Natural resource curse: a non linear approach in a panel of oil exporting countries

Majda Seghir and Olivier Damette

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O.Damette[*] and M.Seghir[†]

Abstract

This paper explores the idea of regime switching as a new methodological approach to bring new insights into the natural resource curse hypothesis in the case of oil exporting countries. The basic idea is that when a threshold of oil dependence is passed, the relationship between economic growth and its determinants could move smoothly from a regime to another. Relying upon the estimation of a PSTR model, our findings offer strong evidence that oil revenues non-linearly impacts economic growth and that resource curse only exists under the condition of high oil dependence. More precisely, below the level of 51% of oil dependence, oil revenues have a positive impact on economic growth, whereas above this level, it have serious drawbacks on economic growth through inefficiencies into the quality and the quantity of government expenditures.

J.E.L.: O11, Q32, Q38, Q43

Key words: Natural resource curse, Panel Smooth Transition Regression, Oil exporting countries,

[*] BETA-CNRS, University of Lorraine, France. Email: Olivier.Damette@univ-nancy2.fr
[†] Erudite, University of Paris Est-Créteil, France. Email: majda.seghir@etu.u-pec.fr

1. <u>Introduction</u>

Natural resources give a nation a comparative advantage over others which leads to a better–economic growth, all other things being equal. This assertion of Ricardian inspiration is far from being true: between the 1960's and the 1990's, the gap between economic growth in rich and poor countries in natural resources had grown in favor of the poor ones. In fact, energy commodities, such as oil, gas or coal exhibit some particular features which combination impedes economic growth and produces what has been called the "resource curse" (Sachs and Warner, 1995; Auty, 2001; Polterovich and Popov, 2010). Those features include the unique role of energy commodities as a driver for global industrialization; the reserve depletion; the high price sensibility to variation of supply and demand, the ownership of oil and gas reserves by governments.

Despite historical evidence, the causes of the resource curse are still a matter of debate and the negative correlation between economic growth and the availability of natural resources is far from being well-assessed. In fact, in the empirical literature as well as in the theoretical literature (see Frankel (2010) for an exhaustive literature review), this curse appears to be the result of some specific mechanisms, of a particular combination of the factors identified below and even, of a particular context. Nonetheless, some findings support that the natural resource abundance could be a blessing. Alexeev and Conrad (2009) demonstrate that oil and mineral resources have enhanced rather than inhibited long-term growth. Cavalcanti, Mohaddes and Raissi (2011) broadly corroborate this finding, supporting the more intuitive idea that oil has a positive effect on both income levels and economic growth.

In this paper, we focus on oil exporting countries. First, we argue that the resource curse is more often a result of the level of oil dependence rather than a consequence of the mere existence of the natural resource. Second, we investigate the role of oil as limiting factor of production. Indeed, oil can enter the economic circuit as a source of revenues as well as an energy commodity used in the production process. The first function of oil is the most frequently investigated in the literature. Studies in the literature of natural resource curse, consider oil and by extension all energy commodities as a source of revenues which has a negative impact on economic growth through different mechanisms. On the other side, natural resources and more precisely energy commodities play a key role as a factor of production. Hence, all the possible contribution of oil to the economy will be addressed. This paper explores the contribution of oil as a source of income and as well as an input.

The previous studies on natural resource curse use standard linear models with interacting terms (between a proxy of natural resource abundance and a variable of institutional quality) and might not properly address nonlinear effects. There are two major drawbacks with this kind of specification. First, it assumes the same effect of natural resources on economic growth across the countries. However, this assumption is far from being true. Even, when considering a homogenous panel of oil exporting countries, the natural endowment of each country as well as production capacities are different and, by extension, the amount of oil revenues and by extension the effect of oil rent on economic growth should be different. Secondly, the standard approach assumes that the natural resource effect identified is constant over time. This postulate is unrealistic mostly in the case of oil exporting countries where the oil market and by extension the oil rent are subject to large time fluctuations induced by uncertainty over supply and demand. Therefore, the methodology used in most of the studies dealing with natural resource curse is a less effective approach.

