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An Investigation of the Impacts of Institutional Quality, Intellectual Property Rights and Human Capital on Economic Growth: Some Evidence from G7 and D8 Countries

Asghar Mobarak *

Foreign Trade researcher of the Ministry of Industry, Mines and Trade, Tehran, Iran

Abstract
The existing literature primarily indicates a positive association between institutions and economic growth. However, institutions do not exert a similar impact on economic growth across different sets of countries. In this study, we analyzed the impact of institutional quality on economic growth using a sample of 15 members from G7 and D8 Countries in the period 1984-2017 using a Panel Smooth Transition Regression framework. González, Teräsvirta, and Van Dijk (2005) indicated that there is a non-linear relation between institutional quality and growth modulated by institutional development. On the other hand, we found that institutional quality can positively (or negatively) affect growth in case of a low (high) level of institutional development. This result suggests therefore a reconciliation of the theories asserting that institutional quality can "sand the wheels" or "grease the wheels" of economic growth. The main result of this study confirms the negative impact of institutional quality on economic growth in this block of countries.

Keywords: Economic Growth, Panel Smooth Transition Regression (PSTR) Model, Institutional Quality Index.
JEL Classification: K14. K15, K18.

*Corresponding Author, Email: asghar_mobarak@yahoo.com

1. Introduction

Achieving a high rate of economic growth is one of the fundamental objectives for each country. The government as an important and effective sector in the economy is a prerequisite for this purpose. In particular, interest in economic growth has always been at the center of the literature in developed economics (Khalkhali & Dar, 2012). The milestone of recent studies on this theme is Armey curve which explains a non-linear relationship between the size of the government and economic growth including a maximum point which is viewed as the optimal size of government to cause a high level of economic growth.

The role of institutions in economic development was first identified by Lewis and Şener (2012). Later literature considers institutions as the potential source of differences in cross-country differences in growth (see, for example, North & Thomas, 1973; Acemoglu, Johnson, & Robinson, 2005). Empirical evidence, though not free from controversy, is indicative of a positive impact of economic institutions on economic growth. Acemoglu et al. (2005) find positive effects of the development of private property and the introduction of extractive institutions in previously poor regions.

Recent literature on economic growth has identified institutional quality as the major factor, which has been largely overlooked by both the neoclassical and endogenous growth theories. The empirical literature has also confirmed the importance of variables such as political democracy, government stability, economic stability, economic freedom, violence, frequent armed conflicts, and level of corruption (Acs & Szerb, 2009).

Corruption is commonly defined as "the misuse or the abuse of public office for private gain" (World Bank, 2005). 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, Kobrin, and Naim (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) in the case of countries such as Georgia and Russia, by De Soto (2000) for Bertrand, Djankov, Hanna, and Mullainathan (2007) or Ebben and De Vaal (2009) in the case of India or, Zaire and Nigeria, respectively. 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 for the EU28 situation in general.

Iqbal and Daly (2014) argue that weak institutions divert resources from the productive sector to the unproductive sector hence promoting rent-seeking activities. Strong institutions reduce the chances of rent-seeking activities and accelerate the economic growth process and productivity of the reproducible factors. This study argues that a weak institutional framework creates an opportunity for rent-seeking

[1]-Overall, according to World Bank (2005), 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.

behavior that may divert resources to unproductive sectors. The consequences of these activities for growth can be negative: resources may not be efficiently allocated, externalities may be ignored, and transaction costs may be increased. North (1990) argues that institutional weaknesses lead to rent-seeking activities hence low development. The incomplete rule of law, non-enforcement of property rights, inadequate policies, and the lack of reliable infrastructure constitute a weak institutional framework that may promote rent-seeking activities (Iqbal & Daly, 2014).

Therefore, in both rich and poor countries, corruption remains an important public matter (Ebben & De Vaal, 2009). The World Bank (2005) 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 1000 billion Dollar per year.

