Natural Resources Effect on Economic Growth: The role of institutional quality

Youmanli OUOBA[1]

Economics department, University of Ouaga 2 (Burkina Faso), Email: theodoreouoba@yahoo.fr Tel. 00226 72 17 35 90

Relwendé SAWADOGO

Economics department, University of Joseph KI-ZERBO (Burkina Faso), Email: resawadogo@yahoo.fr Tel : +33754225990/+22670042253

Abstract

The objective of this study is to analyze the effect of natural resource rents on economic growth in 19 African countries with institutional quality as a conditioning variable. Using Panel Smooth Transition Regression Model (PSTR) under the period 1985-2014, the results confirm the curse in African countries but this no longer exists beyond a certain threshold of government stability (index> 5.59) and corruption (index> 1.3). The robustness of these results is confirmed using Panel Transition Regression Model (PTR). The findings suggest that African countries lack good and strong institutions to manage efficiently their resources. Therefore, these countries may reduce their dependence through economic diversification and improvement of the quality of their institutions.

Keywords: Resources curse; Institutional quality; Threshold effect; Panel

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[1] Corresponding author

1. Introduction

Most resource-rich countries rely on resources for economic growth and inclusive development. While some countries have achieved significant economic growth with resources, others have even made little economic progress compared to resource-poor countries. In the latter case, the literature considers these countries among those who are victims of the resources curse (Sachs and Warner, 1995).

The sources of the curse have been widely discussed in the literature (see Fleming et al., 2015). Among these sources, the quality of institutions occupies a prominent place. Indeed, several authors indicated that when institutions are of good quality, natural capital could rather be a "blessing" for a country (Mehlum et al, 2006). Indeed, Mehlum et *al.* (2006) indicated that good quality of institutions leads to the creation of more infrastructures and more productive activities. However, the presence of poor quality of institutions rather contributes to pervert this effect of natural resources. Therefore, institutions seem to play a crucial role in economic development based on natural resources (Brunnschweiler, 2008). Moreover, it is often considered that the quality of institutions is itself affected by the abundance of these resources. Indeed, the presence of natural resources reduces the incentives for public and private agents to accumulate human capital because they consider natural capital to be their main source of wealth (Gylfason, 2001). Similarly, individuals at the head of institutions would be tempted to appropriate this rent for themselves or for an elite, instead of investing it in policies for growth (Sachs and Warner, 2001). This dual causality between resources and institutions would ultimately affect the economic performance of a country. It is therefore relevant to question the role that institutions would play in a country that relies on its resources for economic growth. In other words, the following questions need to be answered: (i) does the quality of institutions condition the effect of natural resources on economic growth in resource-rich countries? In other words, is there an institutional quality threshold, from which the effect of natural resources on economic growth is more pronounced? Answering such questions is the main motivation of this paper.

The objective of this work is to analyze the effect of natural resource rents on economic growth in African countries using the quality of institutions as a conditioning variable. Although there is abundant literature on the resource curse, there has been little work on the role of institutional quality in the non-linear relationship between natural resources and economic growth. The previous empirical studies are tested the curse hypothesis with resource dependence on the one hand (Seghir and Damette 2013; Belarbi et al.2015) and institutional quality on the other hand (Sarmidi et al, 2012, Ndjokou and Tsopmo, 2017), as conditioning variables. Unlike these previous studies, this study contributes to empirical knowledge of the curse by focusing on African countries that are well endowed in natural resources and where there is contradicting empirical evidence on the curse in the literature. Moreover, it used a consistent threshold estimation procedure and a large sample for a comparative purpose with the previous funding,

The rest of the paper is organized as a continuation. Section 2 presents a review of the academic literature on the relationship between natural resources, economic growth and institutions. The methodological approach and the variables used to conduct the study are described in section 3. Section 4 presents the results of the estimates. The study ends with a conclusion that highlights the main findings and implications for economic policies.

2. Natural resources and growth: review on the role of institutions

There is abundant literature on the causes of the resource curse. Fleming et al., (2015) identified several factors including (i) exchange rate appreciation, (ii) price volatility, (iii) poor quality of institutions, (iv) authoritarian political systems, (v) corruption; (vi) expectations and negativity of adjusted net savings; (vii) temporary loss of learning effects;

(viii) pensioner behavior; and (ix) unsustainable policies. In this review, the factors on which the analysis will focus are corruption, authoritarian political systems and, in general, the quality of institutions.

The literature has identified the quality of institutions as a major determinant of the resource curse. Analyzes of the relationship between institutions and growth are rooted in the work of Mehlum et al. (2006) and Robinson et al. (2006).These effects can be seen in the analyzes of the role that institutions play in countries rich in natural resources(see figure 1). So, two types of natural resources effect on growth can be described as direct and indirect effect.