The alternative solution proposed in this paper consists in using a Panel Smooth Threshold Regression (PSTR hereafter) methodology, recently developed by Gonzalez et al. (2005) and Fok et al. (2004) following the work of Granger and Teräsvirta (1993) in a time series context. This model can be thought as a linear model with coefficients that vary across countries and over time. Heterogeneity in the regression coefficients is authorized by assuming that these coefficients are continuous functions of an observable variable through a bounded function of this variable called the transition function. The model could also be interpreted as a nonlinear homogeneous panel model. The transition variable plays a key role in influencing the effects of explanatory variables on the dependent variable. Thus, it is different from random coefficients models (Hsiao and Pesaran, 2004). In addition, this smooth model is less restrictive than the PTR developed by Hansen (1999) as stressed by Hudson and Minea (2013).

In the context of oil resource curse hypothesis, the oil dependence measure is the proper transition variable, as the impact of the explanatory variables on the economic growth vary with the transition variables at different regimes. Indeed, the higher are the revenues from oil, the higher is the risk of degradation in the institutional quality, in the allocation of government budget and by extension the bad is overall economic performance. In order to document these effects, we split the economic growth determinants into two categories. The first one is represented by the oil independent variables such private investment and total labor force. The second category contains the variables identified as sensitive to oil revenues, namely the institutional quality, the government expenditure, the degree of openness to international trade and the domestic consumption of fossil fuel.

The contribution of this paper is threefold. First, we use a nonlinear PSTR specification to investigate the natural resource curse hypothesis as PSTR models can capture both cross country heterogeneity and time-variability of the relationship between oil dependence and economic growth determinants. Second, using the proxy of oil dependence (i.e. oil rent and oil exports as a percentage of GDP) as the transition variable in PSTR models can prove that beyond an endogenously determined threshold, the proxy has a negative impact on economic growth determinants. Third, we introduce the fossil fuel consumption as a determinant of economic growth under the assumption of its positive contribution as an abundant production factor. Thus the estimation results reconcile the conflicting views in the literature, supporting both the views of a resource curse and of a blessing.

The paper begins with a brief review of the literature on natural resource curse. Then, section 3 presents the PSTR methodology. The next section introduces the data set and explained the threshold variables used in our model. The estimation results are presented and discussed in section 5. Finally, section 6 provides some concluding comments on the key points of this paper.

2. Natural resource from blessing to curse:

The first explanations for the resource curse, known as the “Prebisch-Singer hypothesis”, assert that the share of raw material in GDP decreases faster than the share of manufacturing products because of the combined effect of a relatively slow rate of technical progress in the primary sector and an adverse trend in the commodity terms of trade. A come back to protectionism for developing countries is then recommended as their industries are not competitive (Prebisch, 1950; Singer, 1950). However, Cuddington, Ludema and Jayasuriya (2001) find that the relative commodity prices follow a random walk across the 20th century and consequently there is no evidence of a significant negative trend in real commodity prices. Matsuyama (1992) argues that specialization in primary commodities can be detrimental to growth if it crowds out the manufacturing sector and the latter is the locus of positive externalities. This de-industrialization issue is also the core of the Dutch disease analysis even if the mechanisms are different. The Dutch disease theory is based on a positive demand shock of raw material which leads to labor and resources reallocation towards the non-tradable sector to the detriment of other tradable sectors (Corden and Neary, 1982; Krugman, 1987; Neary and Van Wijnbergen, 1986). The excess demand in the non-tradable sector implies a change in the relative prices and thus an appreciation of the exchange rate detrimental to the non-resources tradable sector. Dutch disease appears to be a market failure that impedes the economy industrialization and by extension economic growth. However, there is no empirical evidence for the Dutch disease diagnosis in natural resource rich countries (Davis, 1995; Oomes and Kalcheva, 2007).

In a different vein, the second stand of the natural resource curse literature focuses on institutional explanations, either if the weakness of political institution is pre-resource boom or if it occurs after the boom. Sala-i-Martin and Subramanian (2003) were among the first to look for a political link as an explanation of the connection between resource abundance and poor economic growth. Adopting the Sachs-Warner cross-sectional empirical strategy, they found that, while resource abundance is linked to slow economic growth, the entire effect operates through an institutional channel, represented by a rule of law index. If the institutional effect is controlled for, resource abundance has no further direct effect on economic growth. Overall, we can summarize the institutional effect by variants of Rent-seeking behavior in natural resource countries. Lane and Tornell (1996) and Tornell and Lane (1999) highlight a voracious effect through which governments transfer wealth from private sector to powerful interests, possibly by taxation, theft, bribe channels, forced participation, nationalization or expropriation. Torvik (2002) and Mehlun et al. (2006) stress the negative effect on growth of the switching behavior of individuals from increasing returns to scale industries to non-productive rent-seeking. The institutional arguments cover also the significant effect of natural resource to erode country's political institution and to conduct to conflicts, especially when the degree of fractionalization is high (Hodler, 2006; P*opov and Zhuravskaya, 2007*; Bjorvatn et al, 2012).

