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Governance regimes, corruption and growth: Theory and evidence

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We study the role of political accountability as a determinant of corruption and economic growth. Our model identifies two governance regimes defined by the quality of political institutions and shows that the relationship between corruption and growth is regime specific. We use a threshold model to estimate the impact of corruption on growth where corruption is treated as an endogenous variable. We find two governance regimes, conditional on the quality of political institutions. In the regime with high quality political institutions, corruption has a substantial negative impact on growth. In the regime with low quality institutions, corruption has no impact on growth. *Journal of Comparative Economics* **36** (2) (2008) 195–220. Faculty of Economics, University of Cambridge, Sidgwick Avenue, Austin Robinson Building, CB59DD Cambridge, UK; University of Birmingham, Birmingham, UK; Aston Business School, Aston University, Birmingham, UK.

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1. Introduction

Corruption, economic growth and the quality of political institutions are related through a complex web. As with many other social systems, the links among the variables within the corruption-growth-institutions nexus are unlikely to be simple linear relationships. Feedback effects, thresholds and other sources of non-linear dynamics are likely to play a role. In this paper, we explore the possibility that differences in the quality of political institutions—in particular in their capacity to hold political leaders accountable for their actions while in office—may in itself be a source of nonlinearity in the mapping between corruption and growth. To see why this may be the case, think of two societies, B and G. In society B, political institutions are so dysfunctional that the political leadership is effectively free to extract as much rent as they like from the economy. In response to this, citizens leave the formal sector of the economy and seek refuge in the informal sector. The net result is low growth or stagnation. In society G, on the

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other hand, political institutions allow citizens to replace leaders if they are too corrupt. This has a disciplining effect on their behavior and allows the formal economy to flourish and grow. Moreover, economic growth means that the resource base from which leaders extract rents expands over time. This makes them more eager to hold on to political power and creates a benign feedback loop between economic growth and corruption: high growth reduces corruption which, in turn, increases growth. It is clear from this example that the quality of institutions can play a critical role in defining the relationship between corruption and economic growth and that empirical investigations that postulate a simple linear relationship are missing potentially important effects. To develop this argument, we, firstly, propose a political economy model that identifies two governance regimes and shows why the relationship between growth and corruption is regime specific as suggested by the example above. Secondly, we explicitly treat corruption and growth as endogenous variables in an empirical setting that allows for the estimation of threshold effects. In this way, we provide new evidence on the relationship between corruption and growth and the role that institutional quality plays in shaping this relationship.

The novelty of the empirical contribution is that we estimate a non-linear growth model that allows for threshold effects. To this end, we use the method proposed by Caner and Hansen (2004). Our results suggest that there do exist multiple governance regimes and that the relationship between corruption and growth is highly regime specific. Our empirical investigation contributes to the literature on the growth consequences of corruption.[1] Most of the studies in this literature assume that the relationship between corruption and growth (or its constituents) is linear.[2]

To our knowledge there are only two recent studies that introduce nonlinearities into the corruption/growth relationship. Firstly, Méndez and Sepúlveda (2006) argue that the relationship between corruption and growth is non-monotonic (quadratic) and that this relationship depends on the degree of political freedom. They show that corruption has a beneficial impact on long-run growth at low levels of incidence but is harmful at high levels and that there therefore may exist a growth maximizing level of corruption. Importantly, this effect is only robust in a subsample of countries with a high degree of political freedom; elsewhere the relationship between corruption and growth is not robust. Using a different definition of political institutions, we find a similar result, namely that in countries with high quality institutions, corruption has a large, negative impact on growth and conversely that growth reduces corruption; while in countries with low quality institutions, corruption has, in contrast, no impact on growth. The main innovation of our approach, relative to Méndez and Sepúlveda (2006), is that we do not split the sample of countries according to some predetermined rule, but allow for the data to determine which of two potential growth regimes a country belongs to. We also present some estimations of the impact of growth on corruption. In this case, we find that faster growth reduces corruption in countries with high quality institutions, while in countries with poor institutions, growth has no impact on corruption. Secondly, Méon and Sekkat (2005) propose an interesting test of the "greasing the wheels" versus "sand in the wheels" hypothesis of corruption. Using interactions between indicators of the quality of institutions and corruption, they report that corruption is most harmful to growth where governance is weak. The main difference between this approach and ours is that the threshold methodology we employ allows all parameters of the model to differ across regimes and to be *discretely* different, while the "interaction methodology" employed by Méon and Sekkat (2005) pre-supposes that corruption is a smooth function of the index used to measure the quality of institutions. Both approaches have merits, but we believe (partly based on our theoretical model) that discontinuities are likely to be important. We also differ from these studies by considering both short- and long-run growth rates and by using instrumental variables to deal with the problem of reverse causality.[3] The seminal empirical paper on multiple regimes in the neoclassical growth model is the study by Durlauf and Johnson (1995).[4] In contrast to this study, we focus on regimes that are identified by the quality of political institutions rather than by the level of income. Moreover, we use a different statistical technique to identify the regimes that takes into account the joint determination of growth and corruption.

Our theoretical model combines elements from the literature on retrospective voting (e.g., Ferejohn, 1986) with elements from both the literature on endogenous growth and the literature on corruption with non-benevolent prin-

[1] See, for example, the surveys by Rose-Ackerman (1999), Bardhan (1997) or Svensson (2005).

[2] See, for example, Mauro (1995), Mo (2001), Gyimah-Brempong (2002), Wei (2000), Paldam (2002) and Lambsdorff (2003). It is, however, an open question how robustly related corruption is to growth in *linear* growth models (see Sala-i-Martin et al., 2004).

[3] Méndez and Sepúlveda (2006) report results from a short panel. This enables them to control for omitted country specific fixed effects and in that way to address the endogeneity problem.

[4] See Azariadis and Drazen (1990) and Blackburn et al. (in press) for theoretical underpinnings.

cipals (e.g., Aidt, 2003). It differs from previous models of endogenous corruption and growth, such as Ehrlich and Lui (1999), by emphasizing the incentives of political leaders rather than of bureaucrats and the importance of political accountability rather than of bureaucratic control structures. In particular, we consider a society where rulers—interpreted as elected politicians or dictators depending on the context—extract rents from citizens by charging a fee for entry into the formal sector of the economy. Citizens can decide to shelter themselves from rent extraction in the informal sector, but at the cost of lower wages and 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, as in Ferejohn (1986), while in autocracies replacement often takes place through coups, revolts or revolutions. Rulers are willing, up to a point, to reduce corruption today to avoid replacement and loss of future rents, but only where institutions are of a sufficiently high quality.

We make a distinction between two types of governance failures which we refer to as 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 the opposition by the ruling elite, or where political power is concentrated in the hands of a dictator. Taken together, the two types of failure characterize exogenous aspects of the quality of governance institutions.

The model identifies two governance regimes. In regime G, institutions, as captured by p- and q-failures, are of a sufficiently high quality to allow citizens to use the threat of replacement to reduce corruption. In this regime, economic growth can reduce corruption by improving the incentives of rulers. This feature is novel and gives a new reason for reverse causality from growth to corruption. Conversely, the model also allows corruption to reduce growth. Together these two effects imply that economic growth and corruption are endogenous and self-reinforcing: high growth reduces corruption which, in turn, enhances the growth performance of the economy. This amplifies the (negative) impact of corruption on growth and can, under some special circumstances, lead to multiple equilibria. In regime B, institutions are deficient and citizens cannot control their rulers. Corruption is at the maximum and growth no longer has a benign impact on the level of corruption. Our empirical findings are consistent with the key predictions from the model, namely that (a) there exist two governance regimes, (b) economic growth and corruption are jointly determined and (c) the relationship between the two is regime specific.

The paper is organized as follows. In Section 2, we set out the model. In Section 3, we study the impact of (exogenous) growth on corruption and highlight a new channel through which economic growth can reduce corruption. In Section 4, we specify a simple endogenous growth mechanism that allows corruption to affect growth. In Section 5, we study equilibrium configurations of the overall model. In Section 6, we discuss our empirical specification. In Sections 7 and 8, we present the empirical results. In Section 9, we discuss the findings and conclude.

2. The model

In this section, we introduce our model. It explains how corruption (rent extraction) and economic growth are linked and jointly determined by the quality of political institutions. The model focuses on grand corruption in a context in which a non-benevolent ruler extracts rents from the economy, only constrained by the fact that citizens may attempt to replace him if too much is extracted and by the elasticity for the economic base from which resources can be extracted. We begin by laying out the economic structure followed by a description of the political system.

2.1. 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 labor each period that is inelastically supplied to either the formal or the informal sector. In the formal sector, there is a competitive labor market and individuals are either employed by private firms or work in the public sector.

Private firms produce a consumption good, c_t, with a linear technology $c_t = A_t e_t$ where e_t is the input of labor and A_t is productivity. Workers are paid the competitive wage $w_t = A_t$. The assumption of a linear production function is somewhat unrealistic as production of consumption goods is likely to involve decreasing returns in practice. It,

however, makes it possible to tie down the wage rate of the formal sector in a simple manner and is, in this respect, similar to the assumption of a numeraire sector often made in models of the political economy of trade (e.g., Grossman and Helpman, 1994). 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 labor input devoted to the production of public services.[5] The labor market in the formal sector clears at the competitive wage $w_t = A_t$ and employees in the private and public sector receive the same wage.

To operate in the formal sector, individuals have to pay a fee τ_t, leaving them with net income $A_t(1-\tau_t)$. The cost of providing public services, $w_t x_t = A_t x_t$, 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. As in the formal sector, we assume that individuals earn their marginal product in the informal sector and denote income earned in the informal sector by $\theta_i w_t = \theta_i A_t$, where $\theta_i \in [0,\theta]$ is the productivity of individual i in that sector.[6] The population's (potential) productivity in the informal sector is distributed according to the cumulative distribution function $F(\theta_i)$. All individuals know their own productivity before they choose which sector to work in. We require that F is differentiable and (weakly) concave. All income, net of fees, is spent on private consumption each period. All individuals benefit from the supply of public services, but those employed in the formal sector typically benefit more.[7] Instantaneous utility is $c_{it} + \upsilon_i y_t$, where $\upsilon_i = 1$ if individual i is employed in the formal sector and $\upsilon_i = \delta \in [0,1]$ otherwise; c_{it} is consumption of the private good. Utility is discounted with the factor $\beta \in (0,1]$.