Moreover, Transparency International underlines that 2/3 of the world countries have corruption rates above the average. This explains why international organizations, such as the World Bank (2005), the International Monetary Fund (2011), the United Nations Development Program, and other organizations have attempted to address the corruption issue since the early 1980s. This also justifies that the implementation 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, 1995; Andvig, Fjeldstad, Amundsen, Sissener, & Soreide 2000; Acemoglu et al., 2005). In particular, the impact of corruption on economic growth is extensively addressed, along with two main conflicting views. According to the first view, which is the oldest historical one, corruption "greases the wheels" of business and economic growth and development. It can be efficiency-enhancing by allowing firms and individuals to get around the rules of an ineffective administrative and legal system that slows down investment and therefore growth (Leff, 1964; Nye, 1967; Huntington, 1968; Méon & Weill, 2005). According to the proponents of this theory, corruption addresses the institutional shortcomings: if countries cannot develop their institutional environment, corruption becomes a natural loophole allowing the system to achieve growth, at least in a short medium-term perspective. The 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 that 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 that are 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 nature of the relation between growth and corruption, and also use a richer data set including both developed and developing countries. The remainder of the paper is organized as follows. Section 2 provides a review of the literature. 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 includes the concluding remarks.

2. Review of the Literature

2.1. Theoretical Approach

The first theoretical studies about the corruption-economic growth nexus have highlighted the positive effects of institutional quality on economic activity. These models provide a theoretical framework to analyze the impact of institutional quality on economic growth. Thus, in the 1960s, Leff (1964), Leys (1965), and Huntington (1968) have suggested that institutional quality could stimulate growth and improve economic welfare via at least two kinds of channels. Firstly, institutional quality 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, Levy (2007) has built an equilibrium queuing model of bribery and has shown that bureaucratic institutional quality 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) theoretically highlight that if combating institutional quality is too costly, then the level of institutional quality that maximizes output could be greater than zero.

Nevertheless, in the recent period, several other theoretical analyses, although supporting the greasing the wheels hypothesis, have underlined that the ability of bureaucratic institutional quality to speed up procedures could be limited by the fact that companies that give the highest bribes spend more time negotiating regulations (Kaufmann, Kraay, & Mastruzzi, 2010). 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 (Bardhan, 2006).

The arguments above in favor of the efficiency effects of institutional quality depend on the static and partial perspectives of the context in which institutional quality is taking place, and ignore the enormous degree of discretion that bureaucrats have (Bodman & Hodge, 2010).

Hence, a vast theoretical literature is concerned with the adverse effects of corruption on growth, supporting the "sanding the wheels" hypothesis. It has been shown that institutional quality negatively affects investment which is a main determinant of growth, and this occurs more significantly in the medium and long run than short run (Akai, Horiuchi, & Sakata, 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 ones. Attila, Chambas, and Combes (2009) have built a

simple model highlighting the adverse effects of corruption, considered as a tax on investment. Murphy, 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, institutional quality 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 Perspectives

In the empirical literature, the impact of corruption on economic growth is evaluated both at the micro-level, using field experiments and firm surveys, and at the macroeconomic level, adopting a cross-country approach. Micro founded empirical analyses (De Soto, 2000; Kaufmann et al., 2010; Fisman & Svensson, 2007) sustain the sanding the wheels hypothesis and find no support of the greasing the wheels view.

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 the 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 who examined econometrically the impact of corruption on economic growth. His study 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 from 0.8% to 1.3%.

Corruption can also affect growth through public investment. Tanzi and Davoodi (1997) 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 with 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 (1997) 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 Tanzi and Davoodi (1997) 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, Lewis and Şener (2012) 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), using a dynamic panel, also shows that corruption decreases economic growth through physical capital and investment and at the same time enhances an unequal income distribution in African countries.

Only a few empirical studies have confirmed the conclusions of the theoretical models on the beneficial effects of corruption on growth and development, thus empirically supporting "greasing 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 negative impact of corruption on economic growth in other conditions.

Using a macroeconomic approach and cross-country analysis, Mironov (2005) analyzed the effects of corruption on economic growth in 141 countries over the period 1996-2004. He added 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 was to identify the impact of corruption on capital accumulation. In both macro and micro studies, he divided corruption into two categories: systematic corruption and residual corruption (or idiosyncratic corruption). The former was correlated with governance characteristics such as poor judiciary system, low government effectiveness, and cumbersome regulation while the latter was 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 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 (2005) on a panel of 69 countries, both developed and developing countries, 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 that experiences a large corruption can fall into a bad governance trap and will have difficulties breaking 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 Pellegrini and Gerlagh (2004). In their analysis, Pellegrini and Gerlagh 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.