Concurrently to these arguments, the historical experience of some countries combined to empirical studies exhibit a positive link between natural resources and economic growth. The development of manufacturing in the U.S. in the 19th and 20th centuries, as well as the recent development of industry in Australia and Norway, could be widely related to their energy commodity wealth (Wright and Czelustra, 2004). Moreover, *Pomerantz (2001)* and Allen (2009) place energy commodity centre-stage in their explanations of why the industrial revolution occurred in Britain. Davies (1995) challenged the conclusions of the resource curse by investigating the performance of mineral and non-mineral in relation to GNP per capita and social indicators. He finds no evidence that commodity rich countries performed less well. Lederman and Maloney (2007*)*, Manzanon and Rigobon(2007) as well as Bravo-Ortega and De Gregorio (2007) support this result.

The overall picture that emerges is that both the curse and the blessing theories are possible, depending of the natural resource level dependence of the economy. This paper contributes to this debate by testing the level of dependence of the economy on energy commodity. We assume that the energy commodities play a double role in the economic growth: first as an abundant production factor and second as a revenue source.

3. Methodology

In this section, we present the panel smooth transition regression model as well as the tests preceding the parameter estimation. First, we describe the model and its properties. Second, we introduce the set of necessary tests before parameter estimation.

a. Model specification

As notice before, the main question is here to resolve the heterogeneity and time variability issues associated with the empirical literature on the resource curse. As mentioned in the introduction, the PSTR specification has the main advantage to allow parameters to vary across countries and over time. Following Gonzales et al. (2005), in the case of two regimes and a single transition function, the model can be written as follows:

$$y_{it} = \mu_i + \beta_0 x_{it} + \beta_1 x_{it} G(s_{it}; \gamma, c) + \alpha_0 z_{it} + \varepsilon_{it};\ i=1,...,N, \text{ and } t=1,...,T. \quad (1)$$

N and *T* denote the cross section and time dimensions of the panel, respectively and ε_{it} is independently and identically distributed error term for all i and t. y_{it} is the dependent variable of economic growth, μ_i is a vector of individual fixed effects, x_{it} is the vector of time-varying explanatory variables (regime dependent variables) and z_{it} is the vector of time-invariant regressors (regime independent variables). The transition function $G(s_{it}; \gamma, c)$ is a continuous function of the observable transition variable s_{it} and is normalized to be bounded between 0 and 1. These extreme values are associated with regression coefficients β_0 and $\beta_0 + \beta_1$ which represent the coefficients associated with the explanatory variables in the linear and in the nonlinear regimes respectively. γ is the transition or slope parameter, describing the slope of the transition function. c is the location parameter.

Theoretically, a smooth transition mechanism can be modeled using various transition functions as long as they are continuous and integrable on [0,1]. We follow Gonzales et al. (2005) and retain the logistic specification as follows:

$$G(s_{it}; \gamma; c) = \left[1 + \exp\left(-\gamma \prod_{j=1}^{m} (s_{it} - c_j)\right)\right]^{-1} \text{with} \quad \gamma > 0 \quad \text{and} \quad c_1 \leq c_2 \leq \cdots \leq c_m. \quad (2)$$

Where γ determines the smoothness of the transitions and $c = (c_1 \ldots c_m)'$ is an m-dimensional vector of location parameters. Gonzales et al. (2005) indicate that it is usually sufficient to consider the cases of $m=1$ or $m=2$. These values generally permit the necessary changes in the slope coefficient to account for a majority of non-linearity due to regime changes. For $m=1$, the model means that the two extreme regimes are associated with low and high values of s_{it} and the change is centred around c_1. When $\gamma \to \infty$, the transition function becomes an indicator function and the PSTR reduces to the panel threshold regression (PTR) model of Hansen (1999). In contrast when $\gamma \to 0$, the transition function becomes constant and the model collapses into a homogeneous or linear panel regression model with fixed effects. In the case of *m=2*, the transition function has its minimum at $(c_1 + c_2)/2$ and attains the value of 1 both at the low and high values of the transition variable. Therefore, the model becomes a three-regime model whose outer regimes are identical and different from the middle regime.

