# Growth, Governance and Corruption in the Presence of Threshold Effects: Theory and Evidence

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*Keywords:* Growth; corruption; threshold effects; governance; democracy; corruption.

*JEL Classification:* D72; D82.

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We study the joint determination of corruption and economic growth. Our model can generate multiple equilibria when complementarity between corruption and growth is sufficiently strong. Our estimates of the impact of corruption on growth take into account that corruption is endogenous and that there may exist different growth/corruption regimes. In a cross section of countries in the 1990s, we identify two regimes, conditional on the quality of political institutions. In the regime with high quality political institutions, corruption has a negative impact on growth. In the regime with low quality institutions, corruption has, overall, little impact on growth, but, if anything, the impact is, surprisingly, positive.

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## 1 Introduction

Corruption, economic growth, and the quality of political institutions are related through a complex web. It is widely acknowledged that corruption can be detrimental to economic growth because of the disincentive effects on innovation and capital accumulation and because of misallocation of talent across productive and unproductive activities.[1] It is also understood that corruption can be self-reinforcing with the potential to generate multiple equilibria and corruption/growth traps and that political institutions can foster or hinder corruption.[2] Yet, many questions remain unanswered, both theoretically and empirically.

This paper contributes to the literature in two ways. First, we develop a political economy model that allows us to characterize equilibrium levels of corruption and economic growth and to highlight a new channel through which economic growth has a (negative) feedback effect on corruption. The model allows for multiple equilibria due to a threshold effect. Second, treating corruption and growth as endogenous variables, we provide new evidence on the impact of corruption on growth. The novelty of the empirical contribution is that we estimate a non-linear growth model that allows for threshold effects. We show that

[1] See, for example, Krusell and Rios-Rull (1996), Acemoglu (1995) and Acemoglu and Verdier (1998).

[2] See, for example, Murphy *et al.*, (1991, 1993). A number of other self-reinforcing mechanisms are discussed in Aidt (2003).

the quality of political institutions determines in which of two possible growth/corruption regimes a country finds itself and estimate the regime-specific marginal growth effect of corruption.

The theoretical model considers a society where rulers – interpreted as politicians or dictators depending on the context – extract rents from the private citizens by charging a fee for entry into the formal sector of the economy. Citizens can decide to shelter themselves from rent extraction (the fee) in the informal sector, but at the cost of lower wages and the loss of access to valuable public services, such as the legal system. Citizens in the formal sector attempt to reduce corruption by threatening to replace a ruler that extracts rents too greedily. In a democracy, this usually takes place through orderly elections, while in autocracies, but occasionally also in democracies, replacement may take place through coups, revolts or revolutions. Rulers are willing, up to a point, to reduce corruption today to avoid replacement and loss of rents in the future.

We show that economic growth can reduce corruption by changing the incentives faced by the rulers. Conversely, we also allow corruption to reduce growth through two channels: corruption has an adverse impact on innovations and reduces the scope for learning-by-doing externalities. Together these effects imply that economic growth and corruption are self-reinforcing: high growth reduces corruption which, in turn, enhances the growth performance of the economy. This can, under some circumstances, lead to multiple equilibria and a threshold effect.

We make a distinction between two types of governance failures: $q$- and $p$-failures. A $p$-failure arises when citizens cannot promise for sure to keep a ruler who behaved well in office. This type of problem, typically, arises in democracies with volatile voter turnout or general apathy among the electorate. A $q$-failure arises when citizens cannot replace under-performing politicians with certainty. This type of problem arises in countries with weak institutions, wide-spread electoral fraud, intimidation of opposition by the ruling elite, or where the political power is concentrated in the hands of a dictator. We show that an improvement in the quality of institutions increases the growth rate of an economy by reducing rent extraction and that the quality of institutions is a key determinant of

whether growth traps exist or not.

The empirical analysis employes the threshold model proposed by Caner and Hansen (2004) to estimate a non-linear growth model that allows economic growth and corruption to be jointly determined and for the possibility of multiple growth/corruption regimes. We use data on real GDP growth, corruption (as measured by Transparency International's corruption perception index) and political institutions (as measured by an index of the quality of democratic institutions constructed by Kaufmann et al. (1999)) from a cross-section of 68 countries in the 1990s. We find the following main results. First, the data identify two growth/corruption regimes. The threshold determining whether a country is in one regime rather than the other is a function of the quality of political institutions. Second, in the regime with high quality institutions, corruption and growth are negatively related. The impact of a one unit increase in corruption reduces growth with between 0.14 and 0.28 percentage points in our preferred specification. In the regime with low quality institutions, corruption has, overall, little impact on growth but, if anything, the impact is, surprisingly, positive.

The paper is organized as follows. In Section 2, we provide a brief survey of existing empirical research in the area. In Section 3, we set out the model. In Section 4, we study the impact of (exogenous) growth on corruption and highlight an new channel through which economic growth can reduce corruption. In Section 5, we specify a simple endogenous growth mechanism that allows corruption to affect growth. In Section 6, we study equilibrium configurations of the overall model and demonstrate through a sequence of examples the possibility of threshold effects and multiple equilibria. In Section 7, we discuss our empirical strategy. In Section 8, we present the empirical results. In Section 9, we discuss the findings.

# 2 The Empirical Literature

The empirical literature on corruption has expanded rapidly in recent years, not the least as a consequence of new survey-based measures of corruption. Roughly speaking, this literature can be divided into two groups: i) studies that focus on the economic consequences

of corruption, and ii) studies that focus on the determinants of corruption.

The consequences of corruption are many, and we shall limit the discussion to those that have a direct bearing on economic growth.[3] In his two seminal papers on the topic, Mauro (1995, 1998) reports that corruption is weakly related to long-run growth in a cross section of countries from around the world, but strongly (negatively) related to the share of investments. Gyimah-Brempong (2002), focussing on a panel of African countries, presents evidence that corruption decreases economic growth both directly and indirectly through decreased investments in physical capital. Mo (2001), in a study of the transmission channels through which corruption may affect growth, reports that the most important channel is political instability. Wie (2000) and Lambsdorff (2003) show how corruption may have an adverse impact on foreign direct investment and net capital inflows, both of which are important determinants of economic growth.[4] In all these studies, the relationship between corruption and growth (or its constituents) is assumed to be linear, thereby ruling out the possibility of threshold effects and other forms of nonlinearity.[5] One exception is a recent study by Mendez and Sepulveda (2005). They argue that the relationship between corruption and growth is non-monotonic, but do not allow for threshold effect, and present evidence that corruption has a beneficial impact on long-run growth at low levels of incident but is harmful at high levels of incident in a cross section of countries.

The empirical literature on the causes of corruption has also expanded rapidly in recent years. Three broad classes of potential determinants have received particular attention: economic factors, cultural and historical factors, and institutional factors. Among the economic factors, it is well-established that poor countries are perceived to be more corrupt than rich countries (Treisman, 2000; Paldam, 2002). In addition, high levels of government

[3] See the surveys by Rose-Ackerman (1999), Bardhan (1997), and Jain (2001) for further details.

[4] In addition to the direct evidence, a number of factors that may be indirectly related to corruption have been found to reduce growth. This includes negative relationships between growth and political instability (Alesina et al., 1996), income inequality (Alesina and Rodrik, 1994, Persson and Tabellini, 1994) and lack of protection of property rights (Knack and Keefer, 1995). Democracy per se is not strongly related to growth (Przeworski and Limongi, 1993), although Barro (1996) does find a non-linear effect suggesting a positive relationship at low levels and a negative relationship for medium levels of political freedom.

[5] In addition, it is an open question how robustly related corruption is to growth in *linear* models (see Sala-i-Martin et al., 2004).

regulation (or lack of economic freedom) is associated with high levels of perceived corruption.[6] Some cultural factors, such as religion, have also been found to affect corruption, with Protestant countries being associated with relatively low (perceived) corruption levels (Paldam, 2001). Many institutional and political variables are also related to corruption. Paldam (2002) shows that democracy decreases corruption, while Treisman (2000) argues that it is the length of exposure to democracy and whether a country has a history of British rule that matter.[7] Along similar lines, La Porta et al. (1999) stress that a country's legal tradition is an important determinant of corruption. Lederman et al. (2005) show, using a cross country panel covering the period 1984-1999, that measures of democracy, political (in)stability, and (lack of) freedom of the press are important determinants of corruption and that other factors, such as legal tradition, and openness to trade, lose their importance once political variables are taken into account.[8] Underlying all these studies is an implicit or explicit presumption that economic, cultural, and institutional factors are causally linked to corruption.

We contribute to the literature on the causes and consequences of corruption in two ways. First, we are explicit, both theoretically and empirically, about the joint determination of corruption and growth. We borrow from the literature on the causes of corruption the notion that some political factors (e.g., democracy and legal tradition) as well as some cultural factors, captured by natural and historical conditions, are exogenous determinants of corruption, but argue that corruption and economic outcomes (growth) are both endogenous.[9] Second, we take the possibility of thresholds and multiple equilibria into account. As far as we are aware, there is only one other paper in the literature on (the causes of)

[6]Other economic factors that are related to perceived corruption include inflation (Paldam, 2002), openness to trade (Ades and di Tella, 1999) and fiscal decentralization (Fisman and Gatti, 2002).

[7]Persson et al. (2003) argue that the institutional details matter and show that a switch from strictly proportional to strictly majoritarian elections has a small negative impact on corruption. A long similar lines, Chang and Golden (2005) show that countries with a closed-list tend to have higher levels of corruption than countries with an open-list PR system.

