Natural Resources and Economic Growth in Sub-Saharan Africa: Does Corruption Matter?

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Martin Ambassa Messy

Research Paper 497

Bringing Rigour and Evidence to Economic Policy Making in Africa

AFRICAN ECONOMIC RESEARCH CONSORTIUM
CONSORTIUM POUR LA RECHERCHE ÉCONOMIQUE EN AFRIQUE

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AERC Research Paper 497
African Economic Research Consortium, Nairobi
April 2022

THIS RESEARCH STUDY was supported by a grant from the African Economic Research Consortium. The findings, opinions and recommendations are, however, those of the author and do not necessarily reflect the views of the Consortium, its individual members or the AERC Secretariat.

Published by: The African Economic Research Consortium
P.O. Box 62882 - City Square
Nairobi 00200, Kenya

ISBN 978-9966-61-196-3

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Abstract

The existing literature on the relationship between natural resources (NRs) and growth is inconclusive. To enrich this debate, some studies have investigated the role of institutions in the NRs-growth nexus. Unlike most previous work, which mostly considers the interactive effect of institutions, notably corruption, on the relation between NRs and growth, this paper determines the optimal threshold of corruption below and above which NRs affect economic growth differently. The aim of this paper is to investigate the effect of NRs on economic growth conditioned by the level of corruption in SSA. Using a panel data on 26 Sub-Saharan Africa (SSA) countries over the period of 1985 to 2014, this paper uses the Panel Smooth Transition Regression (PSTR) model developed by Gonzalez et al. (2005). Firstly, we found evidence of the existence of corruption thresholds that change the effect of NRs on economic growth. These thresholds are 0.94, 0.40, 2.33, 1.16 and 0.48 for public, executive, legislative, judicial and political corruption, respectively. Secondly, the relation between NRs and economic growth below and above each type of corruption gives mixed results. The sensitivity analysis, which led to the decomposition of NRs into forest and oil resources, confirms the divergence of the results found by the baseline specification. These results have significant implications for policy sequencing in SSA. To benefit from NRs-led growth, improvement of the institutional framework, including different political corruption reducing, should precede NRs management policies. Also, a certain diversification of the economies of SSA countries leads to a better efficiency of the NRs on economic activity.

Keywords: Natural resources, Economic growth, Corruption, Panel Smooth Transition Regression (PSTR), Sub-Saharan Africa.
JEL: O11, Q32, Q38, Q43

1.0 Introduction

Does corruption really matter when trying to assess the relationship between natural resources (NRs) and economic growth in Sub-Saharan Africa (SSA)? Available literature mainly demonstrates that NRs tend to adversely affect growth in NRs-rich countries, notably in SSA. Therefore, the theory of “resource curse” has become a well-established finding in literature. Since the pioneering papers of Sachs and Warner (1995, 1997, 2001), resources’ endowments are paradoxically associated with poor economic performance, while it is expected that revenue from NRs should increase investment and economic growth in a country. However, the rise in prices of NRs at the international market is a fundamental driver of the SSA region Gross Domestic Product (GDP), which exceeded an average of 5% between 2000 and 2010 (Devarajan and Fengler, 2013). But this economic performance is far from the potential of SSA’s economies. In fact, according to the IMF (2012), NRs account for at least 65% of their exports. IDEA (2015) also shows that the SSA region has 30% of the world's mineral resources, 15% for oil, 12% for natural gas, and it is the second largest region in forest endowment in the world. Moreover, SSA countries rich in NRs exhibit the poorest economic growth while countries poor in NRs, notably in Asia, are among the fastest growing economies. Empirically, the effect of NRs on growth is still inconclusive, the most literature highlighting a negative effect. At least two main arguments can be put forward to explain why NRs turn to be counterproductive.

The first explanation is the “Dutch disease” theory. The theory was developed by Corden and Neavy (1982), Corden (1984) and van Wijnbergen (1984), following Netherlands’ experience of a declining manufacturing sector after the discovery of natural gas. The Theory shows that when a country experiences a resource boom, it normally undergoes a real appreciation of exchange rate. This appreciation reduces the international competitiveness of other tradable sectors because resource-based exports crowd out commodity exports produced by those sectors (Krugman, 1987). Finally, the real appreciation of exchange rate reduces national income via adverse effects on factors in the manufacturing sector. In the first paper devoted to the empirical analysis of the Dutch disease theory, Sachs and Warner (1995) demonstrated that a 13% increase in primary exports to GDP decreases annual growth by about 1%. The second explanation for the resource curse is related to the quality of institutions. It is well documented that the bad performances of NRs-rich countries are explained by weak quality of institutions (Gylfason, 2001; Mehlum et al., 2006; Torres et al., 2013). From this perspective, scholars agree that resource curse arises because resource abundance tends to weaken political institutions and especially fosters corruption, which consequently hampers economic growth (Leite and Weidmann, 1999; Zhan, 2017). In fact, the fragility of political institutions is exacerbated by revenues generated from NRs' sector. Through corruption, this fragility guarantees supplementary revenues to leaders at the expense of macroeconomic performance.

Corruption is defined by Jain (2001) as an act by which a public service is used by a public official for personal purposes to alter the rules of the game. According to World Bank (2010), corruption means "the misuse or the abuse of public office for private gain". It is characterized by the illegal transfer of public resources to private (Andvig et al., 2000) and in this vein, it is referred to as bribes that officials receive in the exercise of a public service. Philippot (2009) affirms that corruption is generally associated with a low efficacy of bureaucracy due to high transaction costs; for instance, corruption leads to an important economic cost.

According to Transparency International (2018), Sub-Saharan Africa (SSA) is ranked as the most corrupted region in the world. A report from QOG[1] (2015) also asserts that the five most corrupted countries in the world are in SSA. More specifically, the Democratic Republic of Congo (DRC) is ranked as the most corrupted country. It is followed by Somalia, Central African Republic, South Sudan and Equatorial Guinea. All these countries are heavily endowed with NRs. Furthermore, corruption is rampant in Nigeria and Angola, which are the two largest oil-producing countries in SSA. Nigeria's Economic and Financial Crimes Commission agency has estimated that more than US$ 380 billion of public funds have been stolen or wasted by various governments since their independence in 1960. In Angola, more than US$ 1 billion of oil revenue disappeared due to corruption each year in the early 2000s (McMillan, 2005).

From the above stylized facts, corruption seems to be linked to NRs. However, empirical analysis on the relation between NRs and corruption leads to controversial findings. Corruption is said to be associated with NRs curse. For instance, Zhan (2017) showed that resource curse is linked to corruption. Ades and Tella (1999) found a positive relationship between NRs abundance, corruption and rent-seeking. In a related study, Sala-i-Martin and Subramanian (2003) demonstrated that the slow growth experienced by Nigeria after the discovery of oil is due to the emergence of corruption. Similarly, Kolstand and Soreide (2009) argued that corruption plays an important role in explaining resource curse in Least Developed Countries (LDCs). Corruption can "sand the wheels" or "grease the wheels" of an economy. Therefore, it has been asserted that the presence of large resource dividends creates enormous economic opportunities and corruption (Leite and Weidman, 1999; Caselli and Michaels, 2013). The higher the level of corruption in an economy, the more the loss in terms of growth and vice versa (Kolstand and Soreide, 2009). Therefore, an eventual curse of NRs could be linked to a certain level of corruption in the economy.

1 Quality of Government (QOG) Institute of Gotherburg is an international organization that gives the performance of the countries of the world in the quality of governance every year.

The objective of this study is to investigate the effect of NRs on economic growth conditioned by the level of corruption in SSA. The study determines the optimal threshold of corruption that allows a blessing of NRs. It analyses the effects of NRs on growth below and above this threshold. The study complements the existing literature on four aspects. Firstly, in contrast to previous studies on the topic (Erum and Hussain, 2019), we do not limit the study to assess the positive and/or the negative effect of corruption on the relation between NRs and growth. Therefore, to reconcile the “greasing the wheels” and the “sanding the wheels” theories, we highlight that both effects could exist by defining a corruption threshold. Secondly, most of the studies use an aggregate measure of corruption and consider NRs as a whole. Considering the measure of corruption, we disaggregate corruption following the Jain (2001)’ classification into four indicators, namely: judicial corruption, executive corruption, public corruption and legislative corruption[2]. The aim is to have more specific results on the effect of corruption to achieve more focused recommendations. Relatively to NRs, it is well known that they include renewable (forest, food...) and non-renewable (oil, minerals...). For Leite and Weidman (1999), NRs do not affect economic activity in the same way. Based on this conclusion, our study evaluates the effect of NRs by distinguishing forest, oil and mineral resources.

Finally, our econometric investigation is based on the Panel Smooth Transition Regression (PSTR) model. The PSTR model allows us to highlight the heterogeneity of the NRs-growth relationship given the level of corruption. Also, previous studies (Mehlum et al., 2006; Arezki and Van Der Ploeg, 2007) generally use interaction terms, implying a linear interaction between corruption, NRs and growth. By using a PSTR model, we are able to demonstrate that an increase in corruption does not have the same impulse on the marginal effect of NRs over the distribution of corruption. Furthermore, the PSTR method also allows us to derive endogenous threshold values for corruption associated with a shift in the NRs-growth relationship, which a linear model cannot do. Indeed, Jude and Levieuge (2016) showed that PSTR corrects the loss of information associated with the estimation of linear models. Also, linear estimation techniques such as Ordinary Least Squares (OLS) generally exhibit an endogeneity bias that limits the model's convergence; this is corrected by the PSTR (Fouquau et al., 2008).

Following this introduction, the content of the paper is presented as follows: Section 2 outlines how corruption influences the growth effect of NRs. Section 3 describes the methodology. Section 4 highlights and discusses the results and section 5 concludes.

2 The definitions of judicial corruption, executive corruption, public corruption and legislative corruption are given in the subsection devoted to the presentation and description of the data.

