# Corruption, Institutional Quality and Growth: a Panel Smooth Transition Regression Approach*

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**Abstract**

We analyze the impact of corruption and institutional quality on economic growth using a sample of 128 developed and developing countries on the period 1984-2012. We show, by employing a Panel Smooth Transition Regression framework *à la* Gonzalez *et al.* (2005), that there is a non-linear relation between corruption and growth modulated by the institutional development. Specifically, we find that corruption can positively (negatively) affect growth in case of a low (high) level of institutional development. This result suggests therefore a reconcialition of the theories asserting that corruption can "sand the wheels" or "grease the wheels" of economic growth.

**Keywords**: corruption, institutions, growth, Panel Smooth Transition Regression

**JEL classification**: C34, D73, O43, O11

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# 1 Introduction

Corruption is commonly defined as "*the misuse or the abuse of public office for private gain*" (World Bank, 1997). Although it is usually assimilated to bribes, it encompasses different facets as cronyism, nepotism, patronage and embezzlement.[1]

In recent years, corruption has been brought to the front side of the public debate, be it in developed or developing countries. According to Glynn et al. (1997) "*no region, and hardly any country, has been immune*" to corruption. The **developing and emerging countries** have been subject to corruption issues as suggested by Levy (2007) and Varese (1997) in the case of countries as Georgia and Russia, by De Soto (2010) for Peru or by Bertrand et al.(2007) or Ebben and Vaal (2008) in the case of India or, Zaire and Nigeria, respectively. Moreover, according to Transparency International (2009), about a third of international assistance is taken every year by corrupt officials in developing countries. In **developed countries**, numerous corruption cases have also been put forward as underlined by Van den Heuvel (2005) when analyzing the Netherlands case or by the European Commission (2014) for the EU28 situation in general.

Therefore, in both rich and poor countries, corruption remains an important public matter (Ebben and De Vaal, 2011). The World Bank (2013) evaluates the total amount of bribes paid in both developing and developed countries in 2001-2002 at 1 trillion dollars, about 3% of world GDP at the time. Moreover, the World Bank (2005) estimates the costs induced by corruption in both developed and developing countries at a 1000 billion per year. Moreover, Transparency International (2013) underlines that 2/3 of the world countries have corruption rates above the average. This explains why international organizations, such as the World Bank, the International Monetary Fund, the United Nations Development Programme and other organizations, have attempted to address the corruption issue since the early 1980s. This also justifies that the imple-

[1]Overall, according to World Bank (1997), corruption can be divided into three categories: political corruption, bureaucratic corruption and economic and social corruption. In the presence of political corruption (or "grand corruption"), the social welfare maximization, is ruled out in favor of personal interests of politicians who seek to maximize their individual welfare. Bureaucratic corruption, also called petty corruption, reflects the corruption of public officials which are given bribes from the users of public services. The last type of corruption is economic and social corruption. In the case of economic corruption, the exchange is only material and financial. In contrast, in the case of social corruption, corruption will take a much broader meaning, including both material and financial exchanges, but also any kind of abuse of power, such as cronyism, nepotism, influence peddling, or even embezzlement or misappropriation of corporate assets. Even if theoretically a distinction between the different types of corruption can be made, at the empirical level, this is not possible as the data is not available.

mentation of reforms meant to fight against corruption has become more than ever a top priority.

Corruption can strongly affect different facets of the economic, social and human development of a country (Mauro 1997; Mauro 1998; Amundsen 1999; Acemoglu 2005). In particular, the impact of corruption on economic growth is extensively addressed, along two main conflicting views. According to *a first view*, which is the oldest historically, corruption "greases the wheels" of business and economic growth and development. It can be efficiency enhancing by allowing firms and individuals to get round the rules of an ineffective administrative and legal system that slows down investment and therefore growth (Leff 1964; Nye 1967; Hutington 1968; Méon and Weil 2010). According to the proponents of this theory, corruption addresses the institutional shortcomings[2]: if countries can not develop their institutional environment, corruption becomes a natural loophole allowing the system to achieve growth, at least in a short medium term perspective. *A second view* considers that corruption "sands the wheels" of economic growth. This widely accepted view is supported by plenty of factual evidence. In this respect, the theoretical and empirical literature argues that corruption is negatively related to growth through its adverse effects on private investment, public expenditure, human capital as well as governance and institutional quality.

Within this framework, we propose a novel reassessment of the impact of corruption on economic growth through the lens of institutional quality. Our contribution to the literature is fourth-fold. *Firstly*, in contrast to most existing studies on the topic, we do not consider that corruption can have, only a positive, or, only a negative impact on economic growth. Hence, we aim at reconciling the "greasing the wheels"and the "sanding the wheels"views by highlighting that both effects could co-exist. *Secondly*, we explain this by the fact that the relation between growth and corruption could be non-linear. Specifically, we go beyond existing studies which estimate the corruption-growth nexus using linear models: we highlight the existence of non-linearities in this relation and estimate it using a Panel Smooth Transition Regression model. *Thirdly*, we show that this differentiated/non-linear impact of corruption on growth depends on the level of institutional quality of the analyzed countries, captured using an extended set of six institutional variables. *Fourthly*, in comparison to most existing studies that extensively use cross-section data, we employ panel data, account for the time-varying

[2]Institutional development is considered to be a key factor of economic growth as underlined by North (1990). Moreover, Acemoglu (2005) shows that stronger institutional development is growth reinforcing.

nature of the relation between growth and corruption and use also a richer data set including both developed and developing countries.

The remainder of the paper is organized as follows. Section 2 provides a literature review. Section 3 describes the econometric methodology while Section 4 describes the data. Section 5 outlines and discusses the empirical results. Section 6 presents the robustness checks and section 7 concludes.

# 2 Literature review: "grease the wheels" versus "sand the wheels" hypotheses

## 2.1 Theoretical approach

The first theoretical studies about the corruption-economic growth nexus have highlighted the positive effects of corruption on economic activity. These models provide a theoretical framework to analyze the impact of corruption on economic growth. Thus, in the 60s, Leff (1964), Leys (1965) and Huntington (1968) have suggested that corruption could stimulate growth and improve economic welfare via at least two kinds of channels. Firstly, corruption practices, and especially bribes, allow firms to overcome bureaucratic delays. Secondly, these practices provide incentives for bureaucrats to work harder. Along the same lines, in the 80s, Lui (1985) has built an equilibrium queuing model of bribery and has shown that bureaucratic corruption practices tend to select the most efficient firms by awarding contracts to those offering the highest bribes. Similarly, Beck and Maher (1986) develop and compare two models: an equilibrium model of bribery and a competitive bidding model. They conclude that since only the most powerful companies (or investors) are able to pay the highest bribes, corruption greases the wheels of the economy by allocating investments more efficiently. Acemoglu and Verdier (1998) highlight theoretically that if combating corruption is too costly, then the level of corruption that maximizes output could be greater than zero.

Nevertheless, in recent period, several other theoretical analysis, although supporting the greasing the wheels hypothesis, have underlined that the ability of bureaucratic corruption to speed up procedures could be limited by the fact that companies which give the highest bribes spend more time negotiating regulations (Kaufman and Wei, 1999). This can be explained by the adverse effects on officials' behavior: officials are encouraged to slow down the procedures, to cause greater administrative delays in order to extract bribes (Myrdal 1968; Bardhan 2006).

The arguments above in favor of the efficiency effects of corruption depend on the static and partial perspectives of the context in which corruption is taking place and ignore the enormous degree of discretion that bureaucrats have (Hodge et al. 2011).

Hence, a vast theoretical literature is concerned with the adverse effects of corruption on growth, supporting the ”sanding the wheels” hypothesis. It has been showed that corruption negatively affects investment which is a main determinant of growth, and this occurs more significantly in medium and long run than short run (Akai *et al.*, 2005). Pellegrini and Gerlagh (2004) have identified five transmission channels of the effects of corruption on economic growth, among which investment and international trade are the most important. Attila (2009) has built a simple model highlighting the adverse effects of corruption, considered as a tax on investment. Shleifer and Vishny (1993) argue that corruption causes the reallocation of talent away from entrepreneurial activities towards unproductive rent-seeking activities. Overall, in these studies corruption reduces the investment ratio and therefore economic growth.

It is difficult to advance, based only on theoretical models, which of the two views translates better the economic reality (Aidt, 2009). Therefore, *we turn to empirics.*

## 2.2 Empirical perspective

In the empirical literature, the impact of corruption on economic growth is evaluated both at micro level, using field experiments and firm surveys, and at macroeconomic level, adopting a cross-country approach. *Micro founded empirical analyses* (de Soto, 1990; Kaufmann and Wei, 1999; Fisman and Svensson, 2007) sustain the sanding the wheels hypothesis and find no support of the greasing the wheels view.[3]

*Macro evidence* is more mixed. Most of these analyses tend to support the sanding the wheels hypothesis. Within this framework of *sanding the wheel hypothesis*, the negative relationship between corruption and growth can be analyzed via different channels at macroeconomic level: private and public investment, human capital, political stability and institutional quality.