In line with Gonzales et al. (2005), the testing strategy is a step by step procedure. First, we test for linearity: if the null hypothesis is not rejected then the testing strategy has to be stopped and a different transition variable has to be tested. On the contrary, if the null hypothesis of linearity is rejected, the second step consists in testing the non-remaining linearity i.e. testing the number of regimes. Finally, we proceed to the estimation of parameters.

b. Linearity test and parameter estimation

Gonzales et al. (2005) outlined a procedure for testing linearity against PSTR model in line with Luukonen, Saikkonen and Terarsvirta (1988).

Indeed, testing $\beta_1 = 0$ is non standard because the PSTR model is not identified under the null hypothesis (c and γ are unidentified nuisance parameter). In the same way, testing $\gamma = 0$

$$y_{it} = \mu_i + \beta'_0 x_{it} + \beta'_1 x_{it} s_{it} + \cdots + \beta'_m x_{it} s_{it}^m + \alpha_0 z_{it} + \varepsilon'_{it} \quad (3)$$

where the parameter vectors $\beta'_1, \dots, \beta'_m$ are multiples of γ and $\varepsilon'_{it} = \varepsilon_{it} + R_m \beta_1 x_{it}$ with R_m is the remainder of the Taylor expansion. Therefore, testing $H_0\!: \gamma = 0$ is equivalent to testing H_0: $\beta'_1 = \cdots = \beta'_m = 0$. Two usual tests for this null hypothesis are identified in the related literature: the Lagrange Multiplier-based test *(LM)* and its Fisher version *(LM_F):*

$$LM = \frac{TN(SSR_0 - SSR_1)}{SSR_0} \text{ and } LM_F = \frac{\frac{(SSR_0 - SSR_1)}{mk}}{\frac{SSR_0}{TN-N-m(k+1)}} \quad (4)$$

where SSR_0 is the panel sum of squared residuals under H_0(the linear panel with fixed effects), SSR_1 is the panel sum of squared residuals under the PSTR hypothesis and *k* is the number of explanatory variables. Under H_0, the *LM* statistic is asymptotically distributed as $\chi^2(mk)$while the *F*-version has an *F (mk,TN-N-m(k+1))* distribution.

If the null hypothesis of linearity is rejected, the next step is to test the number of transitions function in the model or equivalently the number of extreme regimes. Basically, this test aims at testing whether the total model heterogeneity is captured by the first transition function or whether there is a need for a second transition function. In other words we test the null hypothesis of two regimes (r=1) against the alternative hypothesis of three regimes (r=2). The underlying model becomes:

$$y_{it} = \mu_i + \beta_0 x_{it} + \beta_1 x_{it} G_1\left(S_{it}^{(1)}; \gamma_1, c\right) + \beta_2 x_{it} G_2\left(S_{it}^{(2)}; \gamma_2, c\right) + \alpha_0 z_{it} + \varepsilon_{it} \qquad (5)$$

As before, the transition function is replaced by a Taylor expansion around $\gamma_2 = 0$. Therefore the resulting test collapses into the linearity test discussed before.

Next, we proceed to the parameter estimation of the PSTR model in two steps: first, we remove the individual fixed effects. Second, since the smoothness parameter γ and the location parameter *c* are endogenously determined, we use a grid search to choose the starting values of these parameters. Then, we estimate the other parameters by Non-linear Least Squares (NLS). Note that with normally distributed errors, this procedure is equivalent to the maximization of a concentrated log-likelihood as suggested by Gonzalez et al. (2005).

4. Economic growth determinants and oil dependence

a. Variables discussion

In the present discussion, we focus on the effect of oil dependence on economic growth determinants and by extension on economic growth. Following Boschini et al (2012), we keep two measures of oil dependence, namely oil rent and oil exports, both expressed in proportion of GDP. While most of previous studies exploring the resource curse used a country's dependence on oil exports –that is, the value of its petroleum exports as a fraction of its gross domestic product-, in this paper we count for the oil sold domestically by using oil rent as proxy for oil dependence.

Each of these measures will be involved as transition variables in a separate model to determinate the threshold effect of oil dependence on economic growth.

