Growth, Public Investment and Corruption with Failing Institution

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Growth, Public Investment and Corruption with Failing Institutions

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Abstract

Corruption is thought to prevent poor countries from catching-up. We analyze one channel through which corruption hampers growth: public investment can be distorted in favor of specific types of spending for which rent-seeking is easier and better concealed. To study this distortion, we propose an optimal growth model where households vote for the composition of public spending subject to an incentive constraint reflecting individuals' choice between productive activity and rent-seeking. At equilibrium, the intensity of corruption and the structure of public investment are determined by the predatory technology and the distribution of political power. Among different regimes, the model shows a possible scenario of distortion without corruption in which there is no effective corruption yet still the possibility of corruption distorts the allocation of public investment, thus hampering growth. We test the implications of the model on a panel of countries estimating a system of equations with instrumental variables. We find that countries with a high predatory technology invest more in housing and physical capital in comparison with health and education. For equal initial conditions, such countries grow slower and have higher corruption, in particular when political power is concentrated.

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Introduction

Wide-spread corruption seems to be one of the main reasons preventing poor countries from catching up. Improved institution efficiency and corruption deterrence stand now very high on the agenda of organizations dealing with economic development. The World Bank and the OECD are currently supporting anti-corruption programs to improve governance capacity, promote economic development and fight poverty.

There are many channels through which corruption hampers growth. Corruption acts as a tax on entrepreneurship and productive activity, discouraging investment. Corruption pushes firms and activities into the informal sector. Corruption diverts talent into rent-seeking. On top of these effects on the private sector, corruption weakens the efficiency of state intervention, first by decreasing tax revenue and affecting state budget equilibrium (Tanzi and Davoodi 1997), second by lowering the quality of public infrastructure and reducing public spending efficiency (Gupta and Tiongson 2003), third by distorting the spending structure (Mauro 1997).

The detrimental effect of corruption to the structure of public expenditure is of particular relevance. Indeed, it has been argued by Mauro (1997), Tanzi (1998) and Delavallade (2006) that education expenditure are scaled down in countries with widespread corruption. Lowering the provision of education has a negative effect on future income, and reinforces economic inequality. The distortion in public spending implied by corruption has been the subject of several empirical researches but has not yet received any attention on the theory side. On the contrary, corruption enhances the portion not only of military spending (Gupta, Sharan, and de Mello 2000), but also of public services and order, fuel and energy, and culture expenditure relative to education and health spending (Delavallade 2006). In his influential paper, Mauro (1997) sketches a model based on Barro (1990) with different types of public spending; in his model, corruption acts as a proportional tax on budget surplus, and does not distort the composition of public spending, contradicting to some extent his empirical results.

In this paper, we propose a model which has three distinctive features. First, we define corruption technology as the easiness with which rent-seekers can capture part of public spending. Categories of spending have different corruption technologies, there are specific types of public spending for which rent seeking is easier and better concealed. Second, households vote on the allocation of public investment and rent-seekers may have more political influence than other people. Third, the political economy problem is subject to an incentive constraint, representing the choice made by individuals between productive activity and rent-seeking. The solution to the model will display multiple "regimes". In one of them, rent-seekers have a large political weight, and if the corruption technology is sufficiently efficient, the allocation of public investment will be distorted in favor of specific types of spending (subject to corruption), which in turn affects income growth negatively.

In the empirical part, we analyze how the distinctive features of our model translate into econometric estimates. We estimate on a panel of countries a system of equations with instrumental variables. Growth, corruption and the composition of public investment are a function of the concentration of political power and the corruption technology. We find that countries with a high predatory technology invest more in housing and physical capital in comparison with health and education. For equal initial conditions, such countries grow slower and have higher corruption, in particular when political power is concentrated. A distinctive feature of our approach is to make the marginal effects of corruption technology and political power depend on the level of development. Their effects on the level of corruption, the distribution of public spending and growth turn out to be weaker in countries with a GDP per capita greater than 3 000$ which is in line with the theoretical viewpoint that there are several regimes.

The paper is organized as follows. Section 1 presents the structure of the model. The resolution of the voting problem is proposed in Section 2, with a characterization of the different regimes and some numerical illustrations. In Section 3, we report empirical estimations of the main implications of the model, including the description of data, instruments, and tests. Section 4 interprets the results further and provides robustness analyses to the definition of the public spending variable and to the choice of instruments. Section 5 concludes.

1 A Dynamic Model of Corruption

First consider the following assumptions and definitions. Time is discrete and goes from 0 to infinity. At each date, the economy is populated by a mass of identical households of measure N_t growing at rate n. Households choose between working either in the productive sector or in the rent-seeking activity. We denote $1 - x_t$ the share of the population in the productive sector, and x_t the share in the rent-seeking sector.

1.1 Technology

There are two types of productive public capital: education and health, H_t, and physical capital, K_t. Investment spending in these two types are G_t and I_t. Investment in the first type is free from corruption, while investment in the second type is subject to corruption[1]. Indeed, the former are rather composed of predetermined spending like teachers' wages. They involve a more transparent and better controlled spending process than, for example, secret spending, which are included in I_t. Assessing the impact of spending G_t is easier. Thus, investment spending G_t do not leave public officials much room for maneuver and are less subject to arbitrary decisions than investment in the second type of capital (I_t). Those investment spending concern more rent-generating capital. And high rents for firms imply high embezzlement for public officials, since those of them who are rent-seekers get a share of the procurement contract or of the profits.

[1]This extreme assumption is meant to capture the idea that the degree of exposition to corruption is not identical across categories of public investment.

Corruption acts as a tax on investment I_t[2]. Rent-seekers are able to extract part of public investment I_t which is proportional to their share in population. Only a share $1 - \nu x_t$ of investment spending is effectively invested while $\nu x_t I_t$ accrues as income for rent-seekers. The parameter $\nu \geq 0$ reflects the corruption technology of the economy. It is positively related to the easiness with which rent-seekers can divert resources. The value $1/\nu$ should be interpreted as the share of rent-seekers one "needs" in order to divert 100% of investment. The laws of motion of the two types of capital are:

$$\begin{aligned} H_{t+1} &= (1-\delta_H)H_t + G_t \\ K_{t+1} &= (1-\delta_K)K_t + (1-\nu x_t)I_t \end{aligned}$$

with parameters δ_H and δ_K being the depreciation rates ($\delta_H,\ \delta_K \in (0,1)$). Denoting the per-capita variables as $h_t = H_t/N_t$, $g_t = G_t/N_t$, $k_t = K_t/N_t$ and $i_t = I_t/N_t$, the laws of motion of capital can be rewritten as:

$$(1+n)h_{t+1} = (1-\delta_H)h_t + g_t \tag{1}$$
$$(1+n)k_{t+1} = (1-\delta_K)k_t + (1-\nu x_t)i_t \tag{2}$$

There is one physical good which is used for consumption and investment in any of the two capital goods. Total production Q_t depends positively on labor input $N_t(1-x_t)$ and on services from the two types of capital. The production function is written as the product of two terms:

$$Q_t = b[N_t(1-x_t)]f[H_t, K_t].$$

The function $b[.]$ is increasing and concave, and satisfies the Inada conditions $\lim_{L\to 0} b'[L] = +\infty$ and $\lim_{L\to+\infty} b'[L] = 0$. The production function $f[.]$ is increasing and concave. As in Arrow and Kurz (1970) and Barro (1990), public capital directly enters the production function. One difference with the previous literature is that we have here two different types of public capital having different exposition to corruption.

We assume that the product $b[N_t(1-x_t)]f[H_t, K_t]$ is homogeneous of degree one with respect to labor input $N_t(1-x_t)$ and capital inputs H_t and K_t which allows to write output per person $q_t = Q_t/N_t$ as:

$$q_t = b[1-x_t]f[h_t, k_t].$$

This is another difference with Barro (1990). We do not assume constant returns to scale with respect to accumulable factors h_t and k_t, which makes our results comparable to those in the standard neo-classical growth model of Solow (1956) and Arrow and Kurz (1970). Assuming instead constant return to scale with respect to accumulable factors h_t and k_t would generate endogenous growth with the usual problems (scale effect of population N_t and indetermination of the variables in levels) without giving additional insights with respect to those we will find by assuming standard neo-classical growth.

[2]This is a difference with Mariani (2006) and Acemoglu (1995) In their model, corruption acts as a tax on the producers' income.

Public investment spending are financed by a lump sum tax T_t paid by every citizen:

$$N_t T_t = G_t + I_t \Rightarrow T_t = g_t + i_t.$$

An alternative would have been to tax only the persons in the productive sector which would introduce an additional channel through which corruption plays a role, i.e. by reducing the fiscal basis of the government.

To keep the model as simple as possible we abstract from other types of public spending and from public debt.

1.2 Household Behavior

At each date, households consume their income. Income includes either the product of corruption or the return from the productive activity. Their preferences are represented by a utility function $u[.]$ which is assumed to be of the CIES class with inter-temporal elasticity of substitution σ. Since households choose between production and rent-seeking, the return from these two activities must be equal at an interior equilibrium.

The utility of working in the productive sector U_t is equal to the utility of the income in this sector. We assume that firms operating in this sector are owned by the workers, or, stated otherwise, everybody is self-employed. Workers are thus paid the average product

$$\frac{b[N_t(1-x_t)]f[H_t, K_t]}{N_t(1-x_t)} = \frac{b[1-x_t]}{1-x_t} f[h_t, k_t] = \Gamma[1-x_t] f[h_t, k_t]$$

with $\Gamma[1-x_t] = b[1-x_t]/(1-x_t)$. They also pay taxes T_t. Net income per person is thus

$$y_t = \Gamma[1-x_t] f[h_t, k_t] - T_t = \Gamma[1-x_t] f[h_t, k_t] - g_t - i_t.$$

Hence,

$$U_t = u[y_t]. \tag{3}$$

The utility in the rent-seeking sector V_t is the utility associated with the income from corruption net of taxes. Since total income from corruption is $\nu x_t i_t$, the income per person is νi_t, as long as $x_t \leq 1/\nu$. If $x_t = 1/\nu$, all spending i_t are diverted by rent-seekers, there is no gain for the marginal person to move into rent-seeking.

$$V_t = u\left[\nu i_t - g_t - i_t\right] \text{ if } x_t \leq 1/\nu,$$

$V_t = 0$ otherwise.

In Figure 1 we represent the payoffs of the two activities. The individual utility from corruption V_t does not depend on the share of population which is corrupt for $x_t \leq 1/\nu$ but decreases to 0 as soon as x_t is larger than $1/\nu$. The utility from the productive sector U_t is a positive function of x_t. Indeed, because of marginal decreasing returns to labor, the function $\Gamma[1-x_t]$ is decreasing in $1-x_t$. It decreases from $+\infty$ when $1-x_t = 0$ to $\Gamma[1]$. Three cases may arise.

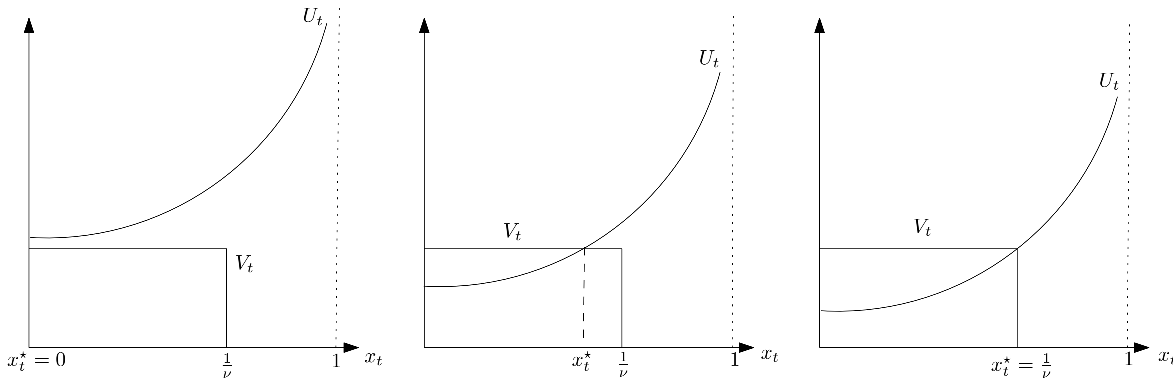

Figure 1: Endogenous corruption. Three regimes.

In the first case (left panel of Figure 1), the return in the rent-seeking sector is always dominated by the one in the productive sector even when the whole workforce is in the productive sector. In this case, we have

$$x_t^* = 0$$

and

$$\nu i_t < \Gamma[1] f[h_t, k_t]. \tag{4}$$

In such a situation, corruption does not exist at all. Condition 4 can be understood as a condition on the parameter ν relative to the function $b[.]$. If ν is large enough, i.e. if the corruption technology is efficient enough, this corner situation will never prevail.

In the second case, represented in the central panel of Figure 1, there is a value of $x_t^\star \in (0, 1)$ for which households are indifferent between the two activities. Equalizing the two utilities, we obtain the following result.

Proposition 1 *If corruption at equilibrium satisfies $x_t \in (0, 1/\nu)$, then the following constraint holds:*

$$U_t = V_t \quad \Rightarrow \quad \Gamma[1 - x_t] f[h_t, k_t] = \nu i_t. \tag{5}$$

Condition (5) states that, at equilibrium, there is a relation between the share of the population in the rent-seeking sector and public capital (h_t and k_t), the effectiveness of corruption technology (ν), and the amount of public spending subject to corruption (i_t). This relation, which describes the choice of activity by households, will act as a constraint for the political economy problem. We label it *incentive constraint*.