The fee and the public service play an important role in the allocation of resources between sectors: a high τ_t or a low y_t encourages individuals to work in the informal sector. The fee should be interpreted broadly as the cost that individuals face when operating in the formal sector, i.e., as a formalization fee. This, of course, includes tax payments, but also, depending on the context, the cost of getting the necessary permits to operate in that sector.[8] Public services should be interpreted partly as law and order, legal services and so on that individuals have access to only if they are formally integrated into the economy. In particular in the context of less developed countries, y_t is also intended to capture other benefits of formalization such as, for example, access to publicly financed infrastructure (Dessy and Pallage, 2003) or participation in the formal credit market (Straub, 2005). However, some public services such as roads, basic public health and so on *are* available also to individuals working in the informal sector of the economy and we use the parameter δ to capture the degree to which this is the case.

Given his or her (known) productivity in the informal sector, individual i decides to work in the formal sector if and only if $A_t(1-\tau_t) + A_t x_t^\alpha \geqslant \theta_i A_t + \delta A_t x_t^\alpha$.[9] The fee revenue at time t accordingly is

$$T_t = A_t \tau_t F\left(1 - \tau_t + (1-\delta) x_t^\alpha\right). \tag{1}$$

We notice from this equation that an increase in the fee has two effects. On the one hand, it increases the yield from a given "tax base." On the other hand, it reduces the base from which fees can be collected by inducing some workers to move to the informal sector. Moreover, for $\delta < 1$ an increase in the supply of public services, ceteris paribus, broadens the "tax base" by inducing entry into the formal sector.

Productivity grows over time, due to technological progress $A_{t+1} = A_t(1+g_t)$ with $g_t \geqslant 0$ and $A_0 > 0$.[10] We restrict attention to constant growth paths with $g_t = g$ for all t. We notice that, for given τ_t and x_t, total revenue

[5] The assumption of decreasing returns in the production of public services ensures interior solutions to the relevant public finance problems. The model could, however, be reformulated with linear technology in all sectors and declining (rather than constant) marginal utility of public services without qualitatively affecting the main results.

[6] Since a large fraction of the informal sector in less developed countries is made up of micro-enterprises many of whom fail (Maloney, 2004), it is reasonable to assume heterogeneity among individuals working in that sector. It is clear, however, that firms in the formal sector also differ. For simplicity we ignore that, but note that the model can easily be extended in that direction.

[7] Some authors, e.g., Johnson et al. (1997), go as far as assuming that only individuals in the formal sector benefit from public services. This would correspond to $\delta = 0$.

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

[9] In less developed countries, the informal sector is sometimes seen as a disadvantaged residual of a segmented labor market where workers are queuing up to get "high quality" jobs in the formal sector. In this conception, some individuals are forced to work in the informal sector as jobs in the formal sector are rationed. In a detailed review of the literature, Maloney (2004) challenges this view and argues that between 60 and 70 percent of urban informal sector workers and entrepreneurs in Latin America are, in fact, in the informal sector by choice. Similar figures are found for the US. We, therefore, find it reasonable to follow Dessy and Pallage (2003), Ihrig and Moe (2004) and many others and model the sector choice as being voluntary.

[10] To insure that discounted utility is bounded, we assume that $\beta(1+g) \leqslant 1$.

increases over time, in line with productivity, as does (recorded) national income, $Y_t = A_t F(1 - \tau_t + (1 - \delta)x_t^{\alpha})$, 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 4, but take g as (exogenously) given for now.

2.2. 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 τ_t and x_t subject to the budget constraint $A_t x_t \leqslant T_t$ as he likes. The "rent" extracted in period t is denoted by z_t and corresponds to the difference between current revenues and expenditures[11]:

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

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.[12] We shall think of z_t as a measure of *rent extraction*.[13] The rent can also 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. This is consistent with the standard definition of corruption as "misuse of public office for private gain."

In the absence of moderating incentives, rulers extract the maximum rent each period. To avoid this, societies develop political institutions to discipline their behavior. 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 may be constrained by the threat of a coup or of a popular revolt (Acemoglu and Robinson, 2001). Formally, at the beginning of each period, citizens announce a performance standard that the ruler must satisfy to get "reappointed" at the end of the period. Citizens can observe perfectly what the ruler does while in office (i.e., z_t, x_t and τ_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 $\hat{s}_t = \{\hat{\tau}_t, \hat{x}_t\}$. The standard requires the ruler to spend a minimum amount on public services $x_t \geqslant \hat{x}_t$ and to keep the fee below a certain threshold $\tau_t \leqslant \hat{\tau}_t$. The two conditions combined determine how much rent extraction is allowed.

The economy is effectively populated by two types of individuals: those who work in the formal sector and those who work in the informal sector. While all citizens agree that rent extraction should be avoided, they disagree about how many public services should be provided. This disagreement arises because citizens working in the formal sector pay the cost of these services, while citizens in both sectors, albeit to different degrees, benefit from having the services provided. As a consequence, citizens in the two sectors would set different standards. However, these differences are not important for our results and we focus on the case in which the formal sector is the dominant political force in society and assume that the performance standards are set by citizens working in that sector. Under the assumption that a majority of the voting population works in the formal sector, this is clearly appropriate in the context of fully functional democracies where politicians look for a minimum winning coalition and thus can ignore the demands of the minority in the informal sector. This justification is even stronger in societies where many of the workers in the informal sector are, in fact, immigrants without the right to vote. In some less developed countries, the informal sector actually employs a majority of the workforce (Schneider and Enste, 2000). Yet, even here, formal sector workers often have substantial political power, partly through trade unions and other interest groups and partly because they are covered by legal protection making it less risky for them to participate in riots and demonstrations. In particular in societies with weak institutions, political power has more to do with the capacity of organizing collective action, access to economic resources, personal political connections and so on than with bare numbers. Although we do not

[11] This formulation is used extensively by Persson and Tabellini (2000).

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

[13] As formulated, the rent is a pure transfer from citizens to the ruler 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 rulers would be willing to pay to gain office (see Nitzan, 1994 for a survey of the literature on rent seeking and rent dissipation).

want to argue that informal sector workers are totally disenfranchised, we do find it acceptable to concentrate our attention on the case where political power rests within the formal sector, but for completeness we also briefly discuss what happens if the informal sector sets the standard.

In a well-functioning democracy, a ruler (politician) who complies with the performance 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 etc. can significantly reduce the level of accountability. We make a distinction between two types of governance failures, called p- and q-failures respectively.

Definition 1. We define p- and q-failures as follows:

1. p-failure: Citizens can only promise to reappoint a ruler who satisfies $\hat{s}_t$ in period t with probability $p \in [0, 1]$.
2. q-failure: Citizens can only promise to dismiss a ruler who does not satisfy $\hat{s}_t$ in period t with probability $1 - q \in [0, 1]$.

A "perfect" democracy corresponds to $p = 1$ and $q = 0$.[14] 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. More fundamentally, p- and q-failures might arise because of informational imperfections that prevent voters from carrying out their intended plans for sure. For simplicity, we do not attempt to model this here but we can think of p and q as reduced form representations of more complicated political games with asymmetric information. As we shall see, the *relative size* of p and q plays an important role in defining different governance regimes.[15]

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, determines whether the incumbent is, in fact, replaced by another ruler. After this, the sequence of events is repeated.

3. Growth and rent extraction

Citizens must accept some corruption and government inefficiency. How much depends both on the quality of their political institutions and on economic conditions. To see this, we begin by characterizing sequences of incentive compatible performance standards. Suppose that citizens announce the standard $\hat{s}_t = \{\hat{\tau}_t, \hat{x}_t\}$ at time t. Define $\hat{z}_t = \widehat{T}_t - A_t\hat{x}_t$ as the maximum rent extraction allowed by the standard. A ruler who complies (C) with the standard at time t expects to get

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

where $\hat{z}_t$ is the rent collected in the current period and 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 β, as rulers apply the same discount factor as citizens. More importantly, for $p < 1$ citizens cannot promise to reappoint a well-performing ruler with certainty. Accordingly with probability $1 - p$, he might not get reappointed, thereby foregoing the option of extracting rents in the future. This reduces his effective discount factor to βp. In short, p-failures reduce the discount factor of rulers below that of their citizens.

[14] By "perfect" we mean that citizens are able to use the only policy tool available to them—the right to dismiss rulers—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-failure.

[15] For a theory of why the quality of governance differs across time and space, see, e.g., Gradstein (2004).

The ruler can alternatively deviate from the standard in period t and extract the maximum rent in the current period. In this case, he selects the fee and spending level that maximize the difference between current revenues, $\tau_t A_t F(.)$, and the cost of providing public services, $A_t x_t$; that is,

$$\{\tau_t^*, x_t^*\} = \arg\max_{\{\tau_t, x_t\}} \tau_t A_t F\big(1 - \tau_t + (1-\delta)x_t^{\alpha}\big) - A_t x_t. \tag{4}$$

We observe that the optimal deviation policy is time-invariant, i.e., $\tau_t^* = \tau^*$ and $x_t^* = x^*$ for all t,[16] but that the maximum rent $\mathcal{T}_t = A_t \mathcal{T}$ increases over time with

$$\mathcal{T} = \big(\tau^* F\big(1 - \tau^* - (1-\delta)(x^*)^{\alpha}\big) - x^*\big). \tag{5}$$

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 collects the maximum rent, $\mathcal{T}_t$, in the current period and obtains the continuation payoff with probability q:

$$V_t(D) = \mathcal{T}_t + \beta q V_{t+1}^*. \tag{6}$$

We can now write the value of being the ruler, V_t^*, as the maximum of the compliance and deviation continuation payoff:

$$V_t^* = \max\big\{V_t(C), V_t(D)\big\}. \tag{7}$$

A sequence of performance standards $\{\hat{s}_t\}_{t=0}^{\infty}$ is incentive compatible if and only if it is in the best interest of the ruler to comply with the standard each period, i.e., if and only if $V_t(C) \geqslant V_t(D)$ for $t = 0, 1, 2, \ldots$. In contrast, when incentive compatibility fails, rulers never comply and their capacity to extract rents is effectively unconstrained. As we shall see below, the distinction between economies in which incentive compatibility can be achieved and economies in which it cannot is crucial.