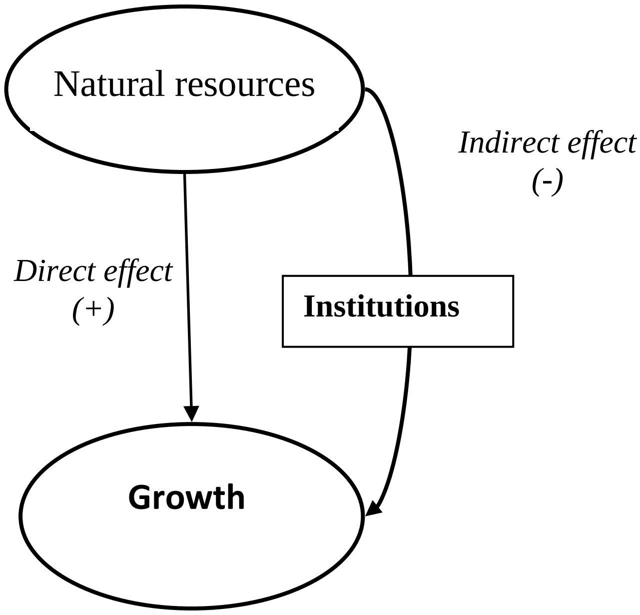

Figure 1: effects of natural resources on growth

Source: authors

The direct effect is one that is analyzed in ordinary growth models. In general, good governance and strong institutions are generally considered as determinants of growth (North, 1990, La Porta et al, 1999). These factors are commonly cited to explain the paradox of underdevelopment in resource-rich countries. In fact, low-quality institutions are associated with low investment, reliable productivity growth, low per capita income, and generally low growth rates (Jude and Levieuge, 2016).

The indirect effect results from the induced effect of the existence of a natural rent on the quality of the institutions. The presence of natural resources reduces the incentives for public and private agents to accumulate human capital because they consider natural capital to be their main source of wealth (Gylfason, 2001). Similarly, individuals at the head of institutions would be tempted to appropriate this rent for themselves or for an elite, instead of investing it in policies for growth (Sachs and Warner, 2001).

Moreover, Auty (2000) emphasizes that there is a link between authoritarian system and natural resources. Yet, under autocratic rule, policies are dictated by the desire to extract money from companies rather than from welfare considerations (Bulte and Damania, 2008). They explain that when there is a resource boom, the value of government support to the resource sector increases, and with it the incentive to bribe the rulers in place. Finally, the abundance of resources reinforces corruption in the presence of weakly democratic institutions (Bhattacharyya and Hodler, 2008) and rent seeking behavior (Lam and Wantchekon, 2003). In some countries, resources increase the power of elites who use a large portion of this rent for their circles rather than for investment purposes to support growth (Deacon and Rode, 2012).

Several studies have confirmed empirically the existence of the curse hypothesis (Sachs and Warner 1995, Leite and Weidmann 1999, Gylfason 2001). However, the resource curse seems to be a statistical mirage (James, 2015) depending on the indicator used. Therefore, the validity of the curse is obviously controversial: 40% of the studies confirmed the curse, 40% found no effect and 20% found a positive relationship (Havranek et al, 2016). Among the studies that confirmed the curse hypothesis, the quality of institutions is one of the causes

(Mehlum et al, 2006, Belarbi et al., 2015). Indeed, the relationship between rent and growth depends on the quality of democratic institutions (Bhattacharyya & Hodler, 2010). Leite and Weidmann (1999) found that the export of natural resources (as a percentage of gross national product) tends to increase corruption, which ultimately reduces growth. In the same context, Stevens and Dietsche (2008) indicated that the quality of institutions partly explains the impact of natural resources on growth and development. In the absence of good institutions, resource revenues are monopolized by political elites (Avom and Carmignani, 2010).

Most previous studies on the curse have considered the relationship between economic growth and the quality of institutions on the one hand and between growth and the abundance of resources on the other hand, as linear and monotonous. Nonlinear relationships are more and more tested. Recent studies show non-linear relationships between resource dependence and economic growth (Seghir and Damette 2013, Belarbi et al.2015). A resource dependency level of more than 69.8% leads to the curse. Moreover, other authors have found that this curse is linked to the level of the quality of the institutions (Sarmidi et al, 2012, Ndjokou and Tsopmo, 2017). The relationship between growth and resources is positive for countries with high quality institutions and negative for those with low quality institutions (Ndjokou and Tsopmo, 2017). This study extends and reinforces this growing literature.