2.0 Literature Review

2.1 Natural Resources and Economic Growth

Since Ricardo (1821), the literature has regarded NRs as a key determinant of economic growth. Indeed, foreign direct investment in the extractive sector and the NRs revenue constitute significant resources to finance domestic investments in education, health and infrastructures (Habakkuk, 1962). According to Wright and Czelusta (2004), industrial development in these countries is closely related to the wealth derived from the extraction of their basic mineral resources. For instance, Norway's industrial boom is closely linked to the revenue generated by export of primary commodities (Davies, 1995). In this sense, NRs are considered as a benefit for the economy.

Despite consistent theoretical arguments, empirical evidence on the growth effect of NRs is still inconclusive. A literature survey by Havranek et al. (2016) shows that approximately 40% of empirical papers found a negative relation between NRs and growth, 40% found no effect and 20% found a positive effect. Many empirical studies have demonstrated the hypothesis of "NRs curse". The explanations for these contradictory results have pointed both to theoretical and methodological issues. Theoretically, most research seems to conclude that the effect of NRs on economic growth is conditioned by several local circumstances, such as the economy's sensitivity to exchange rate appreciation or the theory of Dutch disease and quality of institution. Looking at the Dutch disease explanation, literature seems to suggest that "NRs curse" is due to exchange rate appreciation. Indeed, a boom in the NRs sector, and particularly in the oil sector, is accompanied by an appreciation of the real exchange rate at the expense of the development of an agricultural and industry sector (tradable goods) (Sachs and Warner, 2001). In other words, a benefit of NRs is conditioned by the competition that exists between local enterprises specialized in exchangeable goods sector (van Wijnbergen, 1984; Sachs and Warner, 1999; 2001; Torvik 2001). Sachs and Warner (1995) observed two mechanisms through which NRs affect economic growth: (a) an expense effect which reflects the idea that a boom in exports of NRs leads to an increase in national wealth, and therefore an increase in demand and domestic prices (non-tradable goods and services); (b) a transfer effect, by which a disequilibrium observed in the internal market limits the domestic competitiveness of local enterprises. There is, therefore, a crowding-effect of labour force from the tradable goods sector to the non-tradable goods sector, and consequently the crowding-effect of other forms of capital by natural capital.

Several studies have investigated the role of institutions on the NRs-growth relationship (Gylfason, 2001; Mehlum et al., 2006; Brunnschweiler, 2008; Avom and Carmignami, 2010; Zhan, 2017; Zalle, 2019; Vasilyeva and Libman, 2020; Qiang and Jian, 2020). Moreover, institutional theory seems to suggest that institutions set market rules, structure interactions among economic agents and ensure that economic actions are bounded by these rules. Gylfason (2001) and Mehlum et al. (2006) also argued that the institutional framework creates incentives and that business practices influence the nature of competition and the knowledge acquisition process. Similarly, Brunnschweiler (2008) and Torres et al. (2013) showed that countries that have put in place good institutions benefit from the positive effect of NRs on growth. However, Kolstad and Soreide (2009) showed that the curse of NRs is due to the institutional cost imposed by NRs. According to them, NRs often supply a favourable trend to corruption. In fact, the existence of natural rent stimulates social groups to actively search for benefits. As such, corruption appears when the institutions put in place to handle NRs are not good enough to control the mechanisms of contracts between governments and multinational extractors, taking into consideration the huge potential gains involved (Zhan, 2017). While trying to theorize the channel of rent-seeking, Torres et al. (2013) submitted that in a context of NRs abundance, political leaders tend to develop autocratic systems to retain their power. Zalle (2019) showed that the combined effect of human capital with corruptionis an appropriate lever to take advantage of natural resources in African countries. For Qiang and Jian (2020), the low-quality market allocation system and the property rights curbed the potential advantages of NRs to promote economic development. Vasilyeva and Libman (2020) showed that the elite fragmentation have the negativ effect on the relation between NRs and growth.

Indeed, in the context of abundance of NRs, political leaders tend to develop autocratic systems to reinforce their power. According to Lane and Tornell (1999), this rent-seeking is accompanied by a shift of private agents (especially entrepreneurs) from the most productive sectors of the economy to the NRs sector. Seghir and Damette (2018) conducted a study of Panel Smooth Transmission Regression (PSTR) on NRs spillovers and found the existence of a non-linear relationship between institutions and spillovers from NRs. They showed that the effect of quality of institutions is related to the degree of dependence of economies on NRs. They also found that beyond the 51% dependence threshold, and considering the poor quality of institutions, NRs are counterproductive for economic growth.

Although it is quite difficult to identify indication in literature as to the interaction between institutions (especially corruption and growth) in generating growth, we develop some arguments supporting the idea of heterogeneous effect of NRs on growth depending on corruption. In other words, an interesting issue would be to identify the channels through which corruption affects the relationship between NRs and growth. Several channels have, however, been put forward by the literature to explain the impact of corruption on economic growth, and they concern mainly public finance, private or public investment, trade or competitiveness (Marakbi et al., 2019).

2.2 Effect of Corruption on NRs and Growth Relationship: What Channels?

(a) Corruption and public investment allocation

One of the channels through which corruption can affect economic activity is public investment. Indeed, corruption affects public investment through public spending on at least two fronts. First, corruption may ensure an increased and unproductive allocation of government resources, as corrupt officials seek to maximize their personal rent-extraction potential, which in turn may affect public investment. Moreover, political corruption or “grand” corruption in particular, distorts the entire decision-making process connected with public investment projects (Tanzi and Davoodi, 1997). Indeed, in the different countries, public investment projects tend to be very large. Their accomplishment is often contracted out to domestic or foreign private companies. There is thus a need to select the enterprises that will be responsible for undertaking the project. For a private company, getting a contract to execute a project, and especially a large one, can be very profitable. Therefore, the managers of these companies may be willing to pay a bribe to government officials that help them win the contract. In some countries, commissions paid by entrepreneurs to foreign politicians are both legal and tax deductible. Such "commissions" are often calculated as percentages of the total cost of the project (Montinola and Jackman, 2002). In this context, Haque and Kneller (2008) showed that corruption increases public investment. However, Mauro (1995) found that this effect is inconclusive. Secondly, corrupt public officials could take a different way and maximize their rents by limiting the amount of public consumer spending. They may also do this by under-reporting public funds available for consumption or by redirecting public funds to private (often secret, offshore) bank accounts. In this way, corruption could potentially reduce government size. For example, Johnson et al. (1999) also showed that bribery has been found to reduce state revenue. In the same vein, Elliot (1997) reports that the size of government budgets relative to GDP decreases with levels of corruption. These results have been theoretically explained by governments distorting savings (Barro, 1991).

(b) Corruption and competitiveness

Another channel through which corruption helps to understand the relationship between NRs and economic growth is trade openness. Hodge et al. (2011) suggested the potential for corruption to counteract arrangements towards greater trade openness. For instance, Southgate et al. (2000) showed that restrictions on trade in the form of quotas or licences provide public officials with substantial sources of rents. Since the move towards free trade removes the opportunity to obtain at least some bribes, corrupt officials have a greater incentive to limit trade openness arrangements. Such a situation could reduce the competitiveness of local firms seeking larger market shares. It is therefore reasonable to assume that existing domestic firms possess certain local knowledge that is necessary to minimize bribe expenses. Potential foreign entrants lack this advantage and suffer disproportionately from corruption, which thereby acts as a brake on increased foreign investments (Southgate et al., 2000). Although Hodge et al. (2011) found that prevention of corruption could reduce trade volumes by increasing the international competitiveness of firms that are engaged in corruption, the corrupt firm will only be able to gain some competitive advantage in trade negotiations if all countries do not apply the same rules. Thus, it is not clear that corrupt economies will be more or less competitive. In general, due to increased market competition, technological transfers and access to larger markets are expected to increase economic growth (Wacziarg and Welch, 2008).

3.0 Methodology

In this section, we discuss the model specification used for our analysis. We also present the estimation procedure and describe the data.

3.1 Model Specification

The objective of the paper is fulfilled through the estimation of the PSTR model. The PSTR model was proposed by Gonzalez et al. (2005) and has at least four advantages. Firstly, the coefficient can take different values depending on the "regimes". This implies that the effects of NRs on growth could change depending on the level of corruption. Secondly, since the transition from one regime to another is smooth, the coefficients can change gradually without a loss of potential information as in non-linear GMM model (Jude and Levieuge, 2016). Third, individuals can change between groups over time according to changes in the "threshold variable". Finally, the PSTR model mitigates endogeneity issues as demonstrated by Fouquau et al. (2008).