[8]Seldadyo and de Haan (2005) examine all these various determinants of corruption using the Extreme Bounds Analysis of Sala-i-Martin (1997). They find that the quality of bureaucracy, government effectiveness, government wages, decentralization, military spending, political freedom and the nature of the judiciary system are robustly related to corruption.

[9]This possibility has been acknowledged by Mauro (1995) and others.

corruption that considers thresholds empirically. Haque and Kneller (2004) estimate, using the technique of Hansen (2000), a threshold model with the aim of identifying corruption clubs. They use GDP per capita as the exogenous variable that determines the threshold. In contrast, we allow for endogeneity of corruption in a growth model that focuses on the consequences of corruption and use measures of the quality of political institutions to identify the threshold.

Our paper is also related to the literature on growth models with multiple steady states.[10] The seminal paper by Durlauf and Johnson (1995) analyze a neoclassical growth model with threshold effects. Using regression tree techniques to identify groups of countries that obey a common linear model, they find four separate growth regimes depending on income per capita and adult literacy. In contrast, we are interested in growth/corruption regimes that are identified by the quality of political institutions and use a different statistical technique to identify the regimes.

Hall and Jones (1999), Acemoglu et al. (2001) and others have demonstrated the importance of institutional factors in explaining the world distribution of income. The approach is to use deep historical factors broadly capturing "Western influence" to generate exogenous variation in institutions or social infrastructure.[11] Recently, Persson (2004) has argued that certain constitutional rules, such as age of democracy, can be used as instruments for structural policies (including corruption) in studies that aim at explaining differences in income levels across the world. We build on this literature in our choice of instruments for corruption and argue that a mixture of deep historical or cultural factors (size of country and distance from equator) and constitutional rules (age of democracy, political accountability, and legal tradition) can generate the required exogenous variation in corruption levels that allow us to estimate regime-specific relationships between corruption and growth.

[10] See Azariadis and Drazen (1990), Durlauf (1993) and Gradstein (2004) for theoretical underpinnings.

[11] These factors include distance from equator, fraction of English speakers and settler mortality – factors which affect current economic performance, it is argued, only through they influence on the quality of institutions.

# 3 The Model

## 3.1 The Economy

We consider a society populated by a continuum of individuals with measure 1. Individuals are indexed by $i$ and live for ever. Each individual has one unit of labour each period that is inelastically supplied to either the formal or the informal sector. In the formal sector, individuals are either employed by private firms or by the public sector. Private firms produce a consumption good, $c_t$, with constant returns to scale using labour as the only input and pay the competitive wage $w_t = a_t$, where $a_t$ is productivity. The consumption good is traded internationally at a fixed price, normalized to 1. The public sector produces public services, $y_t$. The production technology is $y_t = a_t x_t^{\alpha}$, with $\alpha \in (0,1)$, where $x_t$ is the labour input devoted to the production of public services. Public sector workers are paid the wage $w_t$. To operate in the formal sector, individuals have to pay a fee $\tau_t$, leaving them with net income $a_t(1-\tau_t)$. The cost of providing public services, $w_t x_t$, is financed out of current fee revenue. In the informal sector, individuals can avoid the fee, but their income is only a fraction of their income in the formal sector. We denote income earned in the informal sector by $\theta_i w_t$, where $\theta_i \in [0,\theta]$ is the productivity of individual $i$ in that sector. Productivity in the informal sector is distributed according to the cumulative distribution function $F(\theta_i)$. We require that $F$ is differentiable and (weakly) concave. All income, net of fees, is spent on private consumption each period. Only individuals employed in the formal sector have access to public services. Instantaneously utility is $c_{it} + \upsilon_i y_t$ where $\upsilon_i = 1$ if individual $i$ is employed in the formal sector and $\upsilon_i = 0$ otherwise. Utility is discounted with the factor $\beta \in (0,1]$.

The fee and the public service play an important role in determining the allocation of resources between sectors: a high $\tau_t$ or a low $y_t$ encourage individuals to work in the informal sector. The fee should be interpreted broadly as the cost that individuals face when operating in the formal economy because of government intervention. This, of course, includes tax payments, but also, depending on the context, the cost of getting the necessary permits to operate in that sector.[12] Public services should be interpreted

[12] De Soto (1990) and Djankov et al. (2002) have shown that this is an important consideration in many

as law and order, legal services and so on that individuals have access to only if they are formally integrated in the economy.[13] For example, individuals in the informal sector of a less developed country would not be able to use the legal system to enforce contracts, nor would a carpenter working in the black economy of a developed country.

Individual $i$ decides to work in the formal sector if, and only if $a_t(1-\tau_t)+a_t x_t^a \geq \theta_i a_t$. The fee revenue at time $t$ accordingly is

$$T_t = w_t \tau_t F(1-\tau_t+x_t^a). \tag{1}$$

Productivity grows over time, due to technological progress $a_{t+1} = a_t(1+g_t)$ with $g_t \geq 0$ and $a_0 > 0$.[14] We restrict attention to constant growth paths with $g_t = g$ for all $t$. We notice that, for given $\tau_t$ and $x_t$, total revenue increases over time, in line with productivity, as does (recorded) national income, $Y_t = w_t F(1-\tau_t+x_t^a)$, and potential national income, $Y_t^P = a_t = w_t$. We return to how productivity growth is determined along a constant growth path in Section 5 and take $g$ as being exogenously given for now.

## 3.2 The Political System

The society is governed by a ruler. Depending on the context, the ruler may be a democratically elected politician, a dictator or someone in between. The ruler oversees the production of public services, collects fees, and extracts rents from citizens by choosing $\tau_t$ and $x_t$ subject to the budget constraint $w_t x_t \leq T_t$. The "rent" extracted in period $t$ is denoted $z_t$ and corresponds to the difference between current revenues and expenditures:[15]

$$z_t = T_t - w_t x_t. \tag{2}$$

less developed countries. See Aidt and Dutta (2004) for a theoretical model of corruption and industrial licences.

[13] In reality, individuals working in the informal sector of the economy may have access to some public services, but, typically, not to all. It is straightforward to modify the model to allow individuals in the informal sector to have access to some, or even all, public services. The results are essentially unaffected.

[14] To ensure that discounted utility is bounded, we assume that $\beta(1+g) \leq 1$.

[15] This formulation was introduced by Persson et al. (1997) and is used extensively by Persson and Tabellini (2000).

We assume that actual and potential rulers care only about their "consumption" of $z_t$ and that rents can only be extracted if in office.[16,17] We shall think of $z_t$ as a measure of *rent extraction*.[18] The rent can be interpreted as income from corruption: the ruler is charging for access to the formal sector in excess of what is required to finance public services.

In the absence of further incentives, rulers extract the maximum rent each period. To avoid this, societies develop political institutions that moderate the behavior of rulers. These institutions allow citizens to hold their rulers accountable and to replace the incumbent if he extracts too much rent. In a fully democratic society, elections serve this role (Ferejohn, 1986; Persson and Tabellini, 2000, chapter 3), but even in autocracies and dictatorships, rulers are constrained by the threat of a coup or a popular revolt. Formally, at the beginning of each period, citizens announce a performance standard that the ruler has to satisfy to be "reelected" at the end of the period. Citizens can observe perfectly what the ruler does while in office (i.e., $z_t$, $x_t$ and $\tau_t$) and so they can base the performance standard on observed policies. We denote the performance standard announced at the beginning of period $t$ by $\widehat{s}_t = \{\widehat{\tau}_t, \widehat{x}_t\}$. The standard requires the ruler to spend a minimum amount on public services $x_t \geq \widehat{x}_t$ and to keep the fee below a certain threshold $\tau_t \leq \widehat{\tau}_t$. The two conditions combined effectively determine how much rent extraction is allowed. For simplicity, we assume that only citizens in the formal sector have political voice.[19]

In a well-functioning democracy, a ruler (politician) who complies with the standard is guaranteed re-election while a ruler (politician) who does not comply is certain of dismissal. These promises are, however, not equally credible in all societies, and in autocracies or dysfunctional democracies intimidation of the opposition, electoral fraud and so on can

[16] We assume that there is an infinite supply of potential rulers all of whom care only about extracting rents, and that rulers who are not holding office get zero utility.

[17] More generally, rulers could also care about public services and pay fees. This complicates the analysis but does not alter the results.

[18] As formulated, the rent is a pure transfer from citizens to the politician and no real resources are (actually) wasted in the process of trying to obtain the rent. Nonetheless, we can think of $z_t$ as a measure of what potential politicians would be willing to pay to gain office (see Nitzan, 1994, for a survey of the literature on rent seeking and rent dissipation).

[19] Similar results can be obtained if we assume that the consent of a majority of citizens is required to replace the ruler and a majority works in the formal sector. The case where citizens in the informal sector have political voice is left for future research.

significantly reduce the level of accountability. We make a distinction between two types of governance failures:[20]

**Assumption 1** *(p-failure) Citizens can only promise to reappoint a ruler who satisfies* $\widehat{s}_t$ *in period* $t$ *with probability* $p \in [0,1]$.

**Assumption 2** *(q-failure) Citizens can only promise to dismiss a ruler who does not satisfy* $\widehat{s}_t$ *in period* $t$ *with probability* $q \in [0,1]$.