Recently, the linkage between institutions and growth has been investigated by Mudassaar, Khan, and Aziz (2019). The data of 84 countries performed with panel OLS and the GMM-based estimation method reveals that favorable institutions positively affect economic growth. Also, some studies suggest the structural models of identifying the impact of institutional quality on economic growth by productive entrepreneurship enhancement, the only assumption imposed is that indeed such institutional quality indicators affect growth (mainly) through their effect on entrepreneurial activity. So, the construction of complex institutional quality–adjusted indices of entrepreneurial ecosystem quality was designed and applied by Acs and Szerb (2009) and Olson, Sarra, and Swamy (2000). While the theoretically void talent classes are mentioned by Valeriani and Peluso (2011).

Dias and Tebaldi (2012) investigated the relationship between institutions, human capital, and economic growth. They found deep structures or structural institutions, which are very persistent and rooted on the historical development path of an economy, affect long-term economic performance, while political institutions are uncorrelated with productivity and long–term economic growth. The empirical estimates also show that growth of physical and human capital, instead of levels, determines long-run economic growth (Dias & Tebaldi, 2012).

There are many studies on the role of governance quality in China's regional economic growth, which confirm a close relationship between governance quality and economic growth in China (Luo, Wang, Raithel, & Zheng, 2015). Theoretically, according to the evolution trend of governance connotation (Faguet, 2014; Iqbal & Daly, 2014), there are seven main single perspectives of governance evaluation in the world: horizontal allocation of power (e.g., marketization), vertical allocation of power (e.g., decentralization), supervising power (e.g., rule of law), bureaucracy, bureaucratic autonomy, governance capacity, and governance output. Therefore, according to their governance perspectives, the existing literature, which studies the effect of governance quality on China's regional economic growth, can be classified into four categories.

Bhattacharjee (2016) followed the quality of governance indicators of Indian states by Acs and Szerb (2009) to test the determinants of growth at the state level in the post-reform period. The study emphasized that even when government size and its associated institutions at the state level are controlled for, economic factors (like an investment) predominantly determine the growth of states. Certain governance indicators such as economic freedom and executive pillars have a significant impact on the economic growth of states. Thus, most of the studies in the Indian context showed the detrimental

impact of government size on economic growth, but the institutional quality of the public sector has had a positive impact on economic growth.

Regarding empirical studies investigating the relationship between innovation and trade openness and FDI, it is worth mentioning that the combination of the two latter is often associated with the financial development of the country. In this context, one can mention Deidda and Fattouh (2002) who identified a strong link between innovation and financial development in high-income countries. Interestingly, these authors claimed that this relationship is not significant for low-income countries. This observation has been confirmed by Adedokun (2017). Arcand, Berkes, and Panizza (2015) showed that a higher level of financial development can generate a profitable environment for innovation and economic growth. This study contributes to these debates by proposing another perspective on this potential relationship between financial development and innovation. Specifically, we investigate the combined effect of economic openness and institutional quality on resident patent applications.

Aidt, Dutta, and Sena (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 the 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 the 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 the 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").

Arcand et al. (2015) investigate 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 results did support 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 in China. In a panel of 117 countries for the period 1984-2007, Al Mamun, Sohag, and Hassan (2017), using a five-time period approach, show that corruption has a significant effect on the growth rate of real per capita income. 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 (2014). Based on the generalized method of movements estimation applied to developed developing countries, the authors suggest that a decrease in corruption raises the economic growth rate in an inverted U-shaped way. Akai et al. (2005) analyze different developing areas of the world for four different time periods (1980-83, 1988-92, 1984-96, and 1994-96). They find that corruption slows the 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, and between countries with different levels of institutional developments). In the following, we use a different approach to analyze, at the 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. The Model

3.1. PSTR Model Specification

In contrast to previous model frameworks of the economic growth (corruption nexus), we use a new approach in this study: 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 a specific theoretical advantage (Lopez-Villavicencio & Mignon, 2016; Colletaz & Hurlin, 2006) 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 on 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 will be conditional on the position in the distribution of the institutional variable (Jude & Levieuge, 2015).

