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Public Goods, Corruption and Growth

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ABSTRACT

In this paper growth implications of corruption are analysed. In order to establish the link from corruption in the public sector to private capital accumulation and growth, a Ramsey-type model is employed. Income redistribution and inefficiency in public good provision are the main distortions caused by corruption. The income redistribution distorts the private investment decisions, while the inefficiency in public sector increases its burden on the private sector and makes less public input available to the firms. It is shown that both effects of corruption lead to lower growth. Moreover, the model provides 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.

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

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

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PUBLIC GOODS, CORRUPTION AND GROWTH

1. INTRODUCTION

Services and infrastructure provided by the public sector play an important role in determining the productive capacity of the private sector as the public sector provides efficiency improvements by dealing with market failures and externalities. This assertion is supported by the well-established literature that investigates the link between the public sector and the performance of the economy. However, the performance of the public sector depends on the quality of institutions it consists of, hence corruption of the public officials that embody those institutions emerge as a significant factor determining the growth potential of the economy. Here we limit ourselves to the definition of corruption as an illicit rent seeking activity of public agents or in general as use of public office for private gain. In other words, we treat corruption a side-effect of the public sector activities. Hence the purpose of this paper is to study how corruption distorts the interactions between the private and public sectors, and how these distortions affect growth potential of the economy.

Specifically, in this paper a Ramsey type growth model with an extension incorporating corruption in the public sector is considered. 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 thus rent seek in the following ways:

- Corrupt tax inspectors conceal tax evasion for bribes from detected taxpayers. This leads to lower tax revenue and thus limits scope of public services available to firms, though it decreases the tax burden on firms.
- 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 red tape is a set of unnecessary procedures that has no productive value for firms. Thus, the firms have to incur the cost of red tape in order to obtain the essential public service. The red tape can be lowered by corrupt officials for bribes paid by the firms. As a result a part of firms' profits is captured by the corrupt officials as rent. This income redistribution from firms to corrupt officials effectively imposes an illegal tax on the firms. Moreover, in the process of rent seeking by the corrupt officials a part of public funds is wasted on red tape and rent extraction activities.

Although, these distortions caused by corruption is not something we did not know about, nevertheless, it is not still clear what their overall effect on growth is. The existing theoretical conclusions about the growth impact of corruption are very conflicting: one finds corruption improving efficiency, while others see it as the biggest obstacle in the way of development. A patchy view of corruption in analysis is likely the reason for getting inconsistent results.

In this paper the attempt is made to capture corruption in broader terms, so to overcome the problem of the ambiguous effect of corruption on growth. The rationale for this is based on the notion that i) corruption is a by-product of the public sector activities; ii) the public sector activities can be aggregated as taxation and spending as mentioned before; iii) then whatever effect is imposed on the private sector by the public sector, is altered by corruption; iv) thus the question becomes how taxation and spending affect growth, and how corruption may change their effect?

So based on this logic this paper contributes to the literature in the following ways:

- A more general model that captures both income redistribution and inefficiency in public good provision caused by corruption has been developed. The income redistribution distorts the saving and investment decisions, while the inefficiency in public good provision changes the relative burden of the public sector and reduces productive public input provision.
- It provides 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.
- The paper demonstrates that corruption never can be growth enhancing if considered holistically.

The paper is structured as follows: first we present a literature review, and then in Section 3 the assumptions of the model and the implications stemming from those assumptions are presented. Then in Section 4, a household's optimization problem choosing optimal intertemporal consumption and saving levels is considered. In Section 5 equilibrium conditions are analysed. Further in Section 6 the government growth optimization, by choosing the tax rate and policy parameters, is examined. Finally, Section 7 presents the conclusions of the paper.

2. A LITERATURE REVIEW

The related literature includes papers that consider growth models with a public sector, growth models with corruption, models with tax evasion and corruption. Though the conventional knowledge is inclined towards seeing the public sector as a burden rather than efficiency enhancing agent, the growth literature treats it as crucial factor for private production. The intuition behind the relationship between the public expenditures and production is that in a state lawlessness, productive capacity of the economy is low, however, with the establishment of government that brings in output-enhancing features, the economy's productive capacity increases. Without the rule of law and protection of property rights there is no incentive to save and invest. A government creates a basis for the rule of law, and moreover, it builds or facilitates

construction of infrastructure. A government creates money as medium of exchange thus promoting trade and specialization in the economy.

