The Effects of Institutions and Natural Resources in Heterogeneous Growth Regimes

Yacine BELARBI[1]
Saïd SOUAM[2]
Lylia SAMI[3]

Abstract

For more than a decade, the dependence to natural resources is the object of a wide debate in the analysis of economic growth in rentier States. Up to now, there is no consensus about the way natural resources could impede or boost the economic development of such endowed countries. The same mitigated results are found concerning the interaction between the institutions and growth. In this paper, we examine the combined interaction effects of oil resources dependence and the quality of institutions on economic growth by using a panel threshold regression methodology. We show that the effect of oil resource dependence on economic growth becomes positive when the quality of institutions improves. Moreover and contrary to many precedent results in the literature, it appears that an increase in oil dependence wipes out the positive effect of institutional quality on growth. Indeed, a positive variation of the quality of institutions does not necessarily lead to a positive variation in economic growth.

JEL Classification: O4, Q0, P16, C21.

Keywords: Natural resources, quality of institutions, growth, threshold regression.

[1] Centre de Recherche en Economie Appliquée pour le Développement – CREAD (Algiers).
[2] Université Paris Ouest Nanterre La Défense, EconomiX and CREST.
[3] Ecole préparatoire d'économie DRARIA (Algiers) and CREAD.

1. Introduction

Oil dependent countries are characterized by an important heterogeneity in their economic performance. The quality of the institutions is considered as an important explanation of the observed growth disparities. Natural resources dependence stimulates rent-seeking behaviors and can lead to contraction of the non-resources production activities. Moreover, it induces corruption (Mauro, 1995 ; Leite and Weidman, 1999), voracity effect (Lane and Tornell, 1999) and may lead to civil conflicts (Collier and Hoeffler, 2005 ; Fearon and Latin, 2003). A boom in natural resources windfalls exacerbates social pressures for more redistribution and increases public spending towards less productive sectors (Arezki and Gylfason, 2013). This financial resources misallocation decreases capital productivity and slows down economic growth tendency.

There is no consensus in the empirical literature dealing with the link between natural resources, quality of institutions and economic growth. This literature can be roughly classified in three categories.

In the first category, natural resources have a negative effect on growth when they are associated with weak institutions. This relation has been empirically documented in Leite and Weidman (1999), Acemoglu et al. (2001, 2002), Ross (2001), Isham et al. (2003), Sala-i-Martin and Subramanian (2013), Bulte et al. (2005), Rodrik et al. (2004) and Collier and Hoeffler (2005).

The second category found that natural resources interact with the quality of institutions. The combined effect of these two factors on growth will depend of the nature of their combination. The most important contributions are Mehlum et al. (2006a, b), Boschini et al. (2007), Arezki and Van der Ploeg (2011) and Gylfason (2011).

The last category considers that the observed heterogeneity in economic growth between rentier states is not explained by institutions. Sachs and Warner (1999) found that the indirect effect of natural resources on growth (through institutions) is weak. In Brunnschweiler (2008) or Brunnschweiler and Bulte (2008), resource abundance positively affects growth and institutional quality. According to Alexeev and Conrad (2009), the institutions are neutral and the negative effect of natural resource endowments on institutions is mainly due to a misinterpretation of the data available.

The above mentioned literature generally uses linear specifications to deal with the relationship between natural resources, economic growth and the quality of institutions. However, Leite and Weidman (1999) and Sala-i-Martin and Subramanian (2013) show that the econometric specification measuring the effect of natural resources and the quality of institutions on growth are not linear, and that these effects are different depending on the impact of the interaction levels between these two variables.

Going through the last result, we propose to use a nonlinear specification which takes into account the indirect and interaction effects. For that purpose, we use a panel threshold regression model (Hansen, 1999 and Gonzalez et al., 2005). We first show that the effect of oil resource dependence on economic growth becomes positive, as the quality of institutions improves. Secondly, it appears that an increase in oil dependence wipes out the positive effect of institutional quality on growth. Indeed, a positive variation of the institution quality does not necessarily lead to a positive variation in economic growth.

The remainder of this paper is organized as follows. Section 2 discusses our specification techniques using panel thresholds regression. Section 3 presents the data and provides some descriptive statistics. Section 4 provides some specification tests and the estimates obtained with threshold effects. Section 5 concludes.