A "perfect" democracy corresponds to $p = 1$ and $q = 0$.[21] A $p$-failure arises when citizens cannot promise for sure to reward good behavior with reappointment. This type of problem, typically, arises in situations with volatile voter turnout or general apathy among the electorate, but otherwise strong democratic institutions. A $q$-failure arises when citizens cannot, in all case, dismiss under-performing rulers, and a society with $q$ close to 1 can be interpreted as a dictatorship.[22]

The interaction between rulers and citizens (in the formal sector) can be summarized as follows. At the beginning of each period, citizens announce a performance standard. Next, the ruler collects fees and decides on public spending. This is observed by citizens. At the end of the period, citizens judge the performance of the ruler against the standard and decide if they want to reappoint the incumbent ruler or not. This together with random events, as captured by $p$ and $q$, determine whether the incumbent is, in fact, replaced by another ruler. After this the sequence of events is repeated.

[20] We take these governance failures as given. For a theory of why the quality of governance (as captured by protection of property rights) differs across time and space, see Gradstein (2004).

[21] By "perfect" we mean that citizens are able to use the only policy tool available to them – the right to dismiss rulers at election times – as effectively as possible. Since this type of implicit incentive contract is fairly crude, it does not imply that citizens can control their rulers perfectly when $p = 1$ and $q = 0$. In reality, asymmetric information, coordination failures and other factors make it difficult for citizens to control rulers even in societies with no $p$- or $q$-failures.

[22] Lassen (2000) studies the impact of $q$-failures on the size of government and show that tax revenues are higher in societies where $q$ is close to 0.

# 4 Growth and Rent Extraction

Citizens must accept some corruption. This is because rulers are willing to give up extracting rents in the current period only if they expect to be allowed to seek rents in the future. In the extreme, if citizens do not allow rent extraction at any time, reappointment has no value, and all rulers would extract the maximum rent while in office. Thus, the best citizens can hope for in a democracy is to reduce corruption to the level that is compatible with rulers wanting to be reappointed.

We characterize the sequence of incentive compatible performance standards as follows. Suppose that citizens announce the standard $\widehat{s}_t = \{\widehat{\tau}_t, \widehat{x}_t\}$ at time $t$. Define $\widehat{z}_t = \widehat{T}_t - a_t\widehat{x}_t$ as the rent extraction allowed by the standard. A ruler who complies $(C)$ with the standard at time $t$ expects to get:

$$V_t(C) = \widehat{z}_t + \beta p V^*_{t+1} \tag{3}$$

where $V^*_{t+1}$ is the continuation value of holding office at the beginning of period $t+1$. We notice that future payoffs are discounted by $\beta$, as rulers have the same discount rate as citizens. More importantly, for $p < 1$ citizens cannot promise to reappoint a well-performing ruler with certainty, and so with probability $1-p$, he might not get reappointed and thereby foregoes the option of extracting rents in the future. This reduces his effective discount factor to $\beta p$. The $p$-failure reduces the discount factor of rulers below that of their constituents.

The ruler can alternatively deviate from the standard in period $t$ and extract the maximum rent. In this case, he sets

$$\{\tau^*_t, x^*_t\} = \arg\max_{\{\tau_t, x_t\}} \tau_t a_t F(1 - \tau_t + x_t^\alpha) - a_t x_t. \tag{4}$$

We note that $\tau^*_t = \tau^*$ and $x^*_t = x^*$ for all $t$[23] and that the maximum rent $\mathcal{T}_t = a_t\mathcal{T}$ is

[23] The first order conditions

$$a_t\left[F(.) - \tau_t f(.)\right] = 0.$$
$$a_t\left[\tau_t f(.)\alpha x_t^{\alpha-1} - 1\right] = 0$$

imply that the solution is stationary. The second order condition is satisfied when $F$ is concave.

increases over time with

$$\mathcal{T} = (\tau^* F(1 - \tau^* - (x^*)^\alpha) - x^*)\,.$$

Citizens would, of course, want to replace the ruler at time $t+1$, but with probability $q$, they fail to achieve this. Thus, a ruler who deviates ($D$) from the performance standard at time $t$ expects to get

$$V_t(D) = \mathcal{T}_t + \beta q V^*_{t+1}. \tag{5}$$

We can now write the value of being the ruler, $V^*_t$, as

$$V^*_t = \max\{V_t(C), V_t(D)\} \tag{6}$$

and note that a sequence of performance standards $\{\widehat{s}_t\}_{t=0}^{\infty}$ is incentive compatible if and only if

$$V_t(C) \geq V_t(D) \text{ for } t = 0, 1, 2, ..... \tag{7}$$

The next proposition characterizes the minimum rent that citizens must allow rulers to extract along incentive compatibility paths.

**Proposition 1** *Assume $\beta(1+g) < 1$. Along paths with constant productivity growth, incentive compatible performance standards must allow rulers to extract at least the rent*

$$z^*_t = \frac{1 - p\beta(1+g)}{1 - q\beta(1+g)} a_t \mathcal{T} \tag{8}$$

*for $t = 0, 1, 2, .....$*

**Corollary 1** *A necessary condition for incentive compatibility is that $p \geq q$.*

Citizens would never allow the ruler to collect more than the minimum rent required for compliance, so $\widehat{z}_t = z^*_t$ for all $t$. Proposition 1, then, implies that a constant fraction of (potential) GDP is, with the approval of citizens, extracted each period. The minimum level of rent extraction depends on the quality of governance and on the growth rate of GDP. As expected, societies with "good" institutions (high $p$ or low $q$) must accept less corruption. The corollary shows that societies with very "bad" institutions ($q$ is high

and/or $p$ low with $q > p$) perform extremely poorly because incentive compatibility fails at each $t$. In such societies, no ruler ever complies with any performance standard, and the only protection that citizens have against corruption is to move into the informal sector.

The impact of economic growth on the minimum level of rent extraction along incentive compatible paths can be calculated from equation (8):

$$\frac{\partial\left(\frac{z_t^*}{a_t}\right)}{\partial g} = \frac{\beta\mathcal{T}(q-p)}{(1-q\beta(1+g))^2}. \tag{9}$$

We see that this is non-positive for $p > q$ and can state the following proposition:

**Proposition 2** *(Growth and Rent Extraction) Assume that $p \geq q$. Economic growth reduces the minimum rent required for compliance.*

Proposition 2 shows that economic growth performs a very similar role to "good" political institutions: it reduces rent extraction. In a society in which GDP and potential rents ($\mathcal{T}_t$) are growing, rulers have an incentive to postpone rent extraction because larger rents can be collected in the future. This makes it easier for citizens to get rulers to comply in the present and rent extraction along incentive compatible paths can be reduced. It is important to notice, however, that two opposite effects are at work. An increase in the growth rate increases the continuation value of retaining office. This, on the one hand, makes rulers who decide to comply more amenable to reduce rent extraction today as long as they can be fairly sure that this is rewarded with reappointment ($p$ high). On the other hand, the incentive to deviate from the performance standard and seek all available rents is enhanced in societies with higher growth rates as long as there is a chance that rulers are reappointed despite their misbehaviour ($q > 0$). Along incentive compatible paths $p \geq q$, and the former effect dominates. Economic growth can, therefore, serve as a substitute for "good" institutions.

Proposition 1 characterizes the irreducible level of rent extraction ($z_t^*$) in incentive compatible economies for any path of fees and spending levels. Given $z_t = z_t^*$ at each $t$, the constrained efficient paths of $\tau_t$ and $x_t$ solve the following problem

$$\max_{\{\tau_t, x_t\}_{t=0}^{\infty}} \sum_{t=0}^{\infty} \beta^t \left[a_t(1-\tau_t) + a_t x_t^a\right] \tag{10}$$

subject to

$$z_t = z_t^* \quad t = 0, 1, 2, 3... \tag{11}$$

$$T_t = z_t + a_t x_t \quad t = 0, 1, 2, 3... \tag{12}$$

where $T_t = a_t \tau F(1-\tau_t+x_t^\alpha)$. The solution to this problem is characterized in the following proposition.

**Proposition 3** *(Tax Rates and Public Services) Assume that $p \geq q$ and that $F$ is uniform on $[0, \theta]$. Along a path with constant productivity growth, the constrained efficient performance standard is unique and stationary, i.e., $\widehat{s}_t^* = \{\widehat{\tau}^*, \widehat{x}^*\}$ for all $t$. Provision of public services is growing over time in line with productivity*

$$y_t^* = a_t \left(\widehat{x}^*\right)^\alpha.$$

*Moreover, $\widehat{\tau}^*$ and $\widehat{x}^*$ are continuous differentiable functions of $\{g, p, q\}$ with $\widehat{\tau}^* < \tau^*$ and $\widehat{x}^* > x^*$.*

Proposition 3 shows that the constrained efficient performance standard is stationary and that provision of public services grows over time in line with productivity. The ruler reduces the fee below and increases the labour input for the production of public services above the rent maximizing levels. More importantly, the size of the formal sector $F\left(1-\widehat{\tau}^*+\left(\widehat{x}^*\right)^\alpha\right)$ is a function of the growth rate $g$ (and $p$ and $q$):

**Proposition 4** *(Growth and the Size of the Formal Sector) Assume that $p > q$ and that $F$ is uniform on $[0, \theta]$. Along a path with constant productivity growth, the size of the formal sector is non-decreasing in the growth rate.*

Proposition 4 shows that the formal sector is large in economies with fast growth. Intuitively, a high growth rate reduces the rent required for incentive compatibility (Proposition 2) because the ruler is more eager not to be replaced. Consequently, the fee is reduced and more public services are provided. This induces some individuals who previously sheltered themselves in the informal sector to move into the formal sector.

