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Abstract

The dependence to natural resource is currently the object of a wide debate in the analysis of economic growth in rentier states. In this work, we examine the interaction effect between oil resources dependence and the quality of institutions on economic growth by employing a panel threshold regression methodology. Our results show that the effect of oil resource dependence on economic growth becomes positive, as the quality of institutions improves. In other side, contrary to many precedent results in this area, an increase in oil dependence wipes out the positive effect of institutional quality on growth. Indeed, a positive variation of the institution quality doesn't necessary lead to a positive variation in economic growth.

JEL Classification: O4, Q0, P16, C21

Keywords: Natural resources, institutional quality, growth, threshold regression

ملخص

الاعتماد على الموارد الطبيعية هو حاليا موضوع نقاش واسع في تحليل النمو الاقتصادي في الدول الريعية. في هذه الورقة، نقوم بدراسة تأثير التفاعل بين الاعتماد على موارد النفط ونوعية المؤسسات على النمو الاقتصادي من خلال توظيف منهجية تتبعية لمستوى الانحدار. تظهر نتائجنا أن تأثير الاعتماد على الموارد النفطية على النمو الاقتصادي يصبح إيجابيا حيث أن نوعية المؤسسات تتحسن. وفي الجانب الآخر، وعلى عكس العديد من النتائج السابقة في هذا المجال، فان زيادة الاعتماد على النفط تقضي على الأثر الإيجابي للجودة المؤسسية وعلى النمو. في الواقع، والاختلاف الإيجابي لجودة المؤسسات لا تقدم بالضرورة الاختلاف الإيجابي في النمو الاقتصادي.

1. Introduction

Oil dependent countries are distinguished by the heterogeneity of their economic performance. It appears that institutions are the most sought-after factor to explain growth disparities between oil dependent economies. Indeed, dependence on natural resources stimulates rent-seeking behavior and can lead to contractions when it comes to other production activities. This in turn can induce corruption (Mauro 1995; Leite and Weidmann 1999), voracity effect (Lane and Tornell 1999) and civil conflict (Collier and Hoeffler 2005; Fearon and Latin 2003). A boom in revenues brought on by natural resources exacerbates social pressures for more redistribution and increases public spending towards less productive sectors (Arezki and Gylfason 2011). The misallocation of financial resources decreases capital productivity and slows down economic growth.

The empirical literature on the link between natural resources, quality of institutions and economic growth can be classified into three categories. In the first category, natural resources have a negative effect on growth when associated with weak institutions. This fact has been empirically documented in the works of Leite and Weidman (1999), Ross (2001), Isham et al. (2003), Sala -i- Martin and Subramanian (2003), Rodrik et al. (2004), Collier and Hoeffler (2005), Acemoglu et al. (2001, 2002), and Bulte et al. (2004).

The second category of literature finds that there is a relation between natural resources and the quality of institutions, but that the combined effect of these two factors on growth depends on the nature of their interaction. These findings have been presented by Boschini et al. (2007), Mehlum et al. (2006), Van der Ploeg and Arezki (2010), Gylfason (2011) and Mohsen et al. (2011).

The third category of literature finds that the observed heterogeneity in economic growth between rentier states is not explained by institutions. In the context of this category, Sachs and Warner (1997) found that the indirect effect of natural resources on growth (through institutions) is weak. For Brunnschweiler (2008) and Brunnschweiler and Bulte (2008), resource abundance positively affects growth and institutional quality. Alexeev and Conrad (2009) found that institutions are neutral and the negative effect of natural resource gains on institutions is mainly due to a misinterpretation of the data available.

In general, the above empirical works use linear specifications to study the relationship between natural resources, economic growth and the quality of institutions. However, Leite and Weidman (1999) and Sala-i-Martin and Subramanian (2003) 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.

Per the above results, we propose to use a nonlinear specification which takes into account the indirect and the interaction effects. Indeed, we use panel threshold regression techniques proposed by Hansen (1999) and Gonzalez et al., (2005).

The remainder of this paper is organized as follows: in the second section we discuss the specification techniques by panel thresholds regression, in the third section we present the data and the estimates obtained using the different panel models with threshold effects and in the last section we conclude on the results.

2. Panel Smooth Transition Regression Model (PSTR)

Threshold models are econometric instruments used to analyze nonlinear economic phenomena. In 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 work, we consider the PSTR models as more appropriate to explain the economic heterogeneity of rentier states.