2. Panel smooth transition regression model (PSTR)

Thresholds models are econometric instruments used to analyze nonlinear economic phenomena. Among these models, depending on the transitional function form between different regimes, we can consider the Panel Threshold Regression model (PTR) developed by Hansen (1999), or the Panel Smooth Threshold Regression model (PSTR) developed by Gonzalez et al. (2005). In this paper, we do consider the PSTR models as more appropriate to describe the heterogeneity in rentier States' economic performance.

Let us consider the processus $\left(y_{it},\ i \in \mathbb{Z}\ and\ t \in \mathbb{Z}\right)$. It satisfies a PSTR representation if and only if:

$$y_{it} = \mu_i + \beta_0' x_{it} + \sum_{j=1}^{r} \beta_1' x_{it} g_j\left(q_{it}^{(j)}; \gamma_j, c^{(j)}\right)$$

where μ_i is an individual effect, ${q^{(j)}}_{it}$ a threshold variable, $\gamma_j > 0$ a smoothing parameter, $c^{(j)}$ a threshold, r is the number of threshold functions and m is the number of thresholds.

$i = 1, \dots, N; t = 1, \dots, T; k = 1, \dots, m; j = 1, \dots, r.$

$X_{it} = (X_{1it}, X_{2it} \dots X_{kit})$ is the matrix of k exogenous explanatory variables, $\beta = (\beta_1, \beta_2, ..., \beta_k)$ are the parameters to be estimated and u_{it} are iid (0, δ_u^2). $g_j\left(q_{it}^{(j)}; \gamma_j, c^{(j)}\right)$ is an integrable transition function on $[0, 1]$.

Gonzalez et al. (2005) proposed to retain for the transition function a logistic form of order m as follows:

$$g_j\left(q_{it}^{(j)}; \gamma_j, c^{(j)}\right) = \left[1 + exp\left(-\gamma_j \prod_{k=1}^{m} \left(q_{it}^{(j)} - c_k^{(j)}\right)\right)\right]^{-1}.$$

The choice of transition variables depends on the studied economic phenomenon, and therefore the statistically significance to account for structural breaks in the model. In our case, we test the two variables "institutional quality" and "resource dependence" as threshold variables. Our choice is justified by the fundamental character of these two variables in understanding the economic oil dependence for the rentier States.

A PSTR model can be estimated in three steps. In the first one, we test the linearity of the model $(H_0: r = 0)$ against a model with transition function $(H_1: r = 1)$. If the linear model is rejected, we test in the second step the number of transition functions to admit $(H_0: r = i \ versus \ H_1: r = i + 1)$ with $(i = 1, \dots, r)$. We also determine the number of thresholds (m) allowed in the transition variable (q_{it}) such as $c_{j,min} > min_{i,t}\{q_{it}\}$ and $c_{j,max} < max_{i,t}\{q_{it}\}, j = 1, \dots, m$. Colletaz and Hurlin (2006) propose to retain the value of m that minimizes the sum of squared residuals (SSR), the Akaike information criterion (AIC) or the Bayesian information criterion (BIC). However, Gonzalez et al. (2005) consider that in practice $m = 1 \ or \ m = 2$ are usually sufficient, since these values are used to capture the variations in the parameters to be estimated. Finally, in the third step we estimate the PSTR model parameters using the method of nonlinear least squares (NLS).

3. Data and descriptive statistics

We consider a panel of 23 oil countries between 1996 and 2009. To control for dependence on natural resources and quality of institution effects, we introduce respectively the variables “share of oil exports in total exports” and “rule of law”. The interaction effect is analyzed by using these variables as explanatory and transition variables in the same time. We add to our econometric specification some other growth determinants variables, such as inflation, investment, trade openness and the growth rate of the population. All these variables are taken from the World Development Indicators database (WDI, 2011) and the World Government based indicators (WGI, 2011).

The used variables are described in Table 1.

Table 1: description of variables

Variables	
GDPG	Growth rate of GDP (constant 2000 U.S. $).
QINST	Rule of law: governance indicator developed by the World Bank, includes several indicators that measure the confidence and respect of the laws and rules of society. Its value varies between -2.5 and 2 .5, a high value indicates a favorable institutional environment and vice versa.
DEP	Dependence on natural resources is represented by the variable oil exports share as a percentage of total exports.
VAPM	the weight of the industry as the value added share of manufactured products as a percentage of GDP
INFL	Macroeconomic stability as measured by the inflation rate
OUVT	Trade openness as the value of (exports of goods and services + the value of imports of goods and services / GDP) (in percent). The higher it is, the more the economy of this country is considered open.
INVEST	Investment as gross fixed capital formation (GFCF) share on GDP.
POPG	Population growth as the annual rate of population growth.