Condition (5) makes the level of corruption endogenous at equilibrium. It is similar to what is found in the models of corruption presented e.g. by Shleifer and Vishny (1993), Banerjee (1997), and Acemoglu and Verdier (2000). Compared to this literature, our set-up makes two breakthroughs. First, we model corruption explicitly by modelling which resources are captured by rent-seekers and by distinguishing between the two types of government spending. Second, our model is a dynamic model, bridging the gap between the standard theory of growth and the mostly static theory of corruption.

In the third case (right panel of Figure 1), the income possibilities from rent-seeking are exhausted: $x_t^* = 1/\nu$. In this case we have

$$\nu i_t = \Gamma[1 - 1/\nu] f[h_t, k_t]. \tag{6}$$

In this case, investment i is entirely diverted implying that the stock of capital k shrinks. Finally, there is a fourth possibility with $\nu i_t > \Gamma[1 - 1/\nu] f[h_t, k_t]$; it would be a situation where rent-seeking is more profitable than productive activity, but where the corruption possibilities are completely exhausted, so that those who work in the productive sector have a lower income but still better than the zero income they would get if they would choose rent-seeking for themselves.

If the situation described in the two latter cases persists, income in the productive sector tends to zero, which cannot be an optimal solution. Hence these regimes can only appear temporarily. In the following sections we will assume that $x_t < 1/\nu$ at equilibrium, i.e. we will rule out this possibility of maximum corruption because it is unrealistic and cannot be a long-run equilibrium anyway.

1.3 Voting on Public Investment

The levels of public investment g_t and i_t, and hence taxes T_t, are chosen through probabilistic voting. Assume that there are two political parties, a and b. Each one proposes a policy. Instead of assuming that an individual votes for party a with probability one every time party a's policy gives him/her higher utility (as in the median voter model), probabilistic voting theory supposes that this vote is uncertain. More precisely, the probability that a person votes for a given party a is a smooth function of the utility gain associated with the implementation of policy a. This function captures the idea that voters care about an "ideology" variable in addition to the specific policy measure at hand. The presence of a concern for ideology, which is independent of the policy measure, makes the political choice less predictable (see Persson and Tabellini (2000) for different formalizations of this approach). The probability that a given voter will vote for party a increases gradually as the party's platform becomes more attractive. Party a maximizes its expected vote share. Party b acts symmetrically, and, at equilibrium, the two proposed policy coincide. The maximization program of each party implements the maximum of the following weighted social welfare function[3]:

$$\max \sum_{t=0}^{\infty} \rho^t W_t \text{ subject to } (1), (2), (5), \text{ and } H_0, K_0 \text{ given.}$$

with

$$W_t = (1 - x_t) U_t + (1 + \theta) x_t V_t \tag{7}$$

[3]This result was first derived by Coughlin and Nitzan (1981).

The parameter θ is the additional weight attached to the persons in the rent-seeking sector. From probabilistic theory, it captures the responsiveness of voters to the change in utility. In particular, a group that has little ideological bias cares relatively more about economic policy. Such groups are therefore targeted by politicians and enjoy high political power[4]. If $\theta = 0$ the problem can be interpreted as the one of a benevolent social planner giving equal weight to all citizens; if $\theta = \infty$, the social planner is the kleptocratic government envisioned by Kanczuk (1998), maximizing the discounted flow of income from corruption. Notice also that this maximization problem can alternatively be interpreted under the light of the lobbying literature (see Bernheim and Whinston (1986)).

2 Solution Characteristics

To solve the planning problem we write the following infinite Lagrangian:

$$\sum_{t=0}^{\infty} \rho^t \{W_t + \rho\lambda_{t+1} [(1-\delta_H)h_t + g_t - (1+n)h_{t+1}] \\ +\rho\mu_{t+1} [(1-\delta_K)k_t + (1-\nu x_t)i_t - (1+n)k_{t+1}] \\ +\phi_t [\Gamma[1-x_t]f[h_t,k_t] - \nu i_t] - \omega_t x_t\}.$$

The variables λ_t and μ_t are the Lagrange multipliers associated to the equality constraints (1) and (2). The variables ϕ_t and ω_t are the Kuhn-Tucker multipliers associated to the constraints:

$$\nu i_t \leq \Gamma[1-x_t]f[h_t,k_t] \\ 0 \leq x_t.$$

The multiplier ϕ_t associated to the incentive constraint is the shadow price of corruption, reflecting the idea that the choice of the allocation of public spending has an effect on the type of activity chosen by households. For example, if the government increases the amount of spending subject to corruption more households will work in the rent-seeking sector (ϕ_t is higher).

At each date, four possible cases are a priori possible, depending on which constraint is binding. Among those, only three are logically possible. Let us consider these cases in turn, which we label by the sign of the vector (ϕ_t, ω_t).

1. $(0,0)$ This case is not possible because $\omega_t = 0 \rightarrow x_t > 0$ which implies that the incentive constraint should be binding, and thus $\phi_t > 0$;

2. $(+,0)$ This is the **interior regime** with $0 < x_t$ (central panel of Figure 1);

[4] An alternative view is that households can gain political power by purchasing votes (see for example Docquier and Tarbalouti (2001)).

3. $(0, +)$ This is the regime where Equation (4) holds, so that the incentive constraint is not binding. There is no corruption and public investment is not distorted (left panel of Figure 1); we label this case the **benchmark regime**;

4. $(+, +)$ This case corresponds to a situation without corruption, but where Equation (4) does not hold. The incentive constraint holds with equality at $x_t = 0$ reflecting the fact that the government has to lower investment i_t in order to deter households from rent-seeking (left panel of Figure 1); we label this case **distortion without corruption**.

Note that these cases stand for three regimes at a unique equilibrium, and not for three different equilibria. They correspond to different values of the parameters at the same equilibrium. Multiple equilibria usually arise in decentralized economies when the level of corrupt activity influences its return (Bardhan 2006), as for example if, when many others are rent-seekers, it was in one's interest to be a rent-seeker as well.

The optimality conditions are derived in Appendix A for the three possible regimes. From these conditions we can derive one relation between income growth and marginal productivity of capital – known in the optimal growth literature as the Keynes-Ramsey rule[5] – and another relation between the marginal productivity of the two types of capital. Let us consider the different regimes in turn.

2.1 Benchmark Regime

This case without corruption can be seen as a benchmark against which we can evaluate the cases with corruption. From the first-order conditions analyzed in Appendix A we derive:

$$\lambda_t = \mu_t, \qquad \forall t. \tag{8}$$

Here, there is no distortion, and the shadow price of both types of capital should be equal at all time.

The "Keynes-Ramsey" rule is given by:

$$\frac{u'[y_t]}{u'[y_{t+1}]} = \left(\frac{y_{t+1}}{y_t}\right)^{\frac{1}{\sigma}} = \frac{\rho(1 - \delta_H + \Gamma[1]\ f'_H[h_{t+1}, k_{t+1}])}{1+n} \tag{9}$$

i.e. the higher the net marginal product of capital $1 - \delta_H + \Gamma[1]\ f'_H[h_{t+1}, k_{t+1}]$, the more it pays to depress the current level of income to enjoy higher income in the future. The only difference with the standard growth model is that the marginal productivity of capital f'_H depends on the other type of capital k. A similar relation can be derived in terms of f'_K.

From Appendix A we also find that:

$$1 - \delta_H + \Gamma[1] f'_H[h_t, k_t] = 1 - \delta_K + \Gamma[1] f'_K[h_t, k_t]. \tag{10}$$

[5]See Ramsey (1928).

At equilibrium the marginal productivity of the two types of capital should be equalized. This condition is comparable to the one in Arrow and Kurz (1970). They propose an optimal growth model with two types of capital where one of them enters directly the utility to the households. The optimal condition from the political problem states that the marginal productivity of the first type of capital should equal the marginal productivity of the second type plus its marginal effect on utility. This last term is not present in our set-up since capital does not affect utility directly.

The benchmark case arises if condition (4) holds, which can be interpreted as an upper bound on the corruption technology ν. Moreover, there is another condition for this regime to prevail. It is derived in the appendix from the positivity of the Kuhn-Tucker multiplier ω_t associated to $x_t \geq 0$. This condition writes:

$$1+\theta < \frac{u[y_t] + u'[y_t]\left(\nu i_t + \Gamma'[1] f[h_t, k_t]\right)}{u[\nu i_t - g_t - i_t]}. \tag{11}$$

It requires θ not too large. For a given corruption technology ν, if θ is large, rent-seekers have much more political weight than productive workers, and it is more likely that the equilibrium without corruption could not prevail.

Balanced growth path

In the long-run, all variables H_t, K_t, G_t, I_t and Y_t grow at the same rate n. All the per capita variables converge to a constant level. The following proposition establishes the two essential properties of the equilibrium without corruption and the conditions to reach it.

Proposition 2 *Along a balanced growth path, if*

$$\nu < \frac{\Gamma[1] f'_H[h,k]}{(n+\delta_K)k} \tag{12}$$

and

$$1+\theta < \frac{u[y] + u'[y]\left(\nu(n+\delta_K)k + \Gamma'[1] f[h,k]\right)}{u[(\nu-1)(n+\delta_K)k - (n+\delta_H)h]}. \tag{13}$$

with h and k given by (14) and (15), the following holds.

1. *There is no corruption: $x = 0$.*

2. *The marginal productivity of both types of capital is equalized:*

$$1 - \delta_H + \Gamma[1] f'_H[h,k] = 1 - \delta_K + \Gamma[1] f'_K[h,k]. \tag{14}$$

3. *The Modified Golden Rule holds:*

$$1 - \delta_H + \Gamma[1] f'_H[h,k] = \frac{1+n}{\rho}. \tag{15}$$

Proof: Condition (12) comes from equation (4) where we have used $i = (n + \delta_K)k$ and $g = (n + \delta_H)h$. Condition (13) is derived from (11). Equation (14) is derived from (10). Equation (15) is derived from (9) where $y_t = y_{t-1}$.

Equation (14) determines the optimal mix of investment at steady state. Equation (15) is a Modified Golden Rule. The marginal productivity of capital is equal to the growth factor of population divided by the discount factor ρ. Conditions (12) and (13) show that such a regime with no distortion will prevail if the corruption technology is not too efficient, and if the political weight of rent-seekers is not too high. In the next section, we provide through a numerical example the zone in the space $\{\nu, \theta\}$ for which this regime holds.

2.2 Distortion without Corruption

In this regime, the incentive constraint holds with equality at $x_t = 0$ reflecting the fact that the government has to lower investment i_t in order to deter households from rent-seeking. This is reflected by the following relation from Appendix A:

$$\lambda_{t+1} = \mu_{t+1} - \frac{\phi_t \nu}{\rho} \tag{16}$$

Comparing with Equation (8), the shadow prices of capital are no longer equal. The value of h (λ) is reduced compared to the value of k (μ), reflecting that there is less capital k in the economy as a consequence of the drop in investment i necessary to deter corruption. The term $\phi_t \nu / \rho$ represents the distortion brought in by the possibility of corruption. In this regime, corruption acts like a negative externality which can be limited at a certain cost.

The Keynes-Ramsey rule is modified by the possibility of corruption. The new expression is given by (from Appendix A):

$$\left(\frac{y_{t+1}}{y_t}\right)^{\frac{1}{\sigma}} = \frac{\rho(1 - \delta_H + \Gamma[1] f'_H[h_{t+1}, k_{t+1}])}{1+n} + \frac{\rho}{1+n} \frac{\phi_{t+1}}{u'[y_{t+1}]} \Gamma[1] f'_H[h_{t+1}, k_{t+1}] \tag{17}$$

Compared to the situation where the possibility of corruption is not binding (equation (9)), income growth is affected by a term involving the value ϕ_{t+1} of the incentive constraint. As $\phi_{t+1} > 0$, the incentive constraint has a positive impact on investment in h, given the stock k. If h increases in the future, the income in the productive sector will be higher, which will redirect part of the workers into that sector. The investment decision in h thus includes the direct effect of h on f'_H and the indirect effect through lowering corruption. If we rewrite the Keynes Ramsey rule at steady state, we obtain a modified "Modified Golden Rule" that incorporates corruption and which reflects the same idea:

$$1 - \delta_H + \Gamma[1 - x]\ f'_H[h, k] = \frac{1+n}{\rho} - \phi \frac{\Gamma[1]\ f'_H[h, k]}{u'[y]}$$

The net marginal productivity of capital is equalized to the discounted growth rate of population minus a term depending on the shadow price of corruption. Since corruption is a cost, capital h is higher for a given level of k and makes the productive sector more rewarding.

To assess the effect of the possibility of corruption on the composition of public investment, consider the ratio g/i at steady state:

$$\frac{g}{i} = \frac{n + \delta_H}{n + \delta_K} \frac{h}{k}.$$

Compared to the benchmark case, we have seen above that h/k is higher when the incentive constraint is binding. As a consequence the ratio g/i will be higher too. In this regime, the possibility of corruption increases the share of public spending free from corruption. This shows that the possibility of corruption does not always distort public investment in favor of specific types of spending for which rent-seeking is easier and better concealed as it is put forward in the empirical literature.