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

$$y_{it} = \mu_{it} + \alpha CORR_{it} + \beta CORR_{it} F(q_{it}, \gamma, c) + \delta X_{it} + \varepsilon_{it} \quad (1)$$

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, $CORR_{i,t}{}^{\varepsilon}$ 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* $(0, \sigma^2)$. The transition function is continuous and integrable on $[0, 1]$. It depends on three parameters: $q_{i,t}$ is the transition variable, γ 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 González et al. (2005), we use a logistic transition function:

$$F(q\_it; \gamma, c) = 1/(1 + \exp(-\gamma(\_j = 1\text{^}m)\Pi(q\_(it) - c\_j)) \quad (2)$$

where $c_1 \leq c_2 \leq \ldots \leq c_m$ 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 the baseline of our analysis. The fact that m=1 means that there is one threshold of institutional quality around which the effect of institutional quality 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 institutional quality evolves from α in the first regime corresponding to f(.)=0 to α + β in the second extreme regime corresponding to f (.)=1, following a single monotonic transition centered around the threshold value c of the transition variable.

3.2. Specification Test

González 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 determining the number r of transition functions. The third helps identify 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 H0:

γ=0 and β=0. Nevertheless, under H_0, the tests are nonstandard because the PSTR model contains unidentified nuisance parameters. In order to solve this problem, González et al. (2005) suggest replacing the transition function with its first-order Taylor expansion around γ = 0 and testing an equivalent hypothesis in an auxiliary regression (Fouquau, Hurlin, & Rabaud, 2008). Hence, we obtain:

$$y_{it} = \mu_i + \theta_0 CORR_{it} + \theta_1 q_{it} CORR_{it} + \zeta X_{it} + \varepsilon_{it} \quad (3)$$

Where parameters θ_0 and θ_1 are proportional to the slope parameter γ of the transition function. Therefore, testing the non-linearity of the model amounts to testing:

$$\begin{cases} H_{0:\theta_1} = 0 \\ H_{1:\theta_1} \neq 0 \end{cases} \quad (4)$$

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 (González et al., 2005). The results of this test are presented in the Appendix and in Table 3 and indicate that the PSTR model is suitable for assessing the impact of institutional quality on growth.

Further, 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 show the existence of one transition function.

In order to determine the optimal number of thresholds, we follow González et al. (2005) and use the sequential test developed by Granger (1993) and Teräsvirta (1994). The results 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.

Finally, the potential endogeneity bias also needs to be addressed. Instrumental

variable methods have not yet been constructed in a PSTR framework (Fouquau et al., 2008; Jude & Levieuge, 2015). Moreover, Eggoh and Khan (2014) show that the nonlinear structure of threshold regression invalidates the usual 2SLS procedure. According to Lopez-Villavicencio and Mignon (2016) and Fouquau, et al. (2008), non-linear modeling strategies can mitigate endogeneity issues. However, for comparative reasons and robustness check, we also perform a GMM (Generalized Method of Moments) approach to estimate a growth equation with interaction terms (Section 7).

4. Data

In our study, we consider a heterogeneous unbalanced panel of 15 countries over the period 1984-2017. 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 institutional quality in particular within the political system. It includes more specific demands on 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 and is intended to assess the degree of institutional quality prevailing in a certain country, based on a survey among foreign investors. The institutional quality 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 to 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 & Weill, 2005).

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 & Goldin, 2004).

In our analysis, each institutional quality variable will be taken as a transition variable. The six variables will be used one at a 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 bureaucratic quality as well as the government stability capture to a certain extent. As in Méon and Weill (2005), two facets of governance that are at the core of the grease the wheels hypothesis: the fact that institutional quality 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

the quality of the bureaucracy as a shock absorber that tends to minimize revisions of a policy when governments change.

Moreover, in the literature on the corruption-growth nexus, there is a specific emphasis on the importance of countries' investment profiles. 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 via ability/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 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.

Moreover, several traditional variables highlighted by growth theories as being key determinants of economic growth are included in the regressions as control variables. Faguet (2014) identifies 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 the *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.

Population growth is also considered in the analysis in the spirit of the neoclassical growth theory (Solow, 1956). It is supposed to negatively affect economic growth.