Consider (Y_{it}, t ∈ Z and i ∈ Z) as a process satisfying a PSTR representation if and only if:

$$Y_{it} = \mu_i + \beta_0^{'} X_{it} + \sum_{j=1}^{r} \beta_1^{'} X_{it} g_j\left(q_{it}^{(j)}; \gamma_j, c_j\right) + u_{it}$$

μ_i: Individual effects

$q_{it}^{(j)}$: Threshold variable

$\gamma \succ 0$: smoothing parameter

c_j: Threshold

r: number of threshold function

m: number of threshold

$i = 1 \ldots N; t = 1 \ldots T; k = 1 \ldots m; j = 1 \ldots r$

X_{it}= (X_{1it}, X_{2it} ... X_{kit}) is the matrix of the 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).

$g_j\left(q_{it}^{(j)}; \gamma_j, c_j\right)$ a continuous and integrable transition function on the interval [0 1].

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

$$g(q_{it}; \gamma, c) = \left[1 + \exp(-\gamma \prod_{j=1}^{m} (q_{it} - c_j)\right]^{-1}, \gamma \succ 0, c_1 \prec \ldots \prec c_m$$

The choice of transition variables depends on the studied economic phenomenon, and therefore the statistical signification 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 rentier states' economic dependence on oil.

A PSTR model can be estimated through three steps: in the first one, we test the linearity of the model (H_0: $r = 0$) against a model with the transition function (H_1: $r = 1$). If the linear model is rejected, in the second step we test the number of transition functions to admit (H_0: $r = i$ *verus* H_1: $r = i + 1$) with ($i = 1, \ldots, r$). In the second step, we determine the number of thresholds (m) to allow in the transition variable (q_{it}) such as $c_{j,min} > min_{i,t}\{q_{it}\}$ et $c_{j,max} < max_{i,t}\{q_{it}\}$, $j = 1, \ldots, m$. Colletaz et al. (2006) propose to retain the value of m that minimizes the sum of squared residuals (RSS), the Akaike information criterion (AIC) or the Bayesian information criterion (BIC). However, Conzalez 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 Analysis of Results

3.1 Data and description of variables

We consider a panel of 23 oil countries between 1996 and 2009. To control for dependence on natural resources and quality of institutions 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 at the same time. We add to our econometric specification some other growth determinant variables, such as: inflation, investment, trade openness and the population growth rate. All these variables a extracted from the World Development Indicators database (WDI 2011) and the World Government based indicators (WGI 2011). The used variables are described in Table 1.

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

Tables 1 and 2 describe all the variables used in our empirical study and some statistical trends analysis. The table in Annex III lists the countries introduced in this analysis.

3.2 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.

However, tests of the hypothesis ($H_0: r = 1 \; vs \; H_1: r = 2$) are inconclusive. We 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 as 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 RSS, AIC and BIC. Table No. 4 below shows that the best choice in terms of the minimum statistics corresponds to m = 2.

3.3 Parameter estimation

3.3.1 GDP growth, dependence on natural resources 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 more preferable to examine the coefficient signs to indicate 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 also increases.

Columns (1) and (2) correspond to model (1) with quality of institutions as a threshold variable. These columns show that for the variable "natural resources dependence," the coefficient β0 is negative and the coefficient β1 is positive and significant. This result means that dependence on natural resources has a negative effect on the growth of GDP, but this effect becomes positive when we introduce the interaction effect between dependence on natural resources and the quality of institutions. Indeed, a positive coefficient β1 indicates that the effect of dependence on natural resources becomes positive on GDP growth when improving the quality of institutions. In other words, the transitional dynamic between

the two regimes shows how the quality of institutions can drive the dependence on natural resource effect from negative to positive. This nonlinearity has been indirectly shown by Sala -i- Martin and Subramanian (2003). For these last authors, dependence on natural resources exerts a negative and nonlinear impact on growth via their deleterious impact on institutional quality, and once the effect of institutions is controlled, the negative effect of natural resources becomes positive. Many other works have suggested the indirect effect hypothesis of natural resources on economic growth. Boschini et al., (2007), Mehlum et al. (2006) and Van der Ploeg and Arezki (2010) have advocated the idea that the resource curse is less severe in countries with good institutions.

