hypothesis that bribery decreases the delays by bureaucratic red tape. Similarly, Guriev (2004) analyses red tape and corruption, and shows that when the bureaucracy is corrupt the level of red tape is above the social optimum. However, our definition of red tape differs from Guriev's. His red tape is a type of the public service that produces useful information about the private agents. We assume that red tape is just an unproductive hurdle created by corrupt officials. It is assumed that all other useful properties of the public sector are embodied in the public goods they provide. In other words, our red tape is only the excessive red tape induced by the corrupt officials for rent creation.

A number of papers recognize to a greater extent that corruption has a substantial adverse effect on economic growth by creating a tremendous burden on the private sector (Aleshina (2005), Ali (2003), Tanzi (2000; 1998; 1997), Keefer and Knack (1997; 1995), Alam (1989), Aidt(2003), Abed and Gupta (2002)). When we take into account the red tape induced by corruption, its illegal nature and costs related to it, it is hardly possible that corruption improves allocative efficiency and supports capital accumulation (Shleifer and Vishny (1993), Aidt (2003)). There is no doubt that corruption is quite complex in its involvement in the economic system. The idea that corruption may affects the economy via different mechanisms is formalized by Shleifer and Vishny (1993). They propose that the officials providing public goods can sell the public good with a mark up (no theft case) or sell it at prices that are lower than the production cost (theft case). So the main driving force of corruption is the rents extracted by the corrupt officials either by decreasing or increasing the burden of regulations on the private agents. The bureaucrats are able to exercise monopolist behaviour in provision of public services and goods as they are bestowed with discretionary power. The illicit rent-seeking misallocates public resources from productive use, thus it is costly for the public sector itself, and certainly wasteful. Keefer and Knack (2002) find that rent-seeking in the form unproductive public investments increases as property rights become more insecure. They used their finding to explain why in countries with less secure property rights the public investments and growth have no or negative association. In our model we follow Keefer and Knack (2002) in terms of defining rent-seeking as diverting public funds to unproductive purposes. However, we assume that this rent-seeking is related to insecure property rights protection directly and used for extraction of income from the private agents. Hence, corrupt rent-seeking not only lowers productive public input, but also redistributes private income from the private agents to the bureaucrats.

It is notable that the key contributions to the analysis of corruption focus on investigating implications of the income redistribution due to corruption. However, less attention has been paid to the inefficiency in the public sector caused by corruption and how this inefficiency can be associated with income redistribution. For example, Ehrlich and Lui (1999) consider a balance between human capital accumulation and political capital accumulation, which is used for rent-seeking. An extraction of output from productive firms is considered in the model of Barelli and Pessôa (2003). Their production technology does not depend on public goods and government is not explicitly modelled. Rivera-Baitiz (2002) captures corruption by the introduction of officials that impose a tax on the profits made by firms engaged in innovation. As a consequence the rate of return to capital decreases. Mauro's (2002) model incorporates inefficiency of the public sector as misuse of public funds which leads to lower productive public inputs to aggregate production, although other effects of corruption has not been accounted for. A similar approach is adopted by Balckburn et al. (2002; 2005), where in the earlier paper corruption is modelled as bribe-taking from tax–evaders, while in the second paper corruption is manifested as embezzlement of public funds. To the best of our knowledge, only Barreto (2000) includes study of both resource misallocation and public sector inefficiency within unified setting. In his model corruption is tied to the accumulation of non-productive capital used for rent-seeking, and the inefficiency of the public sector is manifested as red tape.

In our model we follow Baretto's (2000) approach in the sense that we account for both income redistribution and inefficiency of the public sector caused by corruption. However, the income redistribution in our model stems out of tax evasion and rent-seeking by corrupt officials. The inefficiencies in the public sector stem from excessive red tape and misuse of public funds by bureaucrats. Importantly, unlike Baretto we assume that the level of excessive red tape and corruption depends on the quality of the institutions. Therefore, the burden of the public sector manifested through red tape is correlated with the level of corruption.

The economic effect of corruption can also stem from the distortions in tax collection. A group of papers such as Chen(2003), Lin and Yang (2001) and others have laid good grounds for modelling tax evasion within a growth framework. Chen (2003) incorporates tax evasion into a standard AK- growth model with public capital. Lin and Yang (2001) and Eichhorn (2004) analyse the uncertainty created by tax evasion its economic growth implications. However, these models do not account for corruption. A richer model encompassing tax evasion with corruption has been developed by Acconcia and d'Amato (2003). Specifically, Acconcia and d'Amato (2006) consider a model of corruption explicitly focused on corrupt interactions between the private and public sectors. However, unlike our model they do not account for the effect of corruption through public good provision.

Summing up, the literature lacks a more general approach in explaining the growth effects of corruption. The existing models dealing with corruption are mainly constructed around its redistributive nature. Nonetheless, the distortions created in the functioning of the public sector should be taken into account. These distortions directly affect the amount and quality of the public inputs to private production. Our paper addresses this gap in the literature. It extends existing growth models by incorporating corruption in both government activities.