Furthermore, investment is also considered in the analysis: the 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).

Table 1: Descriptive statistics (dependent and independent variables)

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 2: Linearity tests

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.

5. Empirical Results

Descriptive statistics concerning the sample are reported in Tables 1 and 2. As the range of initial GDP per capita shows (Table 1), our sample contains both developed and developing countries. Table 3 presents the linearity tests (also called homogeneity tests). The latter shows 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 the transition variable, the econometric tests show that one transition function is sufficient to purge the non-linearity between corruption and growth. Moreover, based on the AIC and BIC information criteria, we determine the optimal number of thresholds per transition function. These criteria show that the optimal threshold number is 1 for all transition variables. The correlations between the explanatory variables, on the one hand, and between the institutional variables, on the other hand, are provided in Tables 4 and 5. The correlation among the explanatory variables is low. Thus, all these variables could be included in each PSTR model (and each GMM model, as well).

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, regardless of the specification. The initial GDP per capita has a negative sign suggesting that the conditional convergence hypothesis is verified. That is, 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 view of Solow (1956), the adverse effect of overpopulation on economic growth. The government expenditure affects negatively economic growth, reflecting the government burden and inhibiting growth (Eggoh & Khan, 2014). FDI and private investment positively affect growth, being essential inputs of capital accumulation and therefore of economic growth. The coefficient associated with 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 and technology differences). In the endogenous growth theory, trade affects positively economic growth due to the technological diffusion between countries (Lopez-Villavicencio & Mignon, 2016). The negative sign of inflation on growth suggests an overall adverse impact of inflation on the economic growth of the analyzed countries (as cited in Eggoh & Khan, 2014).

Turning now to our variables of interest, we note that all α coefficients are positive

while all the β coefficients are negative. The direct impact of corruption on economic growth, reflected by α is significant in all regressions (with one exception, in the case of democratic accountability). As β coefficients are negative and significant (with two exceptions: democratic accountability and law and order), this means that each of the institutional development variables (institutional quality, bureaucratic quality, government stability, and 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 α for low values of the institutional variables, to α +β, for high values of the institutional variables. We can note that for almost all models (except for Bureaucratic quality), the estimated slope parameters γ 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 level of institutional quality is, the greater impact of corruption on growth will be. 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 institutional failures. In contrast, when institutions are strong, corruption can be harmful to growth.

The relative importance of different threshold variables on the elasticity of growth for corruption is plotted in Figures 1-6. For each PSTR model (i.e. transition variable), the elasticity of growth with respect to corruption is calculated for any possible theoretical values of qi,t. In Figure 2, 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, etc.) in order to evaluate their estimated elasticity (evaluated at the average of qi,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 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 3, which describes the elasticity of growth to corruption considering institutional quality variables as transition variables.

Table 3: GMM estimates

	Eigenvalue	Difference	Proportion	Cumulated
1	10.227895	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 4: 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