3. Methodology and descriptive statistics

The arguments in the previous section show that the impact of natural resource rent could depend on the quality of the institutional environment. In this case, if the effect of natural resources is not linear, the appropriate econometric model is the threshold effect model. With regard to the aim of this study, the model used is the smooth transition threshold model (PSTR) of González et al. (2005) which is an extension of the models with sharp-transition thresholds (PTR) proposed by Hansen (1999). Thus, unlike the PTR, the PSTR model makes it possible to obtain the marginal impact of natural resources on economic growth according to the level of institutional quality for each country and each year. It is therefore focuses on individual and temporal heterogeneous effects. In addition, it avoids using a dummy variable to characterize membership in one scheme or the other, so that the linearity test eludes Hansen's (1999) criticism that the test of equality between the coefficients associated with the two regimes has a nuisance problem. As such, the use of such a model is important as countries rich in natural resources do not have the same level of institutional quality. Considering PSTR modeling, the model to be estimated is as follows:

$$growth_{it} = a_i + \theta_1 RN_{it} + \theta_2 RN_{it} g(QI_{it}; \gamma, c) + \beta' Z_{it} + \varepsilon_{it} \qquad (1)$$

With $growth$ the real growth rate per capita, a_i, the individual effect, RN the indicator of resources dependence, QI_{it} the level of institutional quality, representing the transition variable. $g(.)$ is the transition function, Z a set of control variables, θ_i the parameters and β' a vector of parameters to be estimated. γ *and* c are respectively the slope of the transition function (or smoothing parameter) and the threshold effect.

The logistic-form of transition function is the one generally used (Gonzalez et al., 2005) and is expressed as follows:

$$g(QI_{it}; \gamma, c) = \left\{1 + exp\left(-\gamma \prod_{j=1}^{m} (QI_{it} - c_j)\right)\right\}^{-1} \qquad (2)$$

With $\gamma > 0$ and $c_{1<\ldots\ldots<c_m}$ and m the threshold number of the transition function The PSTR model can be considered as a model in which there are two extreme regimes between which there would be a continuum of regimes. Indeed, the definition of the transition function imposes that $0 < g(QI_{it}; \gamma, c) < 1$. Thus, when the function $g(.)$ tends to 0, the coefficient θ_1 gives the impact of RN on growth. On the other hand, if $g(.)$tends to 1, then the impact of RN on growth is given by $\theta_1 + \theta_2$

In PSTR modeling, Gonzalez et al. (2005) have proposed three stages. The first is to perform the linearity test on the assumption that $\gamma = 0\ ou \theta_2 = 0$. Under this assumption, the threshold effect is null and the PSTR model is not applicable. However, considering the effects of nuisances under the null hypothesis (Davis, 1987), the transition function g (.) is generally replaced by its Taylor development of order 1 in the neighborhood of $\gamma = 0$. As a result, the model becomes:

$$growth_{it} = a + \delta_1 RN_{it} + \delta_2 RN_{it} QI_{it} + \beta' Z_{it} + \mu_{it} \qquad (3)$$

In equation (3), the model becomes identifiable and δ_2 is proportional to γ. The low gamma value is consistent with a smooth transition between the regimes. Moreover, the model is non-linear only if $\delta_2$is statistically different from 0. The Lagrange Multiplier (LM) and its Fisher version (LMF) are the statistics used to verify beforehand this hypothesis of non-linearity between economic growth and a country's dependence on natural resources. The second step is to determine the threshold number of the transition function (m) whose value is the one that minimizes the AIC and BIC information criteria (Colletaz et al, 2006). In practice, m = 1 or m = 2 is largely sufficient to account for the variation of the parameters to be estimated (Gonzalez et al, 2005). The last step is to estimate the model by the non-linear least squares method.

The estimate of the relationship between economic growth and dependence on natural resources is based on a sample of 81 countries over the period 1985-2014. In addition, to analyze the specificities of African countries, a sub-sample of 19 countries was also considered in the analysis. The impact of dependence on growth is analyzed through the quality of institutions, which is the transition variable. Several proxies are generally used to measure the quality of institutions. The most common indicators in the curse literature are internal and external conflict, investment profile, bureaucratic quality, democracy, and political risk. High values of these indicators indicate a better quality of institutions. Data on these indicators come from the database of the ICRG (2015). In addition, the resource dependence indicator is measured by the total natural resource rent relative to GDP, obtained from the World Bank database. Finally, data on growth and control variables including initial GDP, trade openness, inflation, domestic investment, growth rate of total population, foreign direct investment rate (FDI) and the private sector credit rate were also extracted from the World Bank database (2015), and the human capital index comes from Penn World Table 8.0. The descriptive statistics of all these variables are reported in Tables 1 and 2.