3. THE MODEL

We consider a simple Ramsey-type model similar to Barro (1990). Economy in our model is characterized by the decisions of the representative household-producer under the given government policies. The assumptions used in the model are summarised below.

Assumption 1 (Households).

a) An infinitely living representative household has the following discounted lifetime utility:

$$U(0)=\int_{0}^{\infty} e^{-\rho t}\frac{c(t)^{1-\sigma}-1}{1-\sigma}dt \tag{1}$$

where ρ is the instantaneous rate of time-preference, $1/\sigma$ is the intertemporal elasticity of substitution, $c(t)$ stands for the amount of instantaneous private consumption. The population is static. Some households work for government, the rest work for firms.

Assumption 2 (Firms).

a) There is a continuum of firms. The households own firms and supply labour and capital to them. The labour supply is assumed inelastic for simplicity. It is assumed that firms have an access to the following production function in per capita terms.

$$y(t) = Ak^{1-\alpha}g^{\alpha} \tag{2}$$

where, $0<\alpha<1$, $y(t)$ is instantaneous output per capita, $k(t)$ is instantaneous capital input per capita, $g(t)$ is instantaneous public goods per capita in time t. Parameter A is exogenously given. The firms maximize expected after tax income. They declare only a portion of their true income equal to $(1-e)y$, where $e(e<1)$ is the tax evasion rate defined as a ratio of the declared income to the true income. As a result each firm pays income tax that equals $(1-e)\tau y$ initially.

Assumption 3 (Public sector).

b) The tax system is specified by a constant income tax rate τ $(0<\tau<1)$ and a penalty rate for tax evasion $\theta > 1$. These parameters represent policy variables set by the government. The tax to be paid by the taxpayer is represented by

$$T(y) = \tau y, 0 \leq y\,. \tag{3}$$

c) Tax revenues are used to finance the public goods provided to the firms. The government does not accumulate capital. The government's budget is balanced. The public goods are an essential input to production, so the firms have to obtain them from the public sector. This involves getting through the excessive red tape created by the bureaucracy.

Assumption 4 (Corruption)

a) To combat tax evasion, government audits taxpayers randomly and detects the evasion. The probability of detection depends on the evasion rate. Corrupt tax inspectors conceal the act of tax evasion for bribe paid by the detected tax evader.

b) A part of tax revenue collected by the government is misused through their engagement in excessive red tape creation and rent-seeking.

c) Corrupt bureaucrats take advantage of the discretionary power entrusted to them and erect obstacles (excessive red tape) on the way of the firms obtaining public goods. In order to obtain the essential public input, the firms make side-payments to the corrupt bureaucrats. The magnitude of these extortions is related to the size of the government and the institutional capacity of the public sector. The underlying reason for this assumption is as follows: the bigger the government the more it gets involved in private production; the poorer the quality of the government, the more opportunity for the public officials to abuse their authority and rent seek.

The taxpayers are audited and detected with probability p. This probability is assumed to be dependent on the tax evasion rate e and the institutional parameter $\chi \in (0,1)$ that captures the effectiveness of the tax administration:

$$p = \chi e \,. \tag{4}$$

A taxpayer treats the tax rate, tax audit probability, and the penalty rate as given. When the taxpayer is detected he should pay a fine equal to $\theta \tau e y$, where $\theta > 1$ is the penalty rate.

It is assumed that the environment under consideration allows existence of a corrupt tax inspector with probability p_1. Suppose that the probability of corruption can be expressed by the following dependence between the institutional capacity and the corruptibility of the public officials:

$$p_1 = \varphi(\chi) \,, \tag{5}$$

where φ is a decreasing function in institutional capacity parameter χ.

Due to corruption, the penalty rate θ becomes random. When detected the taxpayer may pay a bribe instead of the tax penalty. In other words θ should be adjusted to the following:

$$\theta_1 = \begin{cases} \theta & \text{with probability} \quad p_1 \\ b & \text{with probability} \quad q_1 = 1 - p_1 \end{cases} \tag{6}$$

where $b < \theta$ is the rate of bribe. The expected value of the random penalty rate is then given by

$$\overline{\theta}_1 = p_1 \theta + q_1 b \tag{7}$$

Since $0 \le p_1 < 1$ and $b < \theta$ the expected penalty rate $\overline{\theta}$ is lower than the statutory penalty rate θ.

There are three possible outcomes. First, the taxpayer successfully evades tax and his income equals $(1-\tau)y + \tau e y$; second, he is caught and the tax inspector is honest then his income equals $(1-\tau)y + (1-\theta)\tau e y$; and the last, he is caught and the tax inspector is corrupt then his income equals $(1-\tau)y + (1-b)\tau e y$.