The simplified form of the PSTR model is given by equation (1).

$$y_{it} = u_i + \beta_0^{'} rn_{it} + \beta_1^{'} rn_{it} g(s_{it}^{j}, \gamma, c) + \alpha^{'} x_{it} + \varepsilon_{it} \tag{1}$$

where y_{it} is the economic growth rate and rn_{it} natural resources in country *i* at time t, for $i = 1,....,N$ and $t = 1,....,T$. u_i represents an individual fixed effect vector. $x_{it} = \left(x_i^1,....,x_i^k\right)$ is a k-dimensional vector of growth determinants usually considered in the literature. ε_{it} is the residual term and $g(s_{it}, \gamma, c)$ is the transition function. As suggested by Granger and Teräsvirta (1993), Teräsvirta (1994) and Jansen and Teräsvirta (1996), the functional form of transition function takes the logistic form as formulated in equation (2).

$$g\left(s_{it}, \gamma, c\right) = \left[1 + \exp\left(-\gamma \prod_{j=1}^{m} \left(s_{it} - c_j\right)\right)\right]^{-1} \tag{2}$$

The transition function is continuous, derivable and is normalized to be bounded between 0 and 1. It allows the system to move progressively from one regime to the other. The variables of the transition function are the transition variable (s_{it}), the threshold parameter (c) and the smoothness parameter (γ) with $\gamma > 0$. Also, $c_1 < ... < c_m$ are a dimensional vector of threshold parameters. The value of the parameter γ describes the smoothness of the transition from one regime to another. As, $\gamma \to \infty$ the transition function approaches an indicator function that takes the value of 1 if $s_{it} > c_j$. If $\gamma \to 0$, it becomes a linear panel regression model with fixed effects. If γ is sufficiently high, then the PSTR model reduces to a threshold model with two regimes. β_0 (below the threshold) shows the NRs' elasticity on growth in low corruption regime while $\beta_0 + \beta_1$ (above the threshold) indicates the NRs' elasticity on growth in high corruption regime.

$$\frac{\partial y_{it}}{\partial rn_{it}} = \beta_0 + \beta_1 g(s_{it}, \gamma, c) \tag{3}$$

Including some control variables, the equation to be estimated is described as follows:

$$y_{it} = u_i + \beta_0^{'} rn_{it} + \beta_1^{'} rn_{it} g(s_{it}^{j}, \gamma, c) + \alpha_0^{'} y_{it-1} + \alpha_1^{'} open_{it} + \alpha_2^{'} term_{it} + \alpha_3^{'} inves \\ \alpha_4^{'} pop_{it} + \alpha_5^{'} \inf_{it} + \varepsilon_{it} \tag{4}$$

The economic growth (y) is captured by the growth rate of GDP. We have two main independent variables. The first variable is NRs (rn) while the second is the corruption (c) variable, mainly taken as threshold variable. The control variables, selected in light of the literature include: initial GDP (y_{it-1}), trade openness (Open), term of trade (term), private investment (Invest), population (Pop) and inflation (Inf).

The one period lagged level of real GDP (y_{it-1}) is used to control the conditional convergence in the spirit of the neoclassical growth theory (Barro and Sala-i-Martin, 1995). Private investment permits us to analyze the effect of private sector on growth. Private investment is captured by private gross fixed capital formation as a ratio of GDP. Theoretically, private initiative generally increases economic growth (Levine and Renelt, 1992). The expected sign is therefore positive. The influence of external sector is also important. For this purpose, openness is a significant variable in many growth econometric regressions (Frankel and Romer,1999). This variable is obtained by dividing the sum of exports and imports by GDP. Considering the liberal theories of international trade and the endogenous growth theory, openness is generally growth-enhancing; the expected sign is therefore positive. It is commonly agreed that very high inflation has distortional effects on long-run economic growth, but at a low level, the inflation-growth nexus can be positive (Frankel and Romer,1999). Thus, the expected sign can be either negative or positive. Regarding the variable terms of trade, many studies have evaluated its relation with growth. This variable is taken as the ratio of GDP. According to the Neoclassical growth model, population growth rate can negatively influence economic growth.

3.2 The PSTR Model Estimation Procedure

The estimation procedure of the PSTR model follows three main steps. First of all, we demonstrate the non-linear relation between corruption, NRs and growth. In other words, we demonstrate the existence of a non-linear relation between NRs and growth conditioned by corruption. For this purpose, we use a linearity test. Under the null hypothesis, the model is linear. For this purpose, we run the standard Fisher test, the Wald test and Likelihood test. Fouquau et al. (2008) demonstrate that the Likelihood test is more robust than the Wald and Fisher tests. Secondly, we determine the number of regimes or the number of transition functions of the PSTR. The null hypothesis tests a single transition function ($m=1$) when the alternative tests the least two transition functions ($m=2$). Third, we estimate the PSTR model using non-linear least squares method.

3.3 The Data

The study focuses on both renewable and non-renewable NRs and takes into consideration countries rich in NRs. The sampled countries were divided into two groups following Bulte et al. (2005). The first group is composed of countries rich in forest resources while the second group consists in countries rich in oil resources. Bulte et al. (2005) emphasize that the effect of institutional variables and more precisely corruption on NRs depends on the type of resources.

Our sample includes twenty-six (26) SSA countries over the period 1985-2014. The traditional growth drivers used and the NRs variable are obtained from the World Development Indicators (WDI). We use the political corruption (corrupt), which is based on four indicators, namely: executive, legislative, judiciary and public corruption. The corruption of the executive concerns the corruption of the members of the executive. This indicator includes bribes collected by members of the executive, embezzlement of public funds or other state resources for personal or family use. Legislative corruption refers to that which occurs in the activities of the legislative system; it considers the financial gains perceived by members of Parliament because of their powers. Judicial corruption captures undocumented additional payments or bribes paid by companies or individuals to speed up court proceedings or to obtain court rulings in their favour. As for public corruption, it formalizes the extent of favours granted by employees of the sector in exchange for bribes, thumb costs and material incentives. It also considers the misappropriation of public funds and the appropriation of public resources for personal use or for family use. The average of these four indicators forms the political corruption index obtained from the Varieties of Democracy data book (2017). The values of corruption are evolving increasingly (from a situation of low corruption to a situation of high corruption).

Table 1: Description of variables

Variables	Descriptions	Expected sign	Sources
Inf	Inflation is captured by the growth rate of the Consumer Price Index (CPI). The CPI is a better approximation of prices than the GDP deflator in developing countries since a large part of the spending consists of consumer spending	+/-	WDI
rn	Natural resource is taken as the ratio between natural resources rent and GDP. The rent of natural resources is the difference between the selling price and the exploitation costs. We distinguish between oil resources and forest resources (Leite and Weidman, 1999)	+/-	WDI
GDP (Y)	Growth rate of real gross domestic product		WDI
GDP initial (y_{it-1})	One period lagged value of real GDP, which controlled the conditional convergence of model	+	Authors
Open	Openness is the ratio between the sum of exportations and importations on real GDP	+	WDI
Invest	Investment is measured by the ratio of total investment in percentage of GDP	+	WDI
/Pop	Growth rate of population. This variable allows the considering of the role of the labour factor in economic activity	-	WDI
Term	Terms of trade is calculated as the ratio of the unit value of exports index to the index of the unit value of imports, measured over the reference year 2000	+	WDI
Corruption (Corrupt)	We measure corruption through the corruption index. It can take value from 0 to 6. A lower value translates a low level of corruption and a high value refers to a high level of corruption. This index is decomposed into four indicators, namely executive corruption, legislative corruption, judiciary corruption and public corruption	+/-	Varieties of Democracy version 6

Source: Authors

Descriptive statistics of variables

Table 1 describes the variables used for analysis in the study. The main statistical description of the variables is presented in Appendix Tables A2 and A3. Concerning our interest variable, the average level of NRs in percentage of the GDP is 14.61% for the entire sample. The country with the highest percentage of NRs in the GDP is

Angola with 41.99% and Senegal has the lowest percentage of NRs in GDP of around 3.15%. Regarding corruption variables, the average score of the sample is below 3. Precisely, the average score is 0.636, 1.700; 1.703 and 0.635 for the executive corruption, legislative corruption, judiciary corruption and public corruption, respectively. Specific trends highlight that Chad has the worst performances in term of executive (0.962) and public corruption (0,958); the worst performances of legislative and judiciary is recorded, respectively, in Tanzania (2.284) and Burkina-Faso (3.351) while Congo and Central Africa Republic recorded the best performances of these variables with scores values of 0.645 and 0.456, respectively. Furthermore, the best performances of executive and public was observed in Botswana (0.230, 0.120, respectively).

Unit root analysis

Before proceeding to the econometric analysis, it seems appropriate to first determine the series integration properties to avoid spurious regression problem. For this purpose, we ran Im Pesaran and Shin (IPS) (2003) test and Pesaran (2007) test. Table 2 summarizes the results of these tests. Both tests confirm that all the variables are I (0), indicating that they are all integrated at level.

Table 2: Results of unit root test

Variables		Rn	Term	Gdp	Pop	Open	Inf	Invest
IPS (2003) First generation test	Level	-3.390*** (0.000)	-8,55*** (0,000)	-8.50*** (0.000)	-1.60** (0.040)	-3.04*** (0.001)	-6.3*** (0.000)	-2.05** (0.01)
Pesaran (2007) Second generation test	Level	5,27** (0,010)	-6,68*** (0,000)	-6.21** (0.010)	-5.25** (0.010)	-6.21** (0.010)	-5.25** (0.010)	-6.22** (0.000)
Conclusion		I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)

Significance level: (***) 1%; (**) 5%, (*) 10%.

4.0 Empirical Results

This section is devoted to results presentation. Firstly, we present the results of linearity and the number of regime tests. This is followed by the results of the PSTR model. Lastly, we present the sensitivity analysis results that have NRs divided into oil and forest resources.

4.1 Results of the Linearity and the Number of Regimes Tests

Before estimating the PSTR, the linear model was experimented with, but it failed to converge due to the challenges associated with the linear model (problem of variable endogeneity, loss of information problem) as highlighted in the second last paragraph of the introduction section. Thus, the analysis of the results will focus on that obtained from the PSTR.

The results of the linearity test (LRT) and of the number of regimes test are reported, respectively, in Tables 3 and 4. From Table 3, the LRT[3] test shows that the hypothesis of linearity of the model is rejected for different corruption indexes. Firstly, this result implies that the relation between NRs and economic growth in SSA is nonlinear, conditionally to all categories of corruption. Secondly, this result justifies the PSTR estimation and consequently requires the determination of the number of regimes or the optimal level of corruption indexes.

3 Fouquau et al. (2008) synthesize the first two statistics (LMW and LMF) through the Likelihood LRT statistic. In their analysis, they show that the LRT statistic, by its construction, is more robust than that of Wald and Fisher.