Table 1. Descriptive statistics (Total sample)

Variables	Obs	Mean	Std, Dev	Min	Max
GDP growth per capita	486	1.741	2.592	-9.177	10.884
Resources dependence	486	7.381	9.929	0.0005	56.197
Human capital	486	2.439	0.566	1.117	3.619
Trade openness	486	70.745	35.39	10.3015	206.879
Inflation	486	103.07	197.107	1E-05	3099.398
domestic investment	486	23.273	8.09	1.550	50.369
Population growth rate	486	1.623	1.406	-1.826	15.526
Initial income	486	8.795	1.561	4.957	12.781
Foreign direct investment	486	3.099	4.265	-3.207	40.409
Private credit	486	53.111	49.4	2.073	397.065
Government stability	486	7.712	1.726	2.567	11.625
Corruption	486	3.149	1.326	0	6
Rule of law	486	3.784	1.443	0.767	6
Investment profile	486	7.75	2.346	1.15	12

Source: authors

It clearly shows a very low level of dependence in the total sample (7.3% of GDP) compared to that of African countries (11.1%). On the other hand, the level of institutional quality is relatively low in African countries compared to that of the total sample countries, whatever the indicator of institutional quality considered.

Table 2. Descriptive statistics (African countries sample)

Variables	Obs	Mean	Std. Dev.	Min	Max
GDP growth per capita	114	1.276	2.775	-8.236	8.472
Resources dependence	114	11.157	10.610	0.0005	51.091
Human capital	114	1.854	0.436	1.117	2.846
Trade openness	114	61.518	25.542	10.301	119.124
Inflation	114	93.507	112.456	0.064	989.994
domestic investment	114	19.968	10.651	1.549	50.369
Population growth rate	114	2.556	0.748	0.326	5.497
Initial income	114	7.068	1.005	4.956	9.337
Foreign direct investment	114	2.7606	4.020	-2.563	29.698
Private credit	114	23.181	26.411	2.073	148.31
Government stability	114	7.622	1.881	2.566	10.991
Corruption	114	2.406	0.934	0.0000	5.466
Rule of law	114	2.850	0.904	0.958	5.986
Investment profile	114	6.678	1.884	1.15	11.322

Source: authors

4. Results and discussion

The results of the linearity tests are shown in Table 3.This test confirms the existence of a non-linear relationship between resource dependence and economic growth. Indeed, the null hypothesis of non-linearity is confirmed for variables such as the rule of law, government stability and corruption. Non-linearity is not confirmed for other institutional quality variables (internal and external conflict, investment profile, bureaucratic quality, democracy and political risk). Moreover, this non-linearity is validated by considering m = 1, by default. This is also confirmed by analyzing the AIC and BIC information criteria (see Table 2). In other words, m = 1 is the value that minimizes these criteria. Thus, there is only one transition function and one threshold for all institutional quality variables.

Table 3: linearity test (homogeneity test)

Variables de transition	**Total sample**		**Africans countries sample**	
	LM Test	F Test	LM Test	F Test
Government stability	15.424***	13.237***	4.170**	1.765**
Rule of law	0.250*	0.208*	20.131***	20.159***
Corruption	7.666***	6.472**	17.415***	8.384***
Investment profile	13.901***	5.931***	2.406	2.027

Source: authors. Note: values in table are t-statistics. *** p<0.01, ** p<0.05, * p<0.1

The validity of the linearity test indicates the relevance of the use of the PSTR model. For the estimates, the program GTVD.SRC executable under RATS was used. The results of this model estimates for both samples are given in Table 4.

Considering the results of the total sample, it appears that resource dependence does not lead to the curse of natural resources. This result reinforces those already existing (Manzano and Rigobon, 2006, Ouoba, 2016). However, the effects vary depending on the institutional quality and the indicator used. Indeed, the results obtained confirm that the resource curse, a priori, is not linked to a country's dependence on resources, but rather to the quality of institutions. In particular, for a low level of government stability (<3.7), the impact of dependence on growth is high. The same is true for low levels of the rule of law (<5.2), corruption (<3.5) and investment profile (<3.7). These seemingly counterintuitive results can be explained by the fact that most of the countries in the sample are relatively reliant on resources (on average 7.3% of GDP) and whose institutions are relatively of good quality. Indeed, considering dependence as a transition variable, the results confirm the positive effect of the quality of institutions on growth (see Table 2A in the appendix). The joint effect of institutional quality with dependence is negative implying that the effect of institutions on growth becomes negative if resource dependence increases. Thus, a high dependence on resources eliminates the positive effect of institutions on growth. This result is only valid with government stability and the investment profile whose dependence threshold is 5.5 and 5.4

respectively. In general, the curse is less severe in countries with good qualities (Boschini et al., 2007, Mehlum et al., 2006, Arezki and Van der Ploeg, 2010) .The thresholds found do not necessarily reflect the situation of developing countries. Given this high variability in the quality of the institutions and the degree of dependence of the countries in the total sample, it seemed necessary to conduct the analysis for the specific case of African countries, which are often perceived as being more dependent on resources (on average 11.1% of GDP) and whose institutional quality is relatively low.