# 5 Rent Extraction and Growth

In the analysis above, we established that (exogenous) economic growth can reduce rent extraction and make it more attractive to seek employment in the formal sector. Numerous studies have pointed out the opposite possibility, namely that corruption is detrimental to economic growth. Krusell and Rios-Rull (1996), for example, argue that vested interests associated with knowledge of how to operate older vintages of technology sometimes block the adoption of the most recent technology and therefore growth. Along similar lines, Dutta (2000) argues that failures by existing social or political institutions to assign the benefits of progress appropriately leads to growth conflicts between workers and capital owners in economies with credit constraints. Misallocation of talent between entrepreneurship and rent seeking is another important reason why corruption hinders growth (Acemoglu, 1995, Acemoglu and Verdier 1998, Murphy et al. 1991, 1993).

To capture the possibility of a negative feedback effect from corruption to growth, we assume that the growth rate of the economy is proportional to the fraction of the population employed in the formal sector[24]

$$g = G[F(1 - \tau + x^{\alpha})] \tag{13}$$

where $G$ is a strictly increasing function with either congestion ($G'' < 0$) or agglomeration ($G'' > 0$) effects. This formulation of the feedback from corruption to growth can be motivated in a number of ways. First, industrial production in the formal sector, typically, generates learning-by-doing externalities with the potential to increase the growth rate of the economy (Arrow, 1962, Lucas, 1988). Activities in the informal sector are less likely to generate such externalities at a scale that has macroeconomic implications. Second, individuals working in the formal sector have access to the legal system. This helps protect property rights and to enforce contracts. This spurs the incentive to produce growth-enhancing innovations.

This specification of the growth process implies that economic growth and corruption become endogenous *and* self-reinforcing: high growth reduces rent extraction which, in

[24] An alternative is to assume, as in Murphy et al. (1991), that the growth rate of the economy is determined by the ability of the most able self-employed person in the economy.

turn, by making working in the formal sector more attractive, enhances the growth of the economy. This opens up the possibility of multiple equilibria and threshold effects.

# 6 Equilibria

We assume citizens do not internalize the impact on the growth rate when they set the performance standard. This seems reasonable insofar as growth is generated by unintended learning-by-doing externalities.[25] Given that, we define an equilibrium of the economy as a situation in which citizens and the ruler make optimal choices for a given (constant) growth rate and in which the actual growth rate of the economy is consistent with these choices:

$$g^* = G\left[F(1-\widehat{\tau}^*(g^*) + (\widehat{x}^*(g^*))^{\alpha})\right] \tag{14}$$

for $g \in [0, \frac{1-\beta}{\beta})$. Equation (14) has no, one or more solutions depending on circumstances.[26]

We begin the analysis by considering how a given equilibrium is affected by a change in the quality of political institutions. We assume that some individuals are employed in the informal sector both before and after the change. Applying the implicit function theorem to equation (14), we find

$$\frac{dg^*}{dp} = \frac{-G'(.)f(.)\frac{\partial \widehat{v}^*}{\partial p}}{1+G'(.)f(.)\frac{\partial \widehat{v}^*}{\partial g}} \tag{15}$$

and

$$\frac{dg^*}{dq} = \frac{-G'(.)f(.)\frac{\partial \widehat{v}^*}{\partial q}}{1+G'(.)f(.)\frac{\partial \widehat{v}^*}{\partial g}}, \tag{16}$$

where $\widehat{v}^{**} = 1-\widehat{\tau}^* + (\widehat{x}^*)^{\alpha}$. We note that $1+G'(.)f(.)\frac{\partial \widehat{v}^*}{\partial g}$ is positive if and only if the initial equilibrium is locally stable in the sense that a small deviation from $g^*$ would, through

[25] If citizens were to internalize the growth effect when they set the performance standard, they would maximize equation (10) subject to the incentive compatibility constraints, the budget constraint, and $g = G(F(.))$. This would rule out expectation-based multiple equilibria of the type discussed below, although the solution to this highly non-linear problem may still exhibit multiple solutions.

[26] A sufficient condition for existence of at least one equilibrium is that

$$1 > \beta\left[1+G\left[F(1-\widehat{\tau}^*(\frac{1-\beta}{\beta}) + \left(\widehat{x}^*\left(\frac{1-\beta}{\beta}\right)\right)^{\alpha})\right]\right]$$

This is sufficient because $G\left[F(1-\widehat{\tau}^*(0) + (\widehat{x}^*(0))^{\alpha})\right] > 0$ and $F(1-\widehat{\tau}^*(g) + (\widehat{x}^*(g))^{\alpha})$ is a non-decreasing function of $g$.

the choices of the citizens and of their ruler, lead to a self-correcting adjustment back to that growth rate. It, therefore, follows that an improvement in the quality of institutions increases growth and reduces rent extraction in situations where the economy is located at a stable equilibrium.[27] Better institutions lead to less rent extraction. This induces more people to work in the market sector generating growth promoting externalities and encouraging innovations. This, in turn, increases the growth rate of the economy. We note that institutions affect growth *indirectly* through their impact on rent extraction: for a given level of corruption, variations in institutional quality do not affect the growth rate.

Below, we discuss three examples that illustrate a range of possible equilibrium configurations. The first example has a unique and stable equilibrium and the other two examples have three equilibria, two of which are stable. Throughout, we assume that $F$ is uniform on $[0, \theta]$.

**Unique equilibrium** In the first example, the economy has a unique equilibrium which may or may not be interior. This configuration can happen in many cases. Assume, for example, that $G(m) = l + \gamma m$ and that $\alpha = \frac{1}{2}$. Figure 1 shows the equilibrium for two different values of $\theta$ – the maximum productivity levels in the informal sector.[28] For $\theta = 1$, some individuals decide to remain in the informal sector and the growth rate is $g^*$. For $\theta = 0.82$, all individuals move into the official sector and the equilibrium growth rate is $g^{**} > g^*$. The kink in the equilibrium locus is caused by the fact that $F(.) = 1$ for all $g > g'$. An improvement in the quality of institutions increases $g^*$, while $g^{**}$ is unaffected: all individuals have already moved to the formal sector, so the improvement in institutional quality does not lead to additional flows.

**Multiple equilibria** Multiple equilibria is a possibility because growth and corruption are self-reinforcing: higher growth leads to lower rent extraction which allows the growth rate to be higher. This can arise under a range of circumstances. One interesting possibility is an economy in which it is almost impossible to replace rulers ($q$ close to 1). In this

[27] After an improvement in the quality of institutions, unstable equilibria become associated with lower growth and more rent seeking.

[28] The parameter values that generate this picture are $p = 0.9$, $q = 0.1$, $\beta = 0.95$, $\gamma = 0.025$ and $l = 0$.

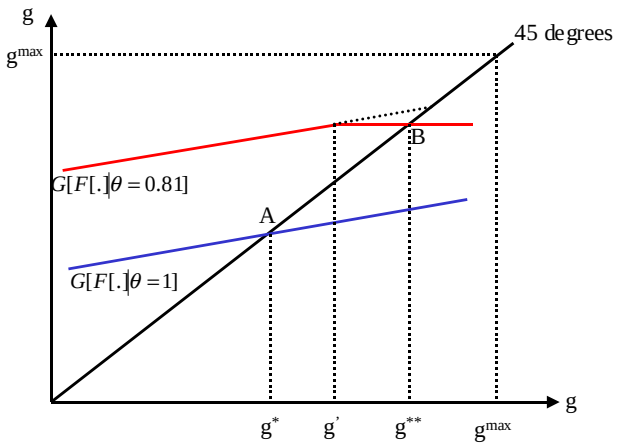


Figure 1: Two economies with a unique equilibrium.

economy, a typical equilibrium configuration is shown in Figure 2.[29] We see that this economy has two stable equilibria: one at point $A$ with relatively low growth and relatively high levels of rent extraction and one at point $C$ with high growth and low rent extraction. A third unstable equilibrium is located in between the two others at point $B$. This suggests that even near-dictatorships can experience high growth at equilibrium $C$. We can think of point $B$ as a threshold. An improvement in the quality of institutions can eliminate the two low growth equilibria and induce the economy to move to equilibrium $C$ where all individuals work in the formal sector.

Another possibility that gives rise to a similar configuration is an economy with fairly good institutions ($q$ is close to 0 and $p$ is close to 1) in which there are substantial agglomeration effects associated with the learning-by-doing or innovation process ($G'' >> 0$).[30] This suggests that it is also possible for societies with strong institutions to be trapped in a low growth, high rent extraction equilibrium. Again, improvements in the quality of institutions can help the economy escape the trap. Both of these examples demonstrate the quality of institutions is an important determinant of whether or not multiple equilibria

[29] The picture can be generated with the following parameter values: $\beta = 0.9$, $p = 1$, $q = 0.99$, $F$ is uniform on $[0, 1.2]$ and $G = l + \gamma F(.)^k$ with $l = -0.24$, $\gamma = 0.5$ and $k = 2$.

[30] An example of this is an economy with the following parameter values: $\beta = 0.9$, $p = 0.9$, $q = 0.1$, $F$ is uniform on $[0, 1.22]$ and $G = l + \gamma F(.)^k$ with $l = -0.34$, $\gamma = 0.6$ and $k = 20$.