Nevertheless, this productive input created by the government is subject to diminishing returns so that a large public sector may become counterproductive at some point. However, this approach leads to the idea of the optimal size of the public sector, which increases productive capacity of the private sector and hence benefits it more than it costs to pay to finance the public sector through taxation. However, the dependence between the efficiency of government and its optimal size is not straightforward too. In fact, Ng (2000) finds that in certain circumstances inefficiency of government may lead to larger optimal government spending.

As a benchmark work in the growth theory that is relevant to the undertaking of this paper we point out Barro (1990) and Barro and Sala-i-Martin (1992), who propose that government services can be treated as a productive input and thus if supplied efficiently in a right amount, government services can increase returns on private capital offsetting the adverse effect of taxation.

Since, government operations are often entangled with corruption, especially in developing and transitional economies, it is logical to pose the question whether corruption affects growth by impeding the provision of public services. The issue is initially considered by Leff (1964), who suggests that corruption that may decrease red tape can be beneficial for economic growth. Similar views are hold in Huntington (1968), Lui (1996; 1985), where corruption is found as an optimal response to market distortions that lessens the burden of regulations, thus may contribute to efficiency improvements. Moreover, the results obtained by Mauro (1995) and Barreto (2000) show that the effect of corruption is indeed controversial and multi-pronged, and there can be cases when corruption may increase economic growth by decreasing the inefficiencies.

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 the corrupt officials can extract either by decreasing or increasing the burden of regulations on the private agents.

Though corruption may decrease the burden of regulations and red tape, one also needs to take into account whether higher corruption leads to higher regulation cost in general. If that is the case then, the decrease in the regulation burden through corruption may abate only a part of the excessive burden created by corrupt bureaucrats. Thus, the overall effect of corruption could be well negative.

In fact, it is being recognized to a greater extent that corruption has substantial, adverse effect on economic growth. The main message sent across by Aleshina (2005), Ali (2003), Tanzi (2000; 1998; 1997) is that corruption is harmful for growth and economic development. The reviews by Alam (1989) and Aidt (2003), and collection of papers by Abed and Gupta (2002) demonstrate the different negative aspects of corruption on economics performance. If one takes into account the illegal nature of corruption (see Shleifer and Vishny(1993)) and costs related to it, and that corruption induced red tape costs, it is hardly possible that corruption improves allocative efficiency and supports capital formation (see Alam (1989)).

However, the relevant literature still 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. This is no doubts a very important aspect of corruption, though the distortions created in functioning of the public sector should be taken into account as well, as the public input is an essential factor of private production. The most significant papers on corruption indeed focus on investigating implications of the income redistribution due to corruption. For example, Ehrlich and Lui (1999) consider a balance between human capital accumulation and political capital accumulation, which is used for rent seeking, while in Barreto's model (2000) corruption is tied to the accumulation of non-productive capital used for rent seeking. An extraction of output from productive firms is considered in the model of Barelli and Pessôa (2003), though their production technology does not depend on public goods and government is not explicitly modelled either. Rivera-Baitiz (2002) captured 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. Only, Mauro's (2002) model incorporates corruption as misuse of public funds which leads to lower productive public inputs to aggregate production.

By the same token, corruption can distort tax collection - the other main government activity. Though not accounting for corruption in tax collection, the following papers laid good grounds for modelling tax evasion with corruption within a growth framework. Chen (2003) first 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. A richer model encompassing tax evasion with corruption is developed by Acconcia and d'Amato (2003, 2006). Specifically, the paper of Acconcia and d'Amato (2006) is the only paper we can cite that considers a model of corruption explicitly focused on corrupt interactions between the private and public sectors and how it affects growth process. This paper is an attempt to extend existing growth models along this line – that is to incorporate corruption in both government activities and account for income redistribution and public sector inefficiency in one model.