Table 3: Linearity test results

Threshold variable	Wald Test (LMW)	Fisher Test (LMF)	LRT Tests (LRT)
Pub_corrup	6.85 [0.44]	0.94 [0.47]	6.88*** [0.00]
Ex_corrup	9.07 [0.24]	1.25 [0.27]	9.13*** [0.00]
Leg_corrup	26.13*** [0.00]	3.69*** [0.00]	26.60**** [0.00]
Judi_corrup	13.36* [0.06]	1.85* [0.07]	13.48** [0.00]
Corrup	12.81* [0.07]	1.78* [0.08]	12.92*** [0.00]

Significance level: (***) 1%; (**) 5%, (*) 10%.

Table 4 reveals that, at the critical level of 5%, the null hypothesis (H0) for two regimes cannot be rejected. In other words, the non-linearity or the conditional effect of corruption in the relation between NRs and economic growth is generated by a two regime process, which corresponds to a high level and a low level of corruption. This result implies that there is an optimal threshold of corruption (public, executive, legislative and judicial) for which the effects of NRs over economic growth change on both sides.

Table 4: Number of regimes test results

Threshold variable	Wald Test (LMW)	Fisher Test (LMF)	LRT Tests (LRT)	Number of threshold
Pub_corrup	4.66 [0.70]	0.62 [0.73]	4.67 [0.69]	1
Ex_corrup	4.70 [0.69]	0.63 [0.72]	4.72 [0.69]	1
Leg_corrup	4.08 [0.77]	0.54 [0.79]	4.09 [0.76]	1
Judi_corrup	7.90 [0.34]	1.06 [0.38]	7.95 [0.33]	1
Corrupt	6.83 [0.19]	2.30 [0.25]	7.02 [0.17]	1

The values in brackets are probabilities.

4.2 Results of the PSTR Model

The PSTR model results are reported in Table 5. Columns 2 to 5 represent the five models we have estimated. The models include each component of corruption taken as an institutional variable: public corruption (model 1), executive corruption (model 2), legislative corruption (model 3) and judicial corruption (model 4). The fifth column considers political corruption, which is the aggregation of the above-mentioned components of corruption, as institutional variable.

From Table 5 (model 5), we draw the following conclusions. First, that the threshold value is 0.486 for political corruption. This value refers to the maximum score of corruption below and above which NRs are expected to have different effect on growth. Below the threshold, the economy is in a situation of low corruption; however, NRs have a non-significant effect on growth, but above the threshold, NRs have a positive effect on growth. Indeed, a variation of 1% of NRs induces an increase of 0.163 point of growth. This counterintuitive result can be justified as follows. Higher levels of corruption become a barrier to the entry of new companies in the extractive industry and, therefore, create a monopoly and stability for business in the extractive industry. This will lead to an increase in profits/resource rents of the existing companies and therefore on economic growth.

Second, by examining each component of corruption (models 1 to 4), the threshold values are 0.948, 0.402, 2.330 and 1.162 for public, executive, legislative and judiciary corruption, respectively. The effect of NRs on growth when public and executive corruption (models 1 and 2) are taken as institutional variables is similar to when political corruption is considered as an institutional variable. Above the threshold, a variation of 1% of NRs induces an increase of 0.209 and 0.157 point of growth for public corruption and executive corruption, respectively. This result confirms the blessings thesis on NRs and agrees with the findings of Acemoglu and Verdier (2000) that derived a positive effect of corruption on economic activity. This result can be accepted as the result of redistributive effect of corruption. Indeed, corruption helps to overcome heavy bureaucratic constraints, inefficient public services and rigid laws (Lein, 1986), especially when institutions are of poor quality (Méon and Weill, 2010). Also, another explanation is the clientelism's effect of politicians. In fact, politicians can use NRs' revenues to finance economic growth with the aim of guaranteeing their continuation in power (Acemoglu et al., 2004; Omgba, 2010).

Furthermore, for the legislative and judicial corruption (model 3 and 4), results reveal the existence of both a positive and a negative relationship between NRs and economic growth. First, in the low-corruption regime of legislative and judicial corruption thresholds (2.330 and 1.162, respectively), there is positive and significant relationship between NRs and economic growth. A 1% change in NRs leads to an increase of 0.094% and 0.781% on economic growth, respectively, for legislative and judicial corruption. This result is consistent with the idea that a good quality institutional framework leads to a blessing of NRs. However, in a situation of high corruption (above the threshold), the results reveal a rather negative effect of NRs on economic growth in SSA. Thus, a variation of 1% leads to a decrease of 0.182% and 0.069% of the economic growth. Such a result can be explained by the theory of rent-seeking. According to this theory, NRs rents induce significant transaction costs, which in turn can lead to non-productive investments in the long term (Rose-Ackerman, 1999). Overall, having different results is thus consistent with the analysis of Leite and Weidman (1999), who have shown that the effects of corruption on NRs depend on the type of corruption.

The results of the threshold values show some disparities between countries. Indeed, although the thresholds indicate the sample averages, it should be noted that not all countries necessarily display these thresholds. Some may be above or below them. For instance, for executive corruption, all the countries in the sample are above the estimated threshold, except for countries such as Burundi and Burkina Faso. For legislative corruption, only Nigeria, Côte d'Ivoire, Congo and Cameroon are below the threshold. As for public corruption, our estimates show that all countries in the sample are below the threshold. Regarding judicial corruption, our results show that Cameroon, Côte d'Ivoire and Nigeria are the few countries with a level of judicial corruption below the threshold.

The divergence in the thresholds obtained can also be observed in terms of the influence of corruption. Our results show that some forms of corruption strengthen the positive effect of natural resources on economic growth. Such a result is based on the idea that although corruption is obstructive in nature and generates additional costs, it plays a redistributive role. Such a role is observed in the situation where the quality of institutions is low, which is characteristic of market failure. Corruption will thus be an oil in the wheels as it overcomes market rigidities. In a context where corruption amplifies the negative effect of natural resources on economic growth, corruption is seen as sand in the wheels. Indeed, corruption encourages the misallocation of funds to the so-called unproductive areas.

Finally, all the control variables explain at least once the economic growth in the sample. For instance, as theoretically demonstrated by exogenous and endogenous growth theories, private investment has a positive effect on economic growth. Also, openness and terms of trade affect economic growth positively and significantly. Concerning openness, the result confirms the predictions of international trade theories of the beneficial effects of comparative advantages, factor endowments, technological difference, economies of scale, technological diffusion, etc on economic growth. Regarding terms of trade, the positive effect can be explained by the Balassa-Samuelson effect. The Balassa-Samuelson mechanism results in a rise in relative prices, in particular wages, in the non-tradable goods sector, which can lead, all other things being equal, to a high demand for goods and services and thus to economic growth. For the two last control variables, namely population and inflation, the estimation results are mixed. Specifically, the two variables affect either negatively or positively economic growth depending on the model considered. Theoretically, it is admitted that inflation can be productive as documented by the structuralism theory; this result has been verified by previous studies such as Fisher (1993). Furthermore, it is well documented that inflation hampers growth (Villavicencio and Mignon, 2011). For population, the neoclassical growth theory (Swan, 1956; Solow, 1956) show that population growth is assumed to hinder economic growth. However, we can also expect population growth to fuel economic growth in the presence of important economies of scale (Jones, 1995; Marakbi et al., 2019).

Table 5: Parameter estimates of the various model of PSTR for natural resources

Threshold variable	model 1	model 2	model 3	model 4	model 5
	Pub_corrup	Ex_corrup	Leg_corrup	Judi_corrup	Corrup
rn (β 0)	0.008 (0.243)	-0.079 (-0.848)	0.094* (1.795)	0.781*** (3.92)	-0.080 (-1.331)
rn (β 1)	0.209** (1.934)	0.157* (1.833)	-0.276** (-2.083)	-0.850*** (-4.29)	0.163** (2.314)
(y_{it-1})	0.735 (1.472)	0.090 (0.115)	0.160 (0.300)	2.22*** (5.07)	0.533 (0.695)
Pop	1.168* (1.823)	1.863** (1.927)	2.158 (1.325)	-2.70*** (-5.96)	0.286 (0.841)
Invest	0.069* (1.857)	0.008 (0.088)	0.102** (2.089)	-0.09 (-0.56)	-0.059 (-0.972)
Inf	0.254 (1.108))	-0.602 (-0.810)	0.842 (0.369)	0.29*** (2.73)	-1.670** (-2.333)
Term	1.768*** (3.305)	2.484* (1.767)	0.016** (2.287)	-0.36 (-0.29)	3.384*** (2.805)
Open	0.004 (0.206)	0.067 (0.504)	0.017 (0.784)	0.22*** (3.57)	0.085*** (2.443)
γ	1.81	50.32	2.65	1.68	6.48
Threshold	0.948	0.402	2.330	1.162	0.486
Number of countries	26	26	26	26	26

(*), (**), (***) the significance at 10%, 5% and 1%, respectively

4.3 Sensitivity Analysis

To evaluate the sensitivity of our results, we decompose the NRs. The aim of this approach is to empirically test the theoretical argument of Bulte et al. (2005) that the effect of NR depends on the growth of the type of natural resources. Following Bulte et al. (2005), we consider two components of NRs, which are oil resources (ORs) and forest resources (FRs).

Tables 6 and 7 present the results of the PSTR estimation when we separately consider the countries with ORs and those with FRs. Ten (10) countries endowed with ORs and twenty-three (23) countries with abundant FRs were selected in the entire sample based on the available data. Several comments and conclusions can be drawn from the results shown in the tables. From Table 6, it can be observed that the relation between ORs and economic growth in SSA is non-linear. The value of the optimal corruption thresholds obtained are 0.948, 0.942, 1.895, 1.448 and 0.874, respectively, for public, executive, legislative, judicial and political corruption. Similarly, for the FRs (see Table 7), the optimal corruption thresholds obtained are 0.947, 0.378, 2.031, 2.000 and 0.390, respectively, for public, executive, legislative, judicial and political corruption.