In the case of African countries, dependence has a negative and significant effect on growth. This result indicates that these countries are victims of the curse of natural resources. These results are in line with those already found by other authors (Ndjokou and Tsopmo, 2017). However, the curse hypothesis no longer exists from a certain level of government stability (index> 5.59) and level of corruption (index> 1.3). In other words, dependence on natural resources becomes a source of "blessing" with high governmental stability and weak corruption. Indeed, a context of government stability and low corruption is a favorable business climate, which allows the country to take advantage of the natural rent and to start sustainable growth. This result is consistent with most previous studies on Africa that confirmed the importance of institutions in growth (Omgba, 2010, Seghir and Damette, 2013, Ndjokou and Tsopmo, 2017). Moreover, the level of corruption threshold observed (index = 1.3) reflects the high level of corruption in African countries. This can be explained by the fact that a high level of corruption can be the result of an abundance of resources generally observed in these countries. Indeed, it is recognized that the abundance of resources leads to institutional failures (James, 2015).

Finally, a comparative analysis of the results of the two samples reveals some differences. These differences lie in the quality of institutions. For African countries, which generally have poor quality institutions, improving them can take advantage of their dependence on resources. This is not the case for the countries in the total sample. Indeed, the results indicate a positive impact of the institutions on growth and confirm that the resource curse in this case, would be linked mainly to the level of dependence and not to the institutions (see Table A2 in the appendix). These results nevertheless show the need for a robustness analysis to confirm the validity of such analyses.

Table 4: PSTR estimation between resources dependence and growth (transition function: Institutional quality)

Variables de transition :	Total sample				Africans countries sample	
	Government stability (1)	Rule of law (2)	Corruption (3)	Investment profile (4)	Government stability (5)	Corruption (6)
θ_1: Dependance	**0.280*** **	**0.194*** **	**0.284*** **	**0.2808*** **	**-0.0574* **	**-0.575*** **
	(0.050)	(0.029)	(0.051)	(0.050)	(0.068)	(0.154)
θ_2: $dependance \times g(.)$	**-0.286*** **	**-0.100*** **	**-0.283*** **	**-0.286*** **	**1.927** **	**0.633*** **
	(0.106)	(0.033)	(0.105)	(0.106)	(0.917)	(0.146)
Threshold effect, (c)	**3.726*** **	**5.255*** **	**3.548*** **	**3.726*** **	**5.594*** **	**1.328*** **
	(0,799)	(0.0083)	(0.000)	(0.8149)	(1.853)	(0.008)
Slope of g(.), γ	**0.4267*** **	**420.080*** **	**0.428*** **	**0.426*** **	**1.488*** **	**16.14**
	(0.124)	(31.366)	(0.135)	(0.123)	(0.581)	(28.236)
Controlled variables						
Human capital	**1.821** **	**1.806** **	**1.811** **	1.821	0.917	1.650
	(0.764)	(0.762)	(0.764)	(0.764)	(1.702)	(1.597)
Trade openness	0.0024	0.003	0.002	0.002	0.006	0.016
	(0.0072)	(0.007)	(0.007)	(0.007)	(0.017)	(0.016)
Inflation	-0.0002	-0.0001	-0.0002	**-0.0002**	**0.006** **	**0.005* **
	(0.0006)	(0.0006)	(0.0006)	(0.0006)	(0.002)	(0.002)
Domestic investment	**0.094*** **	**0.092*** **	**0.094*** **	**0.094**	0.044	**0.036**
	(0.023)	(0.0234)	(0.023)	(0.023)	(0.054)	(0.051)
Population growth rate	-0.006	-0.183	-0.011	-0.006	0.622	-0.612
	(0.181)	(0.136)	(0.179)	(0.181)	(0.514)	(0.410)
Initial income	**-1.546** **	**-1.532** **	**-1.543** **	**-1.546** **	**-3.068** **	**-4.032*** **
	(0.638)	(0.637)	(0.638)	(0.638)	(1.451)	(1.388)
Foreign direct investment	**0.077*** **	0.071**	**0.077*** **	**0.077*** **	**0.139** **	**0.1275* **
	(0.029)	(0.029)	(0.029)	(0.029)	(0.069)	(0.065)
Private credit	**-0.013*** **	**-0.013*** **	**-0.013*** **	-0.013	-0.006	-0.0031
	(0.0037)	(0.003)	(0.0037)	(0.0037)	(0.026)	(0.024)
AIC Criterion	1.38808	1.385	1.38809	1.38808	1.56383	1.44055
BIC Criterion	1.49160	1.488	1.49162	1.49160	1.85185	1.72857
Number of obs.	485	485	485	485	114	114