Most of the studies on the corruption-GDP growth nexus consider investment as the main channel through which *corruption negatively affects growth.* Mauro (1995) has been the first to examine econometrically the impact of corruption on economic

[3]With one exception, presented below and linked to a macroeconomic analysis.

growth, in a study which covers 67 countries over the period 1980-1983. He argues that corruption undermines the economy by limiting investments and by diverting social projects away from their original objectives. Corruption acts as a tax on capital, but unlike formal taxes, it is uncertain, unpredictable and therefore difficult to internalize. As a consequence, it discourages private investment which reduces economic growth. Mauro (1995) has used the Business International Indices of Corruption and Institutional Efficiency in order to identify the channels through which corruption and other institutional factors affect growth, and to quantify these effects. He has regressed investment on these indices which he has called "bureaucratic efficiency". His results show that countries with high levels of corruption tend to have lower investment/GDP and private investment/GDP ratios. Thus, he has highlighted a strongly negative relationship between corruption and investment, showing that corruption reduces private investment by 2,9% and slows economic growth by 0,8 to 1,3%.

Corruption can also affect growth through public investment. Tanzi and Davoodi (1998) using different corruption indexes on two sets of countries for the period 1980-1995, show that corruption can diminish growth by *(i)* increasing public investment while reducing its productivity, *(ii)* by increasing the public investment associated to government wages and salaries or by reducing *(iii)* the quality of existing infrastructure or *(iv)* the government revenue needed to finance productive spending. In other words, Tanzi and Davoodi (1998) suggest that corruption reduces the size and the quality of public investment and therefore GDP growth. However, this conclusion is based on cross-sectional analysis and the endogeneity problem is completely ignored.

The indirect effects of corruption on growth are analyzed by Mo (2001) through the lens of investment, human capital and political instability. The analysis developed on a sample of 45 countries for the period 1970-1985 underlines that corruption affects investment, human capital and political stability negatively. Since these elements are positively related to production and therefore growth, corruption exerts a negative impact on growth. The negative impact of corruption on growth seems to be explained by investment for more than 20% and human capital for 9.7%. Moreover, 53% of the total effect of corruption on economic growth passes through political instability.

Using a Cobb-Douglas production function with human capital and public and private investment, with a level of technology that accounts for the level of corruption, Martinez-Vasquez *et al.* (2005) show that corruption can affect growth directly, through the production process, and indirectly, via the factors of production. Corruption has clearly a negative impact on governance and thus affects growth. Henceforth, corruption affects growth indirectly through a "crowding-out" effect of public investment. The model also emphasizes that corruption affects the level of human capital and the institutional quality negatively. These results obtained from panel data regressions on 50 countries complement those achieved by Dreher and Herzfeld (2005) who find a negative relationship between corruption and economic growth using cross-sectional regressions. Gyimah-Brempong (2002) shows also, using a dynamic panel, that corruption decreases economic growth through physical capital and investment and in the same time enhances an unequal income distribution in African countries.

Only few empirical studies have confirmed the conclusions of the theoretical models on the beneficial effects of corruption on growth and development, *supporting thus empirically the grease the wheel theory.* These studies have however underlined that an eventual positive impact of corruption on growth emerges only under specific conditions and usually goes along with a a negative impact of corruption on economic growth in other conditions.

Hence, Mironov (2005) analyzes, in a macroeconomic approach, the effects of corruption on economic growth in 141 countries over the period 1996-2004, in a cross-country analysis. He adds to this initial study a micro-analysis undertaken on financial data of more than 9,000 companies in 51 countries. The objective of this latter analysis is to identify the impact of corruption on capital accumulation. In both macro and micro studies, he divides corruption into two categories: systematic corruption and residual corruption (or idiosyncratic corruption). The former is correlated with governance characteristics such as poor judiciary system, low government effectiveness and cumbersome regulation while the latter is not linked to governance characteristics and might be understood as a *"corruption gap"* between the observed value and the forecasted value of corruption. Mironov (2005) finds some adverse effects of systematic corruption on economic growth but proves that the residual corruption is positively correlated with GDP growth and capital accumulation in countries with poor institutions.

The "grease the wheels" hypothesis is tested by Méon and Weill (2010) on a panel of 69 countries, both developed and developing, for the period 1994-1997. Using three measures of corruption and five institutional indicators, they show that corruption is detrimental in countries where institutions are effective, but can have positive effects on growth in countries where this is not the case. Hence, their results suggest that in a context of low institutional quality, corruption can be beneficial to growth. Therefore the best policy choice in fighting against corruption depends, in a country, on the dynamics of the interactions between corruption, governance and economic performance.

Nevertheless, this interpretation is challenging: a country which experiences a large corruption can fall into a bad governance trap and will have difficulties to break the vicious cycle of persistent corruption. The implementation of anti-corruption policies is necessary and can thus improve at the same time the other institutional dimensions such as good governance.

A study of the relationship between corruption, economic freedom and growth is proposed by Méndez and Sepúlveda (2006). In their analysis, Méndez and Sepúlveda (2006) split the countries into two groups: "free" countries and "not free" countries. The impact of corruption on growth depends upon the degree of political freedom. In "free" countries, they find a non-monotonic (quadratic) relationship between corruption and growth. Thus, in these countries, corruption has adverse effects at a high level of incidence but has beneficial effects at a low level of incidence. This relationship is not modified by the size of public expenditure. However, in "not free" countries, the impact of corruption on growth is statistically insignificant.

Heckelman *et al.* (2008) have developed a theoretical model and an empirical evaluation of the link between institutions, corruption and economic growth. Their theoretical model highlights a range of possible equilibrium configurations in the relationship between corruption, growth and institutional quality. According to them, corruption has a negative impact on growth in a regime with high institutional quality but has no impact if institutional quality is poor. Their conclusion is in line with both the "grease the wheels" and the "sand the wheels" views. On the one hand, in a context of high institutional quality, corruption will affect growth directly or indirectly through private investment, public investment, human capital, political stability, and other channels. On the other hand, in a context of low institutional quality, corruption allows individuals to circumvent institutional failures. Empirically, they show a robust nonlinear relationship between corruption and growth. This nonlinear relationship is the result of the multiple equilibria due to the specificity of the different governance regimes ("good" or "bad").

Huang (2015) investigates whether corruption negatively impacts economic growth in thirteen Asia-Pacific countries over the 1997-2013 period, using a bootstrap panel Granger causality framework, which takes account of both cross-sectional dependence and heterogeneity across countries. The author does not find support of the sanding the wheel hypothesis. The greasing the wheels hypothesis seems to prevail in South Korea and a positive causality running from economic growth to corruption is found for China. Swaleheen (2011) shows, in a panel of 117 countries, for the period 1984-

2007, using a five time period approach, that corruption has a significant effect on the growth rate of real per capita income and this effect is non-linear, using fixed effects estimation as well as a dynamic panel approach. The non-linear effect of corruption on economic growth is also underlined by Ahmad, Ullah and Arfeen (2012). The authors suggests, based on the generalized method of moments estimation applied to developed and developing countries, that a decrease in corruption raises the economic growth rate in an inverted U-shaped way. Rock and Bonnett (2004) analyze different developing areas of the world, for four different time periods (1980-83, 1988-92, 1984-96 and 1994-96) and find that corruption slows growth and/or reduces investment in most developing countries (particularly small ones), but increases growth in the large East Asian newly industrializing economies.

The above studies use panel data analysis and put forward the possible non-linearities in the corruption-growth nexus, using *(i)* interaction terms, *(ii)* corruption indexes to the power of 1 and 2, or *(iii)* an exogenous split of the data (i.e. between developed or developing countries; between countries having different levels of institutional developments). In what follows, we use a different approach to analyze, at macroeconomic level, the link between corruption and economic growth. This allows us to *endogenously* determine the eventual non-linearities and to show the co-existence of the greasing the wheels and sanding the wheels hypotheses.

# 3 Empirical strategy

## 3.1 PSTR model specification

In contrast with previous modelization frameworks of the economic growth-corruption nexus, we use a new approach: a Panel Smooth Transition Regression (PSTR) model. This methodology, as far as we know, has never been used to address the economic growth-corruption link in the presence of different levels of institutional quality. The PSTR model offers specific theoretical advantages (Mignon and Lopez-Valencio 2010; Hurlin and Colletaz 2006; Hurlin et al. 2009) that makes it suitable for our analysis. First, it allows the economic growth - corruption coefficients to vary with respect to countries. Hence, coefficients can take different values, depending upon the value of other observable variables. The PSTR estimations suppose the existence of an infinite number of intermediary regimes and the coefficients depend upon these regimes. Second, the PSTR model regression coefficients are allowed to change gradually when moving from one group to another as the PSTR is a regime-switching model with a smooth transition from one regime to another and therefore provides smoothing alterations in the coefficients with respect to the threshold variables. Specifically, the PSTR model will allow us to capture the fact that an increase in the institutional quality does not act linearly on growth, but rather conditional on the position in the distribution of the institutional variable (Jude and Levieuge, 2015).