Thus the income after tax and audit is a random variable expressed by the following:

$$y_\tau = \begin{cases} (1-\tau)y + (1-\overline{\theta}_1)\tau e y, & \text{with probability} \quad p \\ (1-\tau)y + \tau e y & \text{with probability} \quad 1-p \end{cases} \tag{8}$$

The expected after-tax income of the taxpayer then is found as $\overline{y}_\tau = (1-\tau)y + \tau e y(1 - p\overline{\theta}_1)$. By denoting $\varepsilon = 1 - e(1 - p\overline{\theta}_1)$ we state it concisely:

. (9)

After taking into account the loss caused by tax evasion the government collects tax revenue that is equal to

$$T_e = \varepsilon \tau y \tag{10}$$

The public funds are assumed to be split between public service production and red tape creation. This condition is formulated as the budget balance given by

$$g + z = \varepsilon \tau y , \tag{11}$$

where g is the productive public input, z is the excessive red tape. We suppose that the public officials use excessive red tape to extort a part of the private agents' after-tax income.

The capability of the bureaucracy to divert public resources to excessive red tape creation depends on the quality of the institutions of the government. In countries with weak public institutions the bureaucrats may have more opportunities to be engaged in rent-seeking through excessive red tape, because the possibility of being detected and punished is relatively low. Essentially, the cost of excessive red tape in the total public expenditure depends on the quality of public institutions. Since, a fraction of the public funds is diverted to excessive red tape creation, so we can suppose that excessive red tape is given by

$$z = \zeta \varepsilon \tau y . \tag{12}$$

The share of the government's budget diverted to excessive red tape is $\zeta = \zeta(\chi)$, $(\zeta \in [0,1))$ and χ is the measure of the quality of institutions. Then the excessive red tape creation capacity is a decreasing function of the institutional quality, or $\zeta'(\chi) < 0$.

The firms have to get through excessive red tape in order to access the public goods. The excessive red tape specified here is costly for the firms to get through. Suppose that the private agent is willing to pay bribes to the public official if it decreases the burden of the excessive red tape. In any case, the private agent incurs a cost either by paying bribes or by getting through the excessive red tape. Suppose the corrupt public official captures a rent equal to $R = \beta z$ by accepting bribes.

We assume that the burden of excessive red tape on the firms is greater than the cost of production of the excessive red tape incurred to the public budget. The underlying intuition is simple: equipped with a discretionary power, corrupt bureaucrats are able to capture greater resources than their cost to create excessive red tape. The cost of red tape is just the time spent by the public officials on its creation and administration. In monetary terms the cost of red tape production is the salary (or part of it) paid to the official. Therefore, we assume that the rent-seeking parameter satisfies the condition $\beta > 1$. By substituting for z from (12) we formulate the rent captured by the corrupt bureaucrats as

$$R = \beta \zeta \tau \varepsilon y \tag{13}$$

On the other hand the rent of the bureaucrat is a loss to the private agent. The private agent incurs a loss equal to R as a result of dealing with a corrupt bureaucrat. That leaves him with the disposable income given by $y_d = (1-\varepsilon\tau)y - R$. Recalling the expression (13) for R and for simplicity denoting it by $\tilde{\beta} = \beta\zeta$ yields

$$y_d = (1-\varepsilon\tau)y - \tilde{\beta}\varepsilon\tau y. \tag{14}$$

More concisely, (14) is written as

$$y_d = [1-\varepsilon\tau(1+\tilde{\beta})]y \tag{15}$$

The effective tax rate or the public sector burden is increased if $\varepsilon(1+\tilde{\beta}) > 1$, or it is decreased if $\varepsilon(1+\tilde{\beta}) < 1$. The tax collection efficiency is captured by $\varepsilon < 1$; whereas the rent-seeking capacity of the corrupt bureaucrats is expressed by $(1+\tilde{\beta}) > 1$. The overall income distribution impact of corruption depends on which effect of corruption dominates. Although, it is most likely that for highly corrupt environments $\varepsilon(1+\tilde{\beta}) > 1$ holds. Therefore, we infer that in such an environment the overall burden of the public sector is not straightforwardly decreased by corruption. When opportunities to gain from tax evasion are relatively small and the predatory bureaucracy can extort larger shares of the private income, disposable income of the private agents decreases.

We can show how the lower public input due to corruption affects the overall productivity of the economy. It is assumed that public services are an essential input to production. Hence we can use the standard profit maximization procedure to analyse how the cost of obtaining public inputs may affect the levels of firms' output. If we treat a public input as just one of inputs to production, we the cost of this input should be incorporated to profit maximization. That is instead of writing the after-tax profit of the firms as $\pi = (1-\tau)(y - wl)$, we express it as $\pi = y - wl - w_g g$.

The only difference of the public input from other inputs is that the public input is not purchased on the market, because its cost is incurred indirectly through taxation. So the amount of tax paid by the firm is not directly linked to the amount of the public good it can get. This means that cost of the public input depends on the level of the firm's economic activity. In our case, it is proportional to the output of the firm or $w_g g = \tau y$. Therefore, for the given tax burden τy, when firms receive less public input g, the cost of obtaining the public input w_g rises.