3. THE MODEL

We consider a simple Ramsey-type model similar to Barro (1990) and Chen (2003). Our model economy is characterized by the decisions of the representative household producer under the given government policies.

Assumption 1 (Households). *An infinitely living representative household has the following discounted lifetime utility:*

$$U(0) = \int_0^{\infty} e^{-rt} \frac{c(t)^{1-s} - 1}{1-s} dt \qquad (1)$$

where r is the instantaneous rate of time-preference, $1/s$ is the intertemporal elasticity of substitution, $c(t)$ stands for the amount of instantaneous private consumption. The population is static.

Assumption 2 (Firms). *There is a continuum of firms. The households own firms and supply labour and capital to them. The labour supply is assumed inelastic. It is assumed that firms have an access to the following production function in per capita terms.*

$$y(t) = A k^{1-a} g^{a} \qquad (2)$$

where, $0<a<1$, $y(t)$ is instantaneous output per capita, $k(t)$ is instantaneous capital input per capita, $g(t)$ is instantaneous public services per capita in time t. Parameter A is exogenously given.

Assumption 3 (Public sector).

1. *The tax system is specified by a constant income tax rate t $(0< t<1)$ and a penalty rate for tax evasion $q > 1$. These parameters represent policy variables set by the government. The tax to be paid by the taxpayer is represented by function*

$$T(y) = ty, 0 \le y. \qquad (3)$$

2. *Tax revenues are used to finance the public good provided to the firms free of charge. These public goods are an essential input to production, so that firms have to obtain them from the public sector. Corrupt bureaucrats construct barriers (red tape) against the firms in obtaining those goods, and let firms to access these goods for some side-payment only. We assume that these side-payments are paid from after-tax income. The magnitude of these extortions is proportional to the size of the government and the institutional capacity of the public sector.*
3. *A part of tax revenue collected by the government is misused through excessive red tape and rent seeking. Otherwise, a balanced budget is assumed.*

The firms maximize expected after tax income. They declare only a portion of their true income equal to ey, where $e(e < 1)$ is the proportion of the income declared. As a result each firm pays income tax that equals to $et y$ initially. However, given the probability of detection of the tax evader p, when detected the taxpayer should pay a fine equal to $qt ey, q > 1$.

An individual taxpayer treats the tax rate, tax audit probability, and penalty rate as given. However, we are introducing corruptibility of the tax inspectors conducting the tax audits. It is assumed that a

tax inspector can be corruptible with probability p_1. Of course, one may argue that the probability of corruption also depends on the efficiency of monitoring of the tax inspectors and penalty system for being corrupt. It is assumed that the environment under consideration allows existence of a corrupt tax inspector with probability p_1.

Due to corruption the penalty rate q becomes random as when audited and detected the taxpayer may pay a bribe instead of a tax penalty. In other words q should be adjusted to the following:

$$\tilde{q} = \begin{cases} q & \text{with probability} \quad p_1 \\ b & \text{with probability} \quad 1 - p_1 = q_1 \end{cases} \tag{4}$$

The expected value of the random penalty rate is given by

$$\bar{\tilde{q}} = p_1 q \tag{5}$$

Since $0 \leq p_1 < 1$, the expected penalty rate is lower than the statutory one.

Given the context, for an individual taxpayer both auditing and getting a corrupt deal is random, thus the income after taxes and audit is a random variable.

$$y_t = \begin{cases} (1 - t)y + (1 - p\bar{q})te y, & \text{with probability} \quad p \\ (1 - t)y + tey & \text{with probability} \quad 1 - p \end{cases} \tag{6}$$

where $b < q$ is the bribe rate, so tax evasion costs the bribe paid instead of penalty.

The expected after-tax income of the taxpayer then is given by

$$\begin{aligned} \tilde{y}_t &= (1 - t)y + tey(1 - pp_1\bar{\tilde{q}}) \\ &= [1 - t(1 - e(1 - pp_1\bar{\tilde{q}}))]y \\ &= (1 - et)y \end{aligned} \tag{7}$$

where $e = 1 - e(1 - pp_1\bar{q})$ is the effective income reporting rate.