Henceforth, the impact of corruption on growth through the channel of institutional quality, is analyzed in a Panel Smooth Transition Regression model à la González *et al.* (2005). We will present the simplest case that takes account of two regimes and a single transition function:

$$y_{i,t} = \mu_i + \alpha CORR_{i,t} + \beta CORR_{i,t} f(q_{i,t}; \gamma, c) + \zeta X_{i,t} + \varepsilon_{i,t} \tag{1}$$

where $y_{i,t}$ denotes the dependent variable (GDP/capita growth rate of a country $i$ at time $t$), $\mu_{i,t}$ the individual fixed-effects, $CORR_{i,t}$ the corruption variable of the country $i$ at $t$, $f(q_{i,t}; \gamma, c)$ the transition function and $\varepsilon_{i,t}$ the error term $i.i.d\ (0, \sigma_\varepsilon^2)$. The transition function is continuous and integrable on $[0, 1]$. It depends on three parameters: $q_{i,t}$ is the transition variable, $\gamma$ is the slope of the transition function and $c$ represents the vector of location parameters such as $c = (c_1, \ldots, c_m)'$, $m$ being the vector dimension.

Following Granger and Teräsvirta (1993) and Gonzalez *et al.* (2005), we use a logistic transition function:

$$f(q_{i,t}; \gamma, c) = \frac{1}{1 + \exp\left(-\gamma \prod_{j=1}^{m} (q_{i,t} - c_j)\right)} \tag{2}$$

with $c_1 \leq c_2 \leq \ldots \leq c_m$ and $\gamma > 0$ the slope of the transition function $f(.)$ which determines the smoothness of the transitions.

González *et al.* (2005) already put forward that it is sufficient to consider $m = 1$ or $m = 2$ as these values allow for commonly encountered types of variation in the parameters. For our analysis, there are no elements in the theoretical or empirical literature that could justify the fact that $m$ could become equal to 2. Moreover, the tests that we will perform further on, will confirm the choice of this model, $m = 1$, as baseline of our analysis. The fact that $m = 1$ means that there is one threshold of institutional quality around which the effect of corruption on growth is non-linear, leading to two extreme regimes. However, even in this case $m = 1$, we still have a continuum of regimes that lie between the two extreme ones (high and low). Thus, as the transition variable $q_{i,t}$ increases, the effect of corruption evolves from $\alpha$ in the first regime corresponding to $f(.) = 0$ to $\alpha + \beta$ in the second extreme regime corresponding to $f(.) = 1$, following a single monotonic transition centered around the threshold value $c$ of the transition variable.

It is worth noting that when $\gamma$ is close to 0, the transition function is constant and the model will amount to estimating a standard fixed-effects model. However for high values of $\gamma$ or when $\gamma$ tends towards $+\infty$, $f(.)$ becomes an indicator function which is defined as:

$$f(.) \equiv \mathbb{I}(q_{i,t} > c) = \begin{cases} 1 & \text{if } \; q_{i,t} > c \\ 0 & \text{otherwise} \end{cases} \tag{3}$$

In this situation, of $\gamma$ tending towards $+\infty$, the PSTR corresponds to the Panel Threshold Regression (PTR) specification (Hansen, 1999). Unlike the PTR model, the PSTR specification allows the corruption-economic growth coefficients to vary over time and across countries since the transition variable is individual-specific and time-varying. The use of this model will therefore enable us to capture the heterogeneity of the relation between corruption and economic growth via the institutional quality of the countries.

Between the two extreme cases $f(.) = 0$ and $f(.) = 1$, the sensitivity of economic growth to corruption depends on the institutional quality and can be captured by:

$$s_{i,t} = \frac{\partial y_{i,t}}{\partial CORR_{i,t}} = \alpha + \beta f(q_{i,t}; \gamma, c) \tag{4}$$

According to the definition of the transition function, we have $\alpha \leq s_{i,t} \leq \alpha + \beta$ for $\beta > 0$ and $\alpha + \beta \leq s_{i,t} \leq \alpha$ for $\beta < 0$ since $0 \leq f(q_{i,t}; \gamma, c) \leq 1$. Furthermore, as previously underlined, the sensitivity of economic growth to corruption can differ under the two extreme regimes $\alpha$ and $\alpha+\beta$ and can be defined as a weighted average of parameters $\alpha$ and $\beta$. Therefore, as in a logit or probit model, it is difficult in general to interpret directly the values of these parameters. It is preferable to interpret their sign which captures an increase or a decrease in the elasticity, depending on the value of the transition variable as well as the individual and time dimension given by the previous equation. Moreover, if each country $i$ at time $t$ has specific values of the transition variable, this sensitivity will be then different for each country. And if a country has a varying $q_{i,t}$, then the elasticity varies over time. Furthermore, the main advantage of the PSTR is the fact that, overall, it allows an endogenous determination of the thresholds.

In the previous specification, the institutional variables are only introduced through the transition functions. But they could have a direct effect on corruption (Fouquau et al, 2008): if each institutional variable has a direct impact on corruption, one could erroneously find switching. Therefore, in order to take account of this issue, we perform linearity tests related to specifications in which the transition variable is also used as an explanatory variable. When direct effects are introduced, the linearity test statistics are lower than the values obtained in the baseline case. However, in all cases, even in the model with direct effect, the null of linearity is always strongly rejected.[4]. Furthermore, our model will be developed in a PSTR approach with institutional indicators considered as transition variables.[5]

## 3.2 Specification tests

Gonzalez *et al.* (2005) suggest three types of tests in order to specify the PSTR model. The first test focuses on the non-linearity of the model. The second allows to determine the number $r$ of transition functions. The third helps identifying the number of thresholds by transition function.

The aim of these tests is to ensure that the use of the PSTR model is appropriate. For the sake of simplicity, we follow Colletaz and Hurlin (2006) and assume that there is only one threshold ($m = 1$). Testing the linearity of the relationship between corruption, institutional quality and economic growth amounts to testing the null hypothesis $H_0$:

[4]The results are available upon request.

[5]The results that we obtain in this situation do not change significantly with respect to the PSTR model that includes institutional variables that are considered both as transition variables and controls.

$\gamma = 0$ and $\beta = 0$. Nevertheless, under $H_0$, the tests are nonstandard because the PSTR model contains unidentified nuisance parameters. In order to solve this problem, Gonzalez *et al.* (2005) suggest to replace the transition function by its first-order Taylor expansion around $\gamma = 0$ and to test an equivalent hypothesis in an auxiliary regression (Hurlin et al, 2008). Hence, we obtain:

$$y_{i,t} = \mu_i + \theta_0 CORR_{i,t} + \theta_1 q_{i,t} CORR_{i,t} + \zeta X_{i,t} + \varepsilon^*_{i,t} \tag{5}$$

where parameters $\theta_0$ and $\theta_1$ are proportional to the slope parameter $\gamma$ of the transition function.

Therefore, testing the non-linearity of the model amounts to testing:

$$\begin{cases} H_0 : \theta_1 = 0 \\ H_1 : \theta_1 \neq 0 \end{cases} \tag{6}$$

A test statistics that can be used in order to test the non linearity of the model is a Fisher's version of the Lagrange Multiplier test (Gonzalez *et al.* 2005). The results of this test are presented in the Appendix in Table 3 and indicate that the PSTR model is suitable to assess the impact of corruption on growth.

Further on, to identify the number of transition functions in our model or equivalently the number of regimes, we use a procedure that is quite similar to the linearity tests. Hence, we use a sequential procedure in order to determine the number of transition functions needed to capture the non linearity of the model. If the above linearity hypothesis is rejected, then we test : $H_0$ the existence of one transition function against $H_1$ the existence of two transition functions of the auxiliary regression. We use the same test statistics and the results[6] show the existence of one transition function.

In order to determine the optimal number of thresholds, we follow Gonzalez *et al.* (2005) and use the sequential test developed by Granger and Teräsvirta (1993) and Teräsvirta (1994). The results[7] suggest that the optimal number of thresholds is $m = 1$.

First, we include in each PSTR regression, among the controls, the institutional variable that acts as a transition variable.

[6] These results are available in the appendix.

[7] These results are available upon request.

Finally, the potential endogeneity bias also needs to be addressed. Instrumental variable methods have not yet been constructed in a PSTR framework (Fouqau et al 2008; Jude and Levieuge 2015). Moreover, Yu (2013) shows that the nonlinear structure of threshold regression invalidates the usual 2SLS procedure. According to Lopez Villavicencio and Mignon (2012) and Fouquau et al (2008), non-linear modeling strategies can mitigate endogeneity issues. However, for comparative reasons and robustness check, we also perform, in section 7, a GMM (Generalized Method of Moments) approach to estimate a growth equation with interaction terms.