The initial positive effect of economic openness (OPNES) on GDP growth is consistent with the empirical results found by Sachs and Warner (1997), Van der Ploeg (2010) and Mehlum et al. (2006a). However, the interaction effect of trade openness and quality of institutions affects GDP growth negatively, and improvement in the quality of institutions yields more openness furthering the negative impact on economic growth. 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 for Mankiw et al. (1992), Knight et al. (1993) and Savvides (1995), and a positive effect as for Kormendi (1985).

Columns (3) and (4) display the results obtained from model (1) estimates with dependence on natural resources as a threshold variable. The coefficient β_0 corresponding to the quality of institutions variable is positive and significant, whereas the coefficient β_1 is negative and significant. This result shows 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, which means that the effect of the quality of institutions becomes increasingly negative on GDP when the level of dependence on natural resources increases. Indeed, a strong dependence on natural resources eliminates the positive effect of institutional quality on growth. This finding has already been pointed out by many 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. (2011) find support for this hypothesis by using a mixture regression approach in the panel data. In the same context of model (2), a high dependence on natural resources makes the effects of inflation, trade openness and population growth positive on economic growth. On the other hand, the effect of investment becomes negative when it coincides with a growing level of natural resource dependence.

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

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

3.4 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 changes in parameters 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:

$$\frac{\delta y_{it}}{\delta x_{it}} = \beta_0 + \beta_1 g(q_{it}; \gamma, c)$$

The estimated parameters vary between the two regimes (or their extreme values) following the values taken by the threshold function. As expressed by the above equation, the parameter β_0 corresponds to the extreme regime where the transition function $(q_{it}; \gamma, c)$ $tend\ to$ 0 and the sum $\beta_0 + \beta_1$corresponds to the extreme regime where the transition function tends to 1. Between the these two extreme regimes, the marginal effects are defined as the weighted average of the parameters $\beta_0$and β_1.

In Annex I we see the analysis of the marginal effect of dependence on natural resources, as a variable, on economic growth when it is combined with the threshold variable quality of institutions. This analysis revealed three major trends: the first is represented by countries with relatively low institutional quality (according to the values of the variable "rule of the law"), such as Algeria, Bolivia, Cameroon, Colombia, Cote d'Ivoire, Ecuador, Egypt, Gabon, Indonesia, Iran, Nigeria, Syria, Vietnam and Yemen, where the marginal effect of dependence on natural resources is not affected by improvement in institutional quality. The second category is represented by the industrialized countries with better institutions, like 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 countries with a medium level of institutional quality, such as Kuwait, Qatar, Oman, Saudi Arabia, Brunei Darussalam and Venezuela, are represented. There, improvement in the quality of institutions leads to a decrease in marginal the effect of dependence on natural resources on growth.

The analysis of the marginal effect of institutional quality when the threshold variable is the variable of dependence on natural resources (Annex II), shows that there are two types of countries: the first type are represented by Brunei Darussalam, Kuwait, Nigeria, Qatar, Venezuela, and Yemen, for which the marginal effect of institutions improves with increased dependence but when reaching a certain level of dependence decreases. This result shows that beyond a certain level of dependence, the positive effect of institutions is gone. The second category represents all other remaining countries in our sample, where the marginal effect of institutional quality remains the same regardless of the level of dependence on natural resources.

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 dependence on natural resources 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 dependence on natural resources on growth. In the case of industrialized countries, the quality of institutions reduces the negative effect on growth brought about by dependence on natural resources, but the quality of institutions is not influenced by the level of dependence on resources.

4. Conclusion

This paper has shown the existence of an interaction effect between dependence on natural resources and the quality of institutions. The introduction of regime change differentiates

the effects of the explanatory variables according to the threshold level reached by the transition function. Indeed, improving the quality of institutions leads to a direct and positive effect of dependence on natural resources on growth. However, a strong dependence on natural resources wipes out the positive effect of institutional quality.

The variable “manufacturing value added as a share of GDP” seems to give an explanation for the performance heterogeneity among rentier states. This result bolsters the perspective that natural resources can lead to a dead end, when they exclude the 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 previous structuralists like Prebisch, who suggests that rentier states must allow their industries to grow, rather than exploit their comparative advantage in natural resources.

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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 of GDP.
POPG	Population growth as the annual rate of population growth.