By routine substitution, using Eqs. (3) and (6), we get that $V_t(C) \geqslant V_t(D)$ if and only if[17]

$$(IC_t) \quad \hat{z}_t + (p-q)\beta \sum_{k=0}^{\infty} (p\beta)^k \hat{z}_{t+1+k} \geqslant \mathcal{T}_t \tag{8}$$

for $t = 0, 1, 2, \ldots$. From this equation, we note that a necessary condition for incentive compatibility is that $p > q$. If this fails, citizens would have to allow rulers to extract more rent today ($\hat{z}_t$) than the maximum rent possible, $\mathcal{T}_t$, which, of course, is impossible. This observation identifies two different *governance regimes*: regime G with incentive compatible institutions ($p > q$) and regime B with incentive incompatible institutions ($p \leqslant q$). We will analyze these two regimes in turn, starting with regime G.

Regime G In regime G, citizens can use the promise of future rents effectively to discipline current rulers thereby reducing rent extraction to the level that is compatible with rulers wanting to be reappointed. The next proposition characterizes the minimum rent that citizens must allow rulers to extract along incentive compatibility paths. All proofs are in Appendix A.

Proposition 2. *Assume $\beta(1+g) < 1$ and $p > q$. Along paths with constant productivity growth, incentive compatible performance standards must allow rulers to extract at least the rent*

$$z_t^* = \frac{1 - p\beta(1+g)}{1 - q\beta(1+g)} A_t \mathcal{T} < A_t \mathcal{T} \tag{9}$$

for $t = 0, 1, 2, \ldots$.

[16] The first order conditions

$$A_t\big[F(.) - \tau_t f(.)\big] = 0,$$
$$A_t\big[\tau_t f(.)(1-\delta)\alpha x_t^{\alpha-1} - 1\big] = 0$$

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

[17] See Appendix A for the details.

Citizens would never allow the ruler to collect more than the minimum rent required for compliance, so $\hat{z}_t^G = z_t^*$ for all t. Proposition 2, then, implies that a constant fraction of (potential) GNP is, with the approval of citizens, extracted each period. The intuition is similar to that of Persson et al. (1997, Proposition 1). Citizens observe how much rent the ruler collects and attempt to throw him out of office if he extracts too much. Citizens must allow the ruler to extract rents because this is what constitutes the value of holding political office. The ruler is only willing to restrain himself in the present because he expects to be able to collect rents in the future. In other words, if the gains from holding office are too small, the ruler will extract the maximum rent today being fully aware that citizens will attempt to replace him at the next opportunity. The amount of rent extraction depends on the quality of governance and on the growth rate of the economy.[18] As expected, marginal improvements in the quality of institutions (a higher p or a lower q) reduce rent extraction and corruption. The intuition is that better institutions make it easier for citizens to reappoint rulers who comply with their demands (higher p). This increases the value of holding political office and allows citizens to reduce per-period rents. In addition, improvements in the quality of institutions make the threat of replacement more effective (lower q). This reduces the temptation to deviate and citizens can, therefore, demand more from those rulers who comply.

More importantly, we see from Eq. (9) that economic growth has a direct impact on the level of rent extraction along incentive compatible paths. Rearranging slightly and taking the derivative of Eq. (9) yields

$$\frac{\partial\left(\frac{z_t^*}{A_t}\right)}{\partial g} = \frac{\beta\mathcal{T}(q-p)}{(1-q\beta(1+g))^2}. \tag{10}$$

We see that this is negative for $p > q$ and we have:

Proposition 3 *(Growth and Rent Extraction). Assume that $p > q$. Economic growth (g) reduces rent extraction ($\frac{z_t^*}{A_t}$).*

Proposition 3 shows that economic growth, at the margin, performs the same role as improvements in the quality of political institutions: it reduces rent extraction. The intuition is as follows. In a society in which GNP 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 so 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 reducing 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 to 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 misbehavior ($q > 0$). Along incentive compatible paths, $p > q$ and the former effect dominates. Economic growth can, therefore, serve as a substitute for improvements in the quality of institutions.

Proposition 2 characterizes the level of rent extraction (z_t^*) in regime G for any path of fees and spending levels. This is what citizens must allow their rulers to extract each period, neither more nor less. Given that, workers in the formal sector will require their ruler to implement the (constrained) efficient sequence of fees and spending levels subject to $z_t = z_t^*$ at each t. Formally, this sequence is the solution to the following problem:

$$\max_{\{\tau_t, x_t\}_{t=0}^{\infty}} \sum_{t=0}^{\infty} \beta^t \left[A_t(1-\tau_t) + A_t x_t^{\alpha}\right] \tag{11}$$

subject to

$$z_t = z_t^*, \quad t = 0, 1, 2, 3, \ldots, \tag{12}$$

$$T_t = z_t + A_t x_t, \quad t = 0, 1, 2, 3, \ldots, \tag{13}$$

[18] The level of rent extraction also depends on the discount factor β. The more farsighted rulers are, the higher the value of holding office. This allows citizens to lower the per-period rent that the ruler is allowed to extract.

where $T_t = A_t\tau_t F(1-\tau_t+(1-\delta)x_t^{\alpha})$. To ensure existence of a unique interior solution to this problem, we need to assume that[19]

$$\alpha < \frac{F(.)-\delta\tau_t f(.)}{F(.)-\delta\tau_t f(.)+(1-\delta)x_t^{\alpha}(f(.)-\delta\tau_t f'(.))} \equiv \overline{\alpha}(\tau_t, x_t) \quad \forall t. \tag{14}$$

Given this assumption, which we take as satisfied in the rest of the analysis, we can characterize the solution to the public finance problem as follows.

Proposition 4 *(Fees and Public Services). Assume that $p > q$ and that $\alpha < \overline{\alpha}(\hat{\tau}^G, \hat{x}^G)$. Along a path with constant productivity growth, the constrained efficient performance standard is unique and stationary, i.e., $\hat{s}_t^G = \{\hat{\tau}^G, \hat{x}^G\}$ for all t. Provision of public services is growing over time in line with productivity*

$$y_t^G = A_t\left(\hat{x}^G\right)^{\alpha}.$$

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

Proposition 4 shows that the constrained efficient performance standard is stationary and that provision of public services grows over time in line with productivity. The ruler is required to reduce the fee below the rent maximizing level and to increase production of public services above that level. The reason is that workers in the formal sector pay fees and care about public services and they, therefore, appreciate paying less for more services. More importantly, Proposition 4 also shows that the size of the formal sector, $F(1-\hat{\tau}^G+(1-\delta)(\hat{x}^G)^{\alpha})$, is a function of the growth rate g (and of p and q), and we find the following important result:

Proposition 5 *(Growth and the Size of the Formal Sector). Assume that $p > q$ and that $\alpha < \overline{\alpha}(\hat{\tau}^G, \hat{x}^G)$. Along a path with constant productivity growth, the size of the formal sector is non-decreasing in the growth rate.*

Proposition 5 compares the size of the formal sector along two different growth paths of an economy and shows that the formal sector, ceteris paribus, will be larger along the path with faster growth. Intuitively, a high growth rate reduces the rent required for incentive compatibility (Proposition 3) 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.

In the analysis above, we assume that performance standards are set by workers in the formal sector. While Propositions 2 and 3 do not depend on this assumption, the optimal sequence of fees and spending levels does. This is because only workers in the formal sector pay fees, providing workers in the informal sector with an incentive to demand lots of public services. Importantly, however, Proposition 5 is true in both cases: irrespective of who sets the performance standard, the size of the formal sector is non-decreasing in the growth rate. The reason is that workers in the informal sector do not want to increase the fee beyond the revenue (or rent) maximizing level and so, the extra services they demand along an incentive compatible path in which they set the performance standard induces some workers to go to the formal sector. This completes the discussion of regime G.

Regime B In regime B where $p \leqslant q$, no ruler ever complies with any performance standard, and the only protection that citizens have against rent extraction is to move into the informal sector. Rulers cannot be disciplined by the threat of replacement because the threat is not credible. Rulers who disregard the performance standard are rarely replaced (q is large), while rulers who comply are rarely rewarded for the effort (p is small). In this environment, the optimal strategy for any ruler is to extract as much as possible today and run the risk of being replaced. We, therefore, have:

Proposition 6. *Assume that $p \leqslant q$. All rulers extract the maximum rent*

$$\frac{z_t^B}{A_t} = \mathcal{T}$$

by setting $\tau_t^B = \tau^*$ and $x_t^B = x^*$ for $t = 0, 1, 2, \ldots$.

[19] This assumption is sufficient. The assumption effectively requires that the production function for public services is sufficiently concave. Notice, moreover, at the optimal solution $F(.)-\delta\tau f(.) > 0$. See Appendix A for details.

The fact that all rulers extract the maximum rent means that rent extraction as a fraction of potential GNP does not depend on the growth rate of the economy and that marginal improvements in the quality of institutions do not lead to a reduction in corruption. An implication, then, is that the size of the informal sector is independent of both the growth rate and the quality of institutions. It is obvious that it does not matter in regime B whether standards are set by formal or informal sector workers: they are not complied with anyway.

4. Rent extraction and growth

In the analysis above, we took economic growth to be exogenous and independent of corruption. Several studies have, however, pointed to the possibility 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. Misallocation of talent between entrepreneurship and rent seeking is another important reason why corruption hinders growth (Acemoglu and Verdier, 1998; Murphy et al., 1991) and one that can lead to multiple equilibria (Ehrlich and Lui, 1999). Yet another reason is corruption-induced under-investment in public capital (Del Monte and Papagni, 2001).

To allow for the possibility that corruption has a negative effect on growth, we endogenize the growth rate. There are, of course, many different ways of doing so.[20] Here, we argue that the formal sector is likely to play an important role. First, industrial production generates learning-by-doing externalities with the potential to increase the growth rate of the economy (Arrow, 1962). Activities in the formal sector are most likely to generate such externalities at a scale that has macroeconomic implications.[21] Second, firms in the formal sector have access to the legal system. This helps to protect property rights and to enforce contracts. This, in turn, spurs the incentive to invest in growth enhancing innovations. Consider, for example, a R&D-based endogenous growth model à la Romer (1986) or Jones (1998, Chapter 5). In this type of model, the growth rate is proportional to the fraction of the workforce employed in R&D activities. Insofar as an increase in the size of the formal sector also leads to an increase in the amount of resources devoted to R&D, the result will be a higher growth rate. Thirdly, Murphy et al. (1991) argue that the growth rate of the economy is determined by the most able self-employed person, again providing a direct link between the growth rate and the allocation of resources between the formal and the informal sector.