2.3 Interior Regime

In this case, Constraint (4) binds. The relation linking the shadow prices of capital becomes:

$$\left(1 - \frac{\nu x_t(1+\theta)}{1+\theta x_t}\right) \lambda_{t+1} = \mu_{t+1}(1 - \nu x_t) - \frac{\phi_t \nu}{\rho}. \tag{18}$$

To better understand this relation compared to (8) and (16), it is useful to compute its value when rent-seekers do not enjoy additional political power, i.e. $\theta = 0$. Then we have:

$$\lambda_{t+1} = \mu_{t+1} - \frac{\phi_t \nu}{\rho(1 - \nu x_t)}.$$

This relation is quite similar to (16). We have the same mechanism: the choice of capital is distorted in favor of the one which is not subject to corruption in order to deter households to work in the rent-seeking sector. When $\theta > 0$, however, there is a force which will work in the opposite direction: since rent-seekers have more weight than workers, the government has a tendency to increase the spending subject to corruption in order to "feed" the rent-seekers. This tendency is reflected by the term on the left-hand-side[6]

$$1 - \frac{\nu x_t(1+\theta)}{1+\theta x_t}.$$

Hence two forces work in opposite directions: the interest of having households working in the productive sector against the additional utility drawn from the presence of rent-seekers.

To better understand the role of the incentive constraint, we look at the optimal value of the corresponding multiplier, ϕ_t, the shadow price of corruption. From the optimality

[6] This term decreases from $1 - \nu x_t$ to $1 - \nu$ as θ goes from 0 to $+\infty$. It therefore increases λ compared to μ as θ rises (ceteris paribus) which goes against the effect of the incentive constraint, $\phi_t \nu / \rho(1 - \nu x_t)$.

conditions of Appendix A, we obtain:

$$\phi_t = \frac{-\theta u[y_t] + \nu\rho\mu_{t+1} i_t - (1-x_t)u'[y_t]|\Gamma'[1-x_t]|f[h_t,k_t]}{|\Gamma'[1-x_t]|f[h_t,k_t]} > 0$$

The shadow price of corruption is the sum of three terms. The first term $-\theta u[y_t]$ is the direct effect of x_t on the objective function W_t. For a correct interpretation of this term, we need to assume that the utility function is positive which requires $\sigma > 1$ with the CIES functional form. When corrupt persons weight more ($\theta > 0$), the cost of the constraint is decreased. The second term $\nu\rho\mu_{t+1} i_t$ is positive and reflects the loss of investment and future capital because of corruption. This second term weights more if the corruption technology (ν) is more efficient. The third term is negative too: if there is more corruption, fewer persons work in the productive sector, but their individual productivity is higher because of decreasing marginal returns to labor.

The Keynes-Ramsey rule is further modified by the presence of corruption. The new expression is given by (from Appendix A):

$$\begin{aligned}\frac{1+\theta x_t}{1+\theta x_{t+1}}\left(\frac{y_{t+1}}{y_t}\right)^{\frac{1}{\sigma}} = & \frac{\rho(1-\delta_H + \Gamma[1-x_{t+1}]f'_H[h_{t+1},k_{t+1}])}{1+n} \\ & + \frac{\rho}{1+n}\frac{\phi_{t+1}}{u'[y_{t+1}]}\frac{\Gamma[1-x_{t+1}]}{1-x_{t+1}}f'_H[h_{t+1},k_{t+1}] \quad (19)\end{aligned}$$

As in the previous case, the incentive constraint has a positive impact on investment in h, given the stock k. Rewriting the Keynes Ramsey rule at steady state, the modified "Modified Golden Rule" is:

$$1 - \delta_H + \Gamma[1-x]\ f'_H[h,k] = \frac{1+n}{\rho} - \phi\frac{\Gamma[1-x]\ f'_H[h,k]}{(1-x)u'[y]}.$$

To assess the effect of corruption on the composition of public investment, consider the ratio g/i at steady state:

$$\frac{g}{i} = (1-\nu x)\frac{n+\delta_H}{n+\delta_K}\ \frac{h}{k}.$$

Compared to the previous regime, there is now a term $(1-\nu x)$ involved in the relation between the two ratios. This term shows that part of investment is deviated from its purpose, highlighting how corruption acts as a tax. Even if h/k is increased compared to the benchmark, g/i may well be decreased if corruption νx is strong enough.

2.4 Numerical illustration

To illustrate the properties of the model, we run a numerical example. We first give the following specific functional forms to our functions:

$$b[1-x] = (1-x)^{\alpha}, \quad f[k,h] = k^{\beta}h^{\epsilon}.$$

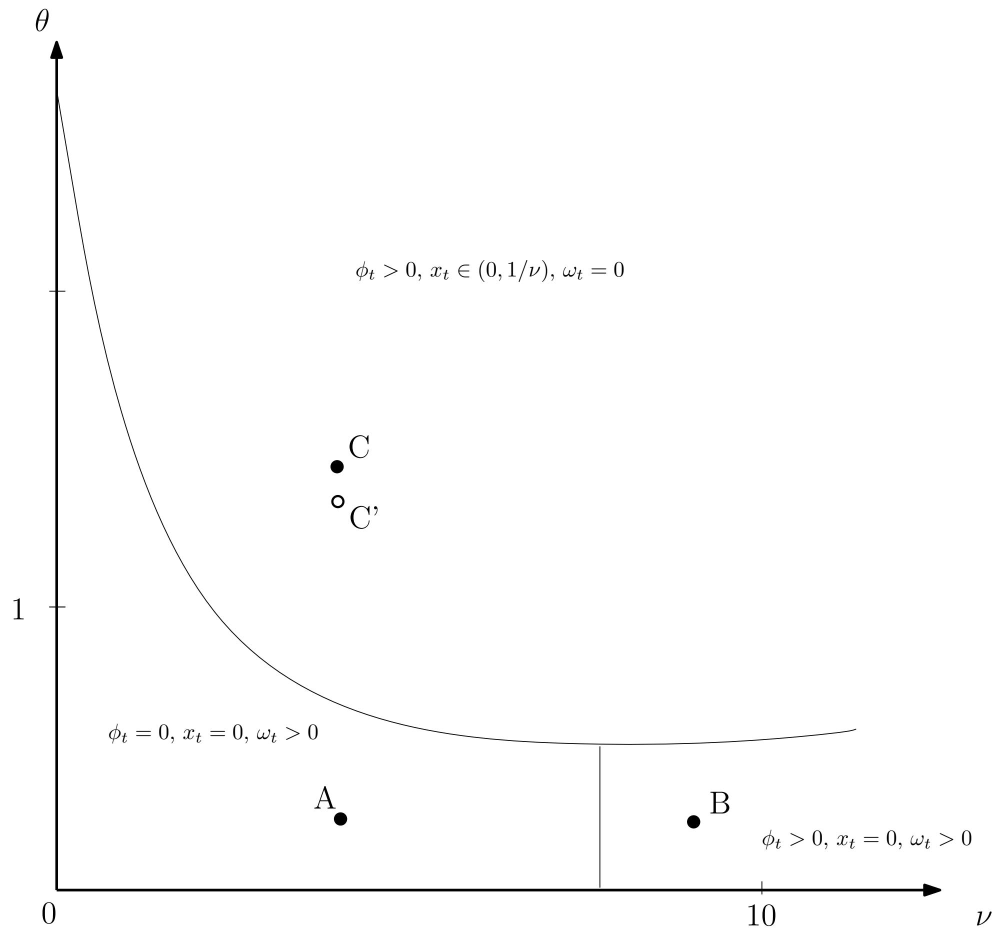

Figure 2: Regimes zones in the $\{\theta, \nu\}$ plane.

	ν	θ	ϕ	x	g	i	g/i	h/k	y
A	4	1/4	0	0	0.37	0.37	1	1	2.13
B	9	1/4	0.015	0	0.36	0.30	1.19	1.19	2.04
C	4	3/4	0.262	0.20	0.24	0.54	0.45	2.02	1.38

Table 1: Steady state comparisons

We assume population growing at rate $n = 0.005$, a discount factor of 0.96, and depreciation rates $\delta_H = \delta_K = 0.04$. The technology parameters are set at $\alpha = 1/2$, $\beta = 1/4$ and $\epsilon = 1/4$. The intertemporal elasticity of substitution is set at $\sigma = 2$. Figure 2 shows where each of the three possible long-run regimes arises in the $\{\theta, \nu\}$ plane. The numerical values corresponding to points A, B, and C are presented in Table 1.

The benchmark regime arises when ν and θ are small enough (from conditions (12)-(13)). Since, in the numerical example, the two types of capital have the same depreciation and productivity parameters ($\delta_H = \delta_K$ and $\beta = \epsilon$), the optimal capital ratio h/k is equal to one in this regime, as well as the optimal investment ratio g/i. Point A represents such a situation. Assuming the same low political weight attached to rent-seekers ($\theta = 1/4$) but increasing the efficiency of the corruption technology ν, the economy switches to a regime where corruption is still absent, but public investment is distorted (point B). As highlighted by the analytical results, the government reduces the investment subject to corruption in order to lower the income from rent-seeking and prevent corruption from happening at equilibrium. The ratio of public spending g/i is now equal to 1.19, reflecting that the possibility of corruption distorts the composition of public spending in favor of investment for which rent-seeking is not possible. This distortion entails a loss of productive efficiency, as it is reflected in the lower value of income per capita y.

The interior regime arises for high values of θ. In this case, for example at point C, the rent-seekers have such a high political weight that public spending subject to corruption are encouraged. The ratio g/i is equal to 0.45. Notice that this does not imply that capital h is low compared to k because the major part of investment in k does not reach its aim. In fact, both capital stocks are lower than in the economy without corruption, but the ratio h/k is higher. As a consequence of low investment levels and distorted allocation, output per person y is lower than in the two previous cases.

In order to illustrate the dynamic behavior of the economy, consider the steady state C. Assume that there is a permanent non anticipated change in one parameter, say a decrease in θ from 1.5 to 1.375. The new steady state is represented by point C'. To simulate the transition from one steady state to one another, we use the method developed by Boucekkine (1995) and Juillard (1996); this method has the advantage of preserving the non-linear structure of the model. The difference between the simulated path and the constant solution represents the difference between an economy which has experienced such a shift to one which has not. Figure 3 represents the transition path[7]. The effect is to decrease corruption, more in the short run than in the long-run, and to increase GDP per capita. There is also an effect on investment ratio in favor of spending g. In the long-run, investment ratio returns to its initial level, but the ratio

[7]The dynamics in the interior regime can be represented by a system of four first order difference equations with two forward-looking variables λ, and μ, and two pre-determined variables k and h. The eigenvalues of the linearized system around C are respectively 0.5553, 0.849, 1.227, 1.876, reflecting that C is a saddle-point and that the Blanchard-Kahn conditions are satisfied. Hence there is a unique trajectory converging to the steady state.

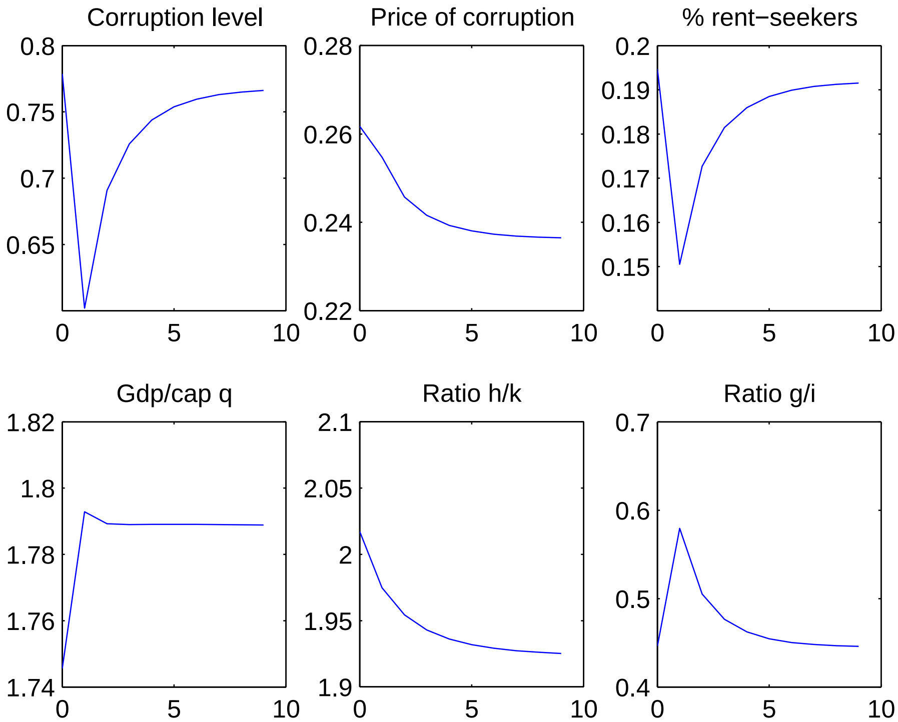

Figure 3: Transition from C to C' - permanent drop in θ

of the capital stocks k/h is now higher, because less investment spending on k has been diverted by rent-seekers.

3 Empirical Analysis

In the model above, long-run corruption level, income per capita and composition of public investment are endogenous and depend on a set of parameters. In this section, we first present observed variables which correspond to these parameters and investigate their effect on the three endogenous variables listed above. In particular, we look if a raise in corruption technology entails a fall in the investment ratio g/i and in GDP per capita, and an increase in the corruption level νx. In the same way, we also look if in countries with a more concentrated political power, θ, GDP per capita is lower and the share of population in the rent-seeking activity higher, as Section 2 suggests. Finally, we estimate the impact of the discount factor, the rate of growth of the population and productivity factors on the three endogenous variables of interest.

The five parameters ν, θ, ρ, n and productivity $\Gamma[.]$ are measured with the following variables. Descriptive statistics of all the variables and the list of countries used in econometric analysis are provided in Appendix B (see Tables 3, 4 and 5). Since the variables are imperfect measures of the parameters and since there might be simultaneity, we may face endogeneity biases. We present further the instruments we use to control for endogeneity.