The estimation strategy allows us to evaluate the co-variation of GDP growth or the share of manufacture value added on GDP to some exogenous variables, taking into account the structural heterogeneity introduced by the transition variable. The model with dependent variable as "share of manufacturing in GDP" will reflect the oil dependence and institution effects on the industrial sector development.

Table 2: descriptive statistics (1996-2009)

	MEAN		**MAX**		**MIN**		**ST. DEV**	
	1996	**2009**	**1996**	**2009**	**1996**	**2009**	**1996**	**2009**
GDPG	4,61	1,67	12,35	8,64	-0,20	-4,60	2,84	3,21
QINST	-0,05	-0,09	1,93	1,90	-1,44	-1,24	0,96	1,03
DEP	57,55	61,97	96,71	97,70	10,59	15,00	31,42	27,91
INFL	13,62	5,36	99,88	28,59	0,50	-4,86	21,24	6,45
INVEST	21,59	23,37	41,31	39,35	13,58	11,23	6,93	7,16
OPEN	0,67	0,71	1,21	1,47	0,25	0,34	0,24	0,26
POP	2,21	2,16	4,98	9,56	0,48	1,06	0,92	1,69
VAPM	13,25	11,72	25,62	27,19	3,21	1,13	6,21	5,78

Source: constructed using data from the World Bank.

Tables 1 and 2 describe all the variables used in our empirical work and some statistical trends analysis. The analyzed countries are listed in Appendix 1.

4. Econometric results

4.1. Specification tests

The results of the linearity tests of the estimated models (see Table 3) show that the null hypothesis of linearity of the model $(H_0: r = 0 \; vs \; H_1: r = 1)$ is rejected at 1% for all specified models.

Table 3: LM tests of residual non-linearity

	Model (1)		Model (2)	
Endogenous Variable	GDPG		GDPG	
Threshold Variable	QINST		DEP	
Number of thresholds	m=1	m=2	m=1	m=2
H_0 : r=0 vs H_1 : r=1	3.500 (0.005)	2.528 (0.007)	1.914 (0.093)	2.709 (0.004)
H_0 : r=1 vs H_1 : r=2	-	-	-	-
	Model (3)		Model (4)	
Endogenous Variable	VAPM		VAPM	
Threshold Variable	QINST		DEP	
Number of thresholds	m=1	m=2	m=1	m=2
H_0 : r=0 vs H_1 : r=1	2.894 (0.015)	2.799 (0.003)	4.951 (0.000)	4.062 (0.000)
H_0 : r=1 vs H_1 : r=2	-	-	-	-

Note: the corresponding p-value for Fisher statistics is between brackets.

However, the tests of the hypothesis $(H_0: r = 1 \; vs \; H_1: r = 2)$ are inconclusive. We do retain the hypothesis of single transition function in all tested models. Indeed, for all cases (m = 1 and m = 2), the null hypothesis of PSTR a model with a single transition function (r = 1) is more likely the alternative hypothesis of a PSTR model with a minimum of two transition functions (r = 2).

The choice of the threshold number is obtained by comparing statistics SSR, AIC and BIC. Table 4 below shows that the best choice is $m = 2$.

Table 4: Determination of the number of thresholds

	Model(1)	*Model(2)*	*Model3)*	*Model(4)*
Endegenous variable	GDPG		VAPM	
Threshold variable	QINST	DEP	QINST	DEP
RSS m=1	2575.07	2621.36	623.35	644.57
RSS m=2	2389.27	2573.13	623.32	582.78
AIC m=1	-2.46	- 2.48	-1.04	- 1.08
AIC m=2	-2.47	- 2.40	-1.06	- 0.99
BIC m=1	-2.63	-2.65	-1.21	- 1.25
BIC m=2	-2.66	-2.58	-1.24	- 1.17
	Number of estimated parameters			
m=1	12	12	12	12
m=2	13	13	13	13

Source : constructed using data from the World Bank.