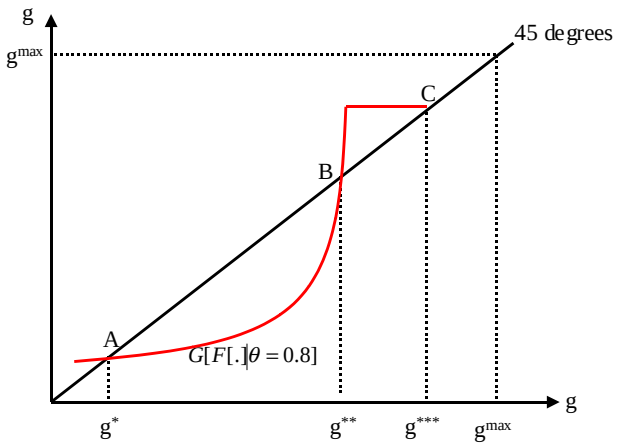


Figure 2: An economy with multiple equilibria.

and threshold effects exist.

# 7 The Empirical Strategy

The theoretical analysis highlights two points that motivate our empirical investigation. First, economic growth and corruption are jointly determined in equilibrium by (exogenous) variations in the quality of political institutions and other exogenous factors, and affect each other negatively. Moreover, the quality of institutions only affects growth indirectly through its effect on corruption. This suggests that measures of institutional quality should be excluded from the estimated growth equation. Second, due to the negative feedback mechanism between growth and corruption, there may exist multiple growth/corruption regimes. The quality of political institutions is an important determinant of whether or not this is the case, and we argue that institutional quality affects the growth performance of a country mainly through this channel. Our approach is to employ recent advances in the econometrics of threshold models to deal with both points (Caner and Hansen, 2004).

We assume that the relationship between corruption, economic growth and political institutions in a cross section of $i = 1, .., 68$ countries in the 1990s can be summarized by

the following equation

$$g_i = \alpha + \beta_1 c_i 1(q_i \leq \gamma) + \beta_2 c_i 1(q_i > \gamma) \tag{17}$$
$$+1(q_i \leq \gamma) x_i \beta_3 + 1(q_i > \gamma) x_i \beta_4 + e_i,$$

where $g_i$ measures growth of real GDP, $c_i$ is an (endogenous) measure of corruption, $q_i$ is an (exogenous) measure of the quality of institutions, $x_i$ is a vector of (other) exogenous variables known to affect economic growth, $1(.)$ is an indicator function and $\gamma$ is a threshold to be estimated. We assume that the error term follows a martingale difference sequence. The key feature of the growth model described in equation (17) is that it allows for two distinct growth regimes. Once the threshold $\gamma$ has been estimated from the data, the quality of political institutions ($q_i$) determines which of the two possible regimes a particular country belongs to. Moreover, the marginal impact of corruption and other (exogenous) determinants of growth is regime specific.

Econometrically speaking, estimation of equation (17) is complicated by the fact that corruption is an endogenous variable and that the error term ($e_i$) is correlated with the corruption variable, $c_i$. Therefore, threshold models developed for the estimation of models with exogenous regressors (see Hansen, 2000) cannot be used. Instead, we estimate equation (17) with the procedure developed by Caner and Hansen (2004). This procedure allows right-hand side variables, in this case corruption, to be endogenous. The reduced form equation for corruption is the conditional expectation of $c_i$ given $x_i'$:

$$c_i = f(x_i', \pi) + u_i \tag{18}$$

with $E(u_i|x_i') = 0$, $\pi$ is an unknown parameter vector and $u_i$ is a random error. The vector $x_i'$ contains some variables (instruments) not included in the growth regression along with the other exogenous variables of the model. We discuss these instruments in more detail below. This equation can be substituted into equation (17) to get:

$$g_i = \alpha + \beta_1 f(x_i', \pi) 1(q_i \leq \gamma) + \beta_2 f(x_i', \pi) 1(q_i > \gamma) \tag{19}$$
$$+1(q_i \leq \gamma) x_i \beta_3 + 1(q_i > \gamma) x_i \beta_4 + v_i$$

where

$$v_i = \beta_1 u_i 1(q_i \leq \gamma) + \beta_2 u_i 1(q_i > \gamma) + e_i \tag{20}$$

The parameters of this equation can be estimated sequentially. First, Least Squares are used to estimate the parameter vector $\pi$ from the reduced form. Second, the threshold $\gamma$ is chosen to minimize the sum of squared residuals from a sequence of regressions of growth on the predicted value of corruption from the first stage. Third, the regime-specific slope parameters, $\beta_1$ to $\beta_4$, are estimated by GMM on the split sample implied by the estimate of $\gamma$ using instrumental variables techniques.

Several business risk analysts and polling organizations routinely construct indexes of "perceived" corruption, based on survey responses of business people, experts and local residents.[31] Our preferred measure of corruption is the average from 1996 to 2002 of the corruption perception index (CPI) constructed by Transparency International. This is a composite index that is compiled by researchers based at the University of Gottingen. It uses information from a number of individual surveys and ratings. For example, the 1998 index is based on 12 surveys from 7 different institutions. Most of the primary indices are first converted to a common scale and they are averaged to produce the corruption perception index, which varies between 10 (the least corrupt country) to 0 (the most corrupt country). Compared to other indices of corruption, the corruption perception index has the advantage that it is available for recent years. In addition, as it is based on averages from different sources, one might hope that measurement errors wash out.[32]

[31] These indices, typically, measure corruption as the likelihood that government officials would demand bribes in exchange for special licenses, policy protection, biased judicial sentences, avoidance of taxes and regulations or simply to expedite government procedures.

[32] It is also worth noting that the sub-indices of the CPI are highly correlated both with each other and across time. Furthermore, indices of perceived corruption constructed from surveys of business people match well with indices constructed from cross-sectional polls of the inhabitants of the countries (Treis-

The quality of political institutions is hard to measure empirically, but an number of alternative measures are available. To keep as closely as possible to the theoretical model, we have chosen to use an index of the quality of governance institutions constructed by Kaufmann et al. (1999), called the voice and accountability index. This index aggregates indicators of various aspects of the political process, civil liberties, and political rights with the purpose of measuring the extent to which citizens of a country are able to participate in the selection of their government and able to hold their chosen government accountable for its policy choices. The variable has been re-scaled to lay in the interval 0 (weak institutions) to 1 (strong institutions).

Table 1 shows a cross tabulation of the countries according to their score on the corruption perception index and on the voice and accountability index. While countries that are not perceived to be very corrupt tend to have good institutions, there is a fair share of countries that, in spite of being perceived to be corrupt still score well on the voice and accountability index. Moreover, we note that poor countries are perceived to be more corrupt than rich countries, with the notable exception of Italy.

[Table 1 to appear here].

We estimate the model on a cross-section of 68 countries drawn from all five continents. Growth is measured as average GDP growth over the period 1996-2000 computed from the PPP-adjusted GDP figures contained in the Penn World Data Tables (Heston et al., 2002). We estimate a number of different specifications of the model. All specifications control for the initial level of GDP in 1995, but differ in the set of control variables included in the growth regression and in the instrumental variables used to generate exogenous variation in corruption. Among the control variables, we include a number of (exogenous) economic factors that are likely to affect economic growth. This include the population growth rate,

man, 2000). These observations give some confidence that these measures do capture important aspects of corruption in a consistent way. Yet, since views on corruption can be influenced by the economic circumstances of a particular country, it cannot be ruled out entirely that the indices partly capture economic outcomes rather than corruption per se, nor can it be ruled out that they capture other aspects of the governance environment than corruption. This should be kept in mind when interpreting the results of the analysis.

a measure of human capital formation and the investment ratio. We also report the results from a more parsimonious specification that only controls for regional effects.

For each of these specifications, we present results for alternative sets of instruments for corruption. As discussed in Section 2, two approaches to isolate exogenous variation in corruption (and other government diversion policies) has been proposed in the recent literature. One approach is to look for deep historical, geographical, or cultural factors such as distance from equator, population share with English as their mother tongue, settler mortality, the size of a country, legal tradition and so on. Another, advocated by Persson (2004), is to use constitutional rules, such as age of democracy, election rules, regime type (presidential versus parliamentarian), as an exogenous source of variation in corruption. We use a combination of these two types of instruments. Among the historical and cultural instruments, we include distance from equator, the area of the country, and legal tradition. Distance from equator reflects, as pointed out by Hall and Jones (1999) and Acemoglu et al. (2001) among others, the depth of European cultural influence and is strongly correlated with the incidence of tropical disease among early European settlers and thus their incentive to build good institutions. Area captures an important aspect of the natural environment of a country and is negatively correlated with corruption (Lederman et al. 2005). This correlation is not surprising: it is reasonable to suppose that larger countries need to develop better quality institutions to effectively protect their and rule their territory. Legal tradition measures whether the legal code of a country belongs to the common law family or not. Legal systems differ in the degree of protection and the opportunities for recourse they offer to private property owners against corrupt officials and derive from historical factors such as colonization. La Porta et al. (1999) argue that common law systems offer greater protection of property against the state and therefore reduce the potential for corruption relative to other legal systems and that the legal tradition affects development (growth) only through this channel.[33] In addition to these historical and cultural instruments, we also consider one of the "constitutional rules"

[33]We have also tried a number of alternative instruments for corruption such as the Index of Ethnolinguistic Fractionalisation (Mauro, 1995), but the results are similar to those presented below.

instrument used by Persson (2004)[34]: the age of democracy, measured as the number of years of uninterrupted democratic rule going back from year 2000. Persson and Tabellini (2003, chapter 5) argue that countries with a longer democratic tradition have developed better and more effective means of controlling corruption (and other diversion policies pursued by governments). Accordingly, age of democracy captures the notion that older democracies are likely to pursue systematically different policies than newer ones, but is in itself not a determinant of growth. Finally, since Caner and Hansen's (2004) procedure requires that the variable $q_i$ is exogenous and the quality of institutions only affects growth through the choice of regime, the voice and accountability index automatically becomes an instrument for corruption. In conclusion, we believe that there are a priori reasons why these five variables are reasonable candidates for instruments. As we shall see below, on purely statistical grounds, the five instruments perform well in the sense of passing Hansen's J-test for over-identifying restrictions and in the sense of being relevant determinants of corruption.