# 4 Data

In our study, we consider a heterogeneous unbalanced panel of 128 countries over the period 1984-2012. The dependent variable is the growth rate of GDP per capita.

Several exogenous variables are used to explain the evolution of the GDP per capita growth rate. These are related to corruption, institutional quality and other macroeconomic variables.

Our variable of interest is corruption. The index that we take into account in order to characterize this variable captures different aspects of corruption in particular within the political system. It includes more specifically demands for special payments and bribes related to import and export licenses, exchange controls, tax assessments, excessive patronage, nepotism, "favor-for-favors"and secret party funding. This variable is taken from the ICRG (International Country Risk Guide) database[8] and is intended

[8]The ICRG index of corruption comes from Political Risk Services Inc., a private firm that annually publishes the International Country Risk Guide (ICRG). The ICRG database provides a quantification of the political, economic and financial risks in general. The ICRG index of corruption has been subject to several critics underlined by Williams and Siddique (2008) and taken up by Swaleheen (2011): *(i)* the ICRG index measures the risk to political stability owing to corruption and not corruption itself; *(ii)* the index is calculated for foreign investors by non-resident country experts and seeks to measure only corruption that threatens foreign investment rather than corruption faced by all firms ; *(iii)* the focus on foreign investment might suggest that more expert resources are allocated to assess corruption in relatively larger economies (as foreign investment is oriented towards these markets) and less to smaller economies, which leads to measurement error. Following Swaleheen (2011), we consider that the ICRG corruption index could be a good proxy of corruption under the following assumptions : *(i)* perceived threat of political instability to foreign investors owing to corruption increases linearly with the corruption *(ii)* corrupt public officials make eventually no distinction between foreign and domestic firms when it comes to extracting bribes, and *(iii)* international bodies use the same range of information for all countries when assessing country risks.

to assess the degree of corruption prevailing in a certain country, based on a survey among foreign investors. The corruption index provided by the ICRG can take values from 0 to 6: the lower the ratings, the greater the degree of corruption. In order to facilitate the interpretation, we rescale the index so that a higher rating would translate a higher incidence of corruption. The expected impact of corruption on economic growth is supposed to be either positive or negative (Aidt et al., 2008; Méon et Weill, 2010).

Six institutional indexes are accounted for, in our analysis, to explain the economic growth. They are meant to capture the different facets of institutional development. As advanced in the literature, the latter is supposed to positively impact economic growth (Glaeser and Sacks, 2004).

In our analysis, each institutional quality variable will be taken as a transition variable. The six variables will be used each at one time, both in a robustness check perspective and as a way to allow for a comparison with previous literature results.

The first institutional variable is the *institutional quality*. We have computed it as an aggregate of five institutional variables: government stability, investment profile, law and order, democratic accountability and bureaucracy quality, using a Principal Component Analysis (PCA). All these five variables that are used to compute it are taken from the ICRG database. As argued previously, they will also be considered individually in the analysis, as transition functions. Two of these variables, namely the *bureacratic quality* as well as the *government stability* capture to a certain extent, as in Méon and Weill (2010), two facets of governance that are at the core of the grease the wheels hypothesis: the fact that corruption may be useful to either speed up the decisions of a sluggish bureaucracy, or to bypass an inefficient government regulation. Thus, government stability assesses the government's ability to carry out its declared programs and its ability to stay in office. The risk rating assigned is the sum of three subcomponents: government unity, legislative strength and popular support. The *bureaucracy quality* assesses the institutional strength and quality of the bureaucracy as shock absorber that tends to minimize revisions of policy when governments change.

Moreover in the literature on the corruption-growth nexus, there is a specific emphasis on the importance of countries' *investment profile*. This variable takes account of factors affecting the risk to investment which are not covered by other political, economic and financial risk components. It captures three components: contract viability/expropriation, profits repatriation and payment delays.

A *law and order* variable is also taken into account. It covers two dimensions: "law" assesses the strength and the impartiality of the legal system and "order" assesses popular observance of the law.

The last institutional variable that is considered is the *democratic accountability*. It assesses how responsive government is to its people, considering that the less responsive it is, the more likely it will fall, peacefully in a democratic society, but possibly violently in a non-democratic one.

Government stability and investment profile range from 0 to 12 points, law and order and democratic accountability indexes are between 0 and 6 points and bureaucracy quality ranges from 0 to 4 points. For all variables, a score of 0 point equates to a very high risk while a score of respectively 12, 6 and 4 points translates a very low risk. In total, our composite indicator ranges from 0 to 52. High values of the indicator reflect high institutional quality and low values of the indicator reflect weak institutional quality.

Moreover, several traditional variables highlighted by growth theories as being key determinants of economic growth are included in the regressions as control variables. Levine and Renelt (1992) identify the following variables as being robust in determining growth: the initial level of real GDP per capita, the rate of population growth and the share of investment in GDP (Mo, 2001). These variables will also be included in our analysis.

The logarithm of *initial level of GDP per capita* is measured by the logarithm of the value of GDP per capita every five years. It aims to take into account the convergence process highlighted by Solow (1956). Countries having a lower initial capital stock per head (or similarly, a lower initial level of production per capita) grow faster than countries with a higher capital stock per head. The expected sign of this variable is therefore negative as suggested by the literature.

The *population growth* is also considered into the analysis in the spirit of the neo-classical growth theory (Solow, 1956 and Swan, 1956). It is supposed to negatively affect economic growth.

Furthermore *investment* is also considered in the analysis: higher investment could have a positive impact on economic growth. In our model, the investment is captured under different angles: as a *(i)* public investment, *(ii)* a private domestic investment as well as *(iii)* a foreign direct investment (FDI)[9]. The latter variable is represented

[9]We aimed at introducing into the analysis the human capital as well, but this variable is strongly correlated with FDI. As we wanted to capture the different forms of investment, we choose to keep the FDI and not to include the human capital into the model.

by the FDI inflows.[10] Gross fixed investment of the private sector covers gross outlays by the private sector (including private nonprofit agencies) on additions to its fixed domestic assets. Government investment is cash payments for operating activities of the government in providing goods and services. Each of these three variables are computed as a percentage of the GDP.

Besides these traditional determinants of economic growth, we consider also other control variables. Hence, we introduce both *inflation* and *trade openness* in the regressions. Inflation is measured by the consumer price index (CPI). The impact of inflation on growth could be either positive or negative (Eggogh and Khan, 2014). Trade openness is the sum of exports and imports of goods and services measured as a share of GDP. The impact of trade openness on growth has been subject to debate, but as suggested by Méon and Weill (2010) and Edwards (1998) among others, we can expect that openness may be positively linked to growth.

The data related to the macroeconomic variables (e.g. traditional growth determinants and control variables) stem from the World development database, with the exception of FDI which is taken from the UNCTAD dataset.

# 5 Results

Descriptive statistics concerning the sample are reported in Tables 1 and 2. As the range of initial GDP per capita shows it (Table 1), our sample contains both developed and developing countries.

Table 3 presents the linearity tests (also called homogeneity tests). The latter show that the link between corruption and growth is non-linear when the institutional development is taken as a transition variable. This holds true for each of the five institutional variables taken separately or when an aggregate institutional quality index is considered (computed as an aggregate of the former five variables).

For each institutional variable taken as transition variable, the econometric tests show that one transition function is sufficient to purge the non-linearity between corruption and growth[11]. Moreover, based on the AIC and BIC information criteria we

[10] These are the net inflows of investment needed to acquire a lasting management interest (10 percent or more of voting stock) in an enterprise operating in an economy other than that of the investor.

[11] For each specification, we compute the LM, pseudo LRT and the $LM_F$ statistics for the linearity tests and for the tests of non-remaining linearity. In the spirit of Colletaz and Hurlin (2006), we only

determine the optimal number of thresholds per transition function. These criteria show that the optimal threshold number is 1 for all transition variables.[12]

The correlations between the explanatory variables, on the one hand, and between the institutional variables, on the other hand, are provided in the Tables 4 and 5. The correlation among correlation among the explanatory variables is low. Thus, all these variables could be included in each PSTR model (and each GMM model, as well).[13]

The results of the PSTR estimates are provided in Table 6. As in logit or probit models, the value of the estimated parameters is not directly interpretable, but their signs are (Fouquau et al, 2008).