4.2. Parameter estimation

GDP growth, natural resources dependence and quality of institutions effects

Table 5 summarizes the results of the joint effect of "institutional quality" and "natural resources dependence" on GDP growth. Note that the coefficients $(\beta_0\ and\ \beta_1)$ are not directly interpretable. Therefore, it is useful to examine the coefficient signs that give the direction in which the relationship evolves between the explanatory variable and the dependent variable. A positive sign of (β_1) indicates that when the threshold variable increases, the associated coefficient grow up.

Table 5: GDP growth, quality of institutions and natural resources dependence

Model	*Model (1)*		*Model(2)*	
Endogenous variable	GDPG			
Threshold variable	QINST		DEP	
	β_0	β_1	β_0	β_1
QINST	-	-	8.208 (2.190)	-12.256 (-3.227)
DEP	-0.179** (-1.990)	0.220** (2.219)	-	-
INF	0.491 (0.814)	-0.552 (-0.914)	-1.152** (-2.908)	1.089** (2.750)
INVEST	-0.202 (-0.596)	0.358 (0.955)	2.809** (3.077)	-2.686** (-2.949)
OPNES	21.357** (2.397)	-23.545** (-2.396)	27.499** (-3.041)	26.095** (2.979)
POPG	-9.732** (-2.585)	11.107 ** (2.841)	-3.810 (-1.650)	4.915** (2.026)
$\hat{\gamma}$	21.522		33.456	
$\hat{c}$	0.511	2.032	82.992	93.827

Note: The corresponding p-value for Fisher statistics are between brackets.

Columns (1) and (2) correspond to the model (1), where the quality of institutions is the threshold variable. These columns show that for the variable "natural resources dependence", the coefficient β_0 is negative and the coefficient $\beta_1$is positive and significant. This result means that natural resources dependence has a negative effect on the growth of GDP. Nevertheless, this effect becomes positive when we introduce the interaction effect between natural resources dependence and the quality of institutions. Indeed, a positive coefficient β_1 indicates that the effect of natural resources dependence becomes positive on GDP growth when the quality of institutions improves. In other words, the transitional dynamic between the two regimes shows how the quality of institutions can drive the natural resource dependence effect from negative to positive. This nonlinearity has been indirectly shown by Sala-i-Martin and Subramanian (2013). For them, natural resources dependence exerts a negative and nonlinear impact on growth via their deleterious impact on institutional quality. And when the effect of institutions is controlled, the negative effect of natural resources becomes positive. Many other papers have suggested the indirect effect hypothesis of natural resources on economic growth. For example, one can cite Mehlum et al. (2006a, b), Boschini et al. (2007) and Arezki and Van der Ploeg (2011) who have advocated for a less severe resource curse in countries with good institutions.

The initial positive effect of economic openness (OPNES) on GDP growth is consistent with the empirical results of Sachs and Warner (1999), Mehlum et al. (2006a) and Van der Ploeg (2011). However, the interaction effect of trade openness and quality of institutions is negative on GDP growth. The improvement of the quality of institutions makes the openness effect on economic growth more and more negative. This result supports the idea of a non-linear effect of trade openness on growth. The population growth effect on GDP growth is negative and the interaction effect with the quality of institutions is positive. This result strengthens the classical divergent debate between a positive effect as in Mankiw et al. (1992), Knight et al. (1993) and Savvides (1995), and a positive effect as in Kormendi and Meguire (1985).

Columns (3) and (4) display the results obtained from the model (1) estimation with natural resources dependence as a threshold variable. The coefficient β_0, corresponding to the quality of institution variable, is positive and significant whereas the coefficient β_1 is negative and significant. This means that initially the effect of quality of institutions on GDP growth is positive. However, in the case of highly resource-dependent countries, this effect is not linear. The joint effect of the level of institutional quality with the natural resources dependence is negative. The effect of the quality of institutions on GDP becomes increasingly negative when the level of natural resources dependence increases. Indeed, a strong dependence on natural resources wipes out the positive effect of institutional quality on growth. This finding has already been pointed out by some authors. Acemoglu et al. (2005) propose the hypothesis of a hierarchy of institutions to explain the heterogeneity in the conditions under which this effect can operate. Flachaire et al. (2014) find supports for this hypothesis by using a mixture regression approach with panel data. In the same context of the model (2), a high dependence on natural resources makes the effect of inflation, trade openness and population growth positive on economic growth. On another side, the effect of investment becomes negative with a growing level of natural resource dependence.