Observations from both tables also show that there is a slight difference in the results for political corruption obtained from the effect of ORs and FRs on growth. Table 7 shows that the effect of FRs on growth is significant and negative in low corruption regimes but positive in high corruption regime. This result is similar to the result obtained from the pooled NRs when political corruption was considered. This result suggests that higher levels of corruption become a barrier to the entry of new companies into the extractives industry and thus create monopoly and stability for companies in this industry. Consequently, this leads to increased profits/resource rents of existing companies which, through trade, will affect economic growth. The effect of ORs on growth is positively significant below the threshold. It, however, has no effect on economic growth above the threshold. This result may be explained by the poor quality of institutions, which limits the ability of firms in the extractives sector to make productive investments. Another explanation can be drawn from the market price situation. Indeed, if market prices are low, the extraction activity is less profitable and therefore individuals have less incentive to invest in it and consequently the output of the sector may decrease or remain unchanged.

The analysis of the effect of each component of corruption on the relation between ORs and FRs on growth, respectively, draws certain highlights. When we consider public corruption and legislative corruption, FRs has no effect on economic growth irrespective of the level of corruption. This result is in line with the work of Bulte et al. (2005). Indeed, according to these authors, there are no statistically significant effects between renewable NRs and economic growth. In addition, the poor institutional framework that characterizes SSA's economies could also justify such a result (Hanousek and Kocenda, 2011).

The sensitivity analysis of our results allowed us to reinforce two theoretical presumptions. The first is that of Leite and Weidman (1999), which asserts that the effect of NRs on economic growth depends on the type of corruption. The second is that of Bulte et al. (2005), which opined that the effects of NRs on economic growth depend on the type of NRs.

Table 6: Sensitivity test with oil resources panel

Threshold variable	model 1	model 2	model 3	model 4	model 5
	Pub_corrup	Ex_corrup	Leg_corrup	Judi_corrup	Corrup
rn (β 0)	0.015 (0.370)	0.044 (1.085)	0.072* (1.893)	0.042** (2.04)	0.150** (2.019)
rn (β 1)	0.344*** (3.035)	0.328** (2.272)	-0.168* (-1.80)	-0.280*** (-3.38)	-0.070 (-1.211)
(y_{it-1})	0.890 (0.635)	0.859 (0.612)	0.866 (0.617)	0.527 (0.36)	2.991*** (-2.721)
Pop	-2.273*** (-2.528)	1.982** (-2.288)	-1.339 (-1.015)	0.332 (0.25)	0.518 (0.606)
Invest	0.020* (1.857)	0.070 (1.011)	0.100* (1.763)	0.052 (0.69)	0.115 (0.961)
Inf	0.184 (0.523)	-0.624 (-1.933)	0.011 (0.034)	-0.0003* (-1.76)	0.0008* (1.791)
Term	0.026*** (2.606)	0.032*** (3.381)	0.203** (2.180)	2.235** (2.04)	0.072 (0.713)
Open	-0.011 (-0.292)	0.009 (0.270)	0.003 (0.008)	0.093*** (3.50)	0.069 (0.989)
γ	1.65	16.11	1.33	28.80	1.89
Threshold	0.948	0.942	1.895	1.448	0.874
Linearity test (LR-Test)	7.39*** [0.000]	13.19*** [0.000]	16.78*** [0.000]	7.51*** [0.000]	15.785*** [0,00]
Test of the number of regime (LR-test)	6.548 [0.477]	6.25 [0.511]	10.88 [0.144]	2.04 [0.958]	9.41 [0.22]
Number of countries	10	10	10	10	10

(*), (**), (***) the significance at 10%, 5% and 1%, respectively. Values in parentheses and brackets represent t-students and p-values, respectively

Table 7: Sensitivity test with forest resources panel

Threshold variable	model 1	model 2	model 3	Model 4	Model 5
	Pub_corrup	Ex_corrup	Leg_corrup	Judi_corrup	Corrup
rn (β 0)	-0.026	-0.146	0.053	0.124*	-0.861***
	(-0.234)	(-1.098)	(0.406)	(1.85)	(-3.531)
rn (β 1)	0.093	0.208**	-0.144	-0.710**	0.953***
	(0.624)	(1.936)	(-0.580)	(-2.00)	(3.748)
(y_{it-1})	0.619	0.396	-0.092	0.563	-2.346
	(1.166)	(0.483)	(-0.129)	(1.10)	(-0.133)
Pop	1.244*	2.080**	2.833	0.050	-0.465
	(1.744)	(2.082)	(1.306)	(0.063)	(-1.277)
Invest	0.062	0.094	0.155*	0.098**	0.002
	(1.539)	(1.011)	(1.899)	(2.44)	(0.076)
Inf	0.253	-0.624	0.218	-0.0003***	-0.106**
	(1.020)	(0.180)	(0.550)	(-2.84)	(-2.341)
Term	1.814***	0.023	1.986*	2.255***	0.114***
	(3.207)	(1.074)	(1.768)	(3.40)	(6.345)
Open	0.013	-0.098	0.046	-0.020	0.070**
	(0.798)	(-0.998)	(1.681)	(-0.57)	(2.332)
Γ	1.82	1.25	1.48	44.70	1.56
Threshold	0.947	0.378	2.031	2.00	0.39
Linearity test (LR-Test)	4.71***	5.73***	24.72***	18.37***	12.14***
	[0.000]	[0.000]	[0.000]	[0.000]	[0,00]
Test of the number of regime	3.291	12.87	7.15	13.52*	10.160
(LR-test)	[0.857]	[0.541]	[0.413]	[0.060]	[0,18]
Number of countries	23	23	23	23	23

(*), (**), (***) the significance at 10%, 5% and 1%, respectively. Values in parentheses and brackets represent t-students and p-values, respectively

5. 0 Robustness

5.1 Alternative Measure of Growth

We also estimated the effect of corruption in the relationship between natural resources and economic growth by measuring the endogenous variable from the real GDP per capita. The results in the Appendix show that the results remain the same (see Table A4 to A8 in the Appendix).

5.2 Endogenous Hypothesis

According to Jude and Levieuge (2016), we use the GMM approach to control the potential endogeneity bias that emanates from corruption, natural resources, and other control variables by using their lagged values in the estimations rather than the contemporaneous values. We derive the GMM analysis upon the estimation of equation (5).

$$y_{it} = u_i + \beta_0^{'} rn_{it} + \beta_1^{'} (rn * cor)_{it}^2 + \alpha_0^{'} y_{it-1} + \alpha_1^{'} open_{it} + \alpha_2^{'} term_{it} + \alpha_3^{'} invest_{it} + \alpha_4^{'} pop_{it} + \alpha_5^{'} \inf_{it} + \varepsilon_{it} \quad (5)$$

where cor_{it} captures the corruption index; the term $\beta_1 \left(RN * cor \right)^2$ reflects both the combined effect of corruption index and natural resources and the non-linearity in the relation. The results of the GMM estimation are reported in Table 8 and are similar to those obtained through the different estimations of PSTR model. Indeed, Table 8 shows that natural resources have a direct negative effect on economic growth. The combined effect is positive and significative for corruption, meaning that the influence on growth of natural resources depends on corruption and the relation is non-linear.

Table 8: Estimation with lag value

Variable	
Rn	-4.363*
	(-1.886)
$\left(RN_{it} * cor_{it}\right)^2$	4.704***
	(4.283)
(y_{it-1})	-7.287
	(-1.353)
Inv	3.847***
	(6.073)
Pop	-1.516*
	(-3.071)
Inf	-0.286
	(-0.525)
Term	-0.162
	(-1.465)
Open	0.078
	(1.066)
AR1 (p-value)	0,048
AR2 Test(p-value)	0,561

(*), (**), (***) the significance at 10%, 5% and 1%, respectively

6. Conclusion

This paper investigates the effect of NRs on economic growth conditioned by the level of corruption in SSA. This objective is divided into two specific ones: (i) the paper determines the optimal threshold of corruption that allows a blessing of NRs; (ii) the paper analyses the effects of NRs on growth below and above this threshold. Applying a PSTR model on a panel of twenty-six (26) SSA countries over the period 1985 to 2014, the paper gives many interesting results. The threshold value is 0.486 for political corruption. Below it, NRs have a non-significant effect on growth, but above the threshold, NRs have a positive effect on growth. By examining each component of political corruption, we observe that the threshold values are 0.948, 0.402, 2.330 and 1.162 for public, executive, legislative and judiciary corruption, respectively. As far as the effect of NRs on growth is concerned, when each component of corruption is taken as an institutional variable, the study reaches to the following results. Above the threshold, a variation of 1% of NRs induces an increase of 0.209 and of 0.157 point of growth for public corruption and executive corruption, respectively. Below the threshold, a 1% change in NRs leads to an increase of 0.094% and 0.781%, and above to a decrease of 0.182% and 0.069% on economic growth for legislative and judicial corruption, respectively. The sensitivity analysis results obtained by decomposing NRs into oil resources (ORs) and forest resources (FRs) also show that the relation between ORs or FRs and economic growth in SSA is non-linear; that is, this relation is conditioned on the existence of a corruption threshold. The channels through which this non-linearity can occur are the competitiveness of economies and the channel of public expenditure and investment.