Thus to minimize the cost of the public input firms should decrease the tax base. However, the cost of the public input $w_g g$ can be reduced only by decreasing the tax burden τy. This is possible only if the firms decrease their output level y. This can be summarized in the following proposition.

Proposition 1: *Corruption leads to higher costs of public goods provision, which then entails a lower productivity of the economy.*

Proof: First, we show how corruption leads to higher costs of public goods. A part of the public funds are diverted by corrupt bureaucracy and hence the amount of public services produced is equal to $g = (1-\zeta)T_e$. We know that $\zeta < 1$ and $T_e < T = \tau Y$, thus the amount of the public services produced always falls short of the potentially attainable level. This can be shown by comparing the ratio of the public input to capital for the Cobb-Douglas technology for corrupt and clean environments:

$\left(\frac{g}{k}\right) = \left(A(1-\zeta)\varepsilon\tau\right)^{\frac{1}{1-\alpha}}$ and $\left(\frac{g_0}{k}\right) = \left(A\tau\right)^{\frac{1}{1-\alpha}}$, so that $\left(\frac{g}{k}\right) < \left(\frac{g_0}{k}\right)$,

where g_0 stands for the public input in the environment without corruption. The private sector receives only the amount of public services equals $g = (1\text{-}\zeta)\ T_e$. A sum of taxes and fraction of income extorted by corrupt bureaucracy is equal to $T_e + R$. The relative cost of public services found as a ratio of the total burden of the public sector to the amount of the public services, $w_{gc} = \frac{T_e + R}{g}$, then by the virtue of equations (13)and (15) one can establish that $w_{gc} = \frac{1+\tilde{\beta}}{1-\zeta} > 1$, as $\tilde{\beta} > 0$ and $\zeta > 0$. Thus, corruption makes public good production inefficient, because every dollar taken from the taxpayers does not create public services worth of the same amount. In the no-corruption case, the relative cost of the public services equals $w_{gn} = \frac{T_0}{g_0}$, where g_0 and T_0 stands for government expenditure and tax revenue in the case of no corruption for our modelled economy. Due to the balanced budget assumption, we have $g_0 = T_0$, hence $w_{gn} = 1$, and $w_{gc} > w_{gn}$. Therefore, we can claim that with corruption productive public services become relatively costly to obtain by the private sector.

The second part of the proposition is proved in two steps:

1) As output price increases the nominal tax base increases as well, therefore, tax revenue increases and as a result the public input also increases. This is expressed algebraically as $\frac{\partial g}{\partial p} > 0$.

2) Using the Hotelling lemma we write $\frac{\partial g}{\partial p} = -\frac{\partial^2 \pi}{\partial p \partial w_g}$. Since $\frac{\partial^2 \pi}{\partial p \partial w_g} = \frac{\partial^2 \pi}{\partial w_g \partial p}$, leads to $\frac{\partial g}{\partial p} = -\frac{\partial^2 \pi}{\partial w_g \partial p}$, from where we obtain $\frac{\partial g}{\partial p} = -\frac{\partial^2 \pi}{\partial w_g \partial p} = -\frac{\partial y}{\partial w_g}$. As $\frac{\partial g}{\partial p} > 0$, then we have $\frac{\partial y}{\partial w_g} < 0$. It follows that the increase in the cost of the public input caused by corruption leads to contraction of output for the given level of other inputs.■

The proposition reflects the main distortions caused by corruption in the interaction between the public and private sectors. In the economy with corrupt bureaucracy the firms may get some relief from tax burden depending on the success in tax evasion. It decreases the tax revenue available for public good production. The productive public input offered is further decreased by red tape and misuse. In addition the corrupt bureaucrats engage in the illicit activity of rent-seeking. As result the firms obtain not only less public input but also yield to pressure of the corrupt bureaucracy and concede a part of their income.

These distortions can be the main reason that makes corruption persistent. The private agents in such an environment prefer to give up a part of their income for protection from arbitrary predation, whereas just paying taxes honestly does not guarantee such protection. Corrupt bureaucrats also have strong interest in keeping the environment hostile towards the private agents. In such conditions the corrupt bureaucrats start playing the role of the "good guys" offering their assistance for some side-payments. The private agents have to accept the "help" offered to overcome the hurdles created by the bureaucrat in the first place.

4. Household's Optimum

The representative household's problem is optimal allocation of capital across time in order to maximize its intertemporal utility. Recall that per capita disposable income is given by:

$$y_d = (1 - \varepsilon(1 + \tilde{\beta})\tau)\, y\,. \tag{16}$$

It is assumed a usual no-Ponzi game condition, so in the long run the level of debt cannot grow as fast as $r(t)$. The households problems is then formalized as

$$\max_{c,e} U(0) = \int_0^{\infty} \exp(-\rho t) \frac{c_t^{1-\sigma} - 1}{1-\sigma} dt \;, \tag{17}$$

s.t. $\dot{k}_t = [1-(1+\beta)\tau(1-e(1-p\bar{\theta}_1))]y_t - c_t$

$\lim_{t\to\infty}\{k_t \mu_t\} = 0$

The last constraint is the transversality condition, which states that households will not be over-accumulating assets.