All control variables have the expected sign and are on the whole significant, whatever the specification. The initial GDP per capita has a negative sign suggesting that the conditional convergence hypothesis is verified: countries having lower GDP per capita tend to grow faster. The initial level of economic development of an economy is thus a key determinant of economic growth. The negative coefficient of population growth translates, in the spirit of Solow, the adverse effect of overpopulation on the economic growth. The government expenditure affects negatively economic growth, reflecting the government burden and inhibiting growth (Eggoh and Khan, 2014). FDI and private investment positively affect growth, being essential inputs of capital accumulation and therefore of economic growth. The coefficient associated to trade openness is also positive, which is in line with both the neoclassical approach and the endogenous growth theory. In the neoclassical case, the positive effects of trade on growth pass through comparative advantages (i.e. production factors endowments, technology differences). In the endogenous growth theory, trade affects positively economic growth due, for example, to the technological diffusion between countries (Mignon and López-Villavicencio, 2011). The negative sign of inflation on growth suggests an overall adverse impact of inflation on the economic growth of the analyzed countries (as in Eggoh and Khan, 2014).

Turning now to our variables of interest, we note that all the $\alpha$ coefficients are positive while all the $\beta$ coefficients are negative. The direct impact of corruption on

report the results of the $LM_F$ statistics as it was documented that the F-version of the test has better size property in small samples.

[12]The results concerning the number of transition functions and the number of thresholds are available upon request.

[13]The correlations between the institutional variables and the other explanatory variables are also performed. They authorize the inclusion of each institutional variable among the covariates. These results are available upon request.

economic growth, reflected by $\alpha$ is significant in all regressions (with one exception, in the case of the democratic accountability). As the $\beta$ coefficients are negative and significant (with two exceptions: democratic accountability and law and order), this means that each of the institutional development variable (institutional quality, bureaucratic quality, government stability, investment profile) tends to bring down the elasticity of growth with respect to corruption. Given the underlying logistic function, this result implies that, for each PSTR model, the elasticity of growth with respect to corruption varies from $\alpha$ for low values of the institutional variables, to $\alpha+\beta$, for high values of the institutional variables. We can note that for almost all models (except for Bureaucratic quality), the estimated slope parameters $\gamma$ are relatively small. This implies that the transition function cannot be reduced to an indicator function (as in a PTR model): the transition between extreme regimes is smooth. The switch between the two extreme regimes emerges around the estimated endogenous location parameters $c$.

This means that the higher the level of institutional quality, the lower the sensitivity of economic growth to corruption. In the same way, the lower the level of institutional quality is, the greater the impact of corruption on growth. The former result is in line with the results of Aidt et al (2008) who state that corruption has a negative effect in countries where institutional quality levels are high. Our results are also in line with both the "grease the wheels" and the "sand the wheels" hypotheses. In the case of institutional shortcomings, corruption can improve efficiency by allowing individuals to circumvent the institutional failures. In contrast, when institutions are strong, corruption can be harmful for growth.

The relative importance of the different threshold variables on the elasticity of growth with respect to corruption is plotted in Figures 1-5. For each PSTR model (i.e. transition variable), the elasticity of growth with respect to corruption is calculated for any possible theoretical values of $q_{i,t}$. In Figure 1, when the institutional quality is taken as a transition variable, we plot the average of the threshold variable over the whole analyzed period for several countries (Haiti, Congo, Liberia, Bangladesh, France, Sweden, Luxembourg) in order to evaluate their estimated elasticity (evaluated at the average of $q_{i,t}$). These results confirm the above interpretations of the model.

Regarding the transitions between the different regimes, we find values for the slopes of the transition functions which are low regardless of the chosen transition variable (with one exception). This confirms that the use of a PSTR modeling was appropriate to capture the non-linearity of the relationship between corruption and economic growth when considering institutional quality as a transition variable. The smooth transition is shown in Figure 1-3, which describes the elasticity of growth to corruption considering institutional quality, government stability and investment profile as transition variables. In the case of bureacratic quality, the slope appears to be sharp, suggesting that any effort of a country where this variable is just below the threshold could lead to a sharp increase of the elasticity of growth with respect to corruption. In the same time, if the bureaucratic quality of a country is far from the threshold value, the same effort will have no impact on the elasticity.

# 6 Robustness check

Our results are obtained while controlling for several country specific characteristics and different institutional dimensions. In order to test the robustness of our PSTR specification and results, we follow three approaches.

First, we test the sensitivity of our results by integrating the transition variable among the controls. As suggested in previous sections, the results of the linearity tests, when the transition variable is among the controls, are still suggesting a non-linearity of the relation, although less important than in the standard case. For robustness reasons, we present the results obtained with the institutional variable introduced both as a transition variable and as a control. These results are available in Table 7.

Second, we test the sensitivity of our results by considering, within the above PSTR approach, an alternative corruption index, namely the Transparency International index of corruption. This index is available on a shorter time period and for less countries than in the initial sample. The results (Table 8) do not change significantly. Hence, our results hold to the use of alternative corruption index [14]

Third, we test the robustness of our methodology. Hence, we follow López-Villavicencio and Mignon (2011) and Eggoh and Khan (2014) and estimate a GMM model (the GMM specification allows to circumvent the potential endogenous bias and reverse causality problems) that captures the relation between growth, institutional variables and corruption as well as other controls. Specifically, we consider a non-linear specification of the dynamic system GMM as into our model we account of the interaction between

[14] This index was considered in two situations: *(i)* only as a transition variable; *(ii)* both as a transition and a control variable as the linearity tests authorized this. The results presented in the appendix are related to the latter approach. The results obtained in the former case are similar and are available upon request.

corruption and each of the six institutional variables (the results that we provide in the appendix, Table 9, are related only to one institutional variable, namely the institutional quality). In other words, this will allow to capture to a certain extent the non linear growth effect of the threshold variable considered above. This specification will allow us also to consider if, beyond a certain level, the threshold variable (i.e. the institutional variable), becomes more or less important in determining the marginal effect of corruption on economic growth. The equation estimated is:

$$y_{i,t} = \mu_i + \alpha CORR_{i,t-1} + \beta_j CORR_{i,t-1} q_{i,t-1} + \zeta_j X_{i,t} + \varepsilon_{i,t} \tag{7}$$

The GMM specification contains the same covariates as in the initial model, while the interaction term will capture eventual change in the impact of corruption on growth in case of structural breaks.

The GMM models have been widely used to address the endogeneity problem that appears in panel data estimation (Arellano and Bover, 1995; Blundell and Bond, 1998), especially of growth regressions. These models also take into account the biases that appear due to country-specific effects or the presence of the initial GDP in the growth's covariates (López-Villavicencio and Mignon 2011). GMM also avoids simultaneity or reverse causality problems. The consistency of the GMM estimator depends on the validity of the instruments. Following Arellano and Bover(1995), Blundell and Bond(1998) and López-Villavicencio and Mignon (2011), we implement two specification tests: first, we test the hypothesis that the difference error term is second order serially correlated. Second, we use Hansen and Sargan tests of over-identifying restrictions to examine the overall validity of the instruments. The results obtained in this modeling framework will be compared to those of the PSTR model. They lead to similar results.

# 7 Conclusion

This paper analyzes the impact of corruption on economic growth conditional on the level of institutional quality of both developed and developing countries. We use a Panel Smooth Transition Regression model considering that the relationship between corruption and growth is non-linear as stated by the recent theoretical and empirical literature. This specification has allowed us to capture the heterogeneity of the relation between corruption and growth. We highlight that the impact of corruption on economic growth is significantly negative in countries with high levels of institutional quality, and in a context of low institutional quality, corruption has no impact on growth. We can identify the main two hypotheses of the impact of corruption on growth through our model: in countries with high levels of institutional quality, corruption seems to “sand the wheels” of economic activity because of the self-reinforcing mechanism discussed above; in contrast, in countries with low levels of institutional quality, corruption seems however to “grease the wheels”.

In the light of the above considerations, we can advance that countries should strive to improve the quality of their institutions. Improving institutional quality will have a direct positive impact on growth but can also have an indirect positive impact on growth by reducing corruption. However, fighting against corruption can sometimes be harmful for growth: in countries with low levels of institutional quality, beyond a certain threshold, the sensitivity of growth to corruption is rather low. Therefore, the growth that could be obtained in these countries, although co-existing with corruption, could be further on used to improve the quality of institutions above a certain threshold, and this will further more, limit corruption. Hence, the issue of an optimal action of governments, in several steps, should be investigated further on.