Thus, after taking into account the loss caused by tax evasion the government collects tax revenue equal to

$$T_e = ety \tag{8}$$

However, it is not the end of the story; we assume that the firms are subject to extortions by the corrupt bureaucracy. In this perspective we follow McChesney (1997) and Barreto (2003) and assume that using the public power the corrupt officials extract rent from the firms. Again for the sake of simplicity, we assume away all possible interactions between the officials and firms, as exogenously given. Assume that the expected extorted amount is given by

$$R = bety \tag{9}$$

where $b < 1$ and depends on the institutional parameter $c \in (0,1)$ given exogenously. It is assumed that $b(c = 0) = 0$ that is a higher value of c is associated with higher rent extraction.

Then the disposable income of the agent is given by

$$\begin{aligned} \bar{y}_d &= (1 - et)y - R \\ &= [1 - et(1 + b)]y \end{aligned} \tag{10}$$

It is clear that in case if $e(1 + b) > 1$ the effective burden of the public sector on the private sector exceeds the statutory burden of the public sector.

The tax revenue collected is not totally spent on the public service production, but rather a part of it is misused. It is assumed that the amount of the misused funds are found as

$$S = cety \tag{11}$$

where c stands for the institutional capacity parameter as described above.

For the given set-up the public sector faces the following budget constraint:

$$\begin{aligned} g &= ety - S \\ &= (1 - c)ety \\ &= (1 - c)T_e \end{aligned} \tag{12}$$

where g is the public sector output, T_e is the effective tax revenue. The outcome for private disposable income given by (13) and the public budget (14) lets us to draw the following conclusion.

Proposition 1:

Corruption increases the relative cost of public services for the firms.

Proof: A part of the public funds are diverted by corrupt bureaucracy and hence the public services produced equal to $g = (1 - c)T_e$, as we know that $1 - c < 1$ and $T_e < T = tY$, the amount of the public services produced always fall short of the potentially attainable level. One can see it by comparing $\left(\frac{g}{k}\right) = (A(1 - c)et)^{\frac{1}{1-\alpha}}$ and $\left(\frac{g_0}{k}\right) = (At)^{\frac{1}{1-\alpha}}$, 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 equal to $g = (1 - c)T_e$ while pays taxes and concedes a fraction of income to corrupt bureaucracy 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 the conditions(10) and (12) one can easily establish that $w_{gc} = \frac{e(1 + b)}{(1 - c)} > 1$. This means corruption causes inefficiency in public good production and thus every dollar taken from the taxpayers does not create public services worth of one dollar. Whereas, in the no corruption case relative cost of the public services equal to $w_{g0} = \frac{T_0}{g_0}$, where g_0 and T_0 stands for government expenditure and tax revenue in the case of no corruption for our modelled economy. Noting that $g_0 = T_0$, it follows that $w_{g0} = 1$. It can be established that $w_{gc} > w_{g0}$, hence one can claim that corruption makes productive public services relatively costly to obtain for the private sector. ■

The result obtained in Proposition 1 can be extended into analysis of the overall effect of corruption on productivity of the economy. It is assumed that public services are an essential input to production; hence we can use the standard profit maximization to analyse how the cost of obtaining public inputs may affect the levels of firms' output. Therefore, if we treat a public input as just one of inputs to production than we should incorporate the cost of this input to profit maximization. So then instead of considering taxes and the public input separately we look at them as if taxes were a direct cost of obtaining the essential public input. That is instead of writing the after-tax profit of the firms as $p = (1 - t)(y - wl)$, we express as $p = y - wl - w_g g$.

The only difference of the public input from other inputs is that the public input is not purchased on the market, and its cost incurs indirectly through taxation. This means that the cost of the public input is proportional to the level of the firm's economic activity- in our case, it is the output of the firm, so that $w_g g = ty$. Therefore, when for the given tax burden ty the cost of obtaining the public input w_g rises, firms receive less public inputs g. It happens because the cost of the public input imposed not through market but through regulation. Thus firms in order to lessen the cost of the public input should decrease the tax base, which stems from the fact that the cost of the public input $w_g g$ can be reduced by decreasing the tax burden ty, which is possible only if the firms decrease their output level y.

Summarizing this discussion we formulate the next proposition.