We split the set of economic growth determinants into two categories. The first one consists in the regime independent variables, namely initial level of GDP (to control for conditional convergence), investment as a ratio of real GDP, age dependency (to control for the structure of population). These variables should not be affected by the level of oil revenues and consequently by the transition variable. The second one consists in variables which are likely to be sensitive to oil revenues i.e. regime dependent variables: the ratio of government consumption to GDP, the extent of international openness, the domestic consumption of fossil fuel and institutional quality.

Indeed, in most of oil exporting countries, the governments spend a large part of the oil rent on financing infrastructure and production projects as well as on direct public transfers and subsidization. Thus these expenses are directly affected by the amount of oil revenues. The international openness measured by the sum of exports and imports as a proportion of GDP, is more likely to arise as the proportion of oil exports grows. We also add fossil fuel consumption as a regime dependent variable. Indeed, despite the positive contribution of natural capital to economic growth, the context of growing foreign demand of oil may reduce the fossil fuel consumption.

Finally we include variables related to institutional quality. Considering the institutional quality, previous studies on natural resource curse use indicators that capture the rules of law (Rodrick, Subramanian, and Trebbi; 2002), measures of an expropriation risk for investors (Acemoglu, Johanson, and Robinson; 2001) or indicators of transparency (Williams, 2011). Some other studies focus on the political structure – for instance, Bjorvatn, Farzanegan and Schneider (2012) use the political fractionalization in understanding the resource curse. In fact, and according to the "rent cycling theory" enunciated by Auty (1990, 2001, 2007, 2009), high-rent countries elicits a political contest to capture ownership whereas in low-rent countries, the government motivates people to create wealth by promoting quality, and fostering civil society. Therefore, the two main questions for economic growth in most of oil exporting countries is "what do governments do with this rent?" and "how does the quality of government decisions evolve with oil rent?" For these reasons, and to shed light on the underlying connections between quality of political decisions and pertinence of economic strategies, we choose to use an indicator of "government effectiveness". This aggregate index reflects the quality of policy formulation and implementation as well as the credibility of the government's commitment to such policies and the degree of independence from political pressures. Finally we include this index among the regime dependent variables to test for to variation of government quality with the level of oil dependence.

b. The models estimated

We define three models to test the hypothesis of natural resource curse. In the first model (called model A), we assume that the transition mechanism in the economic growth equation is determined by oil rent. We are expecting that the stronger is the oil dependence, the higher is the negative effect of oil rent on the economic growth determinants. In the second specification (model B), we control for our results by using the ratio of oil exports instead of the oil rent as a proxy for oil dependence. Finally, we test for a third specification (model C) where the transition variable is the ratio of oil exports and we include the fossil fuel consumption among the regime dependent variables. The rationale behind the latter specification is to investigate the direct contribution of oil endowment as a production factor rather than a mere source of revenue as well as the variation of fossil fuel consumption with the oil exports. The PSTR model can be written as follows:

$$y_{it} = \mu_i + \beta_1^0 s_{it} + \beta_2^0 open_{it} + \beta_3^0 govex_{it} + \beta_4^0 instiqual_{it} + [\beta_1^1 s_{it} + \beta_2^1 open_{it} + \beta_3^1 govex_{it} + \beta_4^1 instiqual_{it}] G(s_{i,t-1}; \gamma, c) + \alpha_0 z_{it} + \varepsilon_{it} \; ; \; i=1,\dots,N, \text{ and } t=1,\dots,T. \qquad (6)$$

and

$$G(s_{i,t-1}; \gamma; c) = \left[1 + \exp\left(-\gamma \prod_{j=1}^{m} (s_{i,t-1} - c_j)\right)\right]^{-1} \qquad (7)$$

Where y_{it} denotes the economic growth per capita. $open_{it}$ is the openness ratio, $govex_{it}$ is the ratio of government expenditure and $instiqual_{it}$ represents the government effectiveness. The set of regime independent variables is represented by z_{it}, namely; the initial level of GDP, investment and age dependency.

The lagged transition variable $s_{i,t-1}$ represents i) the oil rent in model A, ii) the ratio of oil exports to GDP in model B and C. As mentioned by Fouquau, Hurlin and Rabaud (2008), the transition variable may have a direct effect on the dependent variable (the economic growth in this paper). In this case, one could misleadingly find switching. To avoid this shortcoming, we replace the current transition variable with a lagged transition variable to proceed to the estimation of the PSTR.