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| Variable | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|
| **GDP per capita growth** | 1.831862 | 5.634335 | -65.02997 | 104.6576 |
| **Log. of initial level of GDP** | 7.833359 | 1.253338 | 4.18164 | 11.52025 |
| **FDI inflows** | 3.199656 | 6.415241 | -65.41089 | 85.96305 |
| **Population growth** | 1.623801 | 1.222374 | -5.814339 | 17.48324 |
| **GFCF** | 21.15806 | 6.481029 | -2.424358 | 59.60745 |
| **Trade openness** | 78.65813 | 53.64475 | 10.74832 | 449.9926 |
| **Inflation** | 42.32506 | 506.4266 | -16.11733 | 23773.13 |
| **Expense** | 15.87448 | 6.139858 | 2.047121 | 76.22213 |

Table 1: Descriptive statistics (dependent and independent variables)

| Variable | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|
| **Corruption** | 3.029571 | 1.359511 | 0 | 6 |
| **Institutional quality** | 11.83953 | 3.198108 | 1.222096 | 18.5582 |
| **Government stability** | 7.645342 | 2.143941 | 1 | 12 |
| **Investment profile** | 7.34597 | 2.483802 | 0 | 12 |
| **Law and order** | 3.666591 | 1.488646 | 0 | 6 |
| **Democratic accountability** | 3.830576 | 1.622149 | 0 | 6 |
| **Bureaucracy quality** | 2.158577 | 1.18595 | 0 | 4 |

Table 2: Descriptive statistics (institutional quality variables)

128 countries are included in the panel: Albania, Algeria, Angola, Argentina, Armenia, Azerbaidjan, Australia, Austria, Bahrain, Bangladesh, Belgium, Bolivia, Botswana, Brazil, Brunei Darussalam, Bulgaria, Burkina Faso, Cameroon, Canada, Chile, China, Colombia, The Republic of Congo, Democratic Republic of Congo, Costa Rica, Cote d'Ivoire, Croatia, Cyprus, Czech Republic, Denmark, Dominican Republic, Ecuador, Egypt, El Savador, Estonia, Ethiophia, Finland, France, Gabon, Gambia, Germany, Ghana, Greece, Guatemala, Guinea, Guinea-Bissau, Guyana, Haiti, Honduras, Hong-Kong, Hungary, Iceland, Ireland, India, Indonesia, Iran, Iraq, Israel, Jamaica, Japan, Jordan, Kazakhstan, Kenya, Kuwait, Latvia, Lebanon, Liberia, Libya, Lithuania, Luxembourg, Madagascar, Malawi, Malaysia, Mali, Malta, Mexico, Moldava, Mongolia, Morocco, Mozambique, Namibia, Netherlands, New Zealand, Nicaragua, Niger, Nigeria, Norway, Pakistan, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Poland, Portugal, Qatar, Romania, Russia, Saudi Arabia, Senegal, Serbia, Sierra Leone, Singapore, Slovak Republic, Slovenia, South Africa, Spain, Sri Lanka, Sudan, Suriname, Sweden, Switzerland, Syria, Tanzania, Thailand, Togo, Trinidad and Tobago, Tunisia,

Turkey, Uganda, Ukraine, United Kingdom, United States, Uruguay, Venezuela, Vietnam, Yemen, Zambia, Zimbabwe.

| **Threshold variable** | **$LM_F$ test** | P Value |
|---|---|---|
| Institutional quality | 10.557 | 0.000 |
| Government stability | 5.655 | 0.000 |
| Investment profile | 10.097 | 0.000 |
| Law and order | 4.385 | 0.000 |
| Democratic accountability | 4.770 | 0.000 |
| Bureaucracy quality | 3.640 | 0.000 |

Note: The other linearity tests (LM and LRT) lead to the same conclusions.

Table 3: Linearity tests

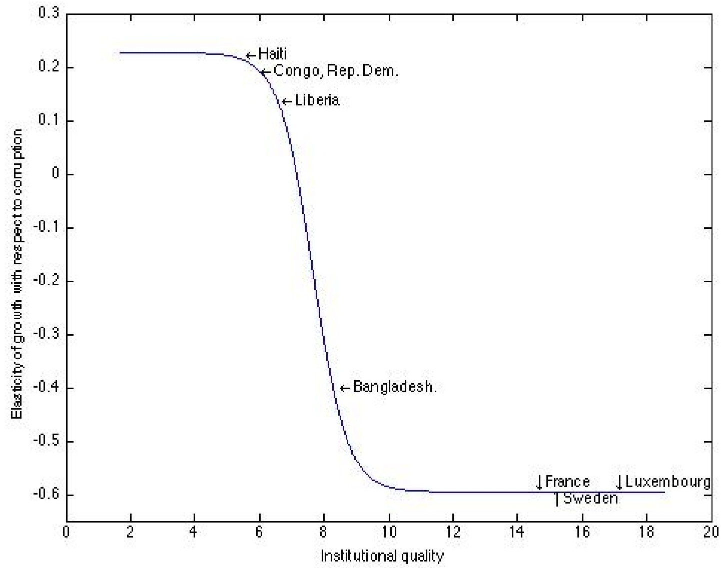


Figure 1: Sensitivity of growth to corruption with institutional quality as a threshold variable: examples of countries

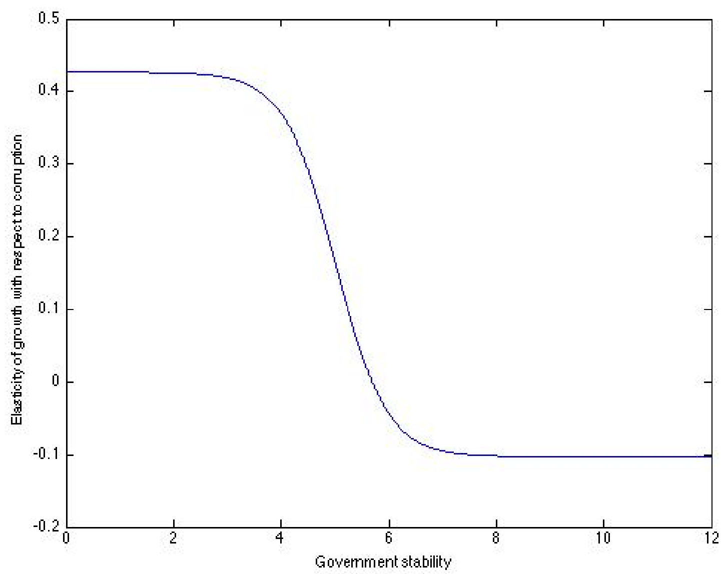


Figure 2: Sensitivity of growth to corruption with government stability as a threshold variable

| | **Corruption** | **Government quality** | **Investment profile** | **Law and order** | **Democratic accountability** | **Bureaucracy quality** | **Institutional quality** |
|---|---|---|---|---|---|---|---|
| **Corruption** | 1.0000 | | | | | | |
| **Government stability** | -0.1151 | 1.0000 | | | | | |
| **Investment profile** | -0.2342 | 0.5718 | 1.0000 | | | | |
| **Law and order** | -0.6685 | 0.3666 | 0.4592 | 1.0000 | | | |
| **Democratic accountability** | -0.5270 | 0.1568 | 0.4440 | 0.4876 | 1.0000 | | |
| **Bureaucracy quality** | -0.6913 | 0.2416 | 0.5016 | 0.6956 | 0.6187 | 1.0000 | |
| **Institutional quality** | -0.4075 | 0.7489 | 0.9222 | 0.6597 | 0.5737 | 0.6426 | 1.0000 |

Table 4: Correlation matrix between institutional quality variables

| | **GDP per capita growth** | **Log. of initial level of GDP** | **Trade openness** | **Inflation** | **Government expenditure** | **GFCF** | **FDI inflows** | **Population** growth |
|---|---|---|---|---|---|---|---|---|
| **GDP per capita growth** | 1.0000 | | | | | | | |
| **Log. of initial level of GDP** | 0.0066 | 1.0000 | | | | | | |
| **Trade openness** | 0.0943 | 0.2937 | 1.0000 | | | | | |
| **Inflation** | -0.1062 | -0.0596 | -0.0416 | 1.0000 | | | | |
| **Government expenditure** | -0.1260 | 0.4296 | 0.0444 | -0.0400 | 1.0000 | | | |
| **GFCF** | 0.2500 | 0.2148 | 0.2330 | -0.0760 | 0.0552 | 1.0000 | | |
| **FDI inflows** | 0.0892 | 0.1299 | 0.4608 | -0.0280 | -0.0333 | 0.1504 | 1.0000 | |
| **Population growth** | -0.1809 | -0.5049 | -0.0366 | 0.0459 | -0.1371 | -0.1891 | -0.0425 | 1.0000 |