Proposition 2: *An increase in corruption leads to higher cost of public goods which then entails a lower productivity of the economy.*

Proof: The first part of the proposition is just the restatement of Proposition 1. 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 $\frac{\partial g}{\partial p} = -\frac{\partial^2 p}{\partial p \partial w_g}$. Since $\frac{\partial^2 p}{\partial p \partial w_g} = \frac{\partial^2 p}{\partial w_g \partial p}$, leads to $\frac{\partial g}{\partial p} = -\frac{\partial^2 p}{\partial w_g \partial p}$, from where we obtain $\frac{\partial g}{\partial p} = -\frac{\partial^2 p}{\partial w_g \partial p} = -\frac{\partial y}{\partial w_g}$. As $\frac{\partial g}{\partial p} > 0$, then $\frac{\partial y}{\partial w_g} < 0$. 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. ■

4. HOUSEHOLD'S OPTIMUM

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

$$y_d = (1 - e(1 + b)t)y. \tag{15}$$

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

$$\max_{c,e} U(0) = \int_0^{\infty} \exp(-rt)\frac{c(t)^{1-s} - 1}{1-s}dt, \tag{16}$$

$$\text{s.t. } \dot{k} = [1 - (1 + b)(1 - e(1 - p\bar{q}))t]y - c$$

$$\lim_{t \to \infty} \{k(t)m(t)\} = 0$$

The solution of the household's problem leads us to a dynamic optimization problem. For this purpose we define the following present-value Hamiltonian:

$$J = u(c)e^{-rt} + m([1 - (1 + b)(1 - e(1 - pp_1q))t]y - c\}. \tag{17}$$

The first-order conditions presented by:

$$J_c = e^{-rt}u'(c) - m = 0 \Rightarrow m = e^{-rt}c^{-s} \tag{18}$$

$$\dot{m} = -J_k \Rightarrow \dot{m} = m((1 - e(1 + b)(1 - pp_1q)t)\frac{\partial y}{\partial k} - r), \tag{19}$$

$$J_c = 1 - pp_1q = 0 \Rightarrow p^* = \frac{1}{p_1q} \tag{20}$$

As the existence of tax evasion has been assumed and thus it implies that the expected penalty rate satisfies $p(q - 1) < 1$. It may mean that the penalty rate is not set too high so that the optimal probability of detection becomes zero. On the other hand, it can be also understood as the probability of corruption being a decreasing function of the penalty rate. For example, assume that the probability of corruption is given by:

$$p_1 = \frac{cq^t}{\exp(q - 1)}, \tag{21}$$

where q is the penalty rate, c is the institutional capacity.

The government seeks to maximize the probability of detection by choosing the penalty rate, and then the first-order condition of the maximization problem for (22) is the following:

$$\frac{dp^*}{dq} = (\frac{1}{p_1q})' = -\frac{p_1q + p_1}{(p_1q)^2} = 0. \tag{23}$$

This condition leads to $p_1q + p_1 = 0$. Taking into account (21) we write $p_1' = [1 - ctq(q - 1)]ct\exp(-(q - 1))$, which then gives $[1 - ctq(q - 1)] + 1 = 0$. The expansion of this equation yields: $-ctq^2 + ctq + 2 = 0$. A solution of which yields us the equilibrium value for the penalty rate:

$$q^* = \frac{1}{2}\left(1 + \sqrt{1 + \frac{8}{ct}}\right). \tag{24}$$

Here we discard one of the roots of the quadratic equation as it is negative. For given detection probability the taxpayer chooses the evasion rate that makes him indifferent between evading further and decreasing the evasion. This condition is stated as

$$p^*[(1-t)y + (1-\bar{q})te y] = (1-p^*)[(1-t)y + tey].$$

After some manipulation we arrive at:

$$p^*[(1-t)y + (1-\bar{q})te y] = (1-p^*)[(1-t)y + tey]$$

$$\Rightarrow p^*(1-t)y + p^*tey - p^*\bar{q}te y - (1-t)y - tey + p^*(1-t)y + p^*tey = 0$$