Source: authors. Note: standards errors are in parenthesis *** p<0.01, ** p<0.05, * p<0.1

With respect to control variables, most significant coefficients have the expected signs. Human capital, domestic investment (investment) and foreign investment (FDI) contribute significantly to economic growth. These results are in line with those of previous work (Hansen and Rand, 2006, Herzer et al, 2008). However, the effect of the first type of investment is greater than the second. This result is at odds with the new growth theory which states that foreign investment is more productive than domestic investment (Tekin, 2012).

One possible explanation for this result is that foreign direct investment in natural resources does not always have the effects of expected trainings. The theory of economic enclaves indicates that these FDI do not sufficiently stimulate local demand to the point of contributing significantly to growth. In addition, the results show that the initial income plays negatively and significantly on growth both in the total sample and in the case of African countries. These results confirm the conditional convergence of Solow. Finally, bank credit to the private sector, expressing the level of financial development (King and Levine, 1993), is negatively related to growth. This result can be explained by the fact that financial development is often accompanied by financial instability that can be detrimental to growth (Jeanneney and Kpodar, 2005). This effect is not significant in the case of African countries justifying the low level of private sector development in these countries.

In order to test the robustness of the results of the PSTR method, we estimate a PTR model of Hansen (1999) as an alternative method. So, we derive the PTR analysis on the estimate of the following equation:

$$growth_i = \mu_i + \theta_1' RN_i I(q_i \leq \gamma) + \theta_2' R_i I(q_i > \gamma) + \beta' Z_{it} + \varepsilon_{it} \qquad (4)$$

Where $I(.)$ is the indicator function that takes the value 1 if the constraint in parentheses is respected and 0 otherwise. $q_i = q(x_i)$ is the threshold variable whose structural equation can be defined as follow:

$$growth_i = \mu_i + \theta_1' RN_i + \beta' Z_{it} + \varepsilon_{it}, \qquad q_i \leq \gamma \qquad (5)$$

$$growth_i = \mu_i + \theta_2' RNI_i + \beta' Z_{it} + \varepsilon_{it} \, , \qquad q_i > \gamma \qquad (6)$$

The threshold parameter $\gamma \in \Gamma$ where Γ is a strict subset of the transition variable q_i assumed unknown and must be estimated. ε_{it} is error term, θ_1' and θ_2' are marginal effect of natural resources and would vary depending on the value of q_i. The null hypothesis of linearity ($H_o: \theta_1' = \theta_2'$) is tested against the alternative hypothesis of a brutal transition model with threshold effect ($H_1: \theta_1' \neq \theta_1'$). Hassen (1999) recommended retaining as optimum estimator of the threshold parameter γ, that minimizes the sum of the squares of the residues.

$$\hat{\gamma} = argmin_{\gamma} S_1(\gamma) \qquad (7)$$

where $S_1(\gamma) = \hat{\varepsilon}(\gamma)'\hat{\varepsilon}(\gamma)$ is the sum of the squares of the residues of the threshold variable under null hypothesis and $\hat{\varepsilon}(\gamma)$ are the estimators of the residues. To test the significance of the threshold level, Hansen (1999) proposed to use Fisher's likelihood statistic defined by:

$$F_1 = \frac{S_0 - S_1(\hat{\gamma})}{\hat{\sigma}^2} \qquad (8)$$

Where S_0 is the sum of the residual squares of the linear model under H_o ; $S_1(\hat{\gamma})$ the sum of the squares of the residuals of the threshold model; $\hat{\sigma}^2$is the variance of the residuals with no change of regime $\hat{\sigma}^2 = \frac{1}{n(T-1)} S_1(\hat{\gamma})$). The distribution of the F_1 statistic is obtained from a classical bootstrap not parametric which allows to derive a distribution of the statistic and the p-value of F_1 under H_o .The rule of decision is as follows: if the p-value of F_1 is smaller than the critical value retained (1%, 5% or 10%) %), then, we reject the null hypothesis of linearity. When the threshold effect is proved and the number of regimes is determined, Hansen (1999) showed that the thresholds obtained $\hat{\gamma}$ have convergent estimators of true values and that the asymptotic distribution of these values is nonstandard. Furthermore, Hansen (1999) suggested constructing a confidence interval on the basis of the maximum likelihood ratio calculated for all $\hat{\gamma}$ in order to establish a "non-rejection" interval of the significance of the threshold. As a result, it determines the likelihood ratio:

$$LR_1(\gamma) = \frac{S_1(\gamma) - S_1(\hat{\gamma})}{\hat{\sigma}^2} \tag{9}$$