Table 5: Correlation matrix between explanatory variables

| **Interaction variable** | **Institutional quality** | **Government stability** | **Investment profile** | **Law and order** | **Democratic accountability** | **Bureaucracy quality** |
|---|---|---|---|---|---|---|
| $\alpha$ : Corruption | 0.2265** | 0.4267** | 0.1946* | 0.2625** | 0.2005 | 0.0319*** |
| | (2.2148) | (2.1410) | (1.8878) | (2.3778) | (1.0130) | (4.1720) |
| $\beta$ : Corruption $\times$ | -0.8218* | -0.5294* | -1.1250** | -0.3996 | -0.1296 | -0.2276*** |
| $\times f(.)$ | (-1.8961) | (-1.6407) | (-2.0466) | (-1.2814) | (-0.5109) | (-3.5175) |
| Loc. parameter | 7.1666 | 5.0171 | 3.1819 | 2.1799 | 3.3515 | 1.5481 |
| Slope parameter | 1.9473 | 2.0934 | 2.0192 | 8.9818 | 3.8525 | 251.0918 |
| **Control variables** | | | | | | |
| Foreign direct | 0.0623*** | 0.0308 | 0.0719*** | 0.0408** | -0.0733 | 0.2281*** |
| Investment | (3.3921) | (0.9066) | (3.8585) | (2.2074) | (-0.7296) | (5.9635) |
| Initial level | -1.4325*** | -1.6583*** | -1.4086*** | -1.2165*** | -0.9507*** | -1.4453*** |
| of GDP | (-8.0190) | (-5.8315) | (-7.7830) | (-6.6549) | (-4.0747) | (-6.1380) |
| Trade | 0.0292*** | 0.0267*** | 0.0279*** | 0.0296 *** | 0.0286*** | 0.0305*** |
| openness | (3.8851) | (4.0530) | (4.4721) | (4.0975) | (2.9131) | (3.3817) |
| Government | -0.2314*** | -0.5299*** | -0.2717*** | -0.2597*** | -0.3303*** | -0.2504 |
| expenditure | (-6.2295) | (-6.5824) | (-6.9229) | (-7.0297) | (-5.7017) | (-6.9839) |
| Inflation | -0.0035*** | -0.0052 | -0.0028*** | -0.0036 *** | -0.0004** | -0.0056*** |
| | (-4.3823) | (-1.5976) | (-3.4599) | (-3.4970) | (-2.7532) | (-2.7826) |
| Population | -0.8121*** | -1.3391** | -0.8491 *** | -0.7727 *** | -1.0568*** | -0.7905 |
| growth | (-5.5748) | (-2.6380) | (-5.7700) | (-5.7760) | (-5.2942 ) | (-5.2376) |
| Investment | 0.1212*** | 0.4476*** | 0.1117*** | 0.1385*** | 0.0747* | 0.1375*** |
| | (5.9495) | (6.1608) | (5.2142) | (6.3472 ) | (1.9005) | (3.5197) |

Note: *, ** and *** denote significance at the 10%, 5% and 1% level, respectively.

Table 6: PSTR estimates

| **Interaction variable** | **Institutional quality** | **Government stability** | **Investment profile** | **Law and order** | **Democratic accountability** | **Bureaucracy quality** |
|---|---|---|---|---|---|---|
| $\alpha$ : Corruption | 0.1763** | 0.2986** | 0.1819* * | 0.0024 | 0.1356 | 0.1403*** |
| | (2.0942) | (2.5739) | (2.1077) | (1.0795) | (0.4728) | (3.7261) |
| $\beta$ : Corruption | -0.7521** | -0.4443* | -0.4313 ** | -0.2906*** | -0.0714 | -0.2835** |
| $\times f(.)$ | (-1.9905) | (-1.6990) | (-1.9144) | (-2.7128) | (-0.2548) | (-2.8412) |
| Loc. parameter | 9.3452 | 7.0261 | 2.9667 | 2.4716 | 3.5003 | 1.9704 |
| Slope parameter | 1.6447 | 2.4009 | 2.3454 | 1.1372 | 2.9363 | 230.2500 |
| **Control variables** | | | | | | |
| Transition | 0.0680*** | 0.0952* | 0.2655*** | 1.6746** | 0.3195*** | 0.0302*** |
| variable | (3.7813) | (1.7271) | (1.8547) | (3.3265) | (2.8981) | (1.8611) |
| Foreign direct | 0.0571*** | -0.0187 | 0.2065** | 0.1514** | 0.1759** | 0.1029*** |
| Investment | (3.2682) | (-0.9128) | (1.9593) | (1.3322) | (2.0005) | (4.6719) |
| Initial level | -1.4794*** | -1.4374*** | -1.1694* | -0.9700*** | -1.3914*** | -1.2918*** |
| of GDP | (-8.1378) | (-7.6065) | (-0.4561) | (-3.5327) | (-4.0901) | (-7.7465) |
| Trade | 0.0259* ** | 0.0273*** | 0.0137*** | 0.0219 *** | 0.0248*** | 0.0281*** |
| openness | (3.5681) | (4.2855) | (2.0185) | (2.9799) | (3.0927) | (3.0888) |
| Government | -0.2531*** | -0.2659*** | -0.2518*** | -0.2344*** | -0.2608*** | -0.3091 |
| expenditure | (-6.6098) | (-6.1006) | (-6.2486) | (-5.8981) | (-5.3020) | (-4.4052) |
| Inflation | -0.0031*** | -0.0035*** | -0.0104*** | -0.0004 *** | -0.0003** | -0.0066*** |
| | (-3.9104) | (-2.8378) | (-1.5339) | (-2.6000) | (-2.5580) | (-2.4892) |
| Population | -0.9532*** | -0.8723** | -0.3542 *** | -0.8317 *** | -0.6316*** | -0.8658 |
| growth | (-5.1437) | (-5.4089) | (-1.3347) | (-4.8445) | (-1.6460 ) | (-4.0865) |
| Investment | 0.1246*** | 0.1607*** | 0.1242*** | 0.0600 | 0.0414* | 0.0912*** |
| | (5.9835) | (5.2970) | (3.5984) | (1.7675 ) | (1.8475) | (3.8922) |

Note: *, ** and *** denote significance at the 10%, 5% and 1% level, respectively.

Table 7: Robustness: PSTR estimates with each institutional indicator among controls

| **Threshold variable** | **Institutional quality** | **Government stability** | **Investment profile** | **Law and order** | **Democratic accountability** | **Bureaucracy quality** |
|---|---|---|---|---|---|---|
| $\alpha$ : Corruption | 0.3138* | 0.4790** | 0.0044 | 0.3008** | 0.5793 | 0.0762*** |
| | (1.6527) | (2.0469) | (1.0404) | (2.0274) | (1.4288) | (3.8137) |
| $\beta$ : Corruption | -0.4239** | -0.6343*** | -0.1041* | -0.5393** | -0.0561 | -0.2073** |
| $\times f(.)$ | (-2.2965) | (-2.6931) | (-1.8154) | (-2.4237) | (-0.942) | (2.0011) |
| Loc. parameter | 8.7414 | 5.8483 | 4.1457 | 1.6562 | 2.3637 | 1.7438 |
| Slope parameter | 2.1993 | 495.1758 | 4.6954 | 0.4354 | 7.4670 | 294.5178 |
| **Control variables** | | | | | | |
| Transition | 1.6264* | 0.3958 | 0.3118*** | 0.9257*** | 0.7532*** | 1.2045** |
| variable | (1.7910) | (1.2160) | (4.1335) | (4.9575) | (2.6822) | (2.4999) |
| Foreign direct | 0.0931** | 0.0190 | 0.0853*** | 0.0956 | 0.0777** | 0.0810* |
| Investment | ( 2.4661) | (0.1195) | (3.2368) | (0.5961) | (1.9673) | (1.7980) |
| Initial level | -0.6771** | -0.8509** | -1.1409 | -1.2611 | -0.8304 | -0.7674 |
| of GDP | (-2.0861) | (-2.5297) | (-6.1146) | (-2.7118) | (-1.1285) | (-3.1975) |
| Trade | 0.0174* | 0.0280*** | 0.0135*** | 0.0233** | 0.0352 | 0.0211*** |
| openness | (1.7391) | (2.4738 ) | (3.3462) | (1.7114) | (1.4338) | (2.9944) |
| Government | -0.2545*** | -0.2533*** | -0.1897*** | -0.3260*** | -0.2056*** | 0.2314*** |
| expenditure | (-4.9575) | (-4.8341) | (-8.2260) | (-3.0771) | (-5.2550) | (-6.0028) |
| Inflation | -0.0003*** | -0.0003 ** | -0.0016*** | -0.0015* | 0.0003 | -0.0004** |
| | (-2.6921) | (-2.3668) | (-3.0130) | (-1.9325) | (1.4855) | (-2.4127) |
| Population | -0.9366*** | -0.1597 | -0.5791*** | -0.4135 | -0.7951*** | -1.0535 |
| growth | (-2.8847) | (-0.7641) | (-4.7787) | (-0.8308) | (-3.6989) | (-5.2844) |
| Investment | 0.0474* | 0.0509 | 0.0618*** | 0.0136 | 0.0640* | 0.0541** |
| | (1.6483) | (1.3841) | (3.9797) | (0.1889) | (1.6474) | (2.1435) |

Note: *, ** and *** denote significance at the 10%, 5% and 1% level, respectively.