$$\Rightarrow (p^*\bar{q} + 1 - 2p^*)te = (2p^* - 1)(1-t)$$

Solving it for e we get the equilibrium tax evasion rate:

$$e^* = \frac{(2p^* - 1)(1-t)}{(p^*\bar{q} + 1 - 2p^*)t}. \tag{25}$$

The growth rate is found as follows. Differentiation of (18) with respect to time yields:

$$\dot{k} = -sc^{-s-1}e^{-rt}\dot{c} + rc^{-s}e^{-rt}. \tag{26}$$

By inserting (18) and (26) to(19), we get

$$e^{-rt}(-sc^{-(1+s)}\dot{c} + rc^{-s}) = e^{-rt}c^{-s}(1 - e(1+b)t)\frac{\partial y}{\partial k}. \tag{27}$$

Rearranging (27) we obtain the equation for growth rate

$$g = \frac{\dot{c}}{c} = \frac{1}{s}((1 - e(1+b)t)\frac{\partial y}{\partial k} - r). \tag{28}$$

The economy in this model is closed; therefore, all debts within the economy cancel out. Consequently, the assets per adult person, h 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, since we are assuming a closed economy. Therefore, we can write $h = k$ and $\dot{h} = \dot{k}$. The return on capital, r, 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. Then take-home income by the factor owners is given by $y_d = (1 - e(1+b)t)y$.

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

$$\frac{\partial y}{\partial k} = A\left(\frac{g}{k}\right)^a(1-a). \tag{29}$$

By inserting (29) into (28) we re-write the growth rate as:

$$g = \frac{1}{s}[(1 - e(1+b)t)(1-a)A\left(\frac{g}{k}\right)^a - r]. \tag{30}$$

A combination of (31) and (32) gives us $\left(\frac{g}{k}\right) = (A(1-c)et)^{\frac{1}{1-a}}$. Using this equation we re-write (33) as

$$g = \frac{1}{s}[(1 - e(1+b)t)(1-a)A(A(1-c)et)^{\frac{a}{1-a}} - r]. \tag{34}$$

This result obtained from intertemporal utility maximization together with the capital accumulation and a standard transversality condition determines the long term dynamics of the given economy. This expression explicitly sows how different corruption in public sector activities may affect economic growth. One can easily see how the corruption parameters e and b alters the growth rate *ceteris paribus*. That is an increase in tax evasion leads to higher growth, whereas an increase in the predatory capacity of the public officials, not surprisingly, reduces growth. There is an indirect effect of corruption coming through inefficiency in public good provision and lower tax revenue due to tax evasion. The higher values of misuse of the public funds, c combined with lower values of the income reporting, e, yields lower productive public input to production and hence growth is lowered.

5. GOVERNMENT OPTIMIZATION

A benevolent government should maximize welfare of the citizens. Cobb-Douglas production function as in Barro (1990) is assumed and hence it is known that the growth maximizing tax rate will coincide with the utility maximizing tax rate. The proof of this condition can be found in Barro (1990).

If the government chooses a statutory tax rate and the penalty parameters that maximizes growth rate given the set-up with regards to tax evasion and corruption, one needs to maximize,

$$Max_{t} g = \frac{1}{s}[(1 - e(1 + b)t)(1 - a)A(A(1 - c)et)^{\frac{a}{1-a}} - r] \qquad (35)$$

Then the FOC for this problem is given by:

$$\frac{\partial g}{\partial t} = \frac{1}{s}\left[\left(\frac{a}{1-a}\right)(1 - et)t^{\frac{a}{1-a}-1} - e(1 + b)t^{\frac{a}{1-a}}\right]\Psi = 0 \qquad (36)$$

where $\Psi = (1 - a)A^{\frac{1}{1-a}}((1 - c)e)^{\frac{a}{1-a}}$.

A solution to (36) leads to the optimal value for the tax rate:

$$t^{*} = \frac{a}{e(1 + b)} \qquad (37)$$

The result for the optimal tax rate is different from Barro's result in terms of the efficiency condition. His result states 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 size as proportion of total output should be constant along the entire dynamic path, which implies that $t_g = a$. However, in our case the effective tax quotient $e(1 + b)\frac{\pounds}{s}1$, therefore 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 $t^{*}\frac{\pounds}{s}t_g$.