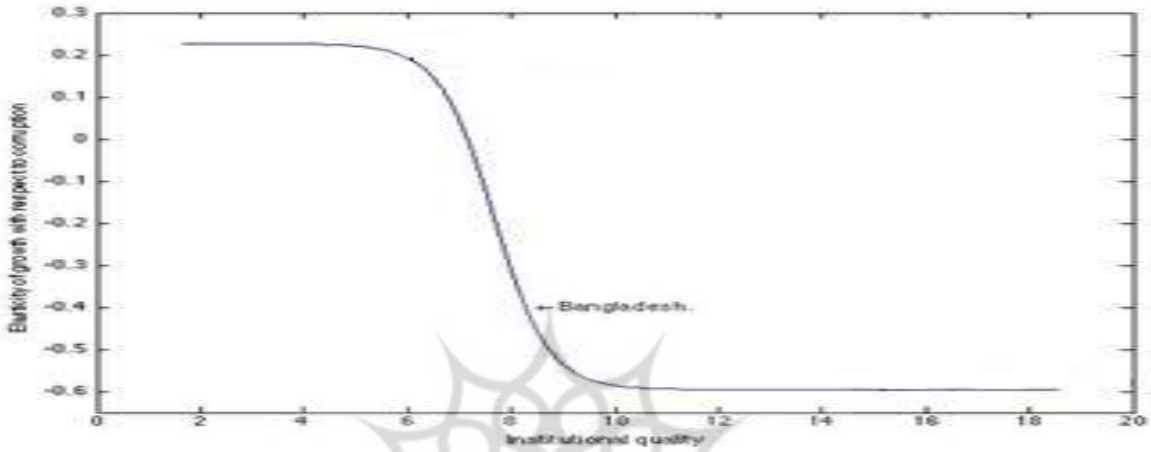

Figure 1: Sensitivity of growth toinstitutional quality with institutional quality as a threshold variable: examples of countries

Source: Author

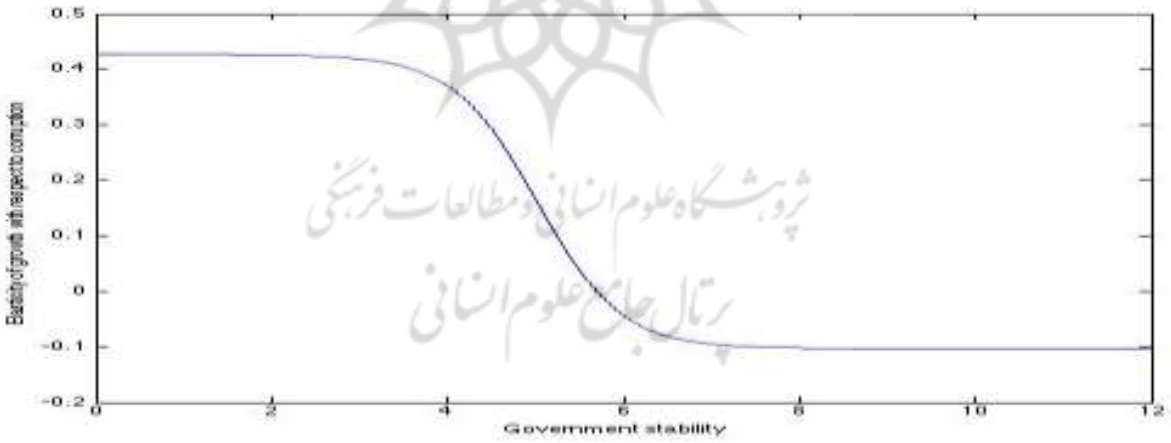

Figure2: Sensitivity of growth to institutional quality with government stability as a threshold variable

Source: Author

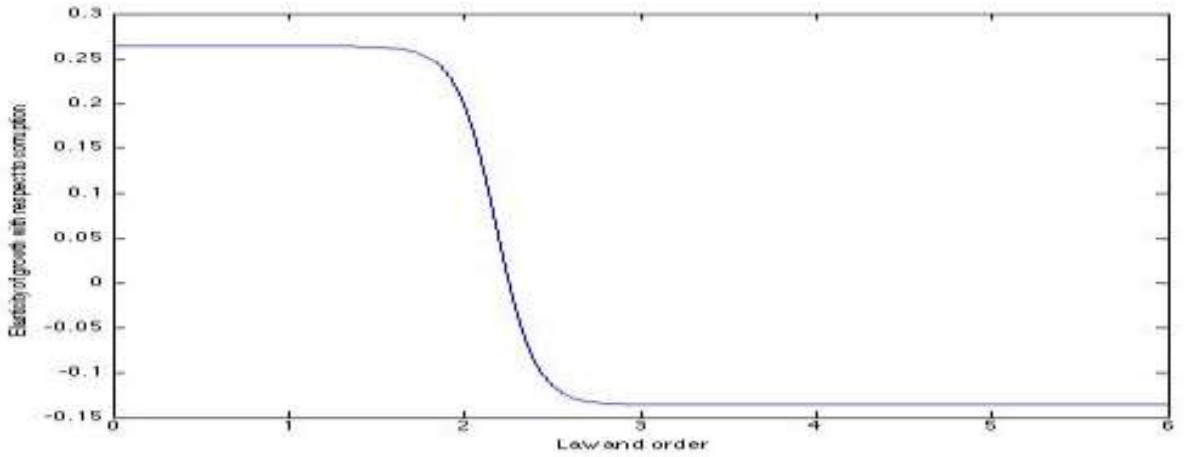

Figure 3: Sensitivity of growth to institutional quality with investment profile as a threshold variable
Source: Author