1. **Techcor**: The effect of ν is estimated by using the *Rule of Law* index available in the *Governance Research Indicator Country Snapshot (GRICS)*. Such index is an aggregate of perceptions of the incidence of crime, of the effectiveness and predictability of the judiciary, and of the enforceability of contracts. To use this index as a proxy for ν, we assume that the technology of corruption is as much efficient as the legal (penal and judicial) system is not. Therefore, we operate the following transformation: $Techcor = 2.5 - Rule\ of\ Law$, so that $Techcor$ varies between 0 and 5. Hence, the higher the variable *Rule of Law*, the higher the probability for a corrupt public agent to be caught and punished, the smaller the technology of corruption ($Techcor$). On the contrary, the weaker the value of *Rule of Law*, the easier it is for rent-seekers to have recourse to corruption and the higher the value of $Techcor$).

2. **Polbias**: As a proxy for θ, that is the political weight given to rent-seekers in the objective function, we use an indicator of the lack of political rights taken from *Freedom House*. Indeed few political rights for the population indicate a strong concentration of power in the hands of a very few. And, those who hold the power are presumably rent-seekers (because of purchasing votes as mentioned above). Hence, if political rights are weak, rent-seekers concentrate power, which means θ is high. We subtract 1 from the original index in order to obtain a variable ranging from 0 (if the country provides very extended political rights to its citizens) to 7 (if the citizens have no political rights). Figure 9 in Appendix B represents the countries in the plane (ν, θ).

3. **Patience**: This variable indicates the number of years the party of the chief executive has been in office[8], taken from the *Database of Political Institutions* (Beck et al. 2001). It is used as a proxy for the discount factor ρ. We assume that political groups anticipate relatively well their term of office. Thus, if the political group has been in power for a long time, it was anticipated, then it is more patient and values more the future than parties who expect to be in power for a shorter period.

4. **Pop**: The rate of growth of the total population, taken from the *World Development Indicators (WDI)* database, stands for n.

5. $\boldsymbol{\Gamma}$[.]: We use a first dummy variable (**Tropic**) which is equal to 1 if the country is located between the tropic of Cancer and the tropic of Capricorn, 0 otherwise; and a second one (**Ldlock**) equal to 1 for landlocked countries, and to 0 otherwise. Hence it enables to control for geographic conditions affecting productivity $\Gamma[.]$.

[8] A "forward-looking" variable indicating in how many years the next elections would take place would have fitted better with the discount factor but, to our knowledge, it is not available.

These two variables are taken from the *Global Development Network Growth Database*, edited by the *Development Research Institute of New York University.*

To control for initial conditions, we introduce the logarithm of 10 year-lagged constant PPP GDP per capita, $\ln \mathbf{Y_0}$. It is provided by the *WDI* database.

The endogenous variables are measured by:

1. **Ratio**: We define the ratio g/i which relates public investment spending free from corruption to investment spending subject to corruption. g is built as the portion of health and education spending in total public expenditure. i gathers expense on housing, fuel and energy, agriculture, mining and manufacture, transport (and other economic activities) as a percentage of total government spending[9]. The part of each sector in total public spending is taken from *Government Finance Statistics Yearbooks* provided by the *International Monetary Fund*. For checking robustness, we try alternative measures of spending subject to corruption, i in Section 4.2. Besides, when data are missing, we use the figure of the following (odd) year when it is available. If it is not, we use the mean of the ratio for a given country.

2. **Corrup**: The extent of corruption is represented in the model by νx, the share of spending which is diverted from its aim. As a proxy for νx, we use the index of "Control of Corruption" ($Corrup_{WB}$) provided by the *World Bank* and presented by Kaufmann, Kraay, and Mastruzzi (2003). The variable we use results from the following transformation: $Corrup = 2.5 - Corrup_{WB}$. This index is an aggregate of the results of several surveys. Some of them are based on questions dealing with the easiness to involve in corruption ν (e.g. "How well would you say the current government is handling the fight of corruption in the government?") and some others with the level of corruption x (e.g. "How many government officials do you think are involved in corruption?"). Hence, *Corrup* is a measure of the interaction term νx. Though it also confuses the extent and the level of corruption, this index has the advantage to measure mainly public corruption and, within public corruption, mainly political corruption. We use such a measure of corruption based on perceptions surveys, although it suffers measurement problem[10]. Other indices used to measure public corruption (e.g. from *Business International* (Ehrlich and Lui 1999) or *Political Risk Services* (Mauro 1997)) present the same disadvantages mentioned above for the one we use. But the *World Bank* index reduces each source-specific bias by combining them.

[9]In the sequel of this paper we will also investigate results when also expenses on defense, and culture and recreation are included in i.

[10]To our knowledge, quantitative indices of political public corruption, not based on perceptions do not allow international comparisons since they are available only for Italy: Golden and Picci (2005) approximate the level of corruption in a given region by calculating the difference between the amounts of physical public capital and the amounts of investment cumulatively allocated for these public works.

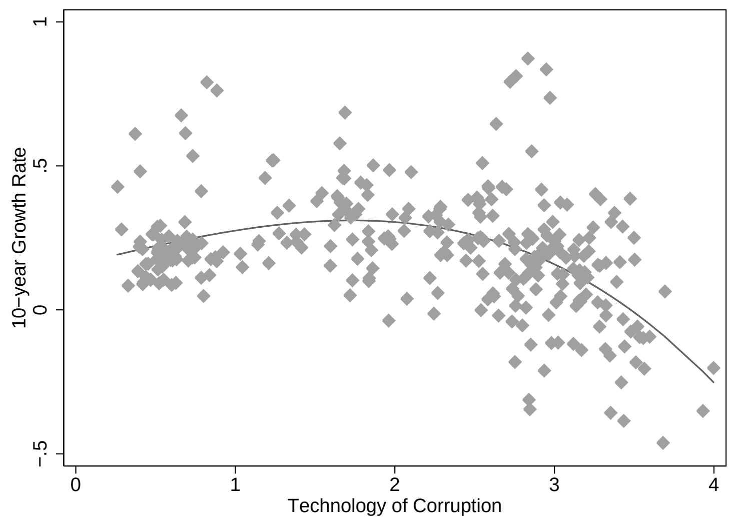

Figure 4: Technology of Corruption and Growth Rate

3. **Growth**: This index measures the logarithm of constant PPP GDP per capita growth on 10 years. It was obtained from data on the logarithm of constant PPP GDP per capita provided by the *WDI* database. Using *Growth* as a dependent variable and regressing it on a set of explanatory variables among which $\ln Y_0$ is equivalent to regressing $\ln Y$ on the same set of variables.

3.1 Estimation results

We estimate a restricted form system of three equations where each endogenous variable is a function of the measured parameters and initial conditions. From theory we know that in the benchmark regime, the endogenous variables are not affected by small variations in ν and θ. Countries in such a situation also have higher income per capita. This view is a priori confirmed by Figure 4 where we observe that the negative correlation between growth and technology of corruption arises only when the technology of corruption is above a certain threshold. To control for this eventuality, we add interaction terms in the list of regressors: $\frac{Techcor}{\ln Y_0}$ and $\frac{Polbias}{\ln Y_0}$.

The estimated system is thus:

$$\begin{cases} Ratio_{it} = \alpha_1 + \alpha_2 Techcor_{it} + \alpha_3 \frac{Techcor}{\ln Y_0}_{it} + \alpha_4 Polbias_{it} + \alpha_5 \frac{Polbias}{\ln Y_0}_{it} \\ \qquad + \alpha_6 Patience_{it} + \alpha_7 Pop_{it} + \alpha_8 Tropic_{it} + \alpha_9 Ldlock_{it} + \alpha_{10} \ln Y_{0it} + \varepsilon_{it} \\ Corrup_{it} = \beta_1 + \beta_2 Techcor_{it} + \beta_3 \frac{Techcor}{\ln Y_0}_{it} + \beta_4 Polbias_{it} + \beta_5 \frac{Polbias}{\ln Y_0}_{it} \\ \qquad + \beta_6 Patience_{it} + \beta_7 Pop_{it} + \beta_8 Tropic_{it} + \beta_9 Ldlock_{it} + \beta_{10} \ln Y_{0it} + \rho_{it} \\ Growth_{it} = \gamma_1 + \gamma_2 Techcor_{it} + \gamma_3 \frac{Techcor}{\ln Y_0}_{it} + \gamma_4 Polbias_{it} + \gamma_5 \frac{Polbias}{\ln Y_0}_{it} \\ \qquad + \gamma_6 Patience_{it} + \gamma_7 Pop_{it} + \gamma_8 Tropic_{it} + \gamma_9 Ldlock_{it} + \gamma_{10} \ln Y_{0it} + \varsigma_{it} \end{cases}$$

Estimates are run on even-year data[11] for the period 1996-2004 on 63 countries using a three-stage least squares (3sls) procedure. We first estimate an unrestricted model. (See Table 6 in Appendix C). At each step, we perform a Wald test that the least significant parameter of each equation is null. If the p-value of a coefficient is superior to 0.15, we reject the coefficient at the following step. Hence, at the end of the procedure, we retain a restricted model for which all coefficients have a low p-value (inferior to 0.15).

The three-stage least squares method provides several advantages. First, it reduces simultaneity bias. If there is a correlation between regressors and error terms, 3sls estimators are still consistent, unlike ordinary least squares estimators. Second, 3sls provide estimators not only correcting for residuals' heteroskedasticity (residuals' variance depends on the technology of corruption and the extent of political rights because these partly reflect the quality of political and legal institutions) but also for the correlation between residuals of two distinct equations in the system. Indeed, the matrix of residuals correlation in Table 7 (Appendix) confirms this hypothesis: some omitted explanatory variables are common to the three equations. Taking into account such a correlation through 3sls between residuals of different equations yields more efficient estimators than equation-by-equation 2sls and than classical estimations of panel data. Finally, 3sls estimations are also preferable to fixed effect ones insofar as it preserves transversal information contained in the data and since our variables, in particular those of corruption, are quite stable over time.

As mentioned above, the variables $Techcor$, $Polbias$ and $Patience$ suffer from substantial measurement error with respect to the actual technology of corruption, the lack of political rights and the discount factor. Hence, for reinforcing the treatment of endogeneity, we introduce external instrumental variables which are used in the first stage of the procedure to provide predicted values of endogenous variables, then considered as their instrumented values. These excluded instruments are defined as follows:

1. **antiq** is an index of the depth of experience of state-level institutions, or state antiquity. It was developed by Bockstette, Chanda, and Putterman (2002)[12] and we use it here as an instrument for political and legal infrastructure.

2. **yrind** stands for the logarithm of the number of years of independence of the state. It measures the autonomy of the political and legal system and its capacity to influence -or resist to foreign influence.

3. **latit** is the absolute value of the latitude of the country[13]. It was first introduced as an instrument for the quality of institutions by Hall and Jones (1999). It is used as a complementary instrument of the previous two instruments insofar as

[11]The index of corruption from the World Bank is only available for even years.

[12]The index was developed from the answers of each country to the three following questions for each period of 50 years: a) Is there a government above the tribal level? b) Is this government foreign or locally based? c) How much of the territory of the modern country was ruled by this government?

[13]The index is available on New York University's web site: http://www.nyu.edu/fas/institute/dri/global%20development%20network%20growth%20database.htm.

the information this variable provides rather concerns the type of institutions settled by European colonists. Indeed, latitude stands for a proxy for geographical endowments. And hospitable environments favored the settlement by colonists which suited investment rather than extraction which predominated in poorly endowed environments. In brief, geographical endowments influenced the formation of long lasting institutions (Acemoglu, Johnson, and Robinson 2000).

4. **legsoc**, **legfr** and **legbr** are dummies equal to 1 respectively if the country's legal system has a socialist origin, a French origin or a British origin[14].

5. **polbiaslag** is the ten-year lagged index of political rights.

6. **poplag** is ten-year lagged index of growth rate of the population.

7. **natres** is the percentage of natural resources exports in GDP one year before. Natural resources include agricultural raw materials, fuel, food, ores and metals. This index is often used as an instrument for the level of corruption since abundant natural resources create strong incentives to rent-seeking, hence to corruption (Leite and Weidmann 1999). Therefore, natural resources exploitation strengthens corruption via its impact on the predatory technology, ν: we expect the technology of corruption to be as much developed as the index of natural resources exports is high. However, these exports being given as a percentage of GDP, we suspect this instrument of being too endogenous.

We perform two tests for evaluating the validity of using instrumented estimations. The first one is a Sargan overidentification test[15] of the correlation of instrumental variables with error terms. If the null hypothesis is not rejected, the instruments are not correlated with the error terms, i.e. the instruments are not invalid. Second, we test whether the instruments are strong or weak, i.e. whether the instruments predict well the endogenous regressors or not. Traditionally, one uses the first-stage F test to do so. Staiger and Stock (1997) suggest that an F statistic exceeding 10 enables inference from instrumented estimations. But recent literature suggests that in the presence of multiple endogenous regressors, the first-stage F test is not sufficient and is less powerful than the one based on the Cragg-Donald (CD) F statistic (see Cragg and Donald (1993) Stock and Yogo (2002) Stock, Wright, and Yogo (2002)). Hence, we provide a test of the null hypothesis that the instruments are weak using the CD F statistic (for critical values, see Stock and Yogo (2002)). These two tests are presented at the bottom of Table 2. We also report the t-statistics associated with the coefficients of the instrumental variables in the first-stage regressions in Appendix C (see Table 8).

[14]These indicators are available on New York University's web site too.
[15]See Sargan (1958).