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

Table 3: LM Tests of Residual Non-linearity

Endogenous Variable Threshold Variable Number of thresholds	Model (1) GDPG QINST m=1	m=2	Model (2) GDPG DEP m=1	m=2
H0 : r=0 vs H1 : r=1	3.500	2.528	1.914	2.709
	(0.005)	(0.007)	(0.093)	(0.004)
H0 : r=1 vs H1 : r=2	- -		- -	
Endogenous Variable Threshold Variable Number of thresholds	**Model (3) VAPM QINST m=1**	**m=2**	**Model (4) VAPM DEP m=1**	**m=2**
H0 : r=0 vs H1 : r=1				
	2.894	2.799	4.951	4.062
	(0.015)	(0.003)	(0.000)	(0.000)
H0 : r=1 vs H1 : r=2	- -		- -	

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

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	-2.4	-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

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

Model	**Model (1)**		**Model(2)**	
Endogenous variable	**GDPG**			
Threshold variable	**QINST**		**DEP**	
	$\beta 0$	$\beta 1$	$\beta 0$	$\beta 1$
QINST			-8.208	-12.256
	-	-	-2.19	(-3.227)
DEP	-0.179**	0.220**	-	-
	(-1.990)	-2.219	-	-
INF	0.491	-0.552	-1.152**	1.089**
	(0.814)	(-0.914)	(-2.908)	(2.75)
INVEST	-0.202	0.358	2.809**	-2.686**
	(-0.596)	(0.955)	(3.077)	(-2.949)
OPNES	21.357**	-23.545**	27.499**	26.095**
	(2.397)	(-2.396)	(-3.041)	(2.979)
POPG	-9.73**	11.107 **	-3.810	4.915**
	(-2.585)	(2.841)	(-1.650)	(2.026)
γ	21.522		33.456	
$\hat{c}$	0.511	2.032	82.992	93.827

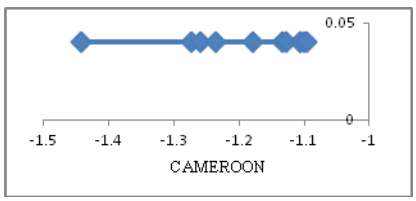
Note: between parentheses corresponding to p-value for Fisher statistics
Source: constructed using data from the World Bank

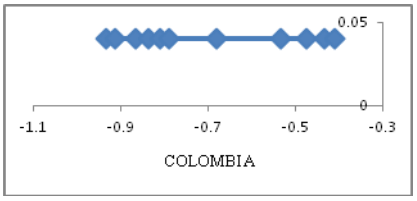
Table 6: VAPM, Quality of Institutions and Dependence on Natural Resources

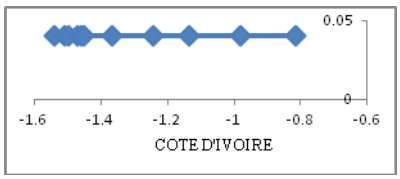
Model	**Model (3)**		**Model (4)**	
Endogenous variable	**VAPM**		**VAPM**	
Threshold variable	**QINST**		**DEP**	
	$\beta 0$	$\beta 1$	$\beta 0$	$\beta 1$
QINST	-	-	0.986	-0.766
			(0.951)	(-0.832)
DEP	-0.355	0.319**	- -	
	(-9.893)	(6.728)		
INF	0.155	-0.154	-0.082	0.089
	(0.531)	(-0.524)	(-0.911)	(0.956)
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)
γ	3.297		2.386	
$\hat{c}$	1.878	1.878	69.868	69.868

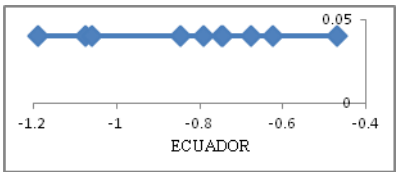
Note: between parentheses is the corresponding p-value for Fisher statistics

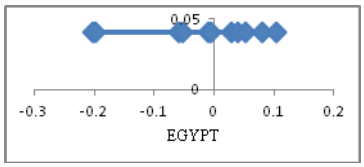
Annex 1: Marginal Effect of Dependence on Natural Resources on Economic Growth As A Function of the Quality of Institutions