We do not want to model the precise mechanism that generates endogenous growth here, but believe that the discussion above is sufficient to allow us to postulate a reduced form relationship between the growth rate and the size of the formal sector:

$$g = H\left[F\left(1-\tau+(1-\delta)x^{\alpha}\right)\right], \tag{15}$$

where H is a strictly increasing (differentiable) function with either congestion ($H'' < 0$) or agglomeration ($H'' > 0$) effects. Since corruption encourages individuals to seek employment in the informal sector, this formulation implies a simple negative feedback loop from corruption to growth.

5. Equilibria

In order to make optimal choices, the citizens and the ruler must form expectations about the growth rate. We follow Katz and Shapiro (1985) and many others and assume that the agents have identical expectations about the growth rate and that, in equilibrium, these expectations are fulfilled. More precisely, we define an equilibrium as a constant growth rate such that (i) agents' expectations are fulfilled and (ii) the choices of citizens and of the ruler are optimal each period. The equilibrium characterization depends on which of the two governance regimes the economy belongs to. We consider each of them in turn.

In regime G, our specification of the growth process implies that economic growth and corruption become endogenous *and* self-reinforcing. High growth reduces rent extraction. This makes working in the formal sector more attractive. The resulting expansion of the formal sector increases the growth rate of the economy. The implication

[20] See, e.g., Jones (1998) or Aghion and Howitt (1998).

[21] The informal sector does often provide training to school leavers with low education that allows them to move to formal sector jobs after some years (Maloney, 2004). Thus, some learning-by-doing takes place in that sector as well. What we argue is that learning effects of the type used in endogenous growth models are more likely to be generated in the formal sector.

of this is that corruption has an amplifying negative effect on growth and this opens up the possibility of multiple equilibria. Formally, an equilibrium growth rate is a solution to

$$g_G^* = H\left[F\left(1-\hat{\tau}^G(g_G^*)+(1-\delta)\left(\hat{x}^G(g_G^*)\right)^\alpha\right)\right] \tag{16}$$

for $g \in [0, \frac{1-\beta}{\beta})$. Eq. (16) has no, one or more solutions depending on circumstances.[22]

To illustrate the range of possible equilibrium configurations of regime G, we discuss three examples. For the majority of parameter values, the economy has a unique and stable equilibrium. An application of the implicit function theorem to Eq. (16) shows that an improvement in the quality of institutions increases growth and reduces rent extraction.[23] Better institutions lead to less rent extraction. This induces more people to work in the formal sector. This, in turn, increases the growth rate because of the resulting growth promoting externalities and innovations. We note that within regime G institutions affect growth *indirectly* through their impact on rent extraction.

In specific circumstances, however, there exist multiple equilibria. One interesting possibility is an economy with deficient, yet incentive compatible, institutions. In such an economy, a typical equilibrium configuration is shown in Fig. 1.[24] 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.[25] A third unstable equilibrium is located in the middle at point B. 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.[26] Another possibility that gives rise to a similar configuration is an economy with high quality 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 ($G'' \gg 0$).[27]

In regime B, there is no feedback from economic growth to rent extraction. This implies that (exogenous) variations in corruption have a smaller negative impact on growth than in regime G and that growth has no effect on corruption.

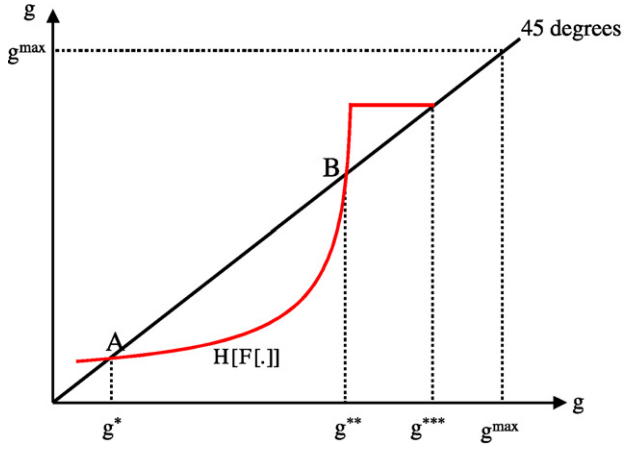

Fig. 1. Economies with multiple equilibria in regime G.

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

$$1 > \beta\left[1+H\left[F\left(1-\hat{\tau}^*\left(\frac{1-\beta}{\beta}\right)+(1-\delta)\left(\hat{x}^*\left(\frac{1-\beta}{\beta}\right)\right)^\alpha\right)\right]\right].$$

This is sufficient because $H[F(1-\hat{\tau}^*(0)+(1-\delta)(\hat{x}^*(0))^\alpha)]$ is positive and $F(1-\hat{\tau}^*(g)+(1-\delta)(\hat{x}^*(g))^\alpha)$ is a non-decreasing function of g.

[23] See Appendix A for a proof.

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

[25] The kink in the equilibrium locus happens at the point where all individuals are employed in the formal sector.

[26] Note that after an improvement in the quality of institutions, unstable equilibria become associated with lower growth and more corruption.

[27] An example of this is an economy with the following parameter values: $\beta = 0.9$, $p = 0.9$, $q = 0.1$, $\alpha = \frac{1}{2}$, $\delta = 0$, F is uniform on $[0, 1.22]$ and $H = l + \gamma F(.)^k$ with $l = -0.34$, $\gamma = 0.6$ and $k = 20$.

Formally, the equilibrium growth rate is uniquely given by

$$g_B^* = H\big(F\big(1-\tau^B+(1-\delta)\big(x^B\big)^\alpha\big)\big).$$

Since the fee is larger ($\tau^B > \hat{\tau}^G(g)$) and less public services are provided ($x^B < \hat{x}^G(g)$) in this regime than in regime G, the growth rate g_B^* is lower than the growth rate associated with the worst equilibrium in regime G. Thus, regime B is characterized by low growth and high levels of rent extraction. While marginal improvements in institutional quality do not affect the growth performance in regime B, sustained improvements may trigger a regime change, thereby leading to better economic performance and a reduction in corruption.

6. The empirical specification

The theoretical analysis highlights two points that motivate the empirical investigation. First, the model gives a new reason why it is important to make a distinction between different governance regimes and it shows that institutional quality does not affect the growth performance of a country directly, but indirectly, through the regime choice and through the impact on corruption levels.[28] Second, within a particular governance regime, economic growth and corruption are jointly determined and the corruption/growth relationship is regime specific. In particular, the model highlights a self-reinforcing relationship between corruption and growth that amplifies the negative impact of corruption on growth in societies where institutional quality exceeds a certain threshold (regime G). In contrast, in societies where the quality of institutions falls short of this threshold (regime B) this amplifying effect is absent. This weakens the negative impact of (exogenous) variations in corruption on growth and implies that growth does not affect the level of corruption.

Before we discuss the details of our econometric procedure, it is useful to lay out some general issues related to the empirical specification. Since corruption and growth are jointly determined, we need to treat both as endogenous; that is, as part of the same general system consisting of one structural equation for growth as a function of corruption and another structural equation for corruption as a function of growth. Unfortunately, an estimator for structural systems with threshold effects has not yet been developed, so the best we can do is to use an instrumental variables approach to get unbiased estimates of either the impact of corruption on growth or the impact of growth on corruption. We have chosen to focus on the equation that links growth to corruption simply because we are, as we shall discuss in more detail below, relatively confident that our instrumental variables for corruption in the growth equation are valid, while we place less confidence on our instrumental variables for growth in the corruption equation. The problem is that most of the standard determinants of growth, as identified by the empirical growth literature, appear to have an impact on corruption as well and cannot therefore be excluded from the corruption equation. As a consequence, we believe that the most reasonable way to proceed is to estimate a growth regression in which corruption is instrumented. However, we do also report in Section 8 some estimates of the reverse relationship, but since the validity of the chosen instruments (initial GDP and population growth) can be questioned, these estimations should be treated with caution.

Formally, we assume that the relationship between corruption, economic growth and institutional quality in a cross section of countries can be summarized by the following equation:

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

where g_i measures growth of real GDP per capita, 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 economic and demographic variables known to affect economic growth directly and a constant term, $1(.)$ is an indicator function and γ is a threshold to be estimated. We assume that the error term follows a martingale difference sequence.[29]

The key feature of this growth model is that it allows for two distinct governance regimes. Once the threshold γ 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 Eq. (17) is complicated by the fact that corruption is an endogenous variable and the error term (e_i) is correlated with the corruption variable, c_i. Therefore,

[28] This is in contrast to Barro (1996), Knack and Keefer (1995) and others who argue that institutions have a direct impact on growth.

[29] This strong assumption is required because simple orthogonality assumptions are insufficient to identify non-linear models.

threshold models developed for the estimation of models with exogenous regressors, such as that proposed by Hansen (2000), cannot be used. Instead, we use 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 the vector of covariates x_i':

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

where π is an unknown parameter vector, h is a (linear) function and u_i is a random error. The vector x_i' contains the selected instrumental variables discussed below, which are not included in the growth regression, along with the other exogenous variables of the model and we require that $E(u_i|x_i') = 0$. This equation can be substituted into Eq. (17) to get:

$$g_i = \beta_1 h\left(x_i', \pi\right) 1(q_i \leqslant \gamma) + \beta_2 h\left(x_i', \pi\right) 1(q_i > \gamma) + 1(q_i \leqslant \gamma) x_i \beta_3 + 1(q_i > \gamma) x_i \beta_4 + v_i, \tag{19}$$

where

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

The parameters of Eq. (19) can be estimated sequentially. First, Least Squares are used to estimate the parameter vector π from the reduced form. Second, the threshold γ 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, β_1 to β_4, are estimated by the Generalized Method of Moments (GMM) on the split sample implied by the estimate of γ.