Table 2: Estimation of the restricted model of three simultaneous equations

Model	4.1		
Explanatory	Dependent Variables		
Variables	$Ratio.10^{-1}$	$Corruption$	$Growth$
$Techcor$	0.83^a	1.10^a	1.24^a
	(0.21)	(0.04)	(0.41)
$\frac{Techcor}{\ln Y_0}.10$	-0.71^a		-1.58^a
	(0.18)		(0.45)
$Polbias$	-0.50^a	0.29^c	
	(0.16)	(0.17)	
$\frac{Polbias}{\ln Y_0}.10$	0.45^a	-0.18	-0.08^b
	(0.14)	(0.12)	(0.03)
$Patience.10^{-1}$	-0.09^b	-0.10^b	0.19^a
	(0.03)	(0.04)	(0.05)
$Pop.10^{-1}$		-0.92^c	
		(0.55)	
$Tropic$	0.12^a		-0.14^b
	(0.04)		(0.06)
$Ldlock$	0.08^b	0.12^c	-0.13^b
	(0.03)	(0.07)	(0.06)
$\ln Y_0$			-1.11^a
			(0.22)
Observations	304		
Instruments	*antiq yrind legsoc legfr legbr poplag polbiaslag Tropic Ldlock* $\ln Y_0$		
Sargan Test	6.02	3.53	1.76
$p - value$	(0.11)	(0.47)	(0.62)
Cragg-Donald F stat.	1.29	4.39	1.29

Notes: Standard errors in parentheses: [a], [b] and [c] denote coefficients significantly not null respectively at the 1%, 5% and 10% level.

4 Interpretation and Robustness

4.1 Interpretation of the results

The two tests run on instruments let think that these are both valid and relevant. For all three equations, the results of Sargan overidentification test reveal that the instruments are not significantly correlated with error terms[16]. Hence, our instruments are valid insofar as they only affect dependent variables through explanatory variables. Thirdly, whether our instruments are strong or weak is less clear cut. For computational issues, the critical values corresponding to 6 endogenous regressors have not been tabulated. But, by extrapolating from the ones tabulated for 1, 2 and 3 endogenous variables (see Stock and Yogo (2002)), we are able to comment on the values of the CD F statistic. The first stage regression of equation of $Corruption$ provides quite high values of the Cragg-Donald F statistic, which indicates that instruments are jointly strong since all linear combinations of the coefficients are well identified. On the contrary, the lower value obtained for the equations of $Ratio$ and $Growth$ (1.29) reveals that some combinations of the coefficients might be badly identified (because of multicollinearity between instruments and between instrumented variables). Hence, inference on any coefficient might not be strictly valid (Stock and Wright 2000) and, in particular, counterfactuals might not be fully reliable. However, on the one hand, when reducing multicollinearity between instrumented variables and dropping from the calculation of the Cragg-Donald F statistic $\frac{Techcor}{\ln Y_0}$ and $\frac{Polbias}{\ln Y_0}$ for the regression of $Ratio$ and $\frac{Techcor}{\ln Y_0}$ for the regression of $Growth$[17], it raises up to respectively 7.08 and 2.91. Given that, for 3 endogenous variables and 7/8 excluded instruments, the critical values are 4.44/4.46 for a 5% significance level, our instruments can be considered as strong. On the other hand, high values of t statistics (see Table 8 in Appendix C) show that instrumental variables are individually significant. Thus, if some linear combinations of coefficients are badly identified, some others are well identified, confidence intervals of the coefficients are reliable and our instruments are not irrelevant.

The first stage regressions of the endogenous regressors on instrumental variables presented in Table 8 suggest a few commentaries. First, the state antiquity reinforces the predatory technology and the lack of democracy. At the same time, states which became independent more recently tend to have weaker legal systems - favoring corruption - and to be weaker democracies. Indeed, when the state was colonized for a long time, a deeper experience of state-level institutions may strengthen mechanisms aiming at circumventing the legal system as well as authoritarian regimes which flout citizens' political rights. But a longer experience of independent state and autonomy helped build a stronger political and legal system. Though often used as an instrument for both kinds of institutions - legal and political -, the latitude of a country (in absolute

[16] The $p - value$ of 0.62 associated to the test statistic for the $Growth$ equation shall be read as follows: if the null hypothesis is true, i.e. if instruments and error terms are not correlated, in 62 estimations out of 100, we would obtain a test statistic at least as high as 1.76.

[17] For the purpose of this calculation of the Cragg-Donald statistic we treat these interaction terms as exogenous regressors.

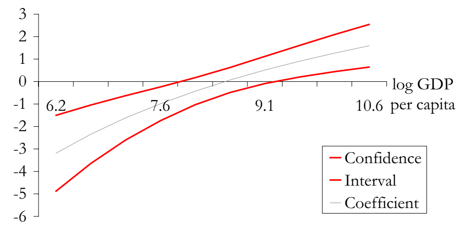

Figure 5: Partial Effect of ν on ratio g/i

value) is a significant determinant of the legal system, but not of political democracy: countries with a high absolute value of latitude have a more hospitable environment and these countries were more likely to be settlement colonies than extractive colonies. Hence, they developed a legal system favorable to production and trade, protecting property and contract rights. And the present rule of law is inherited from such a privileged legal development. As regards to the origin of the legal system, our results are in line with legal origins theory comparing noticeably the effects of common law and civil law (La Porta et al. 1998), (Beck and Levine 2003). Indeed, legal systems with a French or Socialist origin provide significantly less efficient legal regimes (in particular to protect property rights) than those of British origin.

Let us now comment on the estimated coefficients in Table 2. As interaction terms with coefficients α_3, α_5, β_3, β_5, γ_3 and γ_5 are included in the regressions, the partial effect of $Techcor$ and $Polbias$ on the ratio g/i, the level of corruption and GDP growth, when both single and interaction terms are significant, is given respectively by $\alpha_2 + \alpha_3/\ln Y_{0i}$ and $\alpha_4+\alpha_5/\ln Y_{0i}$, $\beta_2+\beta_3/\ln Y_{0i}$ and $\beta_4+\beta_5/\ln Y_{0i}$, and $\gamma_2+\gamma_3/\ln Y_{0i}$ and $\gamma_4+\gamma_5/\ln Y_{0i}$ for each country i. Figures 5 to 8 display the value of these derivatives from the coefficients estimated in equation (4.1) for the relevant range of $\ln Y_{0i}$, from $\min \ln Y_0 = 6.18$ to $\max \ln Y_0 = 10.57$.

The results presented in Table 2 reveal first that the **ratio of spending** g/i is negatively affected by the *technology of corruption* in the poorest countries, positively in the richest ones. Its coefficient is significant at the 1% level and it ranges between -3.19 and 1.59 according to the initial level of GDP: the negative effect of ν on g/i gets stronger when initial GDP decreases.

Figure 5 indicates that the 95%-confidence interval contains both positive and negative values of $\frac{\partial(g/i)}{\partial\nu}$ for GDP per capita between 3 000 \$ and 10 000 \$, only negative ones for GDP per capita lower than 3 000 \$, and positive ones for initial GDP higher than 10 000 \$. In low-income countries, easier access to corruption (or lower punishment for corruption) increases the part of the budget dedicated to rent-generating spending (mostly physical capital spending) at the expense of social spending (mostly in human capital). In middle-income countries, the impact of the technology of corruption on the ratio of spending g/i is undetermined. In high-income countries, the higher the

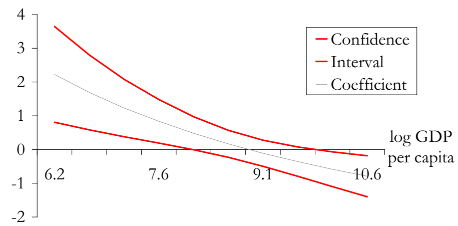

Figure 6: Partial Effect of θ on ratio g/i

technology of corruption, the higher social spending (free from corruption) relatively to capital spending (subject to corruption).

The technology of corruption entails two opposite distortions according to the initial level of GDP per capita. This is in line with the main findings of the model. Indeed, given the effect of ν on g/i, richer countries may be in the regime with distortion but without corruption: easier access to corruption makes effective corruption more plausible. But, the outcome of probabilistic voting is near the one of a benevolent social planner (θ is low)[18], so it reduces investment spending subject to corruption to lower the income from rent-seeking and prevent corruption. On the contrary, poorer countries seem to fit better with the interior regime with corruption and with distortion. Here, the government is more kleptocratic and corruption is not only potential but effective and distorts the structure of the budget in the opposite way, i.e. in favor of rent-generating spending.

The variable of *lack of political rights* (standing for θ) has a coefficient between 2.23 and -0.79). Figure 6 also shows that countries can be split up into two parts according to the level of GDP per capita. High-income countries (GDP per capita superior to 20 000 \$) devote more their public spending to education and health when they are more democratic (to deter corruption, as explained in the regime with distortion but without corruption). This effect is not significant for middle-income countries (between 3 000 and 20 000 \$), to which the regime without corruption rather applies. On the other hand, in low-income countries, which experience the regime with corruption, θ has a significantly positive effect on the ratio g/i: the more political power is concentrated, the higher the portion of government spending devoted to education and health. This positive coefficient is in contradiction with the short term effects described in subsection 2.4. It might be due to "Poverty Reduction Strategies[19]" developed by these countries which lead them to devote higher parts of their budget to education and health policies.

[18]The pairwise correlation coefficient between θ and initial GDP per capita is equal to -0.64 and significant at the 1% level. However, when we introduce the interaction term $\nu\theta$, its coefficient is not significantly different from 0. This might be due to high correlations with ν and θ, which capture all the effect on the ratio of spending.

[19]Poverty Reduction Strategies are settled in most countries benefiting from foreign aid, they noticeably consist in reinforcing public investments in health and education.

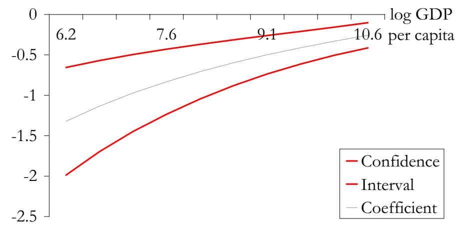

Figure 7: Partial Effect of ν on GDP Growth

In this case, this variable can be considered here as a proxy for such strategies more common to countries lacking of political rights. Then, controlling for poverty reduction strategies, we highlight that corruption increases rent-generating expenditure relatively to social expenditure.

Concerning the combined effects of failing legal and political institutions, simulations show that if Zimbabwe had Denmark's technology of corruption and index of democracy in 2004, that is respectively 0.6 and 0 instead of 3.04 and 3, then its ratio of investment g/i would be equal to 1.79 instead of 1.22. However, the low value of the Cragg-Donald F statistic (1.29) indicates that the instruments are quite weak in the case of the regression of g/i. As mentioned above, we should take with care the figures of simulations based on the regression of g/i.

As expected, the *technology of corruption* (ν) appears to have a positive impact on the **level of corruption** and its coefficient is significant at the 1% level. The *lack of political rights* (θ) has a significant effect on the level of corruption as well, and its global value varies between -0.01 (for the poorest country) and 0.12 (for the richest one). In non democracies, political power is unevenly distributed, and it is likely that rent-seekers have more political weight, which makes the rent-seeking activity more attractive. To be more precise, both variables ν and θ affect more or less the level of corruption according to the GDP of the country. A failing political system increases the level of corruption in all countries but it is more detrimental to the richest countries. On the contrary, a failing legal system reinforces corruption even more in low-income countries than in high-income ones. Counterfactuals highlight that if Burundi's technology of corruption in 2000 was equal to the one of the USA, not only its ratio of investment would be much higher (9.17 instead of 3.06) but its level of corruption would decrease from 3.77 to 0.65. Similarly, with Zimbabwe experimenting the same technology of corruption as Denmark in 2004 (0.59 instead of 3.04, that is divided by 5.11), the level of corruption in the former country would drop from 3.24 to 0.55 (divided by 5.77). As a comparison, the level of corruption in Denmark in 2004 is equal to 0.12.

Techcor and *Polbias*, respectively standing for ν and θ, have no significant effect on **GDP per capita growth**. But negative significant coefficients for interaction terms suggest that whatever the initial level of development of a country be, the *technology*

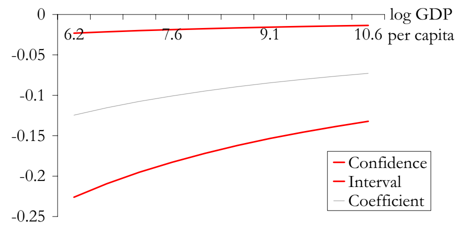

Figure 8: Partial Effect of θ on GDP Growth

of corruption and the *lack of political rights* slow growth down. But the lower the initial level of GDP, the more easy access to corruption (absence of rule of law) stems growth (see Figure 7). Similarly, as Figure 8 shows, in poorer countries, the lack of political rights damages growth more than in initially richer countries. Simulating GDP per capita growth in Burundi, Ethiopia and Zimbabwe respectively with the value of USA, Norway and Denmark have similar effects when we simulate the value of ν or θ. If Burundi's extent of political rights were equal to those in USA, then Burundi's growth rate in 2000 would increase from 0.68 to 1.24% (to 27.6% if it also had the same technology of corruption). If the technology of corruption and the political power of rent-seekers in Ethiopia were as weak as in Norway, its growth rate would raise from 1.43 to 23.9%, hence it would be multiplied by 4.