This result differs also from the result obtained by 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 that is $e(1+b)<1$ holds. If the predatory behaviour of the corrupt public agents imposes a heavy burden on the firms such as that $e(1+b)>1$ then the optimal tax rate must be less than Barro's optimal tax rate. Therefore, the result of this analysis is more general in terms of incorporating the institutional environment into determination of the optimal tax rate.

Another aspect of the issue is 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 $t=a$, this gap is presented by the following:

$$D = t - a = a\left(\frac{1}{e(1+b)} - 1\right). \qquad (38)$$

It can be shown that $\frac{dD}{da} = \left(\frac{1}{e(1+b)} - 1\right) \gtrless 0$ depending on if $e(1+b)<1$ or $e(1+b)>1$. Therefore, it can be concluded that with the increase in the externality of the public sector, the gap between the optimal tax rates for environments with corruption and without corruption may increase or decrease depending on the rent-seeking efficiency of the corrupt bureaucracy. The following proposition summarizes these findings:

Proposition 3:

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 $e(1+b)<1$ from (38) we note that $\frac{dD}{da}>0$, and from the optimal tax rate equation (37) we have $t^*>a$ which implies that t^* increases as the positive externality of the public sector increases; symmetrically, for the case when $e(1+b)>1$ from (38)we note that $\frac{dD}{da}<0$, and from the optimal tax rate equation (37) we have $t^*>a$ which implies that in this case too the optimal tax rate t^* increases as the positive externality of the public sector increases. Therefore, the higher optimal tax rates hence the government size is achievable only at higher levels of the public sector externality. ■

The results obtained to this point enable us to conclude about the overall effect of corruption defined as in this set-up. 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

$$N = B_g[a(g)] - C_g(g) \qquad (39)$$

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

$$a(g) = \; | \; g \tag{40}$$

where ¡ is an index on the efficiency in the public provision of public goods. It is also assumed that $B_g\phi > 0$, $C_g\phi > 0$, $B_g\#\# < 0$ and $C_g\#\# > 0$. Maximizing (39) with respect g to gives:

$$B_g\phi \; = C_g\phi \tag{41}$$

Then totally differentiating (41) with respect to ¡ , we obtain

$$\frac{dg^*}{d|} = \left[\frac{B_g\phi + aB_g\#\#}{C_g\#\# - \; | \; ^2B_g\#\#}\right] \tag{42}$$

The comparative statics show us that $\frac{dg^*}{d|}$ can be positive or negative depending on the sign of the numerator, $B_g\phi + aB_g\#\#$. In case when $\frac{dg^*}{d¡} < 0$ 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

$$a(g) = g^¡ \tag{43}$$

That is the main difference in the formulation of the two analyses, as we see how (43) differs from (40). In order to see how this change in specification of the actual public good we carry out a comparative statics exercise again for (41) with respect to ¡ .

$$\frac{dg^*}{d¡} = \left[\frac{B_g\phi g^¡}{C_g\#\# g^{¡-1} - ¡^2 B_g\#\# g^{2(¡-1)} - ¡^2(¡ - 1)B_g\phi g^{¡-2}}\right] \tag{44}$$

The numerator of RHS of (44)is positive. The denominator is also positive as $B_g\phi > 0$, $B_g\#\# < 0$ and $C_g\#\# > 0$, ¡ < 1, thus $- ¡^2 B_g\#\# g^{2(¡-1)} > 0$ $-(¡ - 1)B_g\phi > 0$. Therefore, $\frac{dg^*}{d¡} > 0$, 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 $\frac{dg^*}{d|} > 0$, our result can be considered a special case of his solution, which does not allow for $\frac{dg^*}{d¡} < 0$ due to the functional form assumed that relates public spending to public good produced.

An 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 given recipient country does not allow for an increase in the public sector externality improvement, then a mechanical approach to raising taxes would prove disastrous in terms of growth prospective. Therefore, policy design in

the highly indebted countries should focus first on the effectiveness of the public sector contribution into the private productivity rather than the amount of the public goods in general.