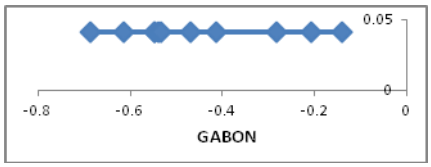


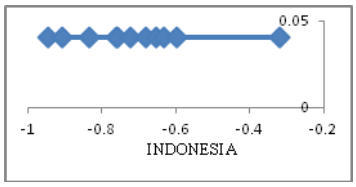


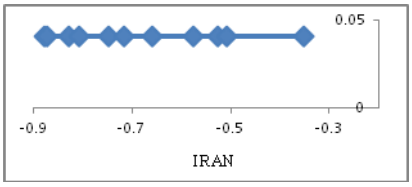


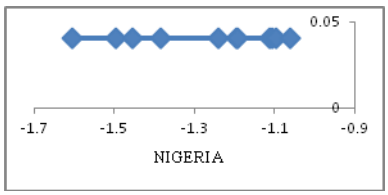


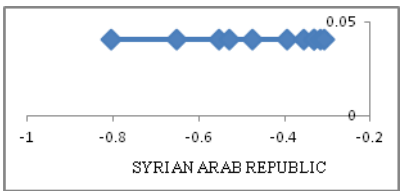


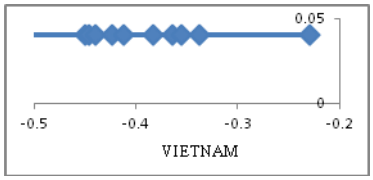


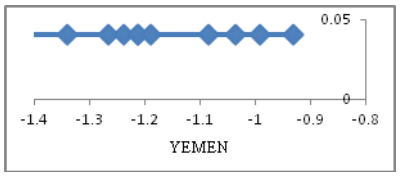


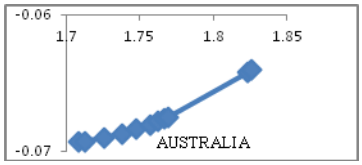


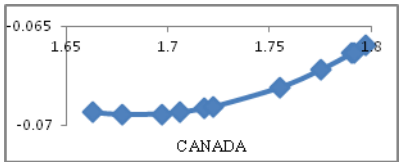


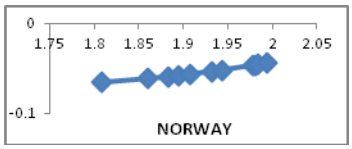


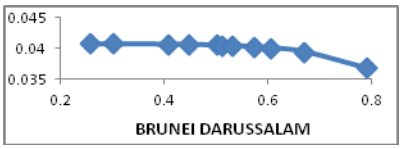


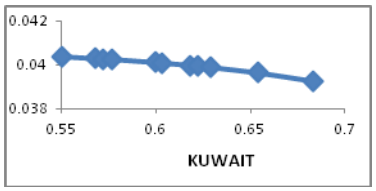








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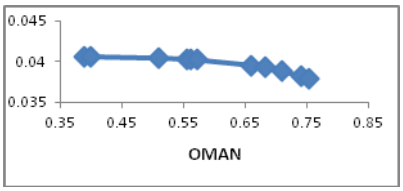
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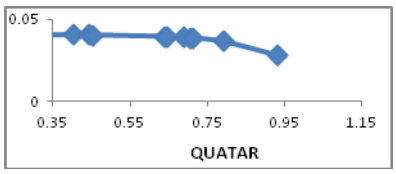
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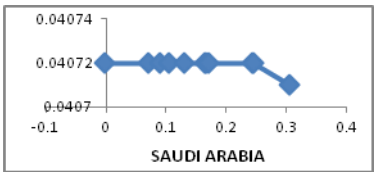
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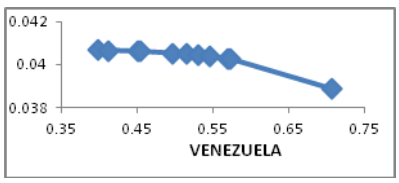
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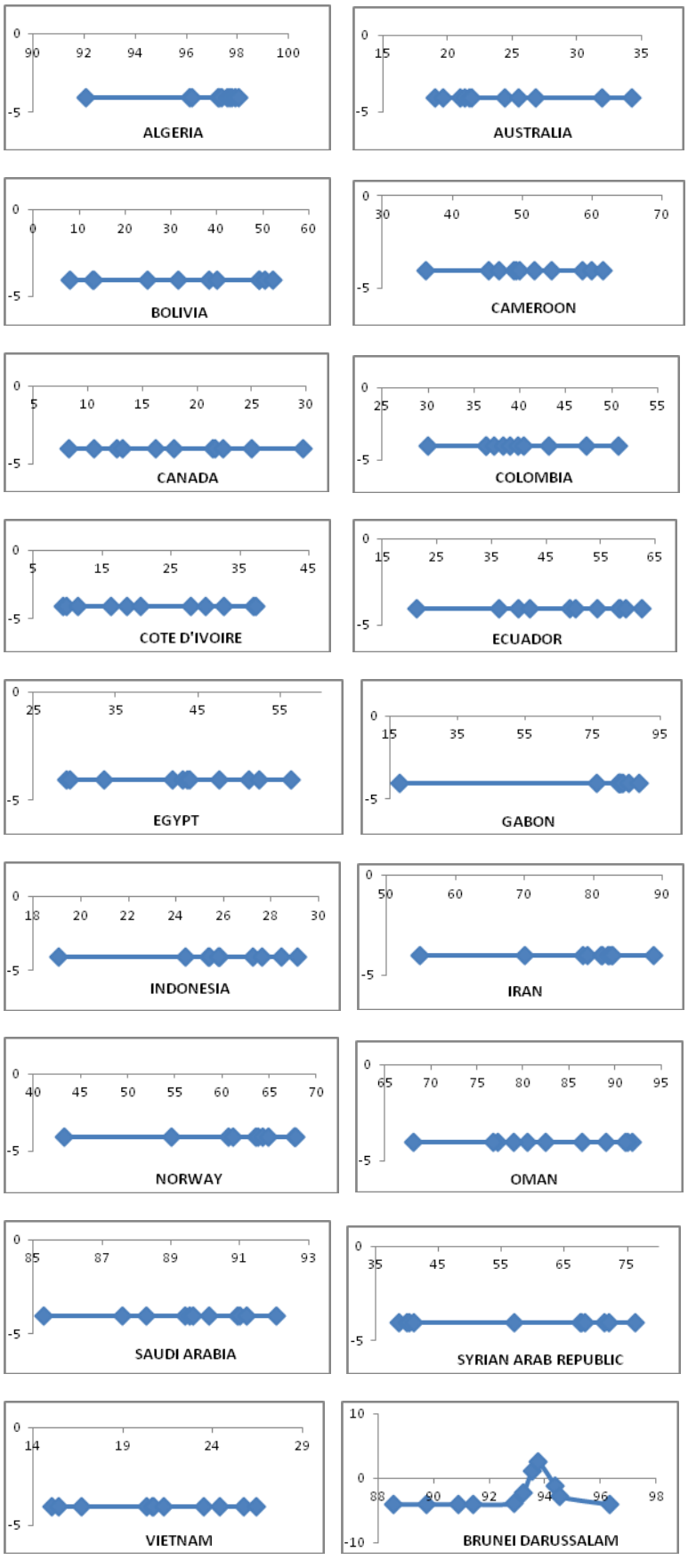