In the regression of growth, the coefficient of the *initial level of GDP per capita* is significant at the 1% level. The growth rate decreases when initial GDP per capita is higher. The convergence rate λ we estimate[20] is equal to 3.5%, higher than the "legendary 2%" of the β-convergence theory and estimations (Abreu, de Groot, and Florax 2005). Similarly, annual GDP per capita has a negative impact on the level of corruption. This led us to consider that the equilibrium without corruption applied to richest countries, whereas the equilibrium with corruption concerned poorest ones. Simulations show that with Denmark's level of GDP per capita in 1994, Zimbabwe's ratio of investment would raise from 1.25 to 3.40 and its growth rate in 2004 would drop from 1.05% to 0.35%. Then, all things being equal, the *population growth rate* has a negative, but not significant, impact on the level of corruption. As for *patience*, approximated by the number of years the party of the chief executive has been in office, it appears to have a positive and significant impact on the growth rate but a negative one on the level of corruption and on the ratio g/i: the more impatient the government, the more extended the level of public corruption and embezzlement and the weaker the growth rate. The two dummies controlling for *geographic conditions* have significant coefficients in the regressions of growth rate and spending ratio. The level of corruption is only explained by *Ldlock*, which coefficient is significant at the

[20]The estimation of the convergence rate $\hat{\lambda}$ can be obtained as: $\hat{\lambda} = -ln(1+\hat{\beta})/10$, where $\hat{\beta}$ is the estimate of the coefficient associated with $\ln Y_0$. The estimated standard error $\hat{\sigma}$ can be approximated by: $\hat{\sigma} = \hat{\sigma}_\beta/[10(1+\hat{\beta})]$. Here, $\hat{\sigma} = 0.009$.

10% level. As expected, hard climatic conditions and landlock threaten growth. On the contrary, difficult geographic conditions enhance the portion of spending in human capital relatively to spending in physical capital, in particular by reinforcing the need for health care.

4.2 Robustness tests

In this section, we perform robustness tests to the components of the ratio g/i and to the set of instruments.

4.2.1 Robustness to the definition of g/i

We undertake sensitivity tests relative to the specification of the ratio g/i of public investment. As mentioned above, it is defined in Table 4 as g/i, where g is composed of part of public spending invested in education and health and i is composed of expense on housing, fuel and energy, agriculture, mining and manufacture, transport (and other economic activities) as a percentage of total government expenditure. Table 9 in Appendix C reports the results of estimating equation 4.1 in which i includes expense on defense first (equation 4.2), then expense on defense and culture, recreation (equation 4.3) in addition to housing and economic activities. Indeed, the portions of these sectors were shown to be those likely to raise up with increasing levels of public corruption (Delavallade 2006). The global effects of the predatory technology and concentration of power on g/i when i includes the percentages of expense not only in economic activities and housing but also in defense are similar to those observed for the main estimations. We note that the negative impact of a failing legal system, favoring corruption, on the ratio g/i is a little less clear cut than in the main analysis. This finding is in line with Delavallade (2006) which shows that the lack of freedom, rather than the extent of corruption, strengthens the portion of defense in the budget. On the other hand, the lack of democracy provides very similar results as those obtained for equation 4.1. Significance of the coefficients has diminished very slightly but is still higher than 10%. It implies that defense and culture are also sectors subject to corruption, hence favored by a weak legal system and a strong concentration of power within rent-seekers, although a little less than economic activities and housing.

4.2.2 Robustness to the choice of instruments

We provide then a test of sensitivity to the set of instruments. The results are presented in Table 10 in Appendix C. In equations 4.4, 4.5 and 4.6, we substitute respectively the absolute value of the latitude, the percentage of natural resources exports in GDP and both of them for the ten-year lagged index of political rights. Estimates are very close to our main estimation (4.1). All coefficients are significant at least at the 10% level and their values are very similar to the previous ones. Tests of validity of the instruments are satisfactory as well. A noticeable difference lies in the higher values of Sargan test statistic when using natural resources exports as an instrument, which indicates a higher correlation between instruments and error terms. Indeed, we expected this instrument not to be valid enough for being given as a percentage of GDP.

5 Conclusion

The main message of this paper is that corruption distorts the structure of public spending, thus takes the economy away from the optimal ratio of public spending and stems growth.

To study this distortion we have provided an optimal growth model with endogenous corruption. Households choose between being producers or rent-seekers. Voters choose the composition of public spending taking into account the behavior of households (incentive constraint). At equilibrium, the level of corruption, the ratio of spending and GDP per capita depend on the predatory technology and the concentration of power in rent-seekers' hands. We make explicit several regimes at equilibrium, with and without corruption.

Our model bridges the gap between the mostly static theory of corruption and the standard theory of growth. In particular, we have shown how rent-seekers' political power and corruption technology affect classical relationships such as the Modified Golden Rule. Most of the theory of corruption focuses on incentives, information and enforcement determining corrupt practices, mainly due to market failures in a static context (Shleifer and Vishny (1993), Banerjee (1997), and Acemoglu and Verdier (2000)). In contrast, there is relatively little theoretical research on the dynamic general equilibrium modelling of corruption and growth. Exceptions are Ehrlich and Lui (1999), Mohtadi and Roe (2003) and Blackburn, Bose, and Haque (2002). Our model is near Ehrlich and Lui (1999) who build a growth model with thresholds in human capital, generating two equilibria, one with corruption and one without. But we go further insofar as they set a given level of government intervention, and corruption is a direct product of government size. Another endogenous growth model is proposed by Mohtadi and Roe (2003). In this model, the equilibrium size of the rent-seeking sector depends on the "state of democracy" which is related to the flow of information and access to the government. Finally, our model differs from Blackburn, Bose, and Haque (2002) in that we model corruption as rent-seeking rather than as tax evasion.

The main results of the theoretical model are the following. Corruption may distort the distribution of public expenditure in two different ways. In both cases, this distortion hampers growth. The way of the distortion depends on the extent to which the political power is concentrated in the hands of rent-seekers and on the nature of corruption (potential or actual). When the power is strongly concentrated, a high technology of corruption leads to high levels of actual corruption and distorts the structure of public spending in favor of investment in physical capital and at the expense of investment in human capital. On the contrary, in a more democratic regime, a higher technology of corruption make potential corruption higher but has no effect on its actual level; and it leads to an increase in expenditure in human capital relatively to physical capital.

Through econometric estimations, we give empirical evidence of the main implications of the model. Indeed, in richer and more democratic countries, when corruption is made plausible by a failing legal system, public spending are distorted in favor of human capital spending, in order to discourage rent-seekers from corruption. This distortion hampers growth. We also show that a failing legal system (i.e. which provides a well developed predatory technology) in a country where the power is strongly concentrated entails a fall in the ratio of human capital spending on physical capital spending. Higher technology of corruption and political weight of rent-seekers (approximated by the lack of extent of political rights) also enhance the level of corruption, reduce GDP per capita and hamper growth even more than the previous distortion. The estimated effects are large. If Burundi had USA's rule of law and democracy levels, investment in education and health relative to investment in physical capital would be six times larger, annual income growth would increase from 0.7% to 3.3% and the level of corruption would decrease from 3.8 to 0.7, equal to the USA level. Besides, the lack of political rights is affecting the level of corruption much more in rich countries than in poor ones. In the latter, the level of corruption is more sensitive to a failing legal system than in rich countries. Hence, among other factors, the limitations of the legal system and, to a lesser extent, the concentration of political power may explain why poor countries have higher corruption than developed ones and why they have difficulties catching them up.

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A Solution to the Planning Problem

We follow McKenzie (1986) and de la Croix and Michel (2002) and use the Lagrangian of period t $\mathcal{L}_t$, which has the interest of being simpler and more intuitive (and yielding the same results as the infinite Lagrangian). The Lagrangian $\mathcal{L}_t$ is composed of the terms of the infinite Lagrangian which depends on h_t, g_t, k_t, i_t and x_t. Replacing W_t by its value from (7), U_t by its value from (3) and $V_t = u[\nu i_t - g_t - i_t]$, we obtain:

$$\begin{aligned}\mathcal{L}_t = (1-x_t)u[\Gamma[1-x_t]f[h_t,k_t] - g_t - i_t] + (1+\theta)x_t u[\nu i_t - g_t - i_t] \\ + \rho\lambda_{t+1}\left[(1-\delta_H)h_t + g_t\right] - \lambda_t(1+n)h_t \\ + \rho\mu_{t+1}\left[(1-\delta_K)k_t + (1-\nu x_t)i_t\right] - \mu_t(1+n)k_t \\ + \phi_t\left(\Gamma[1-x_t]f[h_t,k_t] - \nu i_t\right) + \omega_t x_t \end{aligned} \tag{20}$$

It is equal to the instantaneous utility plus the increase in the value of the two capital stocks, $\rho\lambda_{t+1}h_{t+1} - \lambda_t(1+n)h_t$ and $\rho\mu_{t+1}k_{t+1} - \mu_t(1+n)k_t$ minus the cost of the inequality constraints. For an optimal solution, the derivatives of $\mathcal{L}_t$ with respect to the five variables are zero:

$$\frac{\partial\mathcal{L}_t}{\partial h_t} = \left((1-x_t)u'[y_t] + \phi_t\right)\Gamma[1-x_t]f'_H[h_t,k_t] + \rho(1-\delta_H)\lambda_{t+1} - (1+n)\lambda_t = 0 \tag{21}$$

$$\frac{\partial\mathcal{L}_t}{\partial g_t} = -(1-x_t)u'[y_t] - (1+\theta)x_t u'[\nu i_t - g_t - i_t] + \rho\lambda_{t+1} = 0 \tag{22}$$

$$\frac{\partial\mathcal{L}_t}{\partial k_t} = \left((1-x_t)u'[y_t] + \phi_t\right)\Gamma[1-x_t]f'_K[h_t,k_t] + \rho(1-\delta_K)\mu_{t+1} - (1+n)\mu_t = 0 \tag{23}$$

$$\frac{\partial\mathcal{L}_t}{\partial i_t} = -(1-x_t)u'[y_t] + (1+\theta)(\nu-1)x_t u'[\nu i_t - g_t - i_t] + \rho\mu_{t+1}(1-\nu x_t) - \phi_t\nu = 0 \tag{24}$$

$$\frac{\partial\mathcal{L}_t}{\partial x_t} = -u[y_t] + (1+\theta)u[\nu i_t - g_t - i_t] - \nu\rho\mu_{t+1}i_t - \left((1-x_t)u'[y_t] + \phi_t\right)\Gamma'[1-x_t]f[h_t,k_t] + \omega_t = 0 \tag{25}$$

with

$$y_t = \Gamma[1-x_t]f[h_t,k_t] - g_t - i_t.$$

The multipliers of the inequality constraints should satisfy:

$$\begin{aligned} \phi_t &\geq 0 \\ \phi_t\left(\Gamma[1-x_t]f[h_t,k_t] - \nu i_t\right) &= 0 \\ \nu i_t &\leq \Gamma[1-x_t]f[h_t,k_t] \end{aligned}$$

$$\begin{aligned} \omega_t &\geq 0 \\ \omega_t x_t &= 0 \\ -x_t &\leq 0 \end{aligned}$$

The transversality conditions are:

$$\lim_{t\to\infty} \rho^t \lambda_t h_t = 0, \quad \text{and} \quad \lim_{t\to\infty} \rho^t \mu_t k_t = 0. \tag{26}$$

Benchmark Regime

We first consider the regime where $x_t = 0$, $\phi_t = 0$, and $\omega_t > 0$. Equation (4) holds and the incentive constraint is not binding. There is no corruption and public investment is not distorted. The first order conditions become

$$\begin{aligned}
\frac{\partial \mathcal{L}_t}{\partial h_t} &= u'[y_t]\Gamma[1]f'_H[h_t,k_t] + \rho(1-\delta_H)\lambda_{t+1} - (1+n)\lambda_t = 0 \\
\frac{\partial \mathcal{L}_t}{\partial g_t} &= -u'[y_t] + \rho\lambda_{t+1} = 0 \\
\frac{\partial \mathcal{L}_t}{\partial k_t} &= u'[y_t]\Gamma[1]f'_K[h_t,k_t] + \rho(1-\delta_K)\mu_{t+1} - (1+n)\mu_t = 0 \\
\frac{\partial \mathcal{L}_t}{\partial i_t} &= -u'[y_t] + \rho\mu_{t+1} = 0 \\
\frac{\partial \mathcal{L}_t}{\partial x_t} &= -u[y_t] + (1+\theta)u[\nu i_t - g_t - i_t] - \nu\rho\mu_{t+1}i_t - u'[y_t]\Gamma'[1]f[h_t,k_t] + \omega_t = 0
\end{aligned}$$

First notice that $\lambda_{t+1} = \mu_{t+1}$. The Keynes-Ramsey rule can be derived by replacing λ_t and λ_{t+1} in the first equation by their value computed from the second equation.

$$\lambda_{t+1} = u'[y_t]/\rho \qquad \rightarrow$$

$$\frac{u'[y_{t-1}]}{u'[y_t]} = \frac{\rho\left(\Gamma[1]f'_H[h_t,k_t] + 1 - \delta_H\right)}{1+n}$$

Leading this expression by one period and replacing $u'[y]$ by $y^{-1/\sigma}$ leads to the expression in the text (9).

The relation between the marginal productivities of the two types of capital is derived by combining the Keynes-Ramsey rule derived above with the expression obtained by replacing μ_t and μ_{t+1} in the third equation by their value computed from the fourth equation.

$$\mu_{t+1} = u'[y_t]/\rho \qquad \rightarrow$$

$$1 - \delta_H + \Gamma[1]f'_H[h_t,k_t] = 1 - \delta_K + \Gamma[1]f'_K[h_t,k_t].$$

which is equation (10) of the main text.