# 8 The Results

In this section, we report the results from our examination of the empirical relationship between economic growth and corruption. As a benchmark, we have estimated the econometric model specified in equation (17) on the whole sample of countries without taking the possibility of thresholds into account. A representative subset of the results in which distance from Equator, area, and the voice and accountability index are used as instruments are shown in Table 2. We note that corruption is insignificant in all specifications. Similar results obtain with the other instruments (not reported).[35] Thus, when thresholds are ignored, we are unable, within our particular sample, to identify any relationship between corruption and growth.

[Table 2 to appear here].

[34]The other two instruments used by Persson (2004) – electoral system and regime type – do not generate enough variation to allow separate identification of the two growth/corruption regimes and are therefore not included in the analysis.

[35]The full set of results is available upon request.

Next, we report in Tables $3a-c$ the estimates of equation (17) using the threshold estimation technique and different sets of instrument variables.[36] In all specifications, we find a significant threshold effect and identify two separate growth/corruption regimes: one regime with high quality institutions (voice and accountability index of more than 0.76 and including 19 countries) and another regime with low quality institution (voice and accountability index of less than 0.76 and including 49 countries). The countries in the regime with high quality institutions have, on average, higher growth rates and lower levels of perceived corruption than countries in the regime with low quality institutions. This is indicative of the existence of multiple equilibria, although, as stressed by Durlauf and Johnson (1995), it is not conclusive evidence.[37]

The estimated impact of corruption on growth is different in the two regimes. In the regime with high quality institutions, corruption reduces the growth rate in all specifications. Using the point estimates from Table $3a$, we find that a one unit increase in the corruption perception index reduces growth by between 0.14 and 0.28 percentage points. Alternatively, if the Costa Rica could increase its score on the average corruption perception index from 6.2 to the level of Denmark (which has a score of 9.3), the growth rate of Costa Rica would, ceteris paribus, increase by 0.43-0.87 percentage points. The estimated effect is larger still when age of democracy and legal tradition, respectively, are used as instruments for corruption (see Tables 3b and 3c).

In the regime with low quality institutions, the impact of corruption on growth is less robustly estimated, and the specific results are sensitive to the choice of instruments and control variables. In Table $3a$, where we use distance from equator, area and the voice and accountability index as instruments, the results suggest that corruption increases the growth rate, although the effect is only significant in the specification with regional dummies.[38] In Tables $3b$ and $3c$, where we use age of democracy and legal tradition, re-

[36] We note that in all the reported specifications, we cannot reject the over-identifying restrictions (using Hansen's J-test) and that the instruments are highly significant in the first-stage regressions.

[37] The two regimes can be consistent with a single equilibrium if the equilibrium locus has a discontinuity and some countries are below and other above the discontinuity point.

[38] The positive relationship between corruption and growth is even stronger in specifications that use legal tradition, area and the voice and accountability index as instruments (not reported).

spectively, as instruments, the estimates do point in the direction of a negative relationship between corruption and growth, but the effect is never statistically significant.

# 9 Discussion

The paper provides a theoretical and an empirical investigation of the links between corruption, economic growth, and political institutions that take the possibility of threshold effects and the possibility of multiple equilibria into account. The theoretical model highlights a particular mechanism through which this can happen and stresses the role of political institutions and complementarity between economic growth and corruption. The model is consistent with the empirical results in the sense of identifying two corruption/growth regimes.

Empirically, our results highlight the importance of allowing for non-linear effects in the mapping from corruption (and other divergent government policies) to economic growth. Only when the sample is split according to the quality of political institutions is it possible to establish a significant link between corruption and growth in the sample of countries under consideration. This suggests that regime-specific differences are important. Of particular interest is the result that, conditional on having weak institutions, corruption is not associated with worse growth outcomes, and, if anything, there may even be a small positive impact. This is a surprising finding, which is not consistent with our theory. The finding may instead be related to the greasing the wheels hypothesis of corruption: given deficient institutions, corruption may allow the economy to work more smoothly by allowing individuals to circumvent the worse of these deficiencies (Leff, 1964). This, of course, leaves out the broader question of why the institutions are deficient in the first place, the answer to which might well be related to corruption itself.

We conclude by raising three caveats related to the interpretation of our empirical results. First, as already pointed out above, the fact that we identify two distinct corruption/growth regimes cannot be taken as conclusive evidence of multiple equilibria. Nonetheless, the finding is suggestive. From a policy point of view, the existence (or not) of multiple equilibria is important because it determines whether large-scale institutional

reforms as opposite to piecemeal and gradual reforms are needed to move countries out of the low growth/high corruption regime. Second, although our instruments are statistically valid in the sense of Hansen's J-test and relevant in the sense of explaining corruption, one may still worry that there exist variables omitted from the reported growth regressions that are correlated with the instruments and that the estimates therefore remain biased. We have tried to address this issue by using a range of different instruments. We take some comfort in the fact that the results point in the same direction: negative impact of corruption conditional on high quality institutions and no or a small positive impact of corruption conditional on deficient institutions. Third, we emphasize that the evidence is based on a limited cross section of countries covering a relatively short time period in the late 1990s. Caner and Hansen's (2004) procedure does not allow for a panel structure, so combined cross section time series analysis must await further advances in methodology. Moreover, the fact that the earliest corruption perception data are from the mid-1980s makes it questionable to include corruption perception indices in long-run growth regressions and we believe the best approach, however imperfect it may be, it to focus on the link between corruption and short-run growth.

# 10 Appendix A: Data

Table A1 shows that descriptive statistics of the main variables used in the econometric analysis.

[Table A1 to appear here].

The following variables are used in the analysis:

1. The corruption perception index is measured as an average of up to 12 different corruption perception indices as compiled by Transparency International (http://www.transparency.org).
2. The voice and accountability index measures aspects of the political process, civil liberties and political rights related to the extent to which citizens can participate in the election of their governments and are able to hold them accountable for their policy choices. (Kaufmann et al., 1999).
3. Age of democracy is measured as the number of years with uninterrupted democratic rule, going backwards from year 2000 (democracy defined as the first year in which the POLITY IV index is positive). (constructed from Marshall and Jaggers, 2000).
4. GDP per capita, PPP adjusted, is taken from Penn World Data Tables, version 6.1. (Heston et al., 2002).

5. Investment share of GDP is taken from Penn World Data Tables, version 6.1. (Heston et al., 2002).

6. Human capital is measured as the percentage of population in primary education in 1995. (Barro and Lee, 2001).

7. Population growth is from Penn World Data Tables, version 6.1. (Heston et al., 2002).

8. Legal tradition is a dummy variable equal to 1 if the company law or commercial code of the country is the English Common Law. (La Porta et al., 1999).

9. Distance from equator is the distance from equator (in degrees), ranging between -90 to 90. (Hall and Jones, 1999).

# 11 Appendix B: Proofs

**Proof of Proposition 1**. Note that

$$max\{\beta p(1+g), \beta q(1+g)\} \leq \beta(1+g) < 1 \tag{21}$$

Incentive compatibility requires that

$$V_t(C) = V_t^* \geq V_t(D) \text{ for } t = 0, 1, 2, ..... \tag{22}$$

By routine substitution, using equations (3) and (5), we get that $V_t(C) \geq V_t(D)$ if, and only if

$$IC_t \quad \widehat{z}_t + (p-q)\beta \sum_{k=0}^{\infty} (p\beta)^k \widehat{z}_{t+1+k} \geq \mathcal{T}_t \tag{23}$$

for $t = 0, 1, 2, .....$ The electorate wants to minimize rent extraction $\sum_k \beta^k z_{t+k}$ subject to incentive compatibility constraints $\{IC_{t+k}\}_{k=0}^{\infty}$ for all $t$, yielding

$$\widehat{z}_t - q\beta\widehat{z}_{t+1} = \mathcal{T}_t(1 - \beta p(1+g)) \text{ for } t = 0, 1, 2, ..... \tag{24}$$

Substitution, using the fact that $\mathcal{T}_t = a_0(1+g)^t\mathcal{T}$, yields

$$\widehat{z}_t = \mathcal{T}(1 - \beta p(1+g))a_0(1+g)^t \sum_{k=0}^{\infty} (q\beta(1+g))^k \tag{25}$$

which can be simplified to get $z_t^*$ defined in equation (8). Any sequence $\widehat{z}_t \geq z_t^*$ is incentive compatible