A solution of the household's problem leads us to a dynamic optimization problem. For this purpose we define the following present-value Hamiltonian taking account of that $p = \chi e$:

$$J = u(c)\exp(-\rho t) + \mu\{[1-(1+\tilde{\beta})(1-e(1-p\bar{\theta}_1))\tau]y - c\}. \tag{18}$$

The first-order conditions are presented by:

$$J_c = \exp(\text{-}\rho t)u'(c) - \mu = 0 \;\Rightarrow \mu = e^{\text{-}\rho t}c^{-\sigma} \;, \tag{19}$$

$$\dot{\mu} = -J_k \Rightarrow \dot{\mu} = \mu([1-(1+\tilde{\beta})(1-e(1-e\chi\bar{\theta}_1))\tau])\frac{\partial y}{\partial k} - \rho) \;, \tag{20}$$

$$J_e = 0 \Rightarrow (1-e\chi\bar{\theta}_1) - e\chi\bar{\theta}_1 = 0 \,. \tag{21}$$

By solving (21) we obtain the optimal tax evasion rate as the best response to the given environment:

$$e^* = \frac{1}{2\chi\bar{\theta}_1} \tag{22}$$

The result is quite intuitive. The tax evasion rate is inversely related to the institutional quality and the effective penalty rate. Note, that the deterrence from tax evasion is diminished by direct corruption decreasing the effective penalty rate. The lower quality of the public institutions looking after the tax enforcement, obviously, leads to higher tax evasion.

The growth rate for the given economy is found as follows. By inserting (19) and its derivative with respect to time into (20), and rearranging we obtain the equation for growth rate

$$\gamma = \frac{\dot{c}}{c} = \frac{1}{\sigma}((1-\varepsilon(1+\tilde{\beta})\tau)\frac{\partial y}{\partial k} - \rho) \,. \tag{23}$$

We can see how the parameters ε and $\tilde{\beta}$ alter the growth rate, *ceteris paribus.* An increase in tax evasion captured by the lower values of ε directly contributes to growth. However, it reduces the public input, and thus indirectly deteriorates growth. Not surprisingly, an increase in the predatory capacity of the public officials reflected by rise of $\tilde{\beta}$ reduces growth as it decreases the private disposable income.

The economy in this model is closed; therefore, all debts within the economy cancel out. Consequently, the asset holding per adult person equals the capital per worker k. It stems out from this condition that all of the capital stock must have an owner within the country in a closed economy. The return on capital for the asset holder is the profit distributed after paying effective taxes (which is different than the statutory tax due to evasion and corruption) and paying all bribes to the government officials that regulate the economic activities of the firms.

By taking a derivative of the production function (2) with regards to capital per capita while assuming fixed government expenditure yields:

$$\frac{\partial y}{\partial k} = A\left(\frac{g}{k}\right)^{\alpha}(1-\alpha)\,. \tag{24}$$

By inserting (24) into (23) we re-write the growth rate as:

$$\gamma = \frac{1}{\sigma}[(1-\varepsilon(1+\tilde{\beta})\tau)(1-\alpha)A\left(\frac{g}{k}\right)^{\alpha} - \rho]\,. \tag{25}$$

Recalling that $\left(\frac{g}{k}\right) = \left(A(1-\zeta)\varepsilon\tau\right)^{\frac{1}{1-\alpha}}$ and inserting it into (24) yields the following expression for the marginal product of capital:

$$\frac{\partial y}{\partial k} = A^{\frac{1}{1-\alpha}}(1-\alpha)\left((1-\zeta)\varepsilon\tau\right)^{\frac{\alpha}{1-\alpha}} \tag{26}$$

By examining (26) we conclude that tax evasion and misuse of public funds effectively reduce the amount of public input available to the firms. As a result, the marginal product of capital drops.

Taking account of (26) the growth rate can be stated as:

$$\gamma = \frac{1}{\sigma}[(1-\varepsilon(1+\tilde{\beta})\tau)(1-\alpha)A\left(A(1-\zeta)\varepsilon\tau\right)^{\frac{\alpha}{1-\alpha}} - \rho]\,. \tag{27}$$

This result obtained from the intertemporal utility maximization together with the capital accumulation and a standard transversality condition determines the long term dynamics of the given economy. The virtue of the expression for the growth rate given by (27) is that it captures explicitly the transmission of the adverse effect of corruption on growth. Therefore, we can state that corruption distorts the effective burden of the public sector and decreases private capital productivity. This outcome implies that the return on private capital investment is lower in the corrupt environment than in the clean one. In addition, investment demand is lower in the corrupt environment and as result less capital is accumulated. With lower capital accumulation rates the given economy grows slower.