The last equation can be used to derive an expression for the multiplier ω_t:

$$\omega_t = u[y_t] - (1+\theta)u[\nu i_t - g_t - i_t] + \nu\rho\mu_{t+1}i_t + u'[y_t]\Gamma'[1]f[h_t,k_t]$$

Imposing $\omega_t > 0$ on it gives an upper bound on the parameter θ:

$$1 + \theta < \frac{u[y_t] + \nu\rho\mu_{t+1}i_t + u'[y_t]\Gamma'[1]f[h_t,k_t]}{u[\nu i_t - g_t - i_t]},$$

which is equation (11) of the main text.

Distortion without Corruption

This is regime where $x_t = 0$, $\phi_t > 0$, and $\omega_t > 0$. This case corresponds to a situation without corruption, but where Equation (4) does not hold. When the incentive constraint holds with equality, $-u[y_t] + (1+\theta)u[\nu i_t - g_t - i_t]$ simplifies into $\theta u[y_t]$. The first order conditions are:

$$
\begin{aligned}
\frac{\partial \mathcal{L}_t}{\partial h_t} &= \left(u'[y_t] + \phi_t\right)\Gamma[1] f'_H[h_t, k_t] + \rho(1-\delta_H)\lambda_{t+1} - (1+n)\lambda_t = 0 \\
\frac{\partial \mathcal{L}_t}{\partial g_t} &= -u'[y_t] + \rho\lambda_{t+1} = 0 \\
\frac{\partial \mathcal{L}_t}{\partial k_t} &= \left(u'[y_t] + \phi_t\right)\Gamma[1] f'_K[h_t, k_t] + \rho(1-\delta_K)\mu_{t+1} - (1+n)\mu_t = 0 \\
\frac{\partial \mathcal{L}_t}{\partial i_t} &= -u'[y_t] + \rho\mu_{t+1} - \phi_t\nu = 0 \\
\frac{\partial \mathcal{L}_t}{\partial x_t} &= \theta u[y_t] - \nu\rho\mu_{t+1} i_t - \left(u'[y_t] + \phi_t\right)\Gamma'[1] f[h_t, k_t] + \omega_t = 0
\end{aligned}
$$

From the second and fourth conditions, the shadow prices of capital are no longer equal:

$$\lambda_{t+1} = \mu_{t+1} - \frac{\phi_t \nu}{\rho}.$$

A modified Keynes-Ramsey rule can be derived by replacing λ_t and λ_{t+1} in the first equation by their value computed from the second equation.

$$\lambda_{t+1} = u'[y_t]/\rho \qquad \rightarrow$$

$$\frac{u'[y_{t-1}]}{u'[y_t]} = \frac{\rho\left(\Gamma[1] f'_H[h_t, k_t] + 1 - \delta_H\right)}{1+n} + \frac{\rho\Gamma[1] f'_H[h_t, k_t]}{1+n}\frac{\phi_t}{u'[y_t]}$$

Interior Regime: $0 > x_t > 1$ and $\phi_t \neq 0$

This is the interior regime with $0 < x_t < 1/\nu$. The multiplier $\phi_t > 0$, but $\omega_t = 0$. When the incentive constraint holds with equality, $-(1-x_t)u'[y_t] + (1+\theta)(\nu-1)x_t u'[\nu i_t - g_t - i_t]$ simplifies into $(\nu x(1+\theta) - (1+\theta x))u'[y_t]$, and $u'[y_t] = u'[\nu i_t - g_t - i_t]$. The first order conditions are:

$$
\begin{aligned}
\frac{\partial \mathcal{L}_t}{\partial h_t} &= \left((1-x_t)u'[y_t] + \phi_t\right)\Gamma[1-x_t] f'_H[h_t, k_t] \\
&\qquad\qquad + \rho(1-\delta_H)\lambda_{t+1} - (1+n)\lambda_t = 0 \\
\frac{\partial \mathcal{L}_t}{\partial g_t} &= -(1+\theta x_t)u'[y_t] + \rho\lambda_{t+1} = 0
\end{aligned}
$$

$$\frac{\partial \mathcal{L}_t}{\partial k_t} = ((1-x_t)u'[y_t] + \phi_t)\,\Gamma[1-x_t]f'_K[h_t,k_t] + \rho(1-\delta_K)\mu_{t+1} - (1+n)\mu_t = 0$$
$$\frac{\partial \mathcal{L}_t}{\partial i_t} = \nu x(1+\theta) - (1+\theta x))u'[y_t] + \rho\mu_{t+1}(1-\nu x_t) - \phi_t\nu = 0$$
$$\frac{\partial \mathcal{L}_t}{\partial x_t} = \theta u[y_t] - \nu\rho\mu_{t+1}i_t - ((1-x_t)u'[y_t] + \phi_t)\,\Gamma'[1-x_t]f[h_t,k_t] = 0$$

From the second and fourth conditions, the shadow prices of capital are no longer equal:

$$\left(1 - \frac{\nu x_t(1+\theta)}{1+\theta x_t}\right)\lambda_{t+1} = \mu_{t+1}(1-\nu x_t) - \frac{\phi_t\nu}{\rho}.$$

The shadow price of corruption can be computed by solving the fifth equation for ϕ_t:

$$\phi_t = \frac{\theta u[y_t] - \nu\rho\mu_{t+1}i_t - (1-x_t)u'[y_t]\Gamma'[1-x_t]f[h_t,k_t]}{\Gamma'[1-x_t]f[h_t,k_t]}$$

The Keynes-Ramsey rule can be derived by replacing λ_t and λ_{t+1} in the first equation by their value computed from the second equation.

$$\lambda_{t+1} = (1+\theta x_t)u'[y_t]/\rho \qquad \rightarrow$$
$$\frac{1+\theta x_{t-1}}{1+\theta x_t}\frac{u'[y_{t-1}]}{u'[y_t]} = \frac{\rho(\Gamma[1-x_t]f'_H[h_t,k_t] + 1 - \delta_H)}{1+n} + \frac{\rho}{1+n}\frac{\phi_t}{u'[y_t]}\frac{\Gamma[1-x_t]}{1-x_t}f'_H[h_t,k_t]$$

Leading this expression by one period and replacing $u'[y]$ by $y^{-1/\sigma}$ leads to the expression in the text (9).

B Descriptive Statistics

Table 3 reports the list of countries in the study. In Table 4 we report the descriptive statistics of the variables used in the estimation. Table 5 provides the statistics for each year for the three dependent variables.

Table 3: List of the countries being studied

Argentina	China	Greece	Malaysia	Spain
Australia	Colombia	Iceland	Mauritius	Sri Lanka
Austria	Costa Rica	India	Mexico	Sweden
Bangladesh	Cyprus	Indonesia	Nepal	Syria
Belgium	Denmark	Iran	Netherlands	Thailand
Bolivia	Dominican Rep.	Ireland	New Zealand	Tunisia
Botswana	Egypt	Israel	Norway	Turkey
Brazil	El Salvador	Jamaica	Pakistan	Uganda
Burundi	Ethiopia	Kenya	Panama	United Kingdom
Cameroon	Fiji	Korea, Rep.	Papua New Guinea	United States
Canada	Finland	Lesotho	Peru	Uruguay
Chile	Germany	Madagascar	Philippines	Venezuela
			Singapore	Zambia

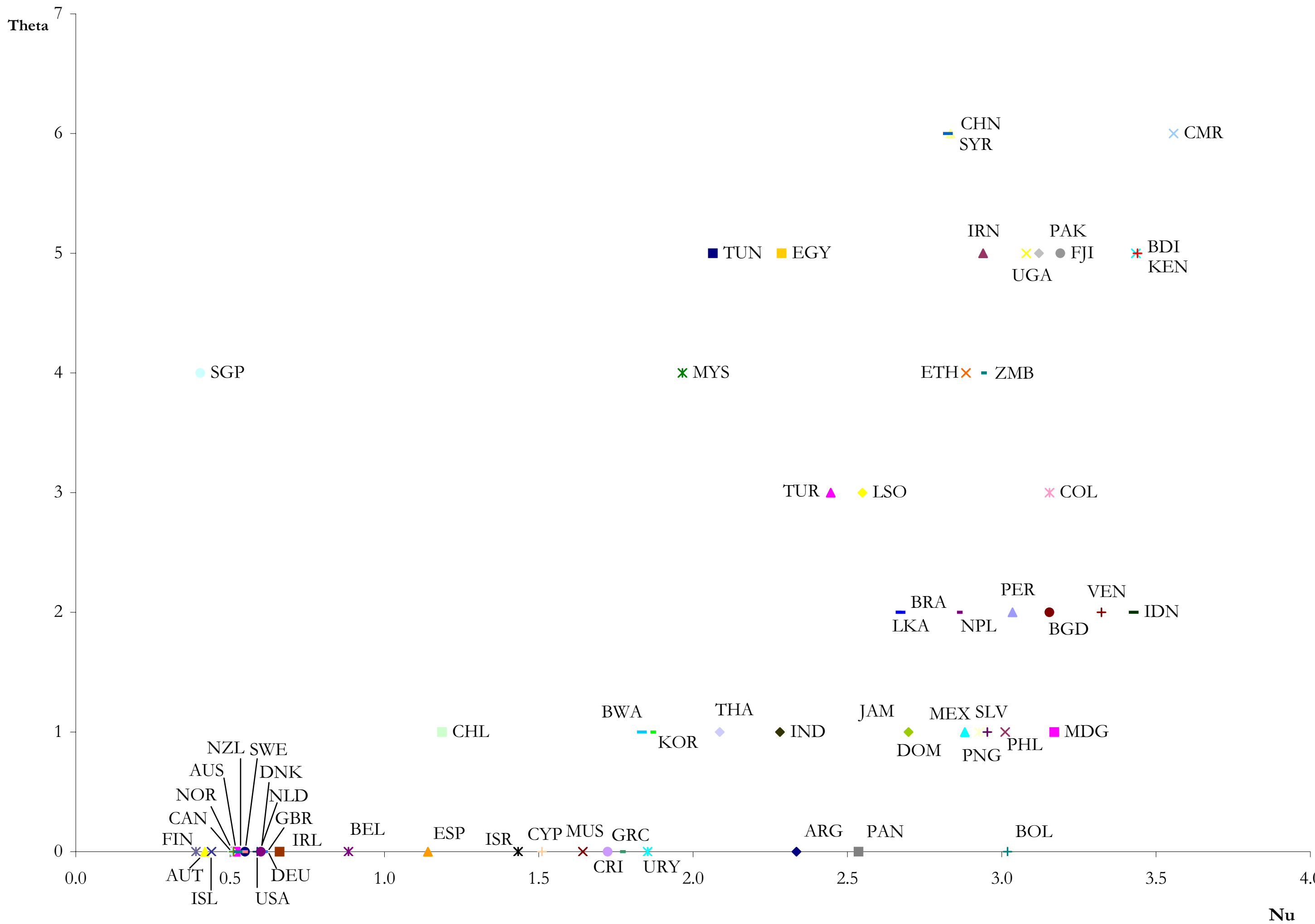
Table 4: Summary Statistics of the Variables Used in The Estimations

	Variable	Obs.	Mean	Std. Dev.	Min	Max
Dependent Variables	$Ratio$	304	1.63	1.08	0.10	7.13
	$Corrup$	304	2.06	1.15	-0.07	3.77
	$Growth$	304	0.21	0.20	-0.46	0.87
Explanatory Variables	$Techcor$	304	2.08	1.04	0.26	4.00
	$Polbias$	304	1.71	1.92	0	6
	$Patience$	304	10.32	12.62	1	71
	Pop	304	1.39	0.79	-0.03	4.00
	$Tropic$	304	0.45	0.50	0	1
	$Ldlock$	304	0.13	0.33	0	1
	$\ln Y_0$	304	8.63	1.09	6.21	10.31
Instruments	$antiq$	304	0.46	0.26	0.07	1
	$yrind$	304	4.63	0.89	3.30	7.71
	$latit$	304	27.45	17.36	0.23	63.89
	$legsoc$	304	0.02	0.13	0	1
	$legfr$	304	0.47	0.50	0	1
	$legbr$	304	0.38	0.49	0	1
	$polbiaslag$	304	1.94	1.94	0	6
	$poplag$	304	1.68	0.98	-0.46	4.09
	$natres$	266	1387.69	1196.11	108.32	8020.70

Table 5: Yearly Statistics of the Three Dependent Variables

	Year	Obs	Mean	Std. Dev.	Min	Max
Ratio	1996	58	1.48	1.01	0.10	4.97
	1998	62	1.60	1.04	0.11	4.83
	2000	62	1.64	1.00	0.11	5.45
	2002	62	1.80	1.28	0.11	7.13
	2004	60	1.63	1.03	0.11	5.19
	Year	Obs	Mean	Std. Dev.	Min	Max
Corrup	1996	58	2.09	1.09	0.26	3.60
	1998	62	2.00	1.21	-0.07	3.61
	2000	62	2.01	1.18	-0.06	3.77
	2002	62	2.10	1.14	0.05	3.65
	2004	60	2.08	1.17	-0.03	3.66
	Year	Obs	Mean	Std. Dev.	Min	Max
Growth	1996	58	0.19	0.23	-0.46	0.83
	1998	62	0.20	0.21	-0.36	0.79
	2000	62	0.22	0.20	-0.39	0.87
	2002	62	0.20	0.20	-0.35	0.81
	2004	60	0.21	0.17	-0.20	0.76