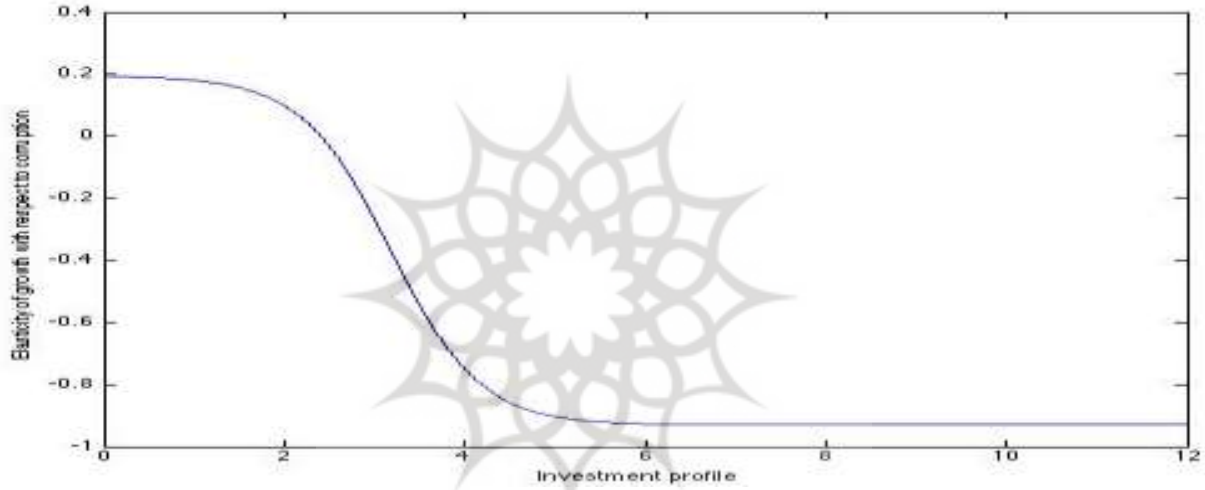

Figure4: Sensitivity of growth to institutional quality with law and order as a threshold variable
Source: Author

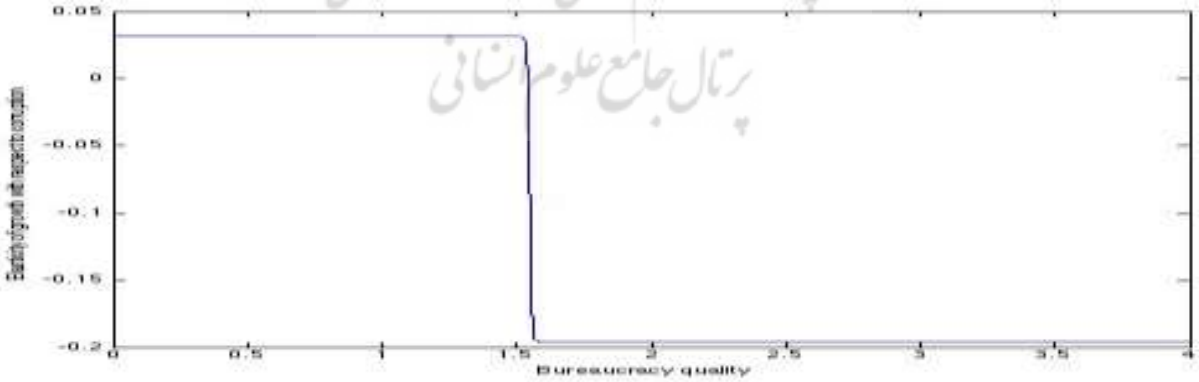

Figure5: Sensitivity of growth to institutional quality with bureaucracy quality as a threshold variable
Source: Author

6. Robustness Check

Now we will check the robustness of our main results. To check the robustness and sensitivity of our results presented in Tables 6 and 7, we estimated our specifications for two different sample countries, that is, developing countries (D8 countries) and advanced countries (G7 countries), to see whether the pattern of our estimates remains consistent. We also use alternative measures of openness in our estimations and whether our conclusion remains unaffected. Due to the lack of alternative long panel data series for institutional measures, we could not use any alternative measure for institutional quality to check the robustness of the estimates of institution measures.