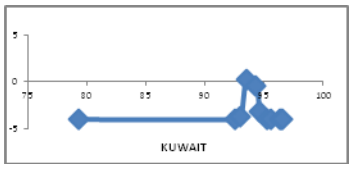
Annex 2: Marginal Effect of Institutional Quality on Economic Growth When Dependence on Natural Resources is the Threshold Variable

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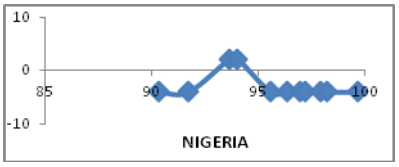
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95
100
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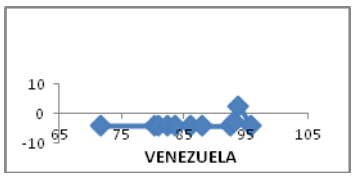
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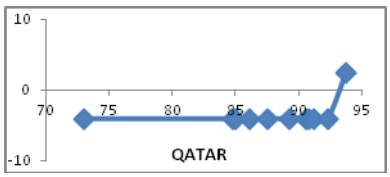
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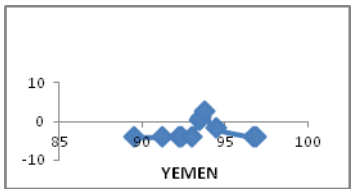
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90
95
100
YEMEN

Annex 3: Countries of the Sample

Algérie	Cote d'ivoire	Kuwait	Oman
Bolivie	Ecuador	Norvège	Arabie saoudite
Brunei Darussalam	Egypte	Nigeria	Australie
Canada	Gabon	Syrie	Venezuela
Cameroun	Indonésie	Yémen	Vietnam
Colombie	Iran	Qatar	