Two main policy implications can be derived from the preceding results. As far as the first implication is concerned, the existence of a corruption threshold that conditions the growth effect of NR casts doubt on the effectiveness of policies to ensure NR blessing. Precisely, these policies do not benefit host countries if they are not preceded by an improvement in their institutional framework. Therefore, it is necessary to establish an order in the implementation of economic policies, giving priority to policies against public, executive, legislative, judicial and political corruption to benefit from NR. Furthermore, due to the endogenous nature of corruption which, in a context of abundant NR, is combined with several social challenges (conflicts, bureaucratic instability...), it should be noted that reduction of corruption requires to build strong institutions that ensure compliance with the laws or social policies previously established. Regarding the second implication, although our results also imply the implementation of public policies to encourage corruption in countries with low levels of corruption, this is not an effective alternative for reducing the natural resource curse, given the significant costs in terms of legitimacy and government instability associated with high levels of corruption. Thus, reforms in the field of legislative, judicial and political corruption will likely result in a gradual increase of benefits from NRs, even for countries situated far below the threshold. On the contrary, reforms focused on public and executive corruption are only effective for countries close to the threshold value. Nevertheless, due to institutional complementarities, reforms targeting specific corruption can in fact bring other characteristics closer to their respective thresholds, thereby leading to a potential long-run incremental effect on growth.

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Appendix

Table A1: Descriptive statistics of the variables

Variables	Obs	Mean	Std. Dev	Min	Max
Gdp	780	3.623	5.843	-50.248	35.224
Rn	780	14.615	15.344	0.321	77.054
Pop	780	2.715	0.962	-6.342	7.988
Open	780	65.965	27.958	14.325	178.99
Invest	779	12.426	7.7111	-27.009	59.723
Inf	774	102.460	1250.566	-13.056	24411.03
Ex_corrup	780	0.636	0.2277	0.600	0.969
Leg_corrup	779	1.700	0.648	0.120	3.503
Judi_corrup	780	1.7032	0.815	0.456	3.351
Pub_corrup	780	0.635	0.253	0.407	0.974
corrupt	780	0.701	0.335	0.185	0.937

Table A2: Descriptive statistics of the variables

Variables	Obs	Mean	Std. Dev	Min	Max
Gdp	780	3.623	5.843	-50.248	35.224
Rn	780	14.615	15.344	0.321	77.054
Pop	780	2.715	0.962	-6.342	7.988
Open	780	65.965	27.958	14.325	178.99
Invest	779	12.426	7.7111	-27.009	59.723
Inf	774	102.460	1250.566	-13.056	24411.03
Ex_corrup	780	0.636	0.2277	0.600	0.969
Leg_corrup	779	1.700	0.648	0.120	3.503
Judi_corrup	780	1.7032	0.815	0.456	3.351
Pub_corrup	780	0.635	0.253	0.407	0.974
corrupt	780	0.701	0.335	0.185	0.937

Table A.3: Average of some variables by country

Pays	Gdp	RN	exce_Corrup	Leg_corrup	Pub_corrup	Judi_corrup
South Africa	0.41299043	5.06313736	0.40867802	2.01134434	0.50776944	2.77363098
Angola	4.81647422	41.9994687	0.90212434	1.90496329	0.82872481	1.67948101
Benin	4.06291907	6.37857595	0.6182067	1.98928635	0.6260678	1.55508676
Botswana	6.13848834	2.97593521	0.23031741	2.0820613	0.12000001	3.35143741
Burkina	5.36224281	9.29226416	0.23450264	2.08393604	0.13032235	3.35107399
Burundi	2.00058669	19.999506	0.42024237	2.53071481	0.38958971	0.97575116
Cameroon	2.03642737	10.6946623	0.84145654	0.99161312	0.85786375	0.60808272
Central Africa	0.45394401	9.01900449	0.88692571	1.55036055	0.84921569	0.45694071
Congo	2.41252546	54.7373562	0.88708997	0.64549627	0.82044525	1.20104894
Ivory Coast	2.07732399	5.87732456	0.78398632	1.91866429	0.71073316	1.38414404
Demo. Rep. Congo	0.51815194	25.6809742	0.85629919	1.07705908	0.94917193	0.9939726
Gabon	1.95250391	40.412352	0.79299447	0.89929508	0.84921379	0.84766033
Gambia	3.3803111	3.56823355	0.57419574	2.15854112	0.55644709	2.28749674
Ghana	5.53946474	10.3556053	0.67098774	1.82768809	0.67491002	1.88771521
Malawi	3.91716555	9.11927182	0.46308483	2.05665915	0.45783655	2.16282233
Mali	4.71816454	7.11773955	0.74086521	1.54461356	0.76542996	1.7326044
Mozambique	7.17854056	12.0070519	0.51665307	2.37370254	0.68096809	2.16207465
Namibia	3.92969565	4.4532564	0.4838371	2.2470981	0.50276542	2.94674
Niger	3.61924508	9.21921656	0.50355706	2.01600059	0.68991228	1.77722419
Nigeria	4.85449508	38.7179416	0.83639967	0.91135868	0.8915615	0.94406167
Rwanda	4.96202361	7.28347953	0.44616105	1.42146554	0.31011795	1.27037824
Senegal	3.3442291	3.1548785	0.47462434	1.92924371	0.64992067	1.72125775
Tanzania	4.8749836	7.79435895	0.48540488	2.28400982	0.42220699	1.68625224
Chad	6.28298716	19.479325	0.96219873	1.03008987	0.95888094	1.40047093
Togo	2.73192545	8.40643974	0.8581379	1.51387459	0.73133671	1.34727561
Zimbabwe	1.12097866	7.64081838	0.65181857	1.31702941	0.57671524	1.84479399

Table A.4: Linearity tests of type of corruption

Threshold variable	Wald Test (LMW)	Fisher Test (LMF)	LRT Tests (LRT)
Pub_corrup	15.693*** [0.008]	3.073*** [0.009]	15.808*** [0.007]
Ex_corrup	15.333*** [0.009]	3.001*** [0.011]	15.443 *** [0.009]
Judi_corrup	10.233** [0.022]	1.015 [0.408]	11.245** [0.021]
Leg_corrup	11.833** [0.037]	2.309** [0.042]	11.898** [0.036]

Table A.5: Tests of number of regimes of type of corruption

Threshold variable	Wald Test (LMW)	Fisher Test (LMF)	LRT Tests (LRT)	Number of thresholds
Pub_corrup	8.108 [0.150]	1.561 [0.168]	8.139 [0.149]	1
Ex_corrup	6.219 [0.286]	1.195 [0.309]	6.237 [0.284]	1
Judi_corrup	7.664 [0.176]	1.475 [0.195]	7.691 [0.174]	1
Leg_corrup	4.541 [0.474]	0.872 [0.500]	4.550 [0.473]	1

Table A.6: Linearity tests of type of natural resource

Threshold variable	Wald Test (LMW)	Fisher Test (LMF)	LRT Tests (LRT)
Forest	22.114*** [0.000]	4.819*** [0.000]	24.151*** [0.000]
Oil	19.945*** [0.001]	4.192*** [0.001]	21.168*** [0.001]

Table A.7: Tests of number of regimes of type of natural resource

Threshold variable	Wald Test (LMW)	Fisher Test (LMF)	LRT Tests (LRT)	Number of thresholds
Forest	6.904 [0.228]	1.218 [0.305]	7.087 [0.214]	1
Oil	7.473 [0.188]	1.366 [0.240]	7.636 [0.177]	1

Table A.8: Parameter estimates of corruption model of PSTR for NRs

Threshold variable		
	Corrup	
β	***$β_0$***	***$β_1$***
Rn +	***0.085***	***0.005*****
	(1.112)	***(1.955)***
(y_{it-1})	*0.084*	*0.207****
	(1.159)	*(3.579)*
Invest	*0.118****	*0.053*
	(2.679)	*(0.725)*
Pop	*0.195*	*0.430***
	(1.534)	*(2.357)*
Inf	0.091	0.050
	(1.479)	(0.706)
term	0.116***	0.095
	(3.042)	(1.061)
Open	-0.469*	0.493*
	(-1.629)	(1.633)
γ	2.138	
Threshold	0.854	
Number of countries	33	

Table A.9: Estimation with lag value

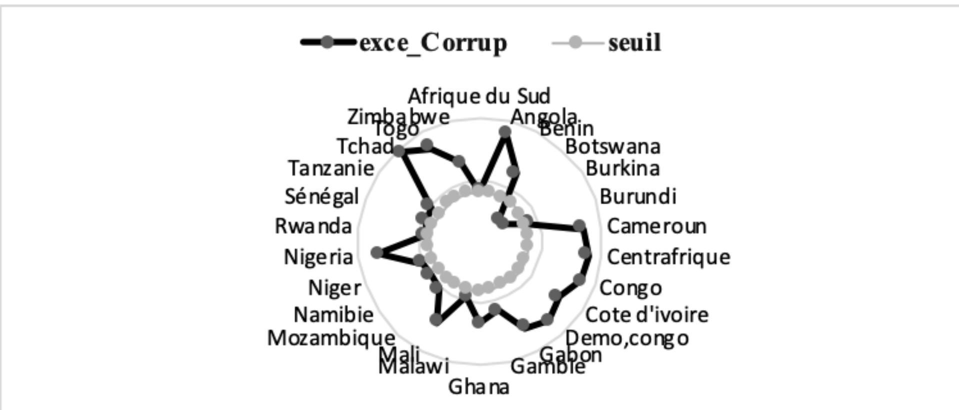
Threshold variable	model 1		model 2		model 3		model 4	
	Pub_corrup		Ex_corrup		Judi_corrup		Leg_corrup	
β	*$β_0$*	*$β_1$*	*$β_0$*	*$β_1$*	*$β_0$*	*$β_1$*	*$β_0$*	*$β_1$*
Rn +	*0.085****	*-0.005*	*0.091****	*-0.014*	0.117***	-0.055	0.097***	-0.014
	(2.248)	*(-0.255)*	*(2.417)*	*(-0.674)*	(2.550)	(-1.8622)	(2.624)	(-0.749)
(y_{it-1})	0.084	0.207***	0.078	0.270***	1.814***	-	0.042	0.224***
	(1.159)	(3.579)	(1.066)	(4.462)	(2.946)	1.703***	(0.705)	(3.457)
						(-2.764)		
Invest		0.053	0.094***	0.147*	0.091	0.050	0.116***	0.095
	0.118***	(0.725)	(2.411)	(1.673)	(1.479)	(0.706)	(3.042)	(1.061)
	(2.679)							
Pop	0.195	0.430**	0.201*	0.443**	0.679***	-0.380**	0.201*	0.582
	(1.534)	(2.357)	(1.625)	(2.401)	(3.569)	(-1.879)	(1.696)	(2.734)
INF	-0.162	0.033*	-0.175*	0.111	-0.469*	0.493*	-0.177*	0.086
	(-1.465)	(0.163)	(-1.745)	(0.544)	(-1.629)	(1.633)	(-1.717)	(0.431)
TERM		0.053	0.094***	0.147*	0.091	0.050	0.116***	0.095
	0.118***	(0.725)	(2.411)	(1.673)	(1.479)	(0.706)	(3.042)	(1.061)
	(2.679)							
OPEN	0.195	0.430**	0.201*	0.443**	0.679***	-0.380**	0.201*	0.582
	(1.534)	(2.357)	(1.625)	(2.401)	(3.569)	(-1.879)	(1.696)	(2.734)
γ	*2.138*		*3.221*		*5.834*		*2.379*	
Threshold	*0.854*		*0.840*		*1.214*		*0.882*	
Number of countries	*26*		*26*		*26*		*26*	