In estimating growth models on cross country data, robustness is a real concern.[30] To deal with this, we estimate the model using two alternative measures of economic growth, two alternative measures of corruption, two sets of instrumental variables and a number of different control variables. The sample contains from 67 to 71 countries drawn from all five continents. Appendix B lists the countries and provides information on the main variables used in the analysis.

We consider both short-run (1995–2000) and long-run (1970–2000) growth in real GDP per capita. The specification with short-run growth rates has the advantage that both the economic data and the measures of corruption and institutional quality (see below) refer to the same time period, but is problematic because temporary shocks may mask longer-term growth effects. The specification with long-run growth rates avoids this problem, but suffers from the problem that growth performance over a 30 years period is explained by the level of corruption at the end of the period. For this to be valid, corruption must be stable over time (see the discussion in Méon and Sekkat, 2005). We believe that both approaches have merits and report results for both specifications.

Several business risk analysts and polling organizations routinely construct indexes of "perceived" corruption, based on survey responses of business people, experts and local residents. 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, but occasionally also use information about "grand corruption" and government capture. We use two alternative measures of corruption. The first measure is the average from 1996 to 2002 of the corruption perception index constructed by Transparency International. The corruption perception index uses information from a number of individual surveys and ratings and varies between 10 (the least corrupt country) and 0 (the most corrupt country). Compared to other indices of corruption, the corruption perception index has the advantage that it is based on averages from different sources, and one might hope that measurement errors wash out.[31] The second measure of corruption is taken from the World Bank's "Governance Matters" database, constructed by Kaufmann et al. (1999) and updated by Kaufmann

[30] The threshold model developed by Caner and Hansen (2004) cannot deal with panel data and we are therefore confined to studying a cross sections of countries.

[31] It is also worth noting that the sub-indices of the corruption perception index 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 (Treisman, 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.

et al. (2005), and is called "control of corruption." It measures the exercise of public power for private gain, including both petty ("additional payments to get things done"), grand corruption and state capture. The indicators in the "Governance Matters" database are constructed from a large number of separate data sources covering several hundred individual perception based measures of governance using an unobserved components model. Thus, the control of corruption indicator is based on broader aspects of corruption than the corruption perception index. In that sense, it captures more precisely our theoretical notion of rent extraction. We use the average value of the control of corruption indicator for the period 1996–2002. The index varies from −1.07 (the most corrupt country) to 2.45 (the least corrupt country) in the sample with short-run growth and from −1.20 to 2.46 in the sample with long-run growth.

The quality of political institutions is hard to measure empirically, but some attractive measurements are available in the "Governance Matters" database discussed above. To keep as closely as possible to the theoretical model, we have chosen to use the so-called voice and accountability index as the threshold variable (q_i in Eq. (17)). 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 the government accountable for its policy choices. It also includes indicators of the independence of the media, which serve an important role in holding those in authority accountable. The index has been time averaged for the available years and re-scaled to lay in the interval 0 (weak institutions) to 1 (strong institutions). We believe that the measure is the best available proxy for the factors that we attempt to capture with p and q in the model.

We have settled for two sets of instruments for corruption. The procedure of Caner and Hansen (2004) requires that the threshold variable (the voice and accountability index) is exogenous. It, therefore, enters the reduced form for corruption and effectively becomes an instrument. However, this can also be rationalized theoretically as the voice and accountability index is directly related to the accountability elements alluded to in our model and to their likely impact on corruption. Instrument set I contains in addition to the voice and accountability index, the index of ethnolinguistic fractionalization. The index of ethnolinguistic fractionalization is a measure of the probability that two randomly selected individuals in a country do *not* belong to the same ethnolinguistic group (see, e.g., Taylor and Hudson, 1972). The index was first suggested as an instrument for corruption by Mauro (1995) in his seminal study of the relationship among growth, corruption and bureaucratic efficiency. He argued that the presence of many different linguistic groups in a country may foster corruption as politicians may favor members of their own group. Also, it is reasonable to assume that the extent to which countries are divided into ethnolinguistic groups is unrelated to economic variables. Instrument set II contains in addition to the voice and accountability index, the number of years of uninterrupted democratic rule going back from year 2000 (age of democracy). Persson and Tabellini (2003, Chapter 5), Persson (2004), and Eicher and Leukert (2006) have recently argued that the type of constitutional arrangements is an important determinant of corruption and other "structural policies" and that these arrangements only affect economic outcomes through this channel. This "hierarchy of institutions" hypothesis suggests that we can use measures of political institutions as instruments for corruption. As for the particular choice, countries with a longer democratic tradition have developed better and more effective means of controlling corruption. Older democracies are, therefore, likely to pursue systematically different policies from newer ones whilst age of democracy is not in itself a determinant of growth.[32]

This scheme of identification is sketched in Fig. 2. We note that while the measure of ethnolinguistic fractionalization only affects growth through the impact on corruption, measures of the quality of political institutions (constitutional arrangements) affect growth partly through the impact on corruption and partly through the impact on the regime choice.

Various economic and demographic factors are assumed to affect growth directly. This includes the (average) investment share, population growth, (average) gross enrollment in primary education and the initial level of GDP (either in 1995 or in 1970). We also control for regional effects (retained only if they are significant) and for whether a country belongs to the Common Law tradition or not.[33]

[32] See Persson et al. (2003), Lederman et al. (2005) and Chang and Golden (2006) for careful studies of the institutional determinants of corruption.

[33] La Porta et al. (1997) argue that the legal tradition affects development. In particular, common law countries tend to protect shareholders better than do civil law countries and this may lead to better economic outcomes and less corruption.

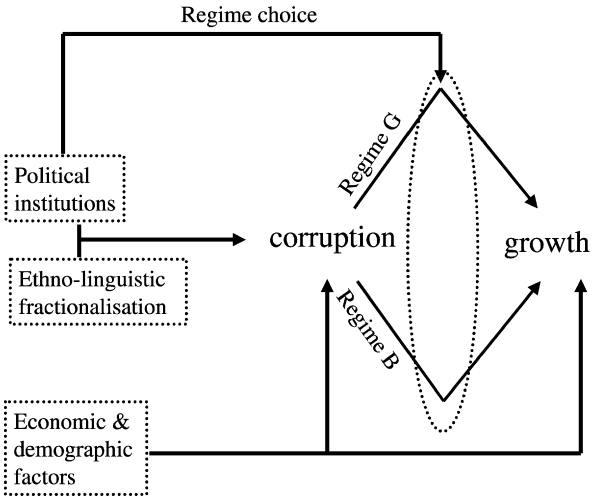

Fig. 2. Sketch of identification scheme.

7. The main empirical results

As a benchmark, we have estimated the econometric model on the whole sample of countries *without* taking the possibility of thresholds into account. The results are reported in Table 1. This table and the ones to follow contains the results for two different model specifications. In Model 1, we control for initial GDP per capita, population growth, and gross enrollment in primary education; in Model 2, we add to the previous specification the investment share. In all specifications, we include regional dummies and a dummy variable that controls for whether a country belongs to the Common Law tradition. To preserve space, however, we only report the coefficients on corruption.[34] From Table 1 we note that corruption is insignificant in all specifications. These results are broadly in line with those of Mauro (1995) who also finds that corruption is at best weakly related to growth in a linear growth model.

Tables 3 to 6 report the estimates using the threshold estimation technique. Each table is divided into two panels. Panel A reports the regime specific estimate of the impact of corruption on economic growth for instrument set I (the ethnolinguistic fractionalization index and the voice and accountability index), while Panel B reports the corresponding results for instrument set II (age of democracy and the voice and accountability index). In all specifications, we find a significant threshold effect that identifies two separate corruption/growth regimes: one regime with high quality institutions and one with low quality institutions. The cut-off value of the voice and accountability index differs somewhat from specification to specification, but is in the range from 0.50 to 0.75. Table 2 reports the average differences between the two regimes. Not surprisingly, we observe that countries in the regime with high quality institutions experience higher growth and lower corruption than countries with deficient institutions. In the short run, the growth "bonus" accruing if a country moves from regime G to regime B is about 26 percent. The corresponding "bonus" for the long run is in excess of 40 percent.

Tables 3 and 4 show the results for the short-run growth rates for the corruption perception index and control of corruption, respectively. For both sets of instruments, the estimated impact of corruption on growth depends on the regime. In the regime with high quality institutions (regime G), corruption reduces growth in all specifications and the effect is highly statistically significant. In the regime with low quality institutions (regime B), the impact of corruption on growth is insignificant in all specifications. The corresponding results for long-run growth, reported in Tables 5 and 6, show a similar pattern: corruption reduces growth in regime G and has no statistically significant impact in regime B. We note that the estimated impact of corruption tends to be slightly smaller in the long run than in the short run. Finally, in each of the tables, we report for each set of instruments two tests from the first stage regressions:

[34] The full set of results, including the first stage regressions, is available upon request.

Table 1
Short-run growth rates (1995–2000) and long-run growth rates (1970–2000): IV (GMM) estimates without thresholds

Model specification	Short-run		Long-run	
	1	2	1	2
Instrument set I				
Corruption perception index	0.2	0.2	0.13	0.13
	(0.88)	(0.87)	(0.49)	(0.40)
Control of corruption	4.3	4.3	0.47	0.59
	(0.89)	(0.88)	(0.74)	(0.82)
Instrument set II				
Corruption perception index	0.15	0.14	0.21	0.41
	(0.67)	(0.64)	(0.75)	(1.40)
Control of corruption	0.3	0.3	0.73	0.71
	(0.75)	(0.74)	(1.27)	(1.37)

Notes: Robust t-statistics in brackets. Model specification 1 includes population growth, the average gross enrollment rate in primary education, the initial level of GDP, regional dummies and a dummy variable for common law countries. Model specification 2 includes all of these variables plus the average investment share. The corruption perception index is measured on a scale from 0 (most corruption) to 10 (least corruption). Control of corruption is measured on a scale from −1.07 (most corruption) to 2.45 (least corruption) for the short-run data set and from −1.20 (most corruption) to 2.46 (least corruption) for the long-run data set.

Table 2
Average growth and corruption differences between the two regimes

	Regime G	Regime B
Short-run growth rates	2.4	1.9
Long-run growth rates	2.0	1.4
Corruption perception index[a]	6.7 (5.8)	3.2 (3.2)
Control of corruption[a]	1.33 (0.96)	−0.49 (−0.46)

Notes: Regime G is defined using a cut-off of the voice and accountability index of 0.5 for the short-run growth rates and 0.65 for the long-run growth rates.