Manufacturing value added and the effects of natural resources dependence and quality of institutions

Table 6 summarizes the results of the combined effects of "institutional quality" and "natural resources dependence" on the manufacturing value added on GDP share. For models (3) and (4), where we consider the weight of manufacturing industry in one economy as the dependent variable, only the model (3) gives significant coefficients. We generally find the same results as in model (1). When the quality of institutions improves, natural resources dependence and investment have positive effect on the weight of manufacturing industry in the economy. However, the effect of the investment seems to be more important than in the model (1).

Table 6: VAPM, quality of institutions and dependence on natural resources

Modèle	*Model (3)*		*Model (4)*	
Endogenous variable	VAPM		VAPM	
Threshold variable	QINST		DEP	
	β_0	β_1	β_0	β_1
QINST	-	-	0.986	-0.766
			(0.951)	(-0.832)
DEP	-0.355**	0.319**	-	-
	(-9.893)	(6.728)		
INF	0.155	-0.154	-0.082	0.089
	(0.531)	(-0.524)	(-0.911)	(0.956)
INVEST	-0.514**	0.594**	0.106	-0.044
	(-2.982)	(3.283)	(0.765)	(-0.314)
OPNES	35.989**	-38.336**	-0.402	-1.709
	(7.529)	(-7.093)	(-0.198)	(-1.036)
POPG	-2.358	2.676*	0.047	0.151
	(-1.636)	(1.814)	(0.117)	(0.353)
$\hat{\gamma}$	3.297		2.386	
$\hat{c}$	1.878	1.878	69.868	69.868

Note: The corresponding p-value for Fisher statistics are between brackets.

4.3. Individual effects analysis

The PSTR models have the advantage of allowing parameters to vary between countries. They provide a parametric approach to bring out the heterogeneity between countries through the calculation of marginal effects. Specifically, these models are used to observe the estimated parameters changes following the variation of threshold variable q_{it}. The marginal effect of a variable x_{it} for the country i in time t is defined by:

$$\frac{\partial y_{it}}{\partial x_{it}} = \beta_0 + \beta_1 G(q_{it};\gamma, c).$$

It is easy to see that $\min\{\beta_0, \beta_0 + \beta_1\} \leq \frac{\partial y_{it}}{\partial x_{it}} \leq max\{\beta_0, \beta_0 + \beta_1\}$ since $0 \leq G(q_{it};\gamma, c) \leq 1$, $\forall q_{it}$. The estimated parameters vary between the two regimes (or their extreme values) following the values taken by the threshold function *G(.)*. The parameter β_0 corresponds to the extreme regime where the transition function $G(q_{it};\gamma, c)$ tends to 0 and $\beta_0 + \beta_1$corresponds to the extreme regime where the transition function tends to 1. Between these two extreme regimes, the marginal effects are defined as a weighted average of the parameters β_0 and β_1.

We present in the following the analysis of the marginal effect of natural resources dependence variable on economic growth when it is combined with the threshold variable quality of institutions (Appendix II). This analysis shows three major trends. The first represented by countries with relatively low institutional quality (according to the values of the variable "rule of the law") as Algeria, Bolivia, Cameroon, Colombia, Côte d'Ivoire, Ecuador, Egypt, Gabon, Indonesia, Iran, Nigeria, Syria, Vietnam and Yemen, where the marginal effect of natural resources dependence is not affected by improvement in institutional quality. The second category is represented by the industrialized countries with better institutions as Australia, Canada and Norway, and where the marginal effect of the dependence becomes less negative with the improvement of the quality of institutions. In the third category with medium level of institutional quality as in Kuwait, Qatar, Oman, Saudi Arabia, Brunei Darussalam and Venezuela, improvement in the quality of institutions leads to a decrease in marginal effect of the natural resources dependence on growth.

The analysis of the marginal effect of institutional quality when the threshold variable is the natural resources dependence variable (Appendix III) shows that there exist two types of countries. The first category is represented by Brunei Darussalam, Kuwait, Nigeria, Qatar, Venezuela and Yemen. For these countries, the marginal effect of institutions first improves with an increase of resource dependence up to a maximum level. Thus after this level of resource dependence, the marginal effect decreases. This result shows that beyond a certain level of dependence, the positive effect of institutions is ousted. The second category represents all other remaining countries in our sample. The marginal effect of institutional quality remains the same regardless of the level of natural resources dependence.