5. Data and empirical results:

a. Dataset and descriptive statistics

The panel dataset includes 23 oil exporting countries and covers the period 1996-2011. The variables used in this paper stem from the World Bank Indicator, International Financial Statistics (IFS) and United Nations Database. The data description and sources are presented in Appendix A. Appendix B reports descriptive statistics of all the variables used. Note that we also compute standard panel unit root tests to avoid spurious regressions problems. All the variables are stationary[3] and the PSTR model is thus well pecified.

b. Linearity tests:

The first step consists in testing the linearity existence. Table 1 depicts the results of linearity test. The two statistics lead to strongly reject the null hypothesis of linearity in the effect of oil dependence on economic growth determinants for each of our three models. The table presents also the test for no remaining non-linearity after assuming a two-regime model (r=1). The results show that the null hypothesis cannot be rejected, implying that the model exhibits only two regimes. Therefore, the coefficients fluctuate between a low regime and a high regime delimited by the threshold (c) and the slope parameter.

Table 1. *Linearity and no-remaining linearity tests*

Model	Model A	
Threshold variable	Oil rent (%GDP)	
	LM	LM_F
$H_0: r = 0\ vs. H_1: r = 1$	21.369 (0.00)	5.261 (0.00)

[3] The results are available upon request

$H_0: r = 1\ vs. H_1: r = 2$	4.108 (0.53)	0.739 (0.59)

Model	Model B	
Threshold variable	Oil exports (%GDP)	
	LM	LM_F
$H_0: r = 0\ vs. H_1: r = 1$	41.473(0.00)	3.522(0.00)
$H_0: r = 1\ vs. H_1: r = 2$	3.925(0.56)	0.705 (0.62)

Model	Model C	
Threshold variable	Oil exports (%GDP)	
	LM	LM_F
$H_0: r = 0\ vs. H_1: r = 1$	23.487(0.00)	4.643(0.00)
$H_0: r = 1\ vs. H_1: r = 2$		

Note: The p-values are reported in parentheses

c. <u>Parameter estimation:</u>

Table 2. *PSTR model estimation*

Model	Model A	Model B	Model C
Threshold variable	Oil rent	Ratio expo	Ratio expo
Initial level of GDP	-0.050***	-0.046***	-0,055***
Invest.	0.111**	0.124**	0.108**
Labor	0.089 ***	0.070***	0.046 *
Oil rent	0.330***		
Oil exports		0.270***	0.349***
Gov. effectiveness	0.052***	0.096***	0.144***
Fossil fuel consumption			0.014**
Openness ratio	-0.061***	-0.034	-0.042
Govex	0.114	0.001	-0.143**
Oil rent* $G(s_{i,t-1}; \gamma, c)$	-0.096***		
Oil exports* $G(s_{i,t-1}; \gamma, c)$		-0,076***	-0.077*
Gov.effectiveness* $G(s_{i,t-1}; \gamma, c)$	-0.045**	-0.156***	-0.117***
Fossilfuel consumption* $G(s_{i,t-1}; \gamma, c)$			0.001
Openness ratio * $G(s_{i,t-1}; \gamma, c)$	0.247***	0.016	0.027
Govex * $G(s_{i,t-1}; \gamma, c)$	-0.680**	-0.186***	-0.154
γ	16.81	5.00	3.89
C	51%	44%	28%

Notes: The dependent variable is the growth of real GDP per capita. γ and c respectively denote the estimated slope parameter and the estimated location parameter in equation (7).

***: significance at 1% level
**: significant at 5% level
*: significant at 1% level

Table 2 reports the parameter estimates of the PSTR specification of the determinants of growth in oil exporting. Considering the set of control variables, the results from the three PSTR specifications lead to similar results. The estimated coefficient of initial GDP confirms the conditional convergence hypothesis that has been reported in various studies (Barro,1991; Mankiw, Romer, and Weil, 1992). Thus the initial economic position is determinant for economic growth. The ratio of domestic investment to GDP and the total labor force have positives and statistically significant coefficient and are consistent with findings in the literature.

The first PSTR specification (Model A) uses oil rent as transition variable which defines the low and the high regimes of oil dependence. Below the threshold of 51% of oil dependence, the government effectiveness indicator and oil rent increase economic growth by 5.2 % and 33% respectively. However, in the high regime of oil dependence, this positive effect wears off and even turns negative. Above the level of 51% of oil dependence, there is a clear evidence of resource curse through the significant negative effect of government effectiveness (decrease economic growth by 4.5 %) and oil rent (decrease economic growth by 9.6 %). We also have to notice the positive interaction between openness and high oil dependence and the negative association between government expenditure and the high level of oil rent.