**Proof of Proposition 3.** To simplify notation define $k(g) \equiv \frac{1-p\beta(1+g)}{1-q\beta(1+g)}\mathcal{T}$. Constraints (11) and (12) in problem (10) are binding at each $t$. We can, therefore, combine the two constraints at each $t$ and consider the following sequence of one-period Lagrangians

$$L_t = \beta^t \left[a_t(1-\tau_t) + a_t x_t^a + \lambda_t \left[a_t \tau F(1 - \tau_t + x^\alpha) - a_t x_t - a_t k(g)\right]\right]. \tag{26}$$

where $\lambda_t$ is the multiplier on the (joint) constraint at time $t$. It is clear that the solution must have $\tau_t$ and $x_t$ strictly positive, and that $\lambda_t > 0$ for all $t$. The Kuhn-Tucker conditions at time $t$ imply

$$-1 + \lambda_t \left[F(1 - \tau_t + x_t^\alpha) - \tau_t f(1 - \tau_t + x_t^\alpha)\right] = 0, \tag{27}$$

$$\alpha x_t^{\alpha-1} - \lambda_t \left[\tau_t f(1 - \tau_t + x_t^\alpha)\alpha x_t^{\alpha-1} - 1\right] = 0, \tag{28}$$

$$\tau F(1 - \tau_t + x_t^\alpha) - x_t - k(g) = 0. \tag{29}$$

We note that any solution must be stationary. Let $\{\tau^{**}, x^{**}\}$ be a candidate solution to the problem. Observe that

$$\left[F(1 - \tau + x^\alpha) - \tau f(1 - \tau + x^\alpha)\right] = 0 \tag{30}$$

and

$$\left[\tau f(1 - \tau + x^\alpha)\alpha x^{\alpha-1} - 1\right] = 0 \tag{31}$$

at $\tau = \tau^*$ and $x = x^*$. Equation (27) and (28) then imply that $\tau^{**} < \tau^*$ and $x > x^*$ for all $t$. Rearrange equations (27) to get

$$\lambda = \frac{1}{\left[F(1 - \tau + x^\alpha) - \tau f(1 - \tau + x^\alpha)\right]} \tag{32}$$

and rewrite equation (28) as

$$\alpha x^{\alpha-1} F(1 - \tau + x^\alpha) - 1 = 0. \tag{33}$$

Equations (29) and (33) determine the constrained efficient $\tau$ and $x$ uniquely. To prove this, we write

$$h_1(\tau, x) = \tau F(1 - \tau + x^\alpha) - x - k = 0, \tag{34}$$

$$h_2(\tau, x) = \alpha x^{\alpha-1} F(1 - \tau + x^\alpha) - 1 = 0. \tag{35}$$

For $\tau < \tau^*$ and $x > x^*$, we got

$$\frac{\partial h_1(\tau, x)}{\partial x} = \tau f(.)\, \alpha x^{\alpha-1} - 1 < 0 \tag{36}$$

$$\frac{\partial h_1(\tau, x)}{\partial \tau} = F(.) - \tau f(.) > 0 \tag{37}$$

$$\frac{\partial h_2(\tau, x)}{\partial x} = \alpha x^{\alpha-2} \left[\alpha x^\alpha f(.) - (1 - \alpha) F(.)\right] < 0 \tag{38}$$

$$\frac{\partial h_2(\tau, x)}{\partial \tau} = -\alpha x^{\alpha-1} f(.) < 0 \tag{39}$$

where a sufficient condition for $\frac{\partial h_2(\tau,x)}{\partial x} < 0$ is that $F$ is uniform on $[0, \theta]$. Thus, for $\tau < \tau^*$ and $x > x^*$, we see that

$$\left.\frac{d\tau}{dx}\right|_{h_1} = -\frac{\frac{\partial h_1(\tau,x)}{\partial x}}{\frac{\partial h_1(\tau,x)}{\partial \tau}} > 0 \tag{40}$$

and

$$\left.\frac{d\tau}{dx}\right|_{h_2} = -\frac{\frac{\partial h_2(\tau,x)}{\partial x}}{\frac{\partial h_2(\tau,x)}{\partial \tau}} < 0 \tag{41}$$

**Proof.** Notice that $h_1(\tau^*, x^*) > 0$ so $h_1(\tau', x^*) = 0$ implies that $\tau' < \tau^*$ because $\tau F(1-\tau+x^\alpha) - x = \mathcal{T}$ at $\{\tau^*, x^*\}$ and $\frac{1-p\beta(1+g)}{1-q\beta(1+g)} < 1$. Notice that $h_2(\tau^*, x^*) = 0$ because $F(1-\tau+x^\alpha) = \tau f(1-\tau+x^\alpha)$ and $\alpha x^{\alpha-1}\tau f(1-\tau+x^\alpha) = 1$ at $\{\tau^*, x^*\}$. Thus, there exist one and only one solution to equations (29) and (33). The proposition follows by setting $\{\widehat{\tau}^*, \widehat{x}^*\} = \{\tau^{**}, x^{**}\}$ ■

**Proof of Proposition 4.** Let $\widehat{\upsilon}^* = 1 - \widehat{\tau}^* + (\widehat{x}^*)^\alpha$ and let

$$\begin{aligned} \Delta &= \frac{\partial h_1(\tau,x)}{\partial \tau}\frac{\partial h_2(\tau,x)}{\partial x} - \frac{\partial h_1(\tau,x)}{\partial x}\frac{\partial h_2(\tau,x)}{\partial \tau} \\ &= \left(F(.) - \tau f(.)\right)\alpha x^{\alpha-2}(\alpha-1)F(.) + \alpha f(.)\, x^{\alpha-1}\left(\alpha F x^{\alpha-1} - 1\right) \end{aligned} \tag{42}$$

where $\Delta < 0$ at $\{\widehat{\tau}^*, \widehat{x}^*\}$ and the functions $h_1$ and $h_2$ are defined in the proof to proposition 3. Using Cramer's rule, we find that

$$\frac{\partial \widehat{\tau}^*}{\partial g} = \frac{\frac{\partial h_2(\widehat{\tau}^*, \widehat{x}^*)}{\partial x}\frac{\partial k}{\partial g}}{\Delta} < 0 \tag{43}$$

$$\frac{\partial \widehat{x}^*}{\partial g} = \frac{\frac{\partial h_1(\widehat{\tau}^*, \widehat{x}^*)}{\partial \tau}\frac{\partial k}{\partial g}}{\Delta} > 0 \tag{44}$$

and so $\frac{\partial \widehat{\upsilon}^*}{\partial g} > 0$. The proposition follows from the fact that the size of the formal sector $F(\upsilon)$ is decreasing in $\upsilon$ until the point where all workers are in the formal sector

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**Table 1. The Corruption Perception Index (1995-2000) and the Voice and Accountability Index: A cross tabulation.**

| | Voice and Accountability | | |
|---|---|---|---|
| Corruption Index | Weak 0-0.5 | Strong 0.5-1 | |
| Most corrupt (0-5) | Cameroon | Czech Rep | Thailand |
| | Indonesia | Uruguay | Argentina |
| | Tanzania | Italy | Latvia |
| | Paraguay | Mauritius | Zambia |
| | Russia | Greece | Bulgaria |
| | Pakistan | Panama | Mexico |
| | Egypt | Mongolia | Jamaica |
| | Croatia | Venezuela | Lithuania |
| | Senegal | Bolivia | Brazil |
| | Turkey | Colombia | Poland |
| | Zimbabwe | India | Czech Rep |
| | Belarus | Trinidad and Tobago | Uruguay |
| | Morocco | Nicaragua | Italy |
| | Peru | Romania | Mauritius |
| | | | Greece |
| Least Corruption (5-10) | Tunisia | Australia | Ireland |
| | | Austria | Israel |
| | | Belgium | Japan |
| | | Canada | Luxembourg |
| | | Chile | Malaysia |
| | | Costa Rica | Netherlands |
| | | Denmark | Norway |
| | | Estonia | Portugal |
| | | Finland | Singapore |
| | | France | South Africa |
| | | Germany | Spain |
| | | Hungary | Sweden |
| | | Iceland | Switzerland |
| | | | UK |
| | | | USA |

Notes: A high value of the corruption index means that the country is less corrupt. The classification is based on the average values of the corruption perception index 1995-2000.
Source: Transparency International and Kaufmann et al. (1999).

**Table 2. IV estimation without threshold effects**

**Dependent Variable:** Per capita GDP Growth (1995-2000 Yearly Average)
**Instruments:** Distance from equator, the voice and accountability index and Area in square kilometres

| *Independent Variables* | **1** | **2** | **3** | **4** | **5[a]** |
|---|---|---|---|---|---|
| Constant | 0.0038 | 0.0028 | 0.0059[#] | 0.0032 | 0.0088 |
| | (1.29) | (0.8) | (1.90) | (0.85) | (3.24) |
| Corruption Index | -4.13e-06 | -0.000010 | 0.00007 | -0.000025 | -0.0005 |
| | (-0.01) | (-0.021) | (0.14) | (-0.05) | (-0.97) |
| Initial GDP | 3.54e-07* | 3.16e-07* | 2.88e-07* | 3.54e-07* | 3.85e-07* |
| | (3.95) | (2.99) | (2.64) | (3.98) | (3.67) |
| Investment ratio | | 0.000078 | | | |
| | | (0.57) | | | |
| Population Growth | | | -0.033[#] | | |
| | | | (-1.70) | | |
| Primary Education | | | | 0.000016 | |
| | | | | (0.34) | |

Notes: t-ratios in brackets. * = significant at the 5 per cent level or more; # significant at the 10 per cent level. a=include set of region dummies.