Our analysis reveals a significant heterogeneity in the functional mechanisms of institutional effects on the economies of rentier States. This heterogeneity indicates that the sensitivity to the combined effects on growth is different between countries. Indeed, if we take the case of Algeria, belonging to the first category, the marginal effect of natural resources dependence is not affected by improving institutional quality. In general, in this category of countries, improving the quality of institutions does not lead to a positive change in the effect of natural resources dependence on growth. In the case of industrialized countries, the quality of institutions reduces the negative effect of natural resource dependence on growth, but the quality of institutions is not influenced by the level of resource dependence.

5. Conclusion

This research has shown the existence of an interaction effect between natural resources dependence and the quality of institutions. The introduction of a regime change differentiates the effects of the explanatory variables according to the threshold levels reached by the transition function. Indeed, improving the quality of institutions leads to a direct and positive effect of natural resources dependence on growth. However, a strong dependence on natural resources wipes out the positive effect of institutional quality.

The variable “manufactured value added as a GDP share” seems to give an explanation to the performance heterogeneity in rentier States. This result joins the view stating that natural resources can be a dead end road, when they exclude manufacturing industry. Matsuyama (1992) shows that the manufacturing sector is characterized by learning by doing but the primary sector is not. This result is consistent with the prediction of former structuralist as Prebisch who suggest that rentier States must allow their industries to grow, rather than to exploit their comparative advantages in natural resources.