Table A.10: Parameter estimates of PSTR for specific natural resources

Threshold variable	model 1		Model 2	
	Oil		Forest	
β	β_0	β_1	β_0	β_1
rn	0.010	-0.027**	-0.016	0.105***
	(1.040)	(-2.075)	(-0.627)	(2.428)
(y_{it-1})	0.199**	-0.162*	1.734***	1.841**
	(2.219)	(-1.794)	(3.433)	(2.228)
Inv	0.204	1.265***	-0.571***	0.789***
	(1.614)	(5.451)	(-5.470)	(5.798)
Pop	0.464***	-0.653***	0.814***	-0.462
	(3.988)	(-3.495)	(2.604)	(-1.302)
Inf	0.254	-0.602	0.842	0.29***
	(1.108))	(-0.810)	(0.369)	(2.73)
Term	1.768***	2.484*	0.016**	-0.36
	(3.305)	(1.767)	(2.287)	(-0.29)
Open	0.004	0.067	0.017	0.22***
	(0.206)	(0.504)	(0.784)	(3.57)
γ	701.817		113.87	
Threshold	0.889		0.790	

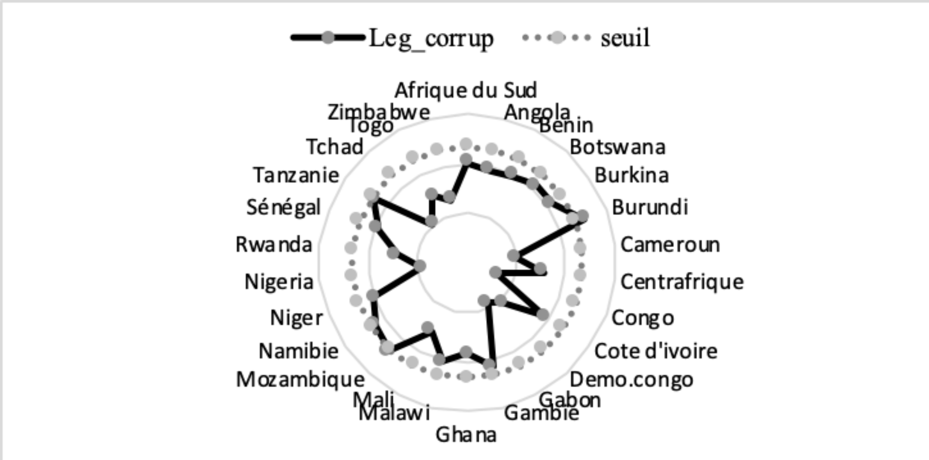
Figures B: Country compared to the corruption threshold found

Figure B1: Corruption in SSA countries rich in NRs regarding the threshold of executive corruption between 1985 and 2014



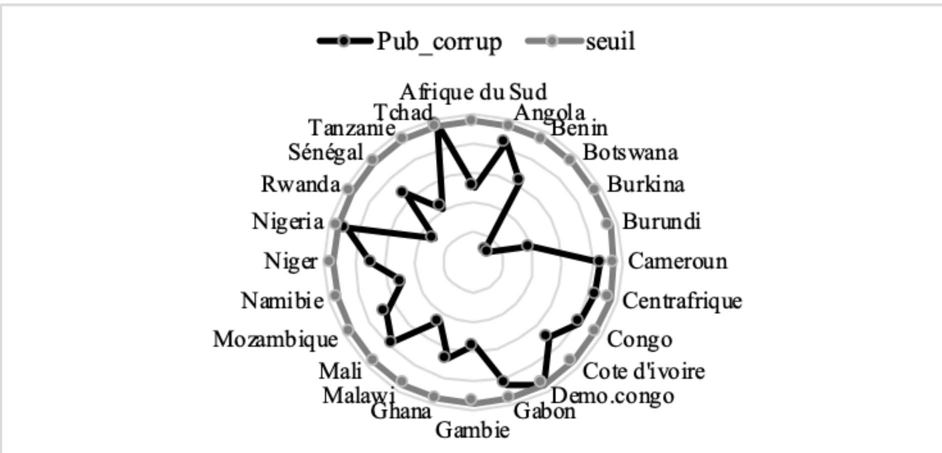
Source: Authors

Figure B2: Corruption in SSA countries rich in NRs in light of the threshold of legislative corruption between 1985 and 2014



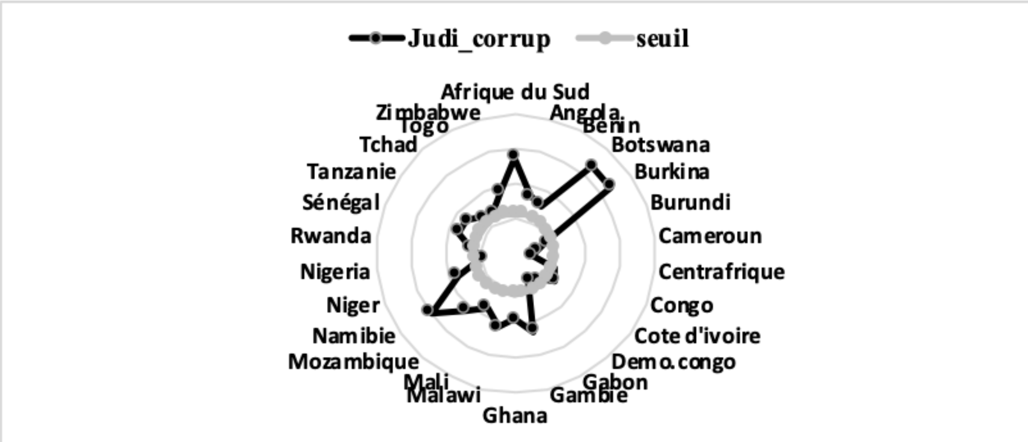
Source: Authors

Figure B3: Corruption in SSA countries rich in NRs regarding the public corruption threshold between 1985 and 2014



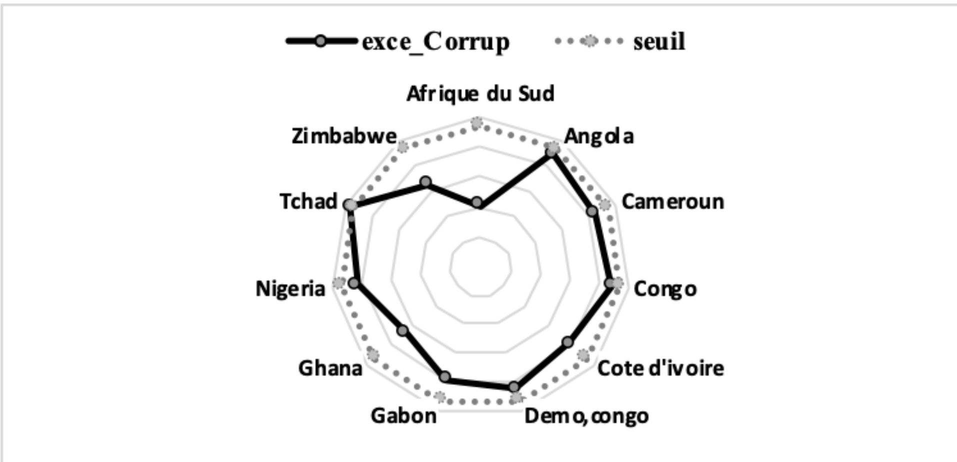
Source: Authors

Figure B4: Corruption in SSA countries rich in NRs with to judicial corruption threshold between 1985 and 2014



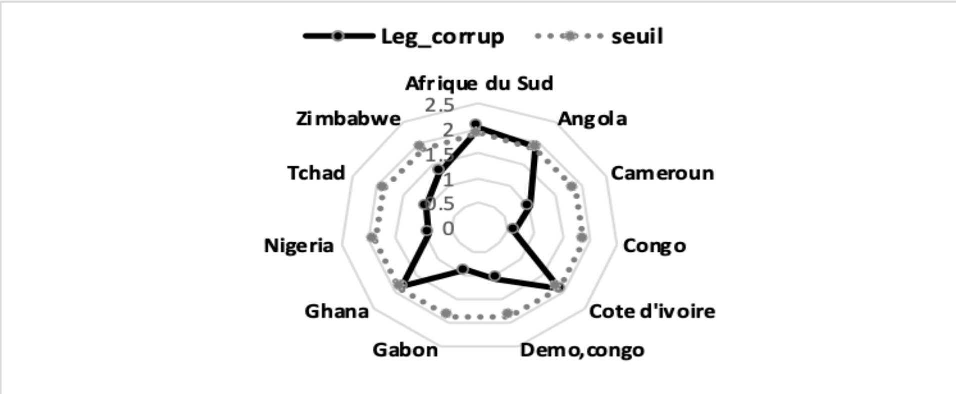
Source: Authors

Figure B5: Corruption in SSA countries rich in OR regarding the threshold of executive corruption between 1985 and 2014