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 through the institutional variable introduced both as a transition variable and as a control. These results are shown in Table 7. They are consistent with the hypothesis that institutions play a critical role in the growth process. For example, North (1990) argues that institutions increase the productivity of factor inputs by improving the incentive structure. Similarly, Acemoglu et al. (2005) showed that good quality institutions enhance a country's ability to utilize modern technologies which, in turn, causes economic growth. Many empirical studies provide evidence that institutions promote economic growth (Acemoglu et al., 2005; Arcand et al., 2015; Bardhan, 2006; Iqbal & Daly, 2014; Colletaz & Hurlin, 2006).

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

Third, we test the robustness of our methodology. We follow Lopez-Villavicencio and Mignon (2016) 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 for the interaction between institutional quality and each of the six institutional variables (the results provided in the Appendix, Table 9, are related only to one institutional variable, namely the institutional quality). In other words, this will allow capturing to a certain extent the non-linear growth effect of the threshold variable considered above. This specification will also allow us to consider whether, beyond a certain level, the threshold variable (i.e. the institutional variable) becomes more or less important in determining the marginal effect of institutional quality on economic growth. The equation estimated is:

$$y_{i,t} = \mu_i + \alpha C\,ORR_{i,t-1} + \beta_j C\,ORR_{i,t-1} q_{i,t-1} + \zeta_j X_{i,t} + \varepsilon_{i,t} \quad (5)$$

The GMM specification contains the same covariates as in the initial model, while the interaction term will capture the eventual change in the impact of institutional quality 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 & Bover, 1995; Blundell & Bond, 1998), especially regarding 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 (Lopez-Villavicencio & Mignon, 2016). 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 Lopez-Villavicencio and Mignon (2016), 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

In the previous section, we used a composite index of institutional quality to quantify the impact of institutions on economic growth. We concluded that institutions perform better in developed Asian economies as compared to developing economies. However, this provides a limited picture in explaining the influence of institutions on growth assuming different stages of development. The findings based on the composite institutional quality index do not identify the effect of individual components of institutional quality. Adedokun (2017) pointed out that various components of institutional quality have differential effects on growth, depending on a country's history, stages of development, and the length of time horizon being investigated. Following Adedokun (2017), we have investigated the impact of various components of institutional quality on economic growth. This paper analyzes the impact of institutional quality on economic growth conditional on the level of institutional quality of both G7 and D8 countries. We use a Panel Smooth Transition Regression model considering that the relationship between institutional quality and growth is non-linear as emphasized by the recent theoretical and empirical literature. This specification has allowed us to capture the heterogeneity of the relation between corruption and growth. The study 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, institutional quality has no impact on growth. We can identify the main two hypotheses of the impact of institutional quality on growth through our model: in countries with high levels of corruption, institutional quality seems to "sand the wheels" of economic activity, because of the self-reinforcing mechanism discussed above. In contrast, in the countries with low levels of corruption, institutional quality seems however to "grease the wheels".

In light of the above considerations, we can advance those 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 institutional quality can sometimes be harmful to growth: in countries with low levels of institutional quality, beyond a certain threshold, the sensitivity of growth to institutional quality is rather low. Therefore, the growth that could be obtained in these countries, although co-existing with corruption, could be further

used to improve the quality of institutions above a certain threshold, and this will furthermore, limit corruption. Hence, the issue of an optimal action of governments, in several steps, should be investigated further on.

The policy implication of the study for emerging economies with a low level of the institutional quality strict rule of law may play as "sand of wheels" of entrepreneurs or investors where, as in high institutional quality countries, corruption will hit the innovation capacity of entrepreneurs in a competitive environment.

Formal and in-depth analysis of those channels by which corruption impacts growth paves the way for future research. Moreover, the assessment of the level of corruption and the measurement of the quality of institutions are still at the beginning and should be improved. Our analysis will consequently have to be carried out again in the future to take advantage of the improvements in those measures and of the availability of longer time series.

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