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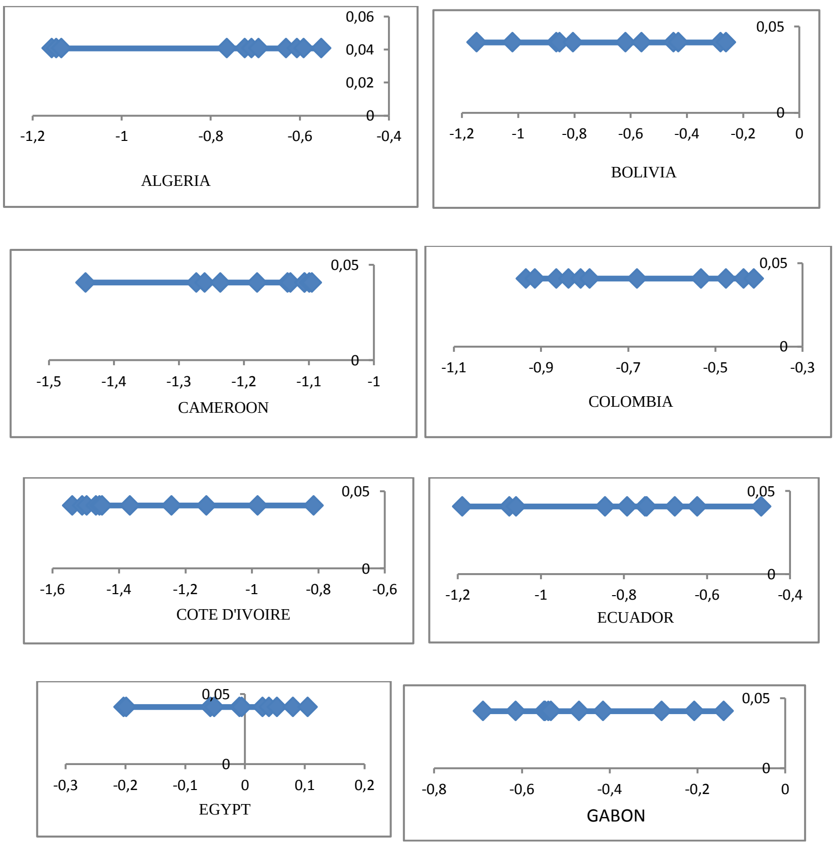
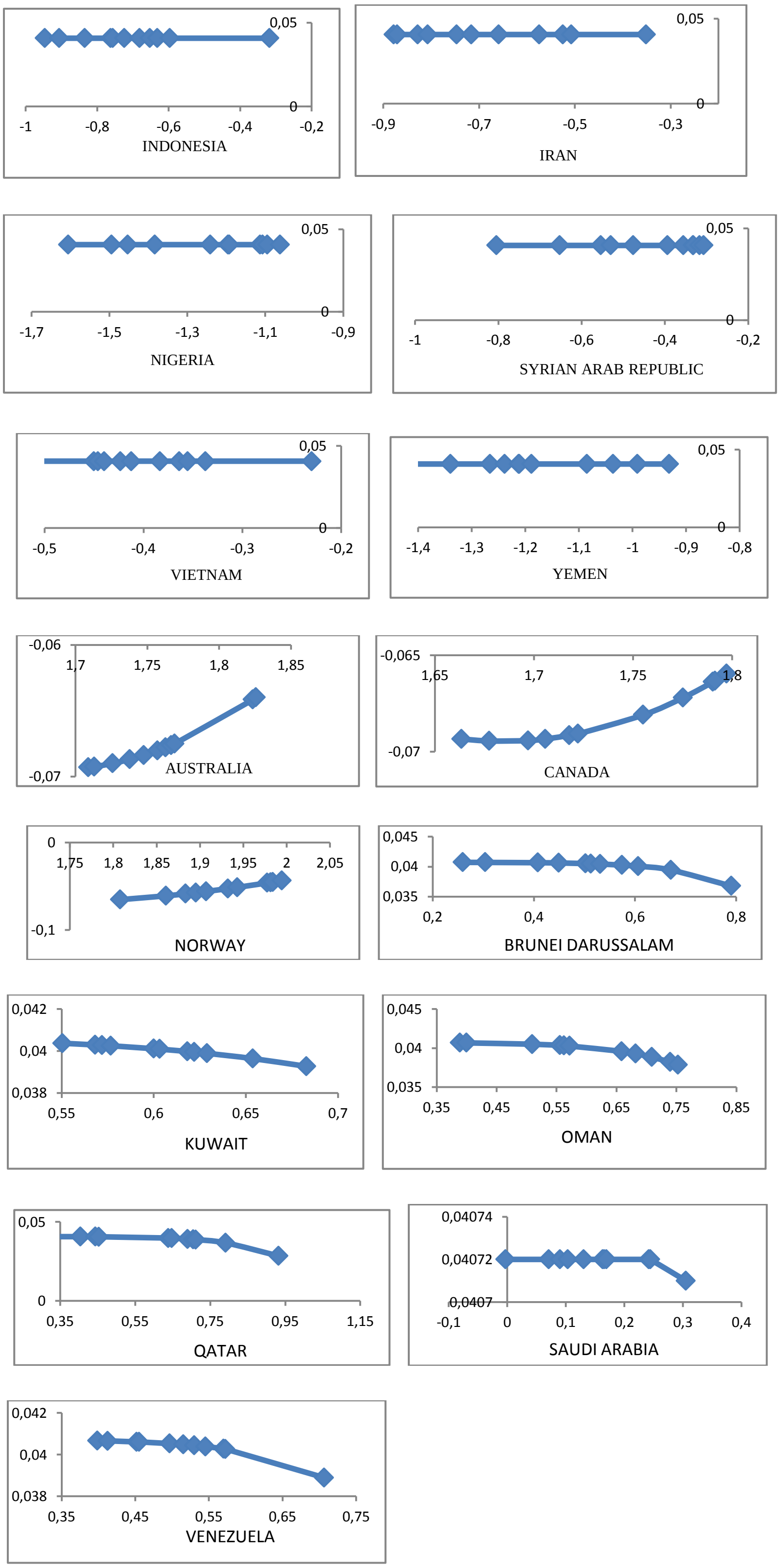
Appendix I: Countries of the sample