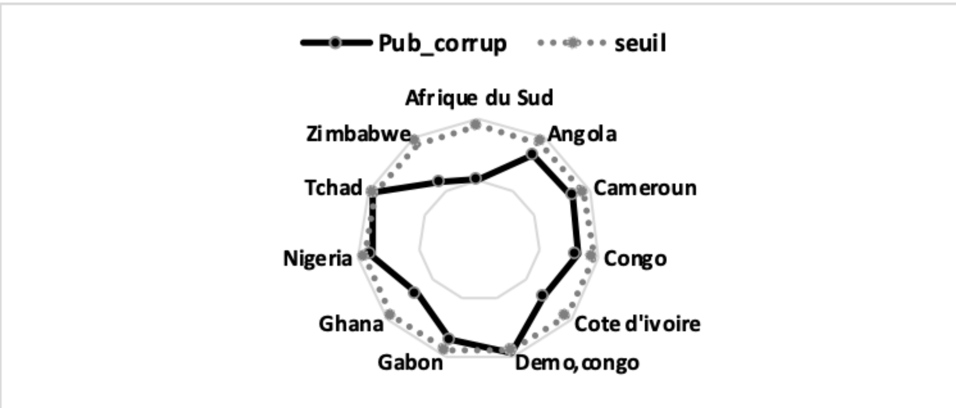
Source: Authors

Figure B6: Corruption in SSA countries rich in OR regarding legislative corruption threshold between 1985 and 2014



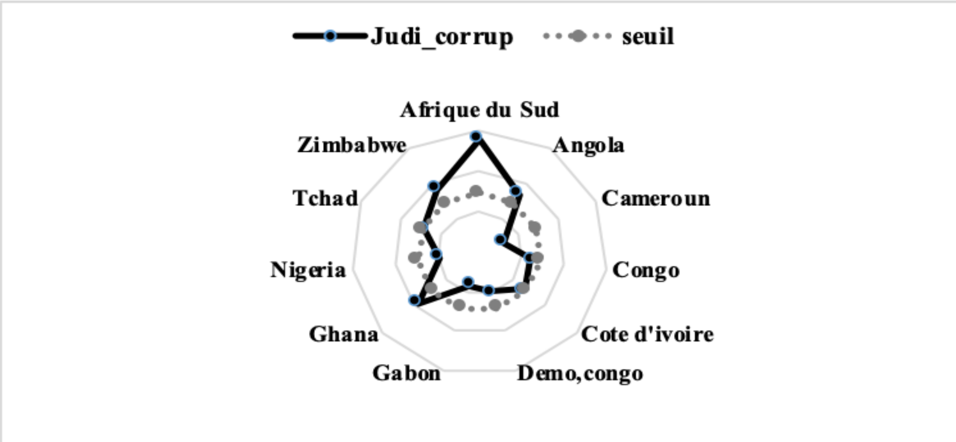
Source: Authors

Figure B7: Corruption in SSA countries rich in OR regarding the threshold of public corruption between 1985 and 2014



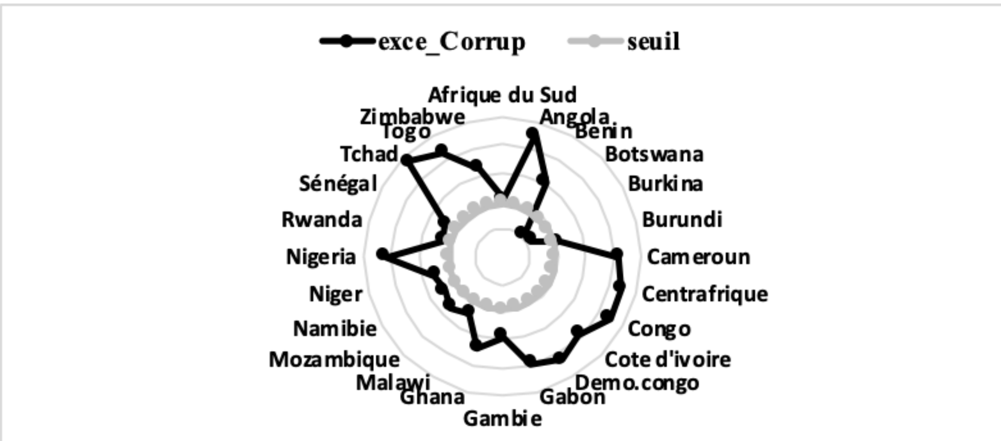
Source: Authors

Figure B8: Corruption in SSA countries rich in OR regarding judicial corruption threshold between 1985 and 2014



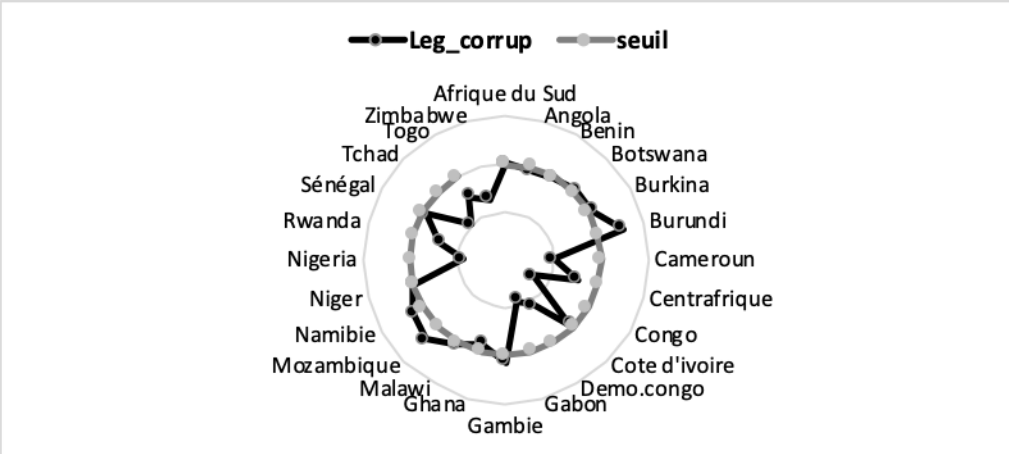
Source: Authors

Figure B9: Corruption in SSA countries rich in FR about the threshold of executive corruption between 1985 and 2014



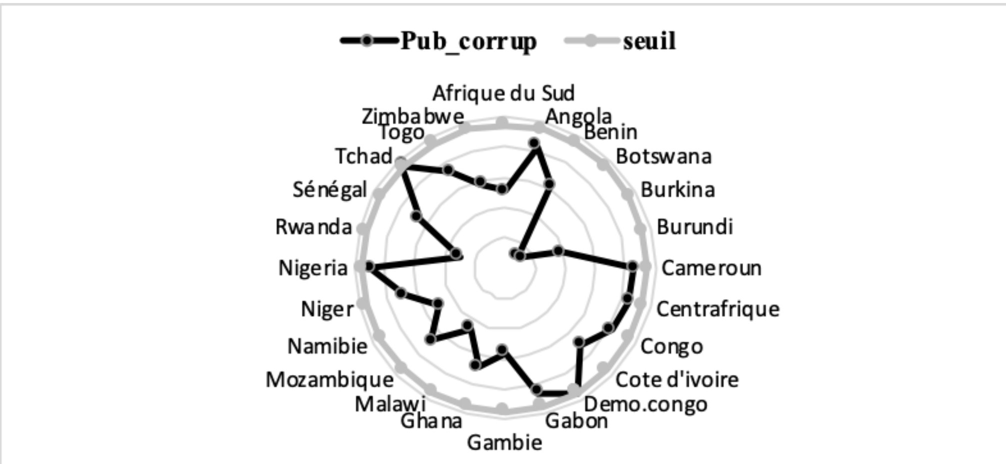
Source: Authors

Figure B10: Corruption in SSA countries rich in FR regarding the threshold of legislative corruption between 1985 and 2014



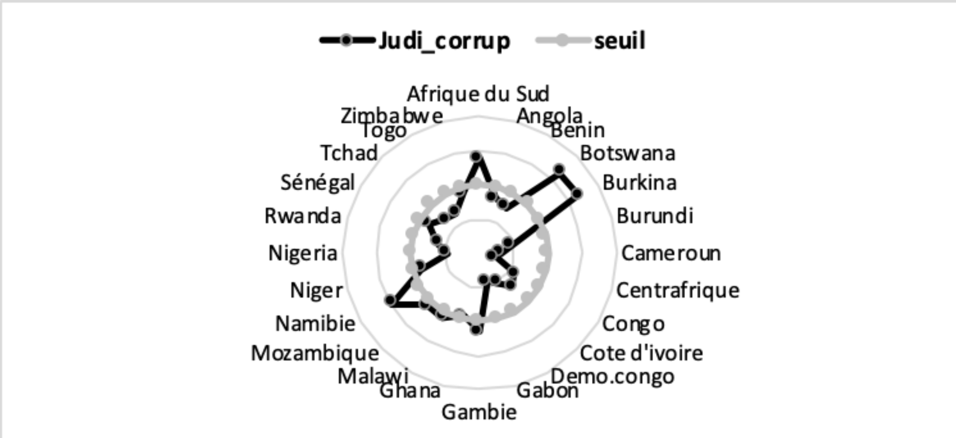
Source: Authors

Figure B11: Corruption in SSA countries rich in FR regarding the threshold of public corruption between 1985 and 2014



Source: Authors

Figure B12: Corruption in SSA countries rich in FR regarding judicial corruption threshold between 1985 and 2014



Source: Authors

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