5. GOVERNMENT OPTIMIZATION

A benevolent government should maximize welfare of the citizens. For the Cobb-Douglas production technology it means that growth maximizing coincides with utility maximizing. The proof of this conclusion can be found in Barro (1990).

The government chooses a statutory tax rate and the penalty parameters that maximizes growth rate. Then given the setting with regards to tax evasion and corruption the optimization problem is given by:

$$\underset{\tau,\theta}{Max}\gamma = \frac{1}{\sigma}\left\{\left(1-\varepsilon(1+\tilde{\beta})\tau\right)\frac{\partial y}{\partial k}-\rho\right\} \tag{28}$$

By substituting for $\frac{\partial y}{\partial k}$ in (28)we re-write the problem as

$$\underset{\tau,\theta}{Max}\gamma = \frac{1}{\sigma}\left\{\left(1-\varepsilon(1+\tilde{\beta})\tau\right)(1-\alpha)A\left(A(1-\zeta)\varepsilon\tau\right)^{\frac{\alpha}{1-\alpha}}-\rho\right\} \tag{29}$$

Then the first-order conditions for this problem are given by:

$$\frac{\partial\gamma}{\partial\tau} = \frac{1}{\sigma}\left[\tilde{A}\left(\left(\frac{\alpha}{1-\alpha}\right)(1-\varepsilon\tau)\tau^{\frac{\alpha}{1-\alpha}-1}-\varepsilon(1+\tilde{\beta})\tau^{\frac{\alpha}{1-\alpha}}\right)\right]=0 \tag{30}$$

where $\tilde{A}_{\tau} = (1-\alpha)A^{\frac{1}{1-\alpha}}\left((1-\zeta)\varepsilon\right)^{\frac{\alpha}{1-\alpha}}$.

$$\frac{\partial\gamma}{\partial\theta} = \frac{1}{\sigma}\tilde{A}_{\theta}\left[-\frac{\partial\varepsilon}{\partial\theta}(1+\tilde{\beta})\tau\varepsilon^{\frac{\alpha}{1-\alpha}}+(1-\varepsilon(1+\tilde{\beta})\tau)\frac{\partial}{\partial\theta}\varepsilon^{\frac{\alpha}{1-\alpha}}\right]=0 \tag{31}$$

where $\tilde{A}_{\theta} = (1-\alpha)A^{\frac{1}{1-\alpha}}\left((1-\zeta)\tau\right)^{\frac{\alpha}{1-\alpha}}$.

Solving (31) yields the optimal value for the penalty rate:

$$\theta^{*} = \frac{1}{p_1}\left(\frac{(1+\tilde{\beta})\tau}{4(1-\zeta)[\tau(1+\tilde{\beta})-\alpha]}-q_1 b\right) \tag{32}$$

To make the tax evader pay bribes instead of the penalty the corrupt tax inspector should set his bribe rate lower than the penalty rate. Suppose, there is a relationship between the penalty rate and the bribe rate $\theta = vb$, where $v<1$. Then, we can state the optimal penalty rate as follows:

$$\theta^{*} = \frac{(1+\tilde{\beta})\tau}{4(1-\zeta)[\tau(1+\tilde{\beta})-\alpha](p_1+q_1 v)} \tag{33}$$

Based on (33) we can infer that generally with lower institutional quality the penalty rate should be higher. In fact, both $\tilde{\beta}'(\chi)<0$ and $p_1{}'(\chi)<0$ by definition, so it can be deduced that $\frac{\partial\theta^{*}}{\partial\chi}<0$. At the same time, we see that the penalty rate should be limited by (33). The penalty rate that is higher than (33) would enable the bureaucracy with more resources to prey on the firms. In other words, setting arbitrarily high penalty rates for tax evasion would not solve the problem of tax evasion, as the problem depends on the quality of institutions rather than its penalizing power. It is likely that the highly punitive authority on the hands of the corrupt bureaucracy leads to more extortions and corruption. The reason for that is that highly punitive power arms the bureaucracy with equipment and resources at the same time for rent-seeking.

Solving (30) yields to the optimal value for the tax rate

$$\tau^* = \frac{\alpha}{\varepsilon(1+\tilde{\beta})} \tag{34}$$

The result for the optimal tax rate is different from Barro's result in terms of the efficiency condition. Barro argues that for the Cobb-Douglas technology the size of government that maximizes growth rate corresponds to the productive efficiency condition. This means that in the steady state government's size as proportion of total output should be constant along the entire dynamic path. In other words, Barro's result implies that $\tau_B = \alpha$. However, because in our model the effective tax quotient is $\varepsilon(1+\tilde{\beta}) \lesseqgtr 1$, depending on the predation efficiency of the corrupt bureaucracy and tax evasion, the optimal tax rate can be less or greater than in Barro's case, or $\tau^* \lesseqgtr \tau_B$.