It is important to note that if $\gamma = \hat{\gamma}$ then $LR_1(\hat{\gamma}) = 0$ and it implies that 〖$LR_1(\gamma)$ is different from F_1. Hansen (1999) showed that the statistic $LR_1(\gamma)$ tends to the random variable ξ whose distribution function is defined by $P(\xi \leq x) = \left(1 - \exp\left(-\frac{x}{2}\right)\right)^2$.The inversion of this distribution makes it possible to derive the expression $c(\alpha) = -2\log\left(1 - \sqrt{1-\alpha}\right)$ necessary for the determination of the confidence interval. The latter corresponds, for a risk threshold of α% to the values of $\hat{\gamma}$ for which $LR_1(\gamma) \leq c(\alpha)$.

The estimation results of the PTR model are reported in Table 5 below. Thus, the results confirm the existence of an intentional quality threshold in the total sample of countries (*columns 1 and 2*) and in the sample of African countries (*columns 4 and 6*). The results are globally identical to those found with the PSTR model especially in the case of African countries. Indeed, we note that the curse hypothesis is well verified in the case of African countries when government stability is low (≤4.416) and corruption is high (≤0.7333). On the other hand, when the quality of institutions becomes high, the abundance of natural resources becomes a blessing for African countries. Thus, the PTR results confirm the robustness of those obtained with PSTR (see table 4). Moreover, the signs of the control variables remain globally identical to those of the PSTR that reinforce the robustness of the results. Finally, the marginal effect of natural resources on growth depends on the quality of the institutions, especially in countries with low institutional quality, as in the case of African countries.

Table 5. PTR estimation between resources dependence and growth (transition function: Institutional quality)

	Total sample			African countries sample		
Transition variables :	Government stability (1)	Investment Profile (2)	Corruption (3)	Government stability (4)	Investment Profile (5)	Corruption (6)
Threshold: $\hat{\gamma}$	**4.0167**	**6.225**	**6.0000**	**4.416**	**1.150**	**0.7333**
Confidence interval: $C.I$	**[3.775, 5.141]**	**[5.9333,6.2333]**	**-**	**[4.166, 0.516]**	**-**	**[0.0208, 0.7417]**
θ_1: Dependence ($q_{it} \ll \hat{\gamma}$)	**-0.4680*** **	**0.08198** **	**0.1492*** **	**-0.2938* **	**-0.47184** **	**-0.749132*** **
	(0.1399)	**(0.037295)**	**(0.03029)**	**(0.157)**	**(0.18361)**	**(0.16651)**
θ_1: Dependence ($q_{it} > \hat{\gamma}$)	**0.1497*** **	**0.14507*** **	**-**	-0.0013	0.019977	-0.00910
	(0.02958)	**(0.03002°**		(0.0723)	(0.0716)	(0.06519)
Controlled variables						
Human capital	**1.3699* **	**1.52657* **	**1.8489** **	1.616	2.7487	1.7763
	(0.78619)	(0.79683)	(0.79782)	(1.871)	(1.8205)	(1.6688)
Trade openness	0.00434	0.005691	0.0068	-0.00545	0.002057	0.01858
	(0.00729)	(0.00738)	(0.007455)	(0.0187)	(0.017941)	(0.01683)
Inflation	-0.00026	-0.00020	-0.007455	**0.0059* **	**0.005890* **	**0.01504*** **
	(0.00063)	(0.00064)	(0.00064	(0.00301)	(0.00295)	(0.00329)
Domestic investment	**0.1777*** **	**0.19299*** **	**0.19050*** **	**0.1522*** **	**0.14332*** **	**0.11437** **
	(0.02811)	(0.028372)	(0.02865)	(0.0549)	(0.05410)	(0.05027)
Population growth rate	**-0.421297*** **	**-0.49200*** **	**-0.465302*** **	0.3346	0.41068	0.22676
	(0.1252)	(0.12685)	(0.12784)	(0.61704)	(0.59945)	(0.55355)
Initial income	**-1.67966** **	**-2.07393** **	**-2.08693*** **	**-3.4120** **	**-4.33605*** **	**-5.0619*** **
	(0.66870)	(0.67170)	(0.67860)	(1.549)	(1.5255)	(1.4157)
Foreign direct investment	**0.066962** **	**0.06344** **	**0.071516** **	**0.1799* **	0.16854	0.065529
	(0.03029)	(0.03081)	(0.03101)	(0.1035)	(0.10139)	(0.0957)
Private credit	**-0.013377*** **	**-0.012919*** **	**-0.01296*** **	-0.01041	-0.0155	-0.0058
	(0.003926)	(0.003979)	(0.00402)	(0.02456)	(0.024038)	(0.02217)
Constant	9.1968*	12.0965**	11.14573**	18.927*	22.9374***	29.7485***
	(4.91833)	(4.9765)	(5.0177)	(10.73)	(10.6236)	(9.9346)
RSS	1657.384	1703.2382	-	339.2354	326.3636	276.1827
Number of obs.	486	486	486	108	108	108
Number of countries	81	81	81	18	18	18