**Table 3a. IV estimation with threshold effects.**

**Dependent Variable:** Per capita GDP Growth (1995-2000 Yearly average)
**Instruments:** Area in square Kms, Distance from Equator
and the voice and accountability index.
**Threshold variable:** the voice and accountability index (VA)

| ***Regime 1: VA>0.76*** | ***1*** | ***2*** | ***3*** | **4** | **5[a]** |
|---|---|---|---|---|---|
| Constant | -0.017* | -0.017* | -0.017* | -0.015 | -0.0078[#] |
| | (-3.68) | (-2.23) | (-2.89) | (-1.59) | (-1.92) |
| Corruption Index | 0.0028* | 0.0028* | 0.0028* | 0.0028* | 0.0014* |
| | (4.03) | (2.04) | (2.44) | (2.08) | (2.38) |
| Initial GDP | 1.56E-0.7 | 1.48E-07 | 1.59E-07 | 1.08E-07 | 2.35E-07* |
| | (1.12) | (0.74) | (0.77) | (0.56) | (4.22) |
| Investment ratio | | 8.64E-06 | | | |
| | | (0.06) | | | |
| Population Growth | | | 0.0033 | | |
| | | | (0.18) | | |
| Primary Education | | | | -3.99E-05 | |
| | | | | (-0.62) | |
| J-test ($\chi^2$)[c] | 0.81 | 0.89 | 0.87 | 2.12 | 3.35 |
| ***Regime 2: VA<0.76*** | **6** | **7** | **8** | **9** | **10[a]** |
| Constant | 0.009* | 0.009* | 0.010* | 0.007[#] | 0.017* |
| | (2.08) | (2.18) | (3.07) | (1.70) | (3.67) |
| Corruption Index | -0.0014 | -0.0015 | -0.0007 | -0.0014 | -0.0022* |
| | (-1.11) | (-1.48) | (-0.75) | (-1.11) | (-2.14) |
| Initial GDP | 0.0038 | 3.60E-07* | 2.81E-07* | 3.58E-07* | 4.18E-07* |
| | (1.29) | (2.49) | (3.85) | (3.44) | (3.79) |
| Investment ratio | | 2.49E-05 | | | |
| | | (0.11) | | | |
| Population Growth | | | -0.046* | | |
| | | | (-3.85) | | |
| Primary Education | | | | 4.27E-05 | |
| | | | | (0.66) | |
| J-test ($\chi^2$)[c] | 0.82 | 0.79 | 0.60 | 0.74 | 1.50 |
| F-test of relevance of instruments[b] | F(3,63)= 22.57* | F(3,63)= 23.33* | F(3,62)= 22.07* | F(3,62)= 21.78* | F(3,58)= 14.40* |

Notes: t-statistics in brackets. * = significant at the 5 per cent level; # significant at the 10 per cent level. a=include set of region dummies. b=the F-test refers to the whole sample. c=The critical value for Hansen's J-test is 5.99.

**Table 3b. IV estimation with threshold effects.**

**Dependent Variable:** Per capita GDP Growth (1995-2000 Yearly Average)
**Instruments:** Age of Democracy and the voice and accountability index
**Threshold variable:** the voice and accountability index (VA)

| ***Regime 1: VA>0.76*** | ***1*** | ***2*** | ***3*** | **4** | **5[a]** |
|---|---|---|---|---|---|
| Constant | -0,025* | -0,031* | -0,025* | -0,027 | -0.016 |
| | (-2.050) | (-2.013) | (-2.077) | (-1.68) | (-1.38) |
| Corruption Index | 0,004* | 0,0048 | 0,0037* | 0,004* | 0.002* |
| | (2.31) | (2.22)* | (2.167) | (2.15) | (2.13) |
| Initial GDP | 1,39e-07 | 2,65e-07 | 1,43e-07 | 1,38e-07 | 1.54E-07 |
| | (0.727) | (1.204) | (0.690) | (0.758) | (1.014) |
| Investment ratio | | -0,00027 | | | |
| | | (-0.93) | | | |
| Population Growth | | | 0,0015 | | |
| | | | (0.071) | | |
| Primary Education | | | | 0,000062 | |
| | | | | (0.725) | |
| J-test ($\chi^2$)[c] | 0,196 | 0,011 | 0,204 | 0,180 | 0.325 |
| ***Regime 2: VA<0.76*** | **6** | **7** | **8** | **9** | **10[a]** |
| Constant | 0,00047 | 0,000075 | 0,0040 | -0,00060 | 0.011 |
| | (0.064) | (0.0099) | (0.571 ) | ( -0.082) | (1.88) |
| Corruption Index | 0.0014 | 0.0015 | 0.0014 | 0.0014 | -0.0009 |
| | (0.851) | (0.858) | (0.87) | (0.80) | (-0.79) |
| Initial GDP | 3,27e-07* | 3,52e-07* | 2,41e-07[#] | 3,24e-07* | 4.39E-07* |
| | (-3.05) | (-2.48) | (1.84) | (3.00) | (5.40) |
| Investment ratio | | -0,000047 | | | |
| | | (-0.230) | | | |
| Population Growth | | | -0,063* | | |
| | | | (-2.99) | | |
| Primary Education | | | | 0,000010 | |
| | | | | (0.19) | |
| J-test ($\chi^2$)[c] | 2,676 | 2,566 | 0,969 | 2,672 | 2.067 |
| F-test of relevance of instruments[b] | F(2,64)= 36,40* | F(2,63)= 40,16* | F(2,63)= 35,68* | F(2,63)= 36,07* | F(2,59)= 25,60* |

Notes: t-statistics in brackets. * = significant at the 5 per cent level or better; # significant at the 10 per cent level. a=include set of region dummies. b=the F-test refers to the whole sample. c=The critical value for Hansen's J-test is 3.84.

**Table 3c. IV estimation with threshold effects.**

**Dependent Variable:** Per capita GDP Growth (1995-2000 Yearly Average)
**Instruments:** Legal tradition and the voice and accountability index
**Threshold variable:** The voice and accountability index (VA)

| ***Regime 1: VA>0.76.*** | **1** | **2** | **3** | **4** | **5[a]** |
|---|---|---|---|---|---|
| Constant | -0.032* | -0.025* | -0.032* | -0.034 | -0.03 |
| | (-2.01) | (-2.15) | (-1.98) | (-1.77) | (-1.39) |
| Corruption Index | 0.0045* | 0.0043* | 0.0047* | 0.0047* | 0.0043 |
| | (2.32) | (2.31) | (2.27) | (2.21) | (1.67) |
| Initial GDP | 1.23E-07 | 1.88E-07 | 6.63E-08 | 1.24E-07 | 5.57E-08 |
| | (0.66) | (0.86) | (0.36) | (0.69) | (0.30) |
| Investment ratio | | -0.00027 | | | |
| | | (-0.914) | | | |
| Population Growth | | | -0.014 | | |
| | | | (-0.56) | | |
| Primary Education | | | | 1.70E-05 | |
| | | | | (0.17) | |
| J-test ($\chi^2$)[c] | 2.94 | 2.28 | 2.93 | 3.00 | 2.03 |
| ***Regime 2: VA<0.76*** | **6** | **7** | **8** | **9** | **10[a]** |
| Constant | 0.0015 | 0.00011 | 0.0044 | 0.0011 | 0.011* |
| | (0.197) | (0.016) | (0.65) | (0.149) | (2.12) |
| Corruption Index | 0.00029 | 0.00040 | 0.00028 | 0.00026 | -0.0011 |
| | (0.168) | (0.27) | (0.192) | (0.145) | (-0.97) |
| Initial GDP | 4.20E-07* | 3.85E-07* | 3.38E-07* | 4.18E-07* | 4.37E-07* |
| | (3.94) | (3.24) | (3.33) | (3.83) | (4.42) |
| Investment ratio | | 7.15E-05 | | | |
| | | (0.34) | | | |
| Population Growth | | | -0.037* | | |
| | | | (-2.05) | | |
| Primary Education | | | | 1.39E-05 | |
| | | | | (0.21) | |
| J-test ($\chi^2$)[c] | 0.031 | 0.019 | 0.0008 | 0.017 | 0.42 |
| F-test of relevance of instruments[b] | F(2,64)= 33.31 | F(2,63)= 35.11 | F(2,63)= 32.54 | F(2,63)= 32.98 | F(2,59)= 22.01 |

Notes: T-statistics in brackets. * = significant at the 5 per cent level; # significant at the 10 per cent level. a=include set of region dummies. b=the F-test refers to the whole sample. c=the critical value for Hansen's J-test is 3.84.

| **Table A1:** Descriptive statistics | | | |
|---|---|---|---|
| Series | Mean | Minimum | Maximum |
| | | | |
| **Institutional Variables** | | | |
| Corruption perception index[a,c] | 5.06 | 1.71 | 9.93 |
| Voice and accountability index | 0.62 | 0.3 | 0.8 |
| **Macroeconomic Series** | | | |
| Per capita GDP growth[b] | 0.0074 | -0.013 | 0.034 |
| Investment/GDP[f] | 18.45 | 5.4 | 43.9 |
| Per capita initial GDP[f] | 11042 | 466 | 34372 |
| Primary Education[e] | 34.6 | 8.2 | 62.0 |
| Secondary Education[e] | 35.6 | 5.2 | 58.8 |
| Population[f] | 47111 | 273 | 971743 |
| Population Growth[f] | 0.05 | -0.07 | 0.25 |
| | | | |

Notes: a = The corruption index is computed as the simple average of the corruption indexes for the period 1995-2000. b = the growth rate is the average annual rate. Sources: c: Transparency International; d: Kaufmann et al. (1999); e: Barro and Lee (2001); f: Heston et al. (2002).