This result also differs also from Chen (2003), who finds that with tax evasion the optimal tax rate is higher than Barro's optimal tax rate. In our case it is possible only if the effective rate of public sector burden is less than the burden of the public sector without corruption, or when $\varepsilon(1+\tilde{\beta}) < 1$ holds. If the predatory behaviour of the corrupt public agents imposes a heavy burden on the firms such as that $\varepsilon(1+\tilde{\beta}) > 1$, the optimal tax rate must be less than Barro's optimal tax rate. Therefore, our result is more general in incorporating the institutional environment into determination of the optimal tax rate.

We are interested in determining how the gap between the Barro's optimal tax rate and the optimal tax rate for the corrupt environment changes as the positive externality of public sector changes. Recalling that Barro's optimal tax rate is $\tau = \alpha$, this gap is presented by the following:

$$\Delta = \tau - \alpha = \alpha\left(\frac{1}{\varepsilon(1+\tilde{\beta})} - 1\right). \tag{35}$$

Hence, we have $\frac{d\Delta}{d\alpha} = (\frac{1}{\varepsilon(1+\tilde{\beta})} - 1)\substack{\geq \\ <}0$ depending on $\varepsilon(1+\tilde{\beta})$ being greater or less than one. Therefore, with the increase in the externality of the public sector, the gap between the optimal tax rates for the environments with corruption and without corruption may increase or decrease depending on the rent-seeking efficiency of the corrupt bureaucracy. The following proposition states the implication of this finding:

Proposition 2: *For the optimal growth path an increase in the public sector size should always follow improvements in the externality provided by the public sector to the private production.*

Proof: For the case when $\varepsilon(1+\tilde{\beta}) < 1$ from (35) we note that $\frac{d\Delta}{d\alpha} > 0$, and from the optimal tax rate equation (32) we have $\tau^* > \alpha$ which implies that τ^* increases as the positive externality of the public sector increases; symmetrically, for the case when $\varepsilon(1+\tilde{\beta}) > 1$ from (35) we note that $\frac{d\Delta}{d\alpha} < 0$, and from the optimal tax rate equation (32) we have $\tau^* > \alpha$, which implies that in this case too the optimal tax rate τ^* increases as the positive externality of the public sector increases. Therefore, the higher optimal tax rates are achievable only with the increase of the public sector externality. Hence the optimal government size depends on the public sector externality or its efficiency.■

We note that this result somewhat contradicts the result obtained by Ng (2000). He shows that inefficiency in public sector may lead to a higher level of optimal spending. Ng demonstrates that if the net benefit of public goods is expressed as

$$N = B_g[a(g)] - C_g(g) \tag{36}$$

where B_g is total benefit, a is the actual or physical amount of public gooad provided, g is monetary amount of public spending, C_g is total cost. Possible excess burden in financing for g is given by:

$$a(g) = \Upsilon g \tag{37}$$

where Υ is an index on the efficiency in the public provision of public goods. It is also assumed that $B_g' > 0$, C_g' >0, $B_g'' < 0$ and $C_g'' > 0$. Maximizing (36) with respect g to gives:

$$B_g'\Upsilon = C_g' \tag{38}$$

Then totally differentiating (38) with respect to Υ, we obtain

$$\frac{dg^*}{d\Upsilon} = \left(\frac{B_g' + aB_g''}{C_g'' - \Upsilon^2 B_g''} \right) \tag{39}$$

The comparative statics show us that $\frac{dg^*}{d\Upsilon}$ can be positive or negative depending on the sign of the numerator, $B_g' + aB_g''$. In case when $\frac{dg^*}{d\Upsilon} < 0$ the result we have obtained in Proposition 2 is not concordant with this finding. We try to resolve this contradiction.

We notice that in our production model we enter the actual amount of public good in a power form

$$a(g) = g^{\Upsilon} \tag{40}$$

That is the main difference in the formulation of the two analyses, as we see how (40) differs from (37). In order to see how this change in specification of the actual public good we carry out a comparative statics exercise again for (38) with respect to Υ.

$$\frac{dg^*}{d\Upsilon} = \left(\frac{B_g' g^{\Upsilon}}{C_g'' \Upsilon g^{\Upsilon-1} - \Upsilon^2 B_g'' g^{2(\Upsilon-1)} - \Upsilon^2 (\Upsilon - 1) B_g' g^{\Upsilon-2}} \right) \tag{41}$$

The numerator of RHS of (41) is positive. The denominator is also positive as $B_g' > 0$, $B_g'' < 0$ and $C_g'' > 0$, $\Upsilon < 1$, thus $-\Upsilon^2 B_g'' g^{2(\Upsilon-1)} > 0$ $-(\Upsilon - 1)B_g' > 0$. Therefore, $\frac{dg^*}{d\Upsilon} > 0$, or an increase in the efficiency of the public good provision always leads to the increase in public spending. As Ng's result also allows for $\frac{dg^*}{d\Upsilon} > 0$, our result can be considered a special case of his solution, which does not allow for $\frac{dg^*}{d\Upsilon} < 0$ due to the functional form assumed that relates public spending to public good produced.