[a] The numbers in brackets are for the short-run data set.

Table 3
Short-run growth rates (1995–2000): IV (GMM) estimates with thresholds and the corruption perception index

Model specification	1	2	Model specification	1	2
Panel A: Instrument set I			***Panel B: Instrument set II***		
Regime G: VA[c] > 0.50 (44 countries)			*Regime G: VA[c] > 0.50 (44 countries)*		
Corruption perception index	0.5 (3.22)	0.6 (3.17)	Corruption perception index	0.5 (3.00)	0.5 (2.75)
Regime B: VA[c] ⩽ 0.50 (20 countries)			*Regime B: VA[c] ⩽ 0.50 (20 countries)*		
Corruption perception index	1.8 (0.70)	3.8 (0.25)	Corruption perception index	2.5 (1.08)	1.7 (0.94)
First stage tests			First stage tests		
J-test: p-value[a]	0.88	0.87	J-test: p-value[a]	0.51	0.49
F-test[b]	16.58***	18.17***	F-test[b]	18.17***	21.48***

Notes: Robust t-statistics in brackets. Instrument set I: index of ethnolinguistic fractionalization and the voice and accountability index; Instrument set II: age of democracy and the voice and accountability index. Regime specific models estimated with GMM. Model specification 1 includes population growth, the average gross enrollment rate in primary education, the initial level of GDP, regional dummies and a dummy variable for common law countries. Model 2 includes all of these variables plus the average investment share. The corruption perception index is measured on a scale from 0 (most corruption) to 10 (least corruption).

[a] Hansen's J-test for joint null that the extra instrument is valid.

[b] The null is that the coefficients on all instruments are zero.

[c] VA means voice and accountability index.

*** Significant at the 1% level.

Table 4
Short-run growth rates (1995–2000): IV (GMM) estimates with thresholds and control of corruption

Model specification	1	2	Model specification	1	2
Panel A: Instrument set I			***Panel B: Instrument set II***		
Regime G: VA[c] > 0.50 (44 countries)			*Regime G: VA[c] > 0.50 (44 countries)*		
Control of corruption	1.3 (3.50)	1.3 (3.37)	Control of corruption	1.2 (3.33)	1.2 3.03
Regime B: VA[c] < 0.50 (20 countries)			*Regime B: VA[c] < 0.50 (20 countries)*		
Control of corruption	4.8 (1.42)	4.4 (1.08)	Control of corruption	5.8 (0.78)	6.5 (0.70)
First stage tests			First stage tests		
J-test: p-value[a]	0.98	0.97	J-test: p-value[a]	0.59	0.50
F-test[b]	29.6***	30.5***	F-test[b]	32.20***	33.8***

Notes: See notes to Table 3. Control of corruption is measured on a scale from −1.07 (most corruption) to 2.45 (least corruption).
[a] Hansen's J-test for joint null that the extra instrument is valid.
[b] The null is that the coefficients on all instruments are zero.
[c] VA means voice and accountability index.
*** Significant at the 1% level.

Table 5
Long-run growth rates (1970–2000): IV (GMM) estimates with thresholds and the corruption perception index

Model specification	1	2	Model specification	1	2
Panel A: Instrument set I			***Panel B: Instrument set II***		
Regime G: VA[c] > 0.65 (33 countries)			*Regime G: VA[c] > 0.65 (33 countries)*		
Corruption perception index	0.37 (3.42)	0.38 (3.18)	Corruption perception index	0.39 (3.35)	0.39 (3.20)
Regime B: VA[c] ⩽ 0.65 (25 countries)			*Regime B: VA[c] ⩽ 0.65 (27 countries)*		
Corruption perception index	−0.77 (−0.54)	1.09 (1.52)	Corruption perception index	0.21 (0.40)	0.99 (0.92)
First stage tests			First stage tests		
J-test: p-value[a]	0.72	0.66	J-test: p-value[a]	0.94	0.93
F-test[b]	29.50***	27.89***	F-test[b]	34.11***	32.51***

Notes: See notes to Table 3.
[a] Hansen's J-test for joint null that the extra instrument is valid.
[b] The null is that the coefficients on all instruments are zero.
[c] VA means voice and accountability index.
*** Significant at the 1% level.

Table 6
Long-run growth rates (1970–2000): IV (GMM) estimates with thresholds and control of corruption

Model specification	1	2	Model specification	1	2
Panel A: Instrument set I			***Panel B: Instrument set II***		
Regime G: VA[c] > 0.65 (33 countries)			*Regime G: VA[c] > 0.65 (33 countries)*		
Control of corruption	0.98 (3.14)	1.00 (3.00)	Control of corruption	1.02 (3.44)	1.02 (3.26)
Regime B: VA[c] ⩽ 0.65 (33 countries)			*Regime B: VA[c] ⩽ 0.65 (33 countries)*		
Control of corruption	−0.19 (−0.08)	1.64 (0.58)	Control of corruption	0.70 (0.49)	1.11 (0.87)
First stage tests			First stage tests		
J-test: p-value[a]	0.68	0.67	J-test: p-value[a]	0.88	0.88
F-test[b]	41.77***	40.07***	F-test[b]	51.41***	49.20***

Notes: See notes to Table 3. Control of corruption is measured on a scale from −1.20 (most corruption) to 2.46 (least corruption).
[a] Hansen's J-test for joint null that the extra instrument is valid.
[b] The null is that the coefficients on all instruments are zero.
[c] VA means voice and accountability index.
*** Significant at the 1% level.

Hansen's J-test for validity and the F-test for relevance of the instruments.[35] We see that both instrument sets pass both tests in all specifications.

Using the corruption perception index, which is easier to interpret than the control of corruption index, a one point reduction in corruption increases growth in the short run by 0.5–0.6 percentage points and by 0.37–0.39 in the long run for countries in regime G. To get a more intuitive understanding of what this means, consider the following experiment. Suppose that Brazil, which is one of the countries in regime G with the worst corruption experience, were to reduce corruption to the level of one of the countries with least corruption, say, Denmark.[36] If so, the growth rate of Brazil would have been 4.23 rather than 1.23 in the late 1990s and 4.07 rather than 2.07 during the period 1970–2000. These are substantial effects. In contrast, based on our results, it would not make a difference to the growth experience if the most corrupt country in regime B, say, Cameroon, somehow reduced corruption to the level of Malaysia, which is one of the least corrupt countries in regime B. Only if institutions were at the same time improved to bring Cameroon into regime G would the reduction in corruption yield a growth bonus.

In conclusion, these results strongly support the view that the relationship between growth and corruption is regime specific. Moreover, we find robust evidence that (exogenous) variations in corruption reduce growth conditional on having governance institutions of a high quality. In contrast, our results suggest that corruption makes little difference to the growth performance of societies with deficient institutions.

8. The reverse relationship

An alternative to our preferred specification is to estimate the reverse relationship with corruption as a function of economic growth. As discussed above, this is problematic because it is hard to find valid instruments for growth in the corruption equation. Nevertheless, we report in Table 7, the results of a representative set of estimations of the reverse

Table 7
Control of corruption index and the corruption perception index: IV (GMM) estimates with thresholds, short-run growth rates (1995–2000) and Long-run growth rates (1970–2000)

Dependent variable:	Control of corruption		Dependent variable:	Corruption perception index	
	Long-run growth rate	Short-run growth rate		Long-run growth rate	Short-run growth rate
	Regime G: $VA^c > 0.50$ (43 countries)	*Regime G: $VA^c > 0.44$ (44 countries)*		*Regime G: $VA^c > 0.50$ (43 countries)*	*Regime G: $VA^c > 0.44$ (44 countries)*
Per capita growth rate	0.67	1.51	Per capita growth rate	1.63	0.66
	(2.47)	(2.59)		(2.43)	(3.09)
	Regime B: $VA^c \leqslant 0.50$ (21 countries)	*Regime B: $VA^c \leqslant 0.50$ (20 countries)*		*Regime B: $VA^c \leqslant 0.50$ (15 countries)*	*Regime B: $VA^c \leqslant 0.50$ (20 countries)*
Per capita growth rate	0.12	0.04	Per capita growth rate	0.13	0.01
	(1.36)	(0.26)		(0.36)	(0.08)
First stage tests			First stage tests		
J-test: p-value[a]	0.87	0.55	J-test: p-value[a]	0.30	0.51
F-test[b]	2.94**	1.52	F-test[b]	4.53***	1.53

Notes: Robust t-statistics in brackets. Regime specific models estimated with GMM. In the specification with long-run growth rates, the corruption equation includes the ethnolinguistic fractionalization index (age of democracy) and regional dummies. In the specification with short-run growth rates, the corruption equation includes the ethnolinguistic fractionalization index and regional dummies. The first stage growth regressions include initial GDP and population growth.

[a] Hansen's J-test for joint null that the extra instruments are valid.

[b] The null is that the coefficients on all instruments are zero.

[c] VA means voice and accountability index.

** Significant at the 5% level.

*** Idem, 1%.

[35] Strictly speaking, the F-test is suitable only for linear IV models. As we use non-linear estimation techniques (GMM), the F-test is not a proper test for weak instruments (Stock et al., 2002) and should be interpreted with care.

[36] The (average) corruption perception index of Brazil is 3.98, while that of Denmark is 9.53.

relationship, with either control of corruption or the corruption perception index as the dependent variable and the two measures of growth as one of the left-hand side variables, respectively. We exclude initial GDP and population growth from the corruption equation. These exclusion restrictions pass Hansen's J-test, but the variables have little explanation power in the specification with short-run growth, and we acknowledge that the validity of the instruments can be questioned.[37]

The results reported in the table confirm the existence of two corruption/growth regimes with a threshold around 0.50. More importantly, they suggest that growth reduces corruption in the regime with high quality institutions (regime G) but has no effect on corruption in the regime with weak institutions (regime B). This, again, is consistent with our theoretical model which predicts that growth should have no effect on corruption when institutions are weak (Proposition 6) while the effect should benign when institutions are strong (Proposition 3).

9. Discussion and conclusion

The paper offers a theoretical and an empirical investigation of the links between corruption, economic growth and institutional quality that take into account the possibility of multiple governance regimes. The theoretical model highlights a particular mechanism through which this can happen and stresses (a) the role of political institutions as a determinant of the governance regime and (b) the complementarity between economic growth and corruption within some, but not all, governance regimes.