Figure 9: 63 Countries' Legal and Political Institutions



C Robustness of the Estimation Results

Table 6: From the Unrestricted to the Restricted Model: a Four-Step Procedure

Model	1	2	3	4.1	1	2	3	4.1	1	2	3	4.1
Explanatory	Dependent Variables											
Variables	$Ratio.10^{-1}$	$Ratio.10^{-1}$	$Ratio.10^{-1}$	$Ratio.10^{-1}$	$Corrup$	$Corrup$	$Corrup$	$Corrup$	$Growth$	$Growth$	$Growth$	$Growth$
$Techcor$	1.57^c	1.57^b	0.84^a	0.83^a	1.53	1.33^b	1.00^a	1.10^a	0.76	0.95^c	1.15^a	1.24^a
	(0.86)	(0.80)	(0.21)	(0.21)	(1.17)	(0.67)	(0.10)	(0.04)	(0.99)	(0.52)	(0.42)	(0.41)
$\frac{Techcor}{\ln Y_0}.10$	-1.50^c	-1.51^c	-0.72^a	-0.71^a	-0.55	-0.34			-1.03	-1.22^b	-1.48^a	-1.58^a
	(0.88)	(0.82)	(0.18)	(0.18)	(1.20)	(0.66)			(1.02)	(0.58)	(0.47)	(0.45)
$Polbias$	-0.71^b	-0.69^b	-0.51^a	-0.50^a	0.33	0.41	0.51^c	0.29^c	0.09			
	(0.34)	(0.34)	(0.16)	(0.16)	(0.46)	(0.34)	(0.27)	(0.17)	(0.39)			
$\frac{Polbias}{\ln Y_0}.10$	0.63^b	0.63^b	0.45^a	0.45^a	-0.22	-0.29	-0.37^c	-0.18	-0.14	-0.06	-0.08^b	-0.08^b
	(0.31)	(0.31)	(0.14)	(0.14)	(0.43)	(0.28)	(0.22)	(0.12)	(0.36)	(0.05)	(0.03)	(0.03)
$Patience.10^{-1}$	-0.12	-0.12^c	-0.09^b	-0.09^b	-0.10	-0.08^c	-0.07	-0.10^b	0.18^c	0.16^b	0.19^a	0.19^a
	(0.09)	(0.07)	(0.03)	(0.03)	(0.12)	(0.05)	(0.05)	(0.04)	(0.10)	(0.07)	(0.05)	(0.05)
$Pop.10^{-1}$	0.06				-0.89	-0.81	-0.96^c	-0.92^c	-0.45	-0.46		
	(0.56)				(0.76)	(0.59)	(0.56)	(0.55)	(0.65)	(0.61)		
$Tropic$	0.17	0.18^b	0.12^a	0.12^a	0.03				-0.14	-0.12	-0.15^b	-0.14^b
	(0.11)	(0.09)	(0.04)	(0.04)	(0.15)				(0.13)	(0.09)	(0.07)	(0.06)
$Ldlock$	0.09	0.09^c	0.08^b	0.08^b	0.12	0.11	0.10	0.12^c	-0.12^c	-0.11^c	-0.12^c	-0.13^b
	(0.06)	(0.06)	(0.03)	(0.03)	(0.08)	(0.07)	(0.07)	(0.07)	(0.07)	(0.06)	(0.06)	(0.06)
$\ln Y_0$	-0.31	-0.32			-0.34	-0.28	-0.14		-0.83^b	-0.88^a	-1.05^a	-1.11^a
	(0.31)	(0.29)			(0.42)	(0.28)	(0.14)		(0.35)	(0.27)	(0.24)	(0.22)
N	304	304	304	304	304	304	304	304	304	304	304	304
Instruments	$antiq$ $yrind$ $latit$ $legsoc$ $legfr$ $legbr$ $polbiaslag$ $poplag$ $\ln Y_0$ $Tropic$ $Ldlock$											
Exp. Var.	Pop	$\ln Y_0$			$Tropic$	$\frac{Techcor}{\ln Y_0}$	$\ln Y_0$		$Polbias$	Pop		
$P(coeff.=0)$	0.92	0.28			0.84	0.61	0.29		0.45	0.94		

Notes: Standard errors in parentheses: ^{a}, ^{b} and ^{c} denote coefficients significantly not null respectively at the 1%, 5% and 10% level.
N stands for the number of observations.
The last two lines should be read as follows: 0.92 indicates the probability that the coefficient associated with the explanatory variable "*Pop*" is not significantly different from 0, according to the Wald test.

Table 7: Residuals' correlation by equation matrix relative to Table 2

	Growth	Corruption	Spending Ratio
Growth	1.00		
Corruption	-0.44^a	1.00	
Spending Ratio	-0.42^a	0.10^c	1.00

Note: ^{a}, ^{b} and ^{c} denote coefficients significantly not null respectively at the 1%, 5% and 10% level.

Table 8: Relevance Test
Do the Instruments Predict Well the Endogenous Regressors?

	$Techcor$	$\frac{Techcor}{\ln Y_0}.10$	$Polbias$	$\frac{Polbias}{\ln Y_0}.10$	$Patience.10^{-1}$	Pop
$antiq$	0.32^b	0.22	1.30^a	1.33^a	0.70^b	-0.14
	(2.44)	(1.48)	(3.95)	(3.21)	(2.09)	(-1.23)
$yrind$	-0.16^a	-0.13^a	-0.36^a	-0.32^b	-0.27^a	-0.05
	(-4.14)	(-2.83)	(-3.67)	(-2.59)	(-2.78)	(-1.54)
$latit.10^{-1}$	-0.23^a	-0.19^a	-0.01	0.05	-0.04	0.01
	(-5.22)	(-3.72)	(-0.12)	(0.37)	(-0.35)	(0.21)
$legfr$	0.39^a	0.28^b	0.56^b	0.47	0.45^c	0.20^b
	(3.76)	(2.33)	(2.16)	(1.42)	(1.71)	(2.28)
$legbr$	-0.13	-0.17	0.28	0.34	0.23	0.23^b
	(-1.18)	(-1.33)	(1.02)	(0.98)	(0.82)	(2.42)
$legsoc.10$	0.07^b	0.05	0.34^a	0.40^a	0.46^a	-0.02
	(2.56)	(1.59)	(5.09)	(4.79)	(6.81)	(-0.79)
$poplag$	0.04	0.05	0.67^a	0.83^a	0.15	0.51^a
	(0.90)	(1.06)	(5.92)	(5.83)	(1.28)	(13.25)
$polbiaslag$	-0.03	-0.02	0.41^a	0.53^a	0.33^a	-0.02
	(-1.50)	(-0.93)	(7.42)	(7.69)	(5.86)	(-1.25)
$natres.10^{-3}$	-0.05^b	-0.05^b	-0.08	-0.09	-0.19^a	0.01
	(-2.02)	(-2.02)	(-1.36)	(-1.29)	(-3.25)	(0.44)
$Ldlock$	-0.20^b	-0.13	-0.05	0.11	0.46^c	-0.17^b
	(-2.09)	(-1.15)	(-0.22)	(0.37)	(1.86)	(-2.01)
$Tropic$	0.01	0.08	-0.36	-0.45	0.82^a	0.01
	(0.09)	(0.60)	(-1.18)	(-1.17)	(2.65)	(0.07)
$\ln Y_0$	-0.55^a	-1.00^a	-0.25^b	-0.54^a	0.78^a	-0.20^a
	(-11.22)	(-17.80)	(-2.00)	(-3.47)	(6.21)	(-4.67)
Observations	266	266	266	266	266	266

Notes: T-statistics in parentheses: ^{a}, ^{b} and ^{c} denote coefficients significantly not null respectively at the 1%, 5% and 10% level.

Table 9: Robustness Tests for the Estimation of the Reduced Model

	4.2			4.3		
Explanatory	Dependent Variables					
Variables	$Ratio.10^{-1}$	$Corrup$	$Growth$	$Ratio.10^{-1}$	$Corrup$	$Growth$
$Techcor$	0.39^a	1.10^a	0.90^b	0.36^a	1.10^a	0.94^b
	(0.13)	(0.04)	(0.41)	(0.12)	(0.04)	(0.41)
$\frac{Techcor}{\ln Y_0}.10$	-0.32^a		-1.19^a	-0.30^a		-1.24^a
	(0.11)		(0.46)	(0.10)		(0.46)
$Polbias$	-0.24^b	0.30^c		-0.23^b	0.30^c	
	(0.09)	(0.17)		(0.09)	(0.17)	
$\frac{Polbias}{\ln Y_0}.10$	0.20^b	-0.19	-0.08^a	0.19^b	-0.19	-0.08^b
	(0.08)	(0.12)	(0.03)	(0.08)	(0.12)	(0.03)
$Patience.10^{-1}$	-0.03	-0.10^b	0.20^a	-0.03	-0.10^b	0.20^a
	(0.02)	(0.04)	(0.05)	(0.02)	(0.04)	(0.05)
$Pop.10^{-1}$		-0.89			-0.90	
		(0.55)			(0.55)	
$Tropic$	0.07^a		-0.16^b	0.06^a		-0.16^b
	(0.02)		(0.06)	(0.02)		(0.06)
$Ldlock$	0.03	0.12^c	-0.14^b	0.03	0.12^c	-0.13^b
	(0.02)	(0.07)	(0.06)	(0.02)	(0.07)	(0.06)
$\ln Y_0$			-0.91^a			-0.94^a
			(0.23)			(0.23)
Observations	304			304		
Instruments	$antiq$ $yrind$ $legsoc$ $legfr$ $legbr$ $poplag$ $polbiaslag$ $Tropic$ $Ldlock$ $\ln Y_0$			$antiq$ $yrind$ $legsoc$ $legfr$ $legbr$ $poplag$ $polbiaslag$ $Tropic$ $Ldlock$ $\ln Y_0$		
Sargan Test Stat.	3.99	3.53	1.76	3.54	3.53	1.76
$P-value$	(0.26)	(0.47)	(0.62)	(0.32)	(0.47)	(0.62)
Cragg-Donald F Stat.	1.29	4.39	3.22	0.57	4.39	3.22

Notes: Standard errors in parentheses: ^{a}, ^{b} and ^{c} denote coefficients significantly not null respectively at the 1%, 5% and 10% level.
In the ratio of model 4.2, i includes expense on economic activities, housing and defense. In the ratio of model 4.3, i includes expense on economic activities, housing, defense and culture.

Table 10: Robustness Tests for the Estimation of the Reduced Model

	4.4			4.5			4.6		
Explanatory				Dependent Variables					
Variables	$Ratio.10^{-1}$	$Corrup$	$Growth$	$Ratio.10^{-1}$	$Corrup$	$Growth$	$Ratio.10^{-1}$	$Corrup$	$Growth$
$Techcor$	0.83^a	1.11^a	1.33^a	1.00^a	1.10^a	1.59^a	0.97^a	1.12^a	1.72^a
	(0.21)	(0.04)	(0.40)	(0.27)	(0.04)	(0.51)	(0.23)	(0.04)	(0.50)
$\frac{Techcor}{\ln Y_0}.10$	-0.71^a		-1.64^a	-0.81^a		-2.11^a	-0.80^a		-2.17^a
	(0.18)		(0.45)	(0.22)		(0.59)	(0.19)		(0.59)
$Polbias$	-0.49^a	0.38^b		-0.65^a	0.33^c		-0.66^a	0.40^b	
	(0.16)	(0.17)		(0.22)	(0.18)		(0.20)	(0.18)	
$\frac{Polbias}{\ln Y_0}.10$	0.44^a	-0.25^b	-0.08^b	0.55^a	-0.20	-0.04	0.56^a	-0.25^b	-0.05
	(0.14)	(0.12)	(0.03)	(0.19)	(0.13)	(0.03)	(0.17)	(0.13)	(0.03)
$Patience.10^{-1}$	-0.09^b	-0.11^b	0.19^a	-0.09^a	-0.11^b	0.18^a	-0.09^a	-0.12^a	0.18^a
	(0.03)	(0.04)	(0.05)	(0.03)	(0.04)	(0.05)	(0.03)	(0.04)	(0.05)
$Pop.10^{-1}$		-1.05^c			-1.00			-1.32^b	
		(0.56)			(0.62)			(0.63)	
$Tropic$	0.12^a		-0.16^b	0.09^c		0.02	0.11^b		-0.03
	(0.04)		(0.06)	(0.05)		(0.09)	(0.05)		(0.09)
$Ldlock$	0.08^b	0.14^b	-0.11^c	0.08^c	0.18^b	-0.03	0.07	0.20^b	0.01
	(0.03)	(0.07)	(0.06)	(0.04)	(0.08)	(0.08)	(0.04)	(0.08)	(0.08)
$\ln Y_0$			-1.11^a			-1.37^a			-1.36^a
			(0.22)			(0.32)			(0.32)
Observations	304			266			266		
Instruments	$antiq\ yrind\ legsoc\ legfr$ $legbr\ poplag\ latit$ $Tropic\ Ldlock\ \ln Y_0$			$antiq\ yrind\ legsoc\ legfr$ $legbr\ poplag\ natres$ $Tropic\ Ldlock\ \ln Y_0$			$antiq\ yrind\ legsoc\ legfr$ $legbr\ poplag\ natres\ latit$ $Tropic\ Ldlock\ \ln Y_0$		
Sargan Test Stat.	6.13	5.78	4.64	3.12	5.28	2.37	4.09	8.65	4.52
$P-value$	(0.19)	(0.33)	(0.33)	(0.37)	(0.26)	(0.50)	(0.39)	(0.12)	(0.34)
Cragg-Donald F Stat.	1.14	4.09	1.12	2.00	3.83	0.82	1.90	3.58	0.71

Notes: Standard errors in parentheses: [a], [b] and [c] denote coefficients significantly not null respectively at the 1%, 5% and 10% level.

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