A policy implication of this finding is that any reforms intended to increase tax burden should entail reforms that improve the externality provided by the public sector to production. For instance, the conditionality of the IMF assistance imposed on the aid recipient countries usually requires an increase in the tax burden so the countries can serve their debt obligations and provide more public goods. If the intrinsic capacity of the government in the recipient countries does not allow improving the public sector externality, a mechanical approach to raising taxes would prove disastrous in terms of economic growth. Therefore, policy design in the highly indebted countries should focus first on the effectiveness of the public sector contribution to the private productivity rather than the amount of the public goods in general.

Based on the results obtained to this point Proposition 3 provides a summary:

Proposition 3: *Optimal growth rate in the corrupt environment cannot exceed the optimal growth rate in the environment without corruption.*

Proof: Let us compare optimal growth rates for cases with and without corruption assuming Cobb-Douglas production function. Recall that the growth rate with corruption is $\gamma = \frac{1}{\sigma}[(1-\varepsilon(1+\tilde{\beta})\tau)(1-\alpha)A\left(A(1-\zeta)\varepsilon\tau\right)^{\frac{\alpha}{1-\alpha}} - \rho]$, and the growth rate without corruption is $\gamma_n = \frac{1}{\sigma}[(1-\tau_B)(1-\alpha)A\left(A\tau_B\right)^{\frac{\alpha}{1-\alpha}} - \rho]$. Note that the optimal tax rate for the case with and without corruption are different due to the difference in the optimal tax rate given by (34).

Comparing two expressions for the optimal growth rates we find that $\gamma_n \geq \gamma$ holds only if $(1-\tau_B)\tau_B^{\frac{\alpha}{1-\alpha}} \geq (1-\varepsilon(1+\tilde{\beta})\tau)\left((1-\zeta)\varepsilon\tau\right)^{\frac{\alpha}{1-\alpha}}$ is true. After some manipulation we arrive at the following expression.

$$[(1-\zeta)\varepsilon]^{\frac{\alpha}{1-\alpha}} \leq \frac{1-\tau_B}{1-\varepsilon(1+\tilde{\beta})\tau} \tag{42}$$

Recalling that $\tau_B = \alpha$ and $\tau^* = \frac{\alpha}{\varepsilon(1+\tilde{\beta})}$ and substituting these into right-hand side of (42) gives $\frac{1-\tau_B}{1-\varepsilon(1+\tilde{\beta})\tau} = \frac{1-\alpha}{1-\alpha} = 1$. As ε, ζ and $\alpha \in (0,1)$, the right-hand side of (42) should satisfy $[(1-\zeta)\varepsilon]^{\frac{\alpha}{1-\alpha}} < 1$. This condition implies that growth rate in corrupt environment strictly less than in clean environment, or $\gamma_n > \gamma$. Therefore, growth in corrupt environment cannot be higher than in the environment without corruption.■

Overall, by modelling corruption as a by-product of the public sector activities we have been able to demonstrate two outcomes: the distortions caused by corruption create investment disincentives and lower the productivity of the private sector. These adverse effects exerted by corruption ultimately translate into lower growth potential for the whole economy.

6. CONCLUSION

The analysis in this paper is based on the growth model that incorporates a broader interaction between corrupt public officials and private agents. We have obtained some useful insights into the growth effects of corruption.

Our model captures corruption of tax inspectors and bureaucracy that delivers public services to the private sector. Corruption of tax inspectors decreases the effective tax revenue and thus limits the production of the public productive input. Even though the taxpayers enjoy a lower tax burden, the lesser amount of public productive input leads to lower productive capacity of the firms. The corrupt bureaucracy misuses a part of public funds and wastes public resources on the non-productive red tape and thus further reduces the amount of the public goods. Since the firms are willing to pay bribes, as long as it decreases the burden of excessive red tape. As the hidden purpose of excessive red tape is to coerce the firms pay bribes, the corrupt officials happily accept the bribes. This condition effectively creates a parallel shadow taxation of the firms and offsets any gain obtained by the taxpayer from tax evasion. As a result, the overall burden of the government run by corrupt bureaucracy becomes quite heavy. Even though this type of income redistribution does not change the total disposable income of the households, nevertheless it creates huge distortions in capital accumulation as it decreases returns on private capital rented by the firms. As the relative cost of the public inputs increases with higher corruption, the firms receive less productive input from the government. As a result growth potential is lower than if there were no corruption.

The main policy implication that we can draw is that public sector burden cannot be arbitrarily increased either by tax rate increase or by authorizing harsher punitive measures for tax evasion. Optimality conditions that we have deduced in the model demonstrate that without improvements in the quality of the institutions, the size of the public sector should not be increased. In other words, the size of the public sector must be related to the quality of the institutions representing it.

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