Empirically, we demonstrate the importance of allowing for non-linear effects in the mapping between corruption and economic growth, as also stressed by Méon and Sekkat (2005) and Méndez and Sepúlveda (2006). We show that regime specific differences are important. The result that corruption has little or no impact on growth in the regime with weak institutions is consistent with our model, but may also be related to the "greasing the wheels" hypothesis of corruption. This hypothesis suggests that corruption may improve efficiency by allowing individuals to circumvent the worst institutional deficiencies. 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 directly to corruption (Aidt, 2003) and we are careful not to interpret our findings as evidence in favor of the proposition that corruption can have beneficial economic consequences in a broader sense.[38] The results show that corruption has a regime specific impact on growth and that it is most harmful where institutions are "good," possibly because of the self-reinforcing mechanism discussed in our model. Our model makes additional predictions about the size of the informal sector and the level of corruption that it would be of interest to explore in future work. It is encouraging to note that recent empirical work by Dreher and Schneider (2006) shows that the link between corruption and the size of the informal sector is regime specific and that there exist systematic differences between rich and poor countries.

We conclude by raising three further caveats related to the interpretation of our empirical results. First, we interpret the two sub-samples identified by Caner and Hansen's (2004) procedure as evidence of two distinct governance regimes, rather than as evidence of the existence of multiple equilibria. This is in line with the warning issued by Durlauf and Johnson (1995), although we cannot rule out alternative interpretations based on multiple equilibria.[39] Second, one may worry that there exist variables omitted from the reported growth regressions that are correlated with the instruments and that the instrumental variables estimates therefore remain biased. We have tried to address these issues by using a range of different instruments. We take some comfort in the fact that all the results point in the same direction: negative impact of corruption on growth conditional on high quality institutions and no impact conditional on deficient institutions. Also the results hold when corruption is regressed on growth, although it is doubtful if our estimates of this effect can be given a causal interpretation. Third, we emphasize that the evidence is based on a cross section of countries. Caner and Hansen's (2004) procedure does not allow for panel analysis, so this must await further advances in the methodology.

[37] For example, high population growth may be associated with (unobserved) social chaos that fosters corruption.

[38] However, the narrower claim that corruption, conditional on weak institutions, may improve productivity levels has found support in Méon and Weill (2006).

[39] Durlauf and Johnson (1995) point out that it is not possible to distinguish empirically between a situation with multiple equilibria (societies with similar characteristics located at different growth/corruption equilibria) and a situation where the equilibrium locus has a discontinuity and some countries are below and others above the discontinuity point.

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Appendix A. Proofs

Deriving Eq. (8). The ruler chooses to fully comply with the standard at time t if and only if $V_t(C) \geqslant V_t(D)$. Assuming that the ruler complies when indifferent, this is necessary and sufficient for incentive compatibility. By forward substitution, we obtain that $V_t(C) \geqslant V_t(D)$ for all t if and only if the following condition holds at $t = 0, 1, 2, \ldots$:

$$\sum_{k=0}^{\infty}(p\beta)^k \hat{z}_{t+k} \geqslant \mathcal{T}_t + \beta q \sum_{k=0}^{\infty}(p\beta)^k \hat{z}_{t+1+k}. \tag{21}$$

Rearranging this equation, we obtain Eq. (8). □

Proof of Proposition 2. Note that

$$\max\{\beta p(1+g), \beta q(1+g)\} \leqslant \beta(1+g) < 1. \tag{22}$$

Incentive compatibility requires that

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

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

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

Substitution, using the fact that $\mathcal{T}_t = A_0(1+g)^t\mathcal{T}$, yields

$$\hat{z}_t = \mathcal{T}\big(1 - \beta p(1+g)\big)A_0(1+g)^t \sum_{k=0}^{\infty}\big(q\beta(1+g)\big)^k \tag{25}$$

which can be simplified to get z_t^* defined in Eq. (9). Any sequence $\hat{z}_t \geqslant z_t^*$ is incentive compatible. □

Proof of Proposition 4. To simplify notation, let $k(g) = \frac{1-p\beta(1+g)}{1-q\beta(1+g)}\mathcal{T}$. Constraints (12) and (13) in problem (11) are binding at each t. We can, therefore, combine the two constraints at each t and consider the following sequence of one-period Lagrangians

$$L_t = \beta^t\big[A_t(1-\tau_t) + A_t x_t^{\alpha} + \lambda_t\big[A_t\tau_t F\big(1 - \tau_t + (1-\delta)x^{\alpha}\big) - A_t x_t - A_t k(g)\big]\big], \tag{26}$$

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

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

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

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

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

$$F\big(1-\tau+(1-\delta)x^{\alpha}\big)-\tau f\big(1-\tau+(1-\delta)x^{\alpha}\big)=0 \tag{30}$$

and

$$\tau f\big(1-\tau+(1-\delta)x^{\alpha}\big)(1-\delta)\alpha x^{\alpha-1}-1=0 \tag{31}$$

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

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

and rewrite Eq. (28) as

$$\alpha x^{\alpha-1}\big[F\big(1-\tau+(1-\delta)x^{\alpha}\big)-\delta\tau f\big(1-\tau+(1-\delta)x^{\alpha}\big)\big]-1=0. \tag{33}$$

Eqs. (29) and (33) determine the constrained efficient τ and x uniquely. To prove this, we write

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

$$h_2(\tau,x)=\alpha x^{\alpha-1}\big[F\big(1-\tau+(1-\delta)x^{\alpha}\big)-\delta\tau f\big(1-\tau+(1-\delta)x^{\alpha}\big)\big]-1. \tag{35}$$

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

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

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

$$\frac{\partial h_2(\tau,x)}{\partial x}=\alpha x^{\alpha-2}\big[(1-\delta)\alpha x^{\alpha}\big(f(.)-\delta\tau f'(.)\big)-(1-\alpha)\big(F(.)-\delta\tau f(.)\big)\big], \tag{38}$$

$$\frac{\partial h_2(\tau,x)}{\partial \tau}=-\alpha x^{\alpha-1}\big[(1+\delta)f(.)-\delta\tau f'(.)\big]<0. \tag{39}$$

A necessary condition for $\frac{\partial h_2(\tau,x)}{\partial x}<0$ is that

$$\alpha<\frac{F(.)-\delta\tau f(.)}{F(.)-\delta\tau f(.)+(1-\delta)x^{\alpha}(f(.)-\delta\tau f'(.))}. \tag{40}$$

Given this assumption, for $\tau<\tau^*$ and $x>x^*$, we see that

$$\left.\frac{\mathrm{d}\tau}{\mathrm{d}x}\right|_{h_1}=-\frac{\frac{\partial h_1(\tau,x)}{\partial x}}{\frac{\partial h_1(\tau,x)}{\partial \tau}}>0 \tag{41}$$

and

$$\left.\frac{\mathrm{d}\tau}{\mathrm{d}x}\right|_{h_2}=-\frac{\frac{\partial h_2(\tau,x)}{\partial x}}{\frac{\partial h_2(\tau,x)}{\partial \tau}}<0. \tag{42}$$

Notice that $h_1(\tau^*,x^*)>0$ so $h_1(\tau',x^*)=0$ implies that $\tau'<\tau^*$ because $\tau F(1-\tau+(1-\delta)x^{\alpha})-x=\mathcal{T}$ at $\{\tau^*,x^*\}$ and $\frac{1-p\beta(1+g)}{1-q\beta(1+g)}<1$. Notice that $h_2(\tau^*,x^*)=0$ because $F(1-\tau+(1-\delta)x^{\alpha})=\tau f(1-\tau+(1-\delta)x^{\alpha})$ and $(1-\delta)\alpha x^{\alpha-1}\tau f(1-\tau+(1-\delta)x^{\alpha})=1$ at $\{\tau^*,x^*\}$. Thus, there exists one and only one solution to Eqs. (29) and (33). The proposition follows by setting $\{\hat{\tau}^G,\hat{x}^G\}=\{\tau^{**},x^{**}\}$. Notice that assumption (40) is sufficient for the existence of a unique solution, not necessary. □

Proof of Proposition 5. Let $\hat{\upsilon}^G=1-\hat{\tau}^G+(1-\delta)(\hat{x}^G)^{\alpha}$, $k(g)=\frac{1-p\beta(1+g)}{1-q\beta(1+g)}\mathcal{T}$ and

$$\Delta=\frac{\partial h_1(\tau,x)}{\partial \tau}\frac{\partial h_2(\tau,x)}{\partial x}-\frac{\partial h_1(\tau,x)}{\partial x}\frac{\partial h_2(\tau,x)}{\partial \tau}, \tag{43}$$

where the functions h_1 and h_2 are defined in the proof of Proposition 4. Given assumption (40), $\Delta < 0$ at $\{\hat{\tau}^G, \hat{x}^G\}$. Using Cramer's rule, we find that

$$\frac{\partial \hat{\tau}^G}{\partial g} = \frac{\frac{\partial h_2(\hat{\tau}^G, \hat{x}^G)}{\partial x} \frac{\partial k}{\partial g}}{\Delta} < 0, \tag{44}$$

$$\frac{\partial \hat{x}^G}{\partial g} = \frac{\frac{\partial h_1(\hat{\tau}^G, \hat{x}^G)}{\partial \tau} \frac{\partial k}{\partial g}}{\Delta} > 0 \tag{45}$$

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

Proof of comparative statics. Assume that some citizens are employed in the informal sector both before and after the change and that the institutional reform does not trigger a regime shift. Applying the implicit function theorem to Eq. (16), we find

$$\frac{\mathrm{d}g_G^*}{\mathrm{d}p} = \frac{-G'(.)f(.)\frac{\partial \hat{\upsilon}^G}{\partial p}}{1 + G'(.)f(.)\frac{\partial \hat{\upsilon}^G}{\partial g}} \tag{46}$$

and

$$\frac{\mathrm{d}g_G^*}{\mathrm{d}q} = \frac{-G'(.)f(.)\frac{\partial \hat{\upsilon}^G}{\partial q}}{1 + G'(.)f(.)\frac{\partial \hat{\upsilon}^G}{\partial g}}, \tag{47}$$

where $\hat{\upsilon}^G = 1 - \hat{\tau}^G + (1-\delta)(\hat{x}^G)^\alpha$. We note that $1 + G'(.)f(.)\frac{\partial \hat{\upsilon}^G}{\partial g}$ is positive if and only if the initial equilibrium is locally stable in the sense that a small deviation from g_G^* would, through the choices of citizens and their ruler, lead to a self-correcting adjustment back to that growth rate. Unstable equilibria become associated with lower growth and more rent extraction. □