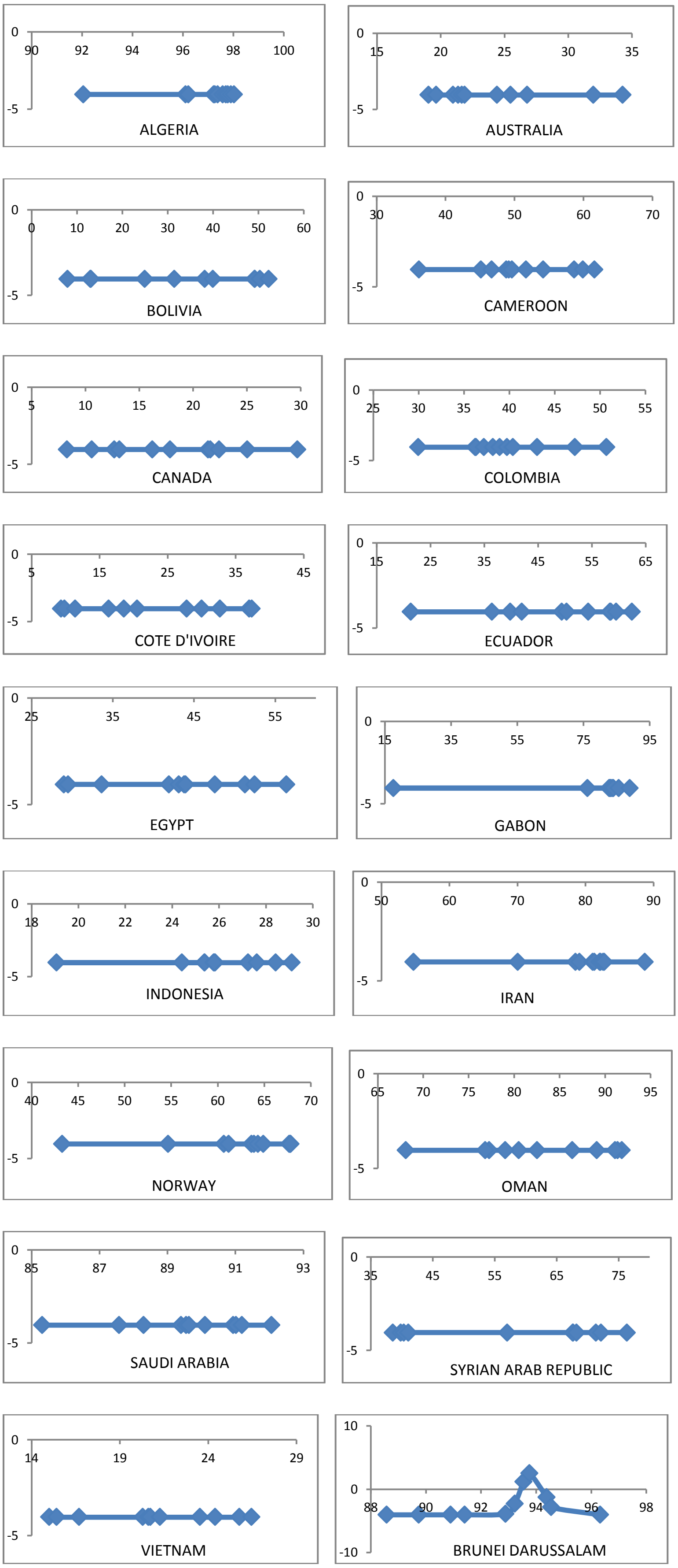
Algeria	Côte d’ivoire	Kuwait	Oman
Bolivia	Ecuador	Norway	Saudi Arabia
Brunei Darussalam	Egypt	Nigeria	Australia
Canada	Gabon	Syria	Venezuela
Cameroon	Indonesia	Yemen	Vietnam
Colombia	Iran	Qatar	

Appendix II: Marginal effect of natural resources dependence on economic growth when the quality of institutions is the threshold variable





Appendix III: Marginal effect of institutional quality on economic growth when natural resources dependence is the threshold variable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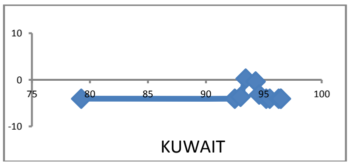
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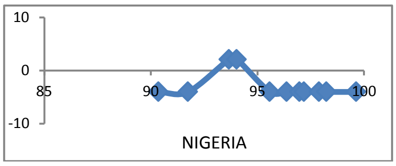
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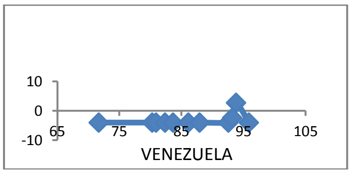
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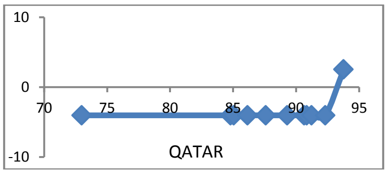
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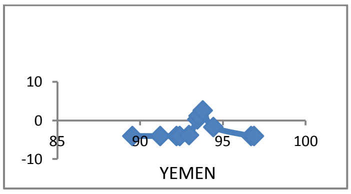
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