Source: authors . Notes: Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1 . Number of Bootstrap replications 300. The confidence interval for the threshold parameters corresponds to the no rejection region of confidence level 95% associated to the likelihood ratio statistic for test on the values of the threshold parameters (see Hansen, 1999).

5. Conclusion and policy recommendations

The objective of this study is to analyze the impact of natural resources on economic growth conditioning of the quality of institutions. The analysis of the relationship between economic growth and dependence on natural resources covered a sample of 19 African countries over the period 1985-2014. In addition, for comparison purpose with the previous findings, a large sample of 81 countries worldwide is used.

Using PSTR model, the results confirm the existence of a non-linear relationship between natural resource dependence and economic growth in African countries sample as well as in the total sample. This non-linear relationship depends on the rule of law, political stability and corruption. Thus, the results indicate that the direct effect of natural resources on economic growth is positive and significant for the total sample while it is negative for African countries. The curse hypothesis is thus confirmed for African countries but reversed for the total sample. Indeed, for the total sample (81countries) the marginal impact of natural resources on growth is positive for low quality of institutions and negative for high quality. On the other hand, for African countries, the hypothesis of the curse no longer exists beyond a certain level of political stability (index> 5.59) and corruption (index> 1.3). The robustness of these results is well confirmed, especially in African countries sample.

Overall, these findings provide a number of policy implications, particularly for African countries. First, African countries must reduce the dependence on natural resources by promoting the diversification of the structure of their economies. Second, the existence of a threshold level of institutional quality conditioning the effect of natural resources on economic growth recommends improving the quality of institutions to benefit from natural resources.

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Appendices

Table A1: linearity test

	Total sample			
	Government stability		**Investment profile**	
Transition variable	LM Test	F Test	LM Test	F Test
Dependence	28.529***	25.187***	22.894***	19.966***

Source: authors. Note: values in table are t-statistics. *** p<0.01, ** p<0.05, * p<0.1

Table A2. PSTR results (transition function : resources dependence)

	Total sample		
Variable de transition	Dependence (1)	**Transition variable**	Dependence (2)
θ_1: government stability	**0.537*****	θ_1: Investment profile	**0.237*****
	(0.093)		(0.067)
θ_2: government stability $\times$ g(.)	**-0.968****	θ_2: Investment profile $\times$ g(.)	**-0.402***
	(0.448)		(0.227)
Threshold effect, (c)	**5.557*****	Threshold effect, (c)	**5.4802*****
	(0.374)		(0.5378)
Slope of g(.), γ	**0.524*****	Slope of g(.), γ	**1.038*****
	(0.093)		(0.324)
controlled variables			
Human capital	**1.345**	Human capital	**1.851****
	(0.824)		(0.849)
Trade openness	-0.0029	Trade openness	-0.004
	(0.0072)		(0.007)
Inflation	0.0002	Inflation	**0.0002**
	(0.0006)		(0.0006)
Domestic investment	**0.0925*****	Domestic investment	**0.100*****
	(0.0238)		(0.023)
Population growth rate	0.268	Population growth rate	-0.0954
	(0.296)		(0.1921)
Initial income	**-1.479****	Initial income	**-1.978*****
	(0.644)		(0.668)
Foreign direct investment	**0.097*****	Foreign direct investment	**0.095*****
	(0.0289)		(0.029)
Private credit	**-0.0124*****	Private credit	-0.013***
	(0.0038)		(0.003)
AIC Criterion	1.39393	AIC Criterion	1.44363
BIC Criterion	1.49746	BIC Criterion	1.54716
Number of obs.	485	Number of obs.	485

Source: authors. Note: standard errors are in parenthesis *** p<0.01, ** p<0.05, * p<0.1. Because of the lack of convergence, the other transition variables are omitted in the two samples.