Appendix B. Data

The following variables are used in the analysis:

1. GDP per capita, PPP adjusted, is taken from World Bank Global Development Network Growth Database (World Bank, 2001) and the Penn World Data Tables, version 6.1 (Heston et al., 2002). The short-run growth rate is annual GDP growth per capita over the period 1995–2000. The long-run growth rate is defined in a similar way for the period 1970–2000.
2. The corruption perception index is measured as an average of up to 12 different perception indices of corruption and is constructed by Transparency International (http://www.transparency.org). We have time averaged the index for the period 1996–2002.
3. Control of corruption (from the "Governance Matters" database) is constructed from a large set of underlying data on various aspects of corruption using an unobserved components model (Kaufmann et al., 1999, 2005). It measures the exercise of public power for private gain. We have time averaged the indicator for the period 1996–2002.
4. The voice and accountability index (from the "Governance Matters" database) 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 policy choices (Kaufmann et al., 1999, 2005). We have time averaged the indicator for the period 1996–2002.
5. Age of democracy is measured as the number of years with uninterrupted democratic rule, going backwards from year 2000 (democracy is defined as the first year in which the POLITY IV index (Marshall and Jaggers, 2000) is positive). The variable is constructed by Persson and Tabellini (2003) and supplemented by our own coding.

6. Investment share of GDP is taken from the World Bank Global Development Network Growth Database (World Bank, 2001) and Penn World Data Tables, version 6.1 (Heston et al., 2002). We have averaged the data for the relevant time periods.
7. Primary education is measured as the gross enrollment ratio (%) i.e., as the ratio of total enrollment (regardless of age) to the population of the age group that officially corresponds to the level of education (World Bank, 2001). We have averaged the data for the relevant time periods.
8. Population growth is from Penn World Data Tables, version 6.1 (Heston et al., 2002).
9. Index of Ethnolinguistic Fractionalization is a measure of the probability that two randomly selected individuals in a country do *not* belong to the same ethnolinguistic group and is taken from World Bank (2001).
10. The Common Law dummy is equal to one if the country belongs to common law tradition and zero otherwise and is taken from La Porta et al. (1997).

Table B.1 shows descriptive statistics of the variables used in the econometric analysis. Table B.2 lists for each country the key variables.

Table B.1
Descriptive statistics

Series	Mean	Minimum	Maximum
Short-run data set			
Corruption perception index	5.07	1.71	9.93
Control of corruption	0.53	−1.07	2.45
Voice and accountability index	0.62	0.27	0.84
Per capita GDP growth (1995–2000)	2.26	−3.10	8.84
Investment/GDP	18.4	5.5	43.9
Per capita initial GDP	10,694	467	28,409
Gross enrollment in primary education	101	63	130
Population growth (1995–2000)	0.06	−0.08	0.25
Ethnic-linguistic fractionalization	0.22	0	0.83
Age of democracy	41	0	203
Long-run data set			
Corruption perception index	5.12	0.4	9.93
Control of corruption	0.37	−1.20	2.46
Voice and accountability index	0.63	0.12	1
Per capita GDP growth (1970–2000)	1.71	−2.90	6.43
Investment/GDP	18.0	2.7	44.2
Per capita initial GDP (1970)	4153.	341	12,963
Gross enrollment in primary education	97.7	49.6	122.1
Population growth (1970–2000)	1.77	0.20	3.21
Ethnic-linguistic fractionalization	37.5	1	93
Age of democracy	45	0	203

Note: Definitions and sources are given in the text.

Table B.2
List of countries and key variables

Country	Data set	Long-run growth rates	Short-run growth rates	Voice and accountability index	Control of corruption	Corruption perception index
Argentina	Both	0.48	1.40	0.67	−0.38	3.17
Australia	Both	1.71	2.77	0.98	2.00	8.57
Austria	Both	2.33	2.40	0.91	1.92	7.60
Belgium	Both	2.04	2.60	0.93	1.38	5.60
Bolivia	Both	0.62	0.83	0.59	−0.71	2.67
Brazil	Both	2.07	1.23	0.67	−0.04	3.98
Cameroon	Both	0.85	1.94	0.28	−1.01	1.71
Canada	Both	2.12	3.23	0.94	2.20	9.20
Chile	Both	2.13	3.18	0.79	1.40	7.03

(*continued on next page*)

Table B.2

Country	Data set	Long-run growth rates	Short-run growth rates	Voice and account-ability index	Control of corruption	Corruption perception index
Colombia	Both	1.87	−0.35	0.45	−0.42	2.82
Costa Rica	Both	1.31	1.93	0.90	0.84	5.34
Denmark	Both	1.92	2.37	1.00	2.36	9.93
Egypt, Arab Rep.	Both	2.38	3.02	0.32	−0.16	3.16
Finland	Both	2.21	4.83	1.00	2.46	9.80
France	Both	1.80	2.14	0.90	1.49	6.67
Greece	Both	2.16	3.22	0.82	0.64	4.83
Honduras	Both	0.33	−0.02	0.53	−0.77	2.04
Iceland	Both	2.92	3.87	0.95	2.24	9.22
India	Both	2.79	4.61	0.64	−0.28	2.85
Indonesia	Both	4.13	−0.01	0.34	−0.90	1.81
Ireland	Both	4.17	8.85	0.94	1.77	7.65
Israel	Both	2.22	0.97	0.78	1.19	6.90
Italy	Both	2.06	1.42	0.86	0.77	4.71
Jamaica	Both	−0.49	−0.60	0.72	−0.35	3.49
Japan	Both	2.68	1.18	0.83	1.23	6.17
Luxembourg	Both	3.11	5.06	0.94	2.07	8.72
Malaysia	Both	4.17	2.65	0.49	0.44	5.06
Mauritius	Both	4.27	4.08	0.82	0.42	4.83
Mexico	Both	1.88	4.22	0.58	−0.31	3.37
Morocco	Both	1.85	1.61	0.42	0.09	4.17
Netherlands	Both	1.83	3.09	0.99	2.25	8.96
Nicaragua	Both	−2.76	−0.58	0.54	−0.52	2.87
Norway	Both	3.00	2.52	0.99	2.12	8.96
Pakistan	Both	1.47	1.07	0.25	−0.84	2.39
Panama	Both	1.36	1.52	0.70	−0.28	2.13
Paraguay	Both	1.55	−2.67	0.44	−0.93	2.32
Peru	Both	0.06	0.72	0.47	−0.18	4.44
Portugal	Both	3.63	4.10	0.92	1.35	6.51
Senegal	Both	0.27	2.17	0.53	−0.36	3.41
Singapore	Both	6.43	5.00	0.59	2.39	9.12
South Africa	Both	−0.15	0.87	0.79	0.49	5.04
Spain	Both	2.35	2.04	0.88	1.39	6.62
Sweden	Both	1.34	2.69	0.99	2.33	9.41
Switzerland	Both	0.80	1.49	1.00	2.25	8.77
Tanzania	Both	1.01	0.62	0.44	−0.90	2.26
Thailand	Both	4.68	0.27	0.60	−0.28	3.14
Trinidad and Tobago	Both	0.72	3.97	0.74	0.17	2.86
Tunisia	Both	3.40	4.21	0.33	0.30	5.25
Turkey	Both	2.22	2.25	0.41	−0.17	3.58
United Kingdom	Both	1.98	2.50	0.94	2.08	8.65
United States	Both	1.76	3.22	0.92	1.81	7.61
Uruguay	Both	1.27	1.82	0.80	0.59	4.58
Venezuela	Both	−0.78	−1.98	0.50	−0.80	2.55
Zambia	Both	−1.96	1.83	0.48	−0.80	3.33
Zimbabwe	Both	0.51	−1.27	0.28	−0.67	3.61
Belarus	SR only		8.79	0.21	−0.65	3.93
Bulgaria	SR only		−3.07	0.68	−0.30	3.35
Croatia	SR only		4.37	0.58	−0.09	3.40
Czech Republic	SR only		1.14	0.84	0.40	4.57
Estonia	SR only		5.03	0.81	0.57	5.68
Germany	SR only		1.68	0.95	1.88	7.83
Hungary	SR only		3.86	0.87	0.67	5.13
Latvia	SR only		5.06	0.77	−0.06	3.30
Lithuania	SR only		3.08	0.80	0.17	3.83
Poland	SR only		4.83	0.85	0.39	4.28
Romania	SR only		−1.95	0.63	−0.32	3.03
Russian Federation	SR only		2.22	0.43	−0.82	2.32
Angola	LR only	−2.90		0.19	−1.15	
Bangladesh	LR only	1.42		0.44	−0.70	0.4

Table B.2

Country	Data set	Long-run growth rates	Short-run growth rates	Voice and account-ability index	Control of corruption	Corruption perception index
Botswana	LR only	4.45		0.76	0.72	6.0
Burundi	LR only	0.56		0.18	−1.05	
Central African Republic	LR only	−0.98		0.41	−1.03	
China	LR only	4.82		0.16	−0.27	3.5
Georgia	LR only			0.46	−0.87	
Guatemala	LR only	0.93		0.44	−0.74	2.9
Haiti	LR only	3.49		0.30	−1.20	
Iran, Islamic Rep.	LR only	0.47		0.27	−0.60	
Lesotho	LR only	3.94		0.56	0.03	
Mozambique	LR only	−1.08		0.50	−0.65	
New Zealand	LR only	1.11		0.97	2.36	9.4
Nigeria	LR only	0.79		0.28	−1.14	1.0
Philippines	LR only	1.01		0.62	−0.43	2.9
Swaziland	LR only	0.21		0.22	−0.39	
Syrian Arab Republic	LR only	2.82		0.12	−0.61	

Notes: "Data set" indicates if the country is included in the short-run data set only (SR only), in the long-run data set only (LR only) or in both data sets (both). The definitions of the variables are given in the text.

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