Table 8: Robustness: PSTR estimates with an alternative corruption index (Transparency International index of corruption)

| **Interaction variable** | **Institutional quality** | **Government stability** | **Investment profile** | **Law and order** | **Democratic accountability** | **Bureaucracy quality** |
|---|---|---|---|---|---|---|
| $\alpha$ : Corruption | 0.8001*** | 0.8849** | 0.7617* | 0.8145** | 0.9587 | 0.6824*** |
| | (2.9591) | (1.9804) | (1.8878) | (2.3778) | (1.0130) | (4.1720) |
| $\beta$ : Corruption $\times$ | -0.3011*** | -0.2999*** | -0.4794*** | -0.5015* | -0.0725 | -0.1948** |
| Institutional quality | (-3.6527) | (-3.1152) | (-2.7065) | (-1.7865) | (-1.1097) | (-2.1404) |
| **Control variables** | | | | | | |
| Interaction | 0.0822*** | 0.0764** | 0.0836*** | 0.0796*** | 0.0558*** | 0.1094*** |
| Variable | (3.2487) | (1.9804) | (2.9278) | (2.9906) | (2.6226) | (3.0187) |
| Foreign Direct | 0.1287*** | 0.0837*** | 0.0956** | -0.2123 | 0.04172* | 0.1663*** |
| Investment | (4.2529) | (3.2617) | (2.1835) | (-1.0026) | (1.7356) | (2.7612) |
| Initial level | -1.5472*** | -2.1098*** | -2.6003*** | -1.9226*** | -2.3114*** | -2.0961*** |
| of GDP | (-3.7573) | (-3.2318) | (-4.2140) | (-2.8529) | (-3.4057) | (-3.0800) |
| Trade | 0.0225** | 0.0941*** | 0.0268*** | 0.0232* | 0.0266 | 0.0361*** |
| openness | (2.5388) | (3.7952) | (3.4918) | (1.6912) | (1.3100) | (3.8672) |
| Government | -0.2185*** | -0.3156*** | -0.2288** | -0.1625** | -0.2408*** | -0.1934*** |
| expenditure | (-4.4012) | (-3.2226) | (-1.8657) | (-2.3707) | (-2.9038) | (-3.3693) |
| Inflation | -0.0002*** | -0.0002** | -0.0003*** | -0.0001 *** | -0.0001* | -0.0002*** |
| | (-3.7502) | (-2.2166) | (-2.9686) | (-4.1714) | (-1.7101) | (-2.8946) |
| Population | -0.9216** | -1.0192 | -0.9160 *** | -1.1781*** | -0.8301*** | -0.8853 |
| growth | (-2.4879) | (-1.4152) | (-4.5648) | (-3.6502) | (-4.6746 ) | (-5.0508) |
| Investment | 0.1662*** | 0.2022*** | 0.1855 | 0.1476** | 0.1634** | 0.1471* |
| | (2.9611) | (4.6517) | (1.2917) | (2.4017) | (2.3001) | (1.8329) |
| Hansen P-Value | 0.259 | 0.277 | 0.294 | 0.278 | 0.266 | 0.281 |
| AR(2) P-Value | 0.240 | 0.223 | 0.246 | 0.235 | 0.218 | 0.227 |

Note: *, ** and *** denote significance at the 10%, 5% and 1% level, respectively.

Table 9: Robustness: GMM estimates

| | Eigenvalue | Difference | Proportion | Cumulated |
|---|---|---|---|---|
| **1** | 10.2278953 | 6.9066619 | 0.6010 | 0.6010 |
| **2** | 3.3212333 | 1.4425762 | 0.1951 | 0.7961 |
| **3** | 1.8786571 | 0.7431574 | 0.1104 | 0.9065 |
| **4** | 1.1354998 | 0.6796719 | 0.0667 | 0.9732 |
| **5** | 0.4558279 | | 0.0268 | 1.0000 |

Table 10: Principal Component Analysis. Eigenvalues of the variance-covariance matrix

| | Prin1 | Prin2 | Prin3 | Prin4 | Prin5 |
|---|---|---|---|---|---|
| **Government Stability** | 0.497211 | -.703531 | 0.427659 | 0.261132 | 0.082119 |
| **Investment Profile** | 0.718512 | 0.036425 | -0.676699 | -0.139261 | -0.071403 |
| **Bureaucracy quality** | 0.236723 | 0.328771 | 0.217449 | -0.193634 | 0.866656 |
| **Democratic accountability** | 0.289909 | 0.575167 | 0.213187 | 0.708974 | -0.192466 |
| **Law and order** | 0.310543 | 0.254579 | 0.516190 | -0.610146 | -0.447238 |

Table 11: Principal Component Analysis. Eigenvectors

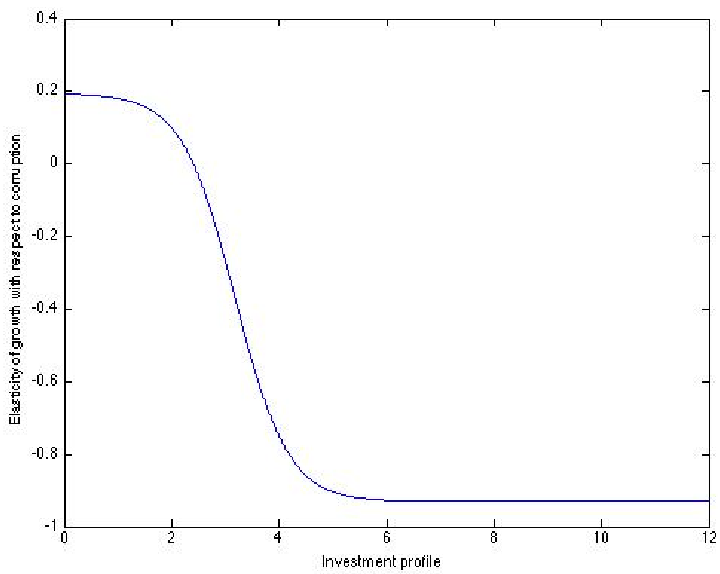


Figure 3: Sensitivity of growth to corruption with investment profile as a threshold variable

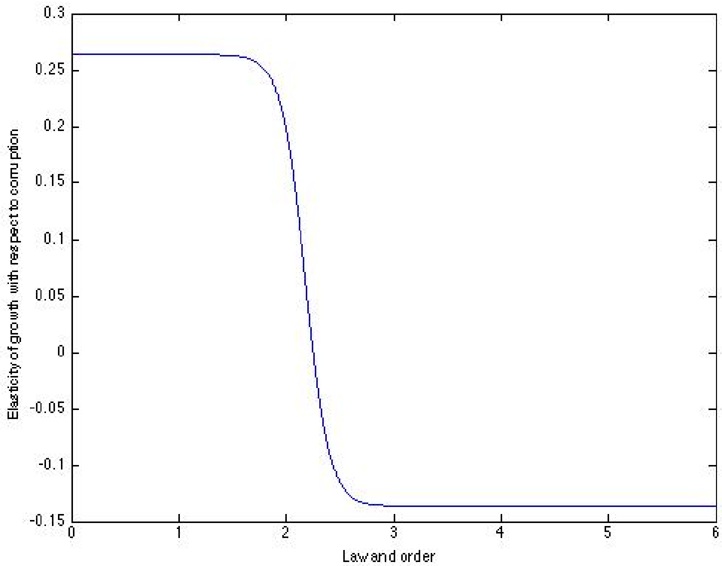


Figure 4: Sensitivity of growth to corruption with law and order as a threshold variable

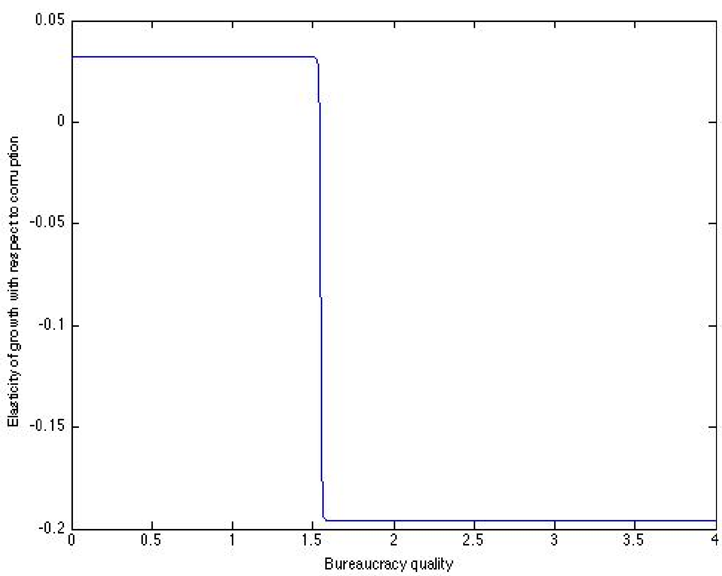


Figure 5: Sensitivity of growth to corruption with bureaucracy quality as a threshold variable