The results obtained to this point enable us to conclude about the overall growth effect of corruption, which constitutes the following proposition:

Proposition 4: *Optimal growth rate in the corrupt environment cannot exceed the optimal growth rate in the environment without corruption.*

Proof: In order to see it let us compare optimal growth rates for cases without corruption and with corruption assuming Cobb-Douglas production function. We recall that the growth rate with corruption is $g = \frac{1}{s}[(1 - \theta b)(1 - a)A(A(1 - c)e t)^{\frac{a}{1-a}} - r]$, and analogously the growth rate without corruption is expressed by $g_n = \frac{1}{s}[(1 - t)(1 - a)A(At)^{\frac{a}{1-a}} - r]$. Note that the optimal tax rate for the case with corruption and no corruption are different due to(37). Comparing two expressions for the optimal growth rates we find that $g_n > g$ holds only if $(1 - t)(At)^{\frac{a}{1-a}} > (1 - \theta b)((1 - c)et)^{\frac{a}{1-a}}$ is true. After some manipulation we arrive at the following equivalent expression.

$$(1 - \theta b)((1 - c)e)^{\frac{a}{1-a}} \leq (1 - t) \qquad (45)$$

If the degree predation is high and misuse of public funds significant, that is if $\theta \to 1$ and $c > 0$ then the right-hand side of (45) is strictly greater than the left-hand side, or $g_n > g$. ■

6. CONCLUSION

This paper is motivated by the interest to investigate the impact of corruption on growth by incorporating into a growth model a broader interaction between corrupt public officials and private agents. In particular, the model captures the corruption of tax inspectors and bureaucracy that delivers public services to the private sector.

The corruption of tax inspectors decreases the effective tax revenue and thus limits the production of the public productive input; even though the taxpayers enjoy lower tax burden the less public productive input leads to lower productive capacity of the firms. The corrupt bureaucracy misuses a part of public funds and also extracts rents from the private agents. This effectively creates a parallel shadow taxation of the firms and offsets any gain obtained by the taxpayer from tax evasion. Thus 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, yet it creates huge distortions in capital accumulation as it decreases returns on private capital rented by the firms. Furthermore the relative cost of the public inputs increased with corruption, hence the firms receive less productive input from the government, and as a result growth potential is lower than if there were no corruption.

The model specified in this paper has some limitations. For the sake of simplicity the tax evasion decision in the model of the taxpayers is reduced to choosing the income reporting rate only. However, the taxpayers may choose first the probability of evasion, and then only how much income to hide from taxation. This may only decrease the effective tax quotient in equilibrium; as a result the gap in optimal tax rates and growth rates between the corrupt and incorrupt environments can be less than in our model. Nevertheless, the qualitative results would not change due to relaxation this assumption; hence corruption still would be growth retarding. The strategic interactions between the tax inspector and taxpayer, tax inspector and tax authorities can be explicitly modelled, though it will not change the overall outcomes of the taxation with corruption, as it adds only to the dimension of the problem.

The second limitation is that it is assumed that all public sector output serves as productive input into private production. In reality a part of public sector output can be public goods consumed by the households. Relaxing this assumption would open another channel that links corruption in the public sector with the utility maximization of the households and thus the capital accumulation process.

Also in the model it has been considered only income tax while neglecting consumption tax. Consumption tax also collected from the firms so all the evasion mechanisms is applicable to it as well. It is clear from the results of the analysis that not only how the tax is paid by the private sector but also how that tax revenue is used also very crucial in determining the impact of corruption. Therefore, a richer structure of tax system will not change the overall impact of corruption as it does not change the mechanics of it.

The other limitation of the model is that in the model the relationship between the government externality and the corruption in the public sector is not captured. This line of analysis implies in fact, modelling of endogenous corruption which depends on the quality of the institutions. It would be interesting to investigate implications of changes in institutional capacity and growth potential of the economy.

Furthermore, the uncertainty created by the stochastic nature of corruption has not been considered. Further research is required in order to see how uncertainty in the economic environment related to the corruption in the public sector. It is likely that corruption distorts capital accumulation not only by decreasing the returns on private capital but also by increasing the uncertainty related to the investment decisions.

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