In order to improve our results, we use another proxy for oil dependence as threshold variable, namely the ratio of oil exports to GDP (Model B). The results obtained from this second specification of the PSTR model are convergent with those from the model A. Finally, the model C highlights the positive contribution of fossil fuel to economic growth as long as the level of oil dependence does not exceed the threshold of 28%. Above this level, the effect is still positive but not significant.

Overall, we can also notice the relatively low values of the smoothness parameters (especially in models B and C) and then the use of the PSTR modeling.

d. Discussion:

It comes from these results, that high oil dependence worsened the institutional quality and by extension the economic growth. In fact, we can distinguish between a direct and an indirect effect of institutional quality. The first one is given directly by government effectiveness through the quality of public services and the ability to implement policy independently from political pressure. The second effect is a consequence of the government effectiveness through the quality of government expenditure. Looking at the results, the contribution of government expenditures smoothly switches from positive in the low oil dependence regime to negative in the high regime. Barro (2003) explains that a negative effect on economic growth because government expenditures do not affect productivity directly and entail distortion of private decisions. In the case of oil exporting countries, the oil rent is spent on large government bureaucracies as well as financing infrastructures and production projects. The latter part could, in principle, be a growth stimulant. However, that role is often undermined owing to the inefficiencies in investment and infrastructure. Gavin (1993) points out "the tendency for governments to invest in projects with high prestige or political payoff, but with little economic rationale" and Esfahani (2006) noted that in oil-rich countries of MENA, a large part of oil revenues are transferred in the form of mass subsidies on energy, staple foods and credit. Thus the quality of government expenditure reflects the governmental activities and quality themselves.

The literature offers several hypotheses to explain the linkages between bad government performances and natural dependence. For instance, Acemoglu and Robinson (2006) model underdevelopment as the result of political elites blocking technological and institutional development because such development may erode the elite's incumbency advantages. Such blocking is more likely to arise when the rents from maintaining power are high, such as where public income is derived from natural resources. To draw a parallel with our results, beyond the threshold of a 51% contribution of oil rent on GDP, there exists such an inefficiency of governments. Moreover, one special feature of the government effectiveness indicator is the government commitment to the policies. Levy and Spiller (1996) and Esfahani (2006) define commitment as the cost that policymakers must bear if they decide to reverse an adopted policy in ways that take away the returns to investments made in response to that policy. If the politicians can change policies with no cost to themselves, they may find it convenient to ignore the losses of the producers, and thus discourage entrepreneurs from investment in the first place. Acemoglu (2003) develops a simple model where commitment problems lead to inefficient policies and institutions and by extension to lower outcomes.

From the previous results, we also report a direct negative effect of oil revenues on economic growth when the level of oil dependence exceeds the threshold of 51% using oil rent and 44% using oil exports. The rationale behind these results lies in the high instability of oil revenues. The macroeconomic imbalances induced by the uncertainty of oil revenues are one of the arguments in favor of the resource curse. Indeed, the uncertainty of unanticipated output growth has a negative effect on growth and thus the positive effect of resources on growth is swamped by the indirect negative effect through volatility. Therefore, oil economies which are highly dependent in oil revenues are more likely exposed to drawbacks from oil volatility. Van der Ploeg and Poelhekke (2009) finds that natural resource exports typically have a positive direct effect on growth, but a larger, indirect, negative effect due to the economic volatility that they create.

In the third PSTR specification (Model C), we use the ratio of oil exports as threshold variable and we introduce the domestic fossil fuel consumption as an economic growth determinant in addition to the previous regime dependent variable. The results from the model C, highlight the positive contribution of fossil fuel consumption to economic growth. However, this effect is extremely robust in the low regime but less in the high regime. Indeed, the oil endowment and the higher oil subsidization lead to low energy prices which is used as a tool to distribute state benefits to the population as well as to promote industrialization and economic diversification[4]. Therefore, the oil exporting countries are among the most-energy intensive economies in the world because of the rising domestic demand and the development of energy-intensive industries. Consequently, arising fossil fuel consumption arise economic growth and denotes a positive effect of natural resource on economic development.

6. Conclusion

[4] According to IEA measures and report, oil exporting countries are among the largest subsidizers of energy in the world. "Joint report by IEA, OPEC, OECD and World Bank on fossil fuel and other energy subsidies: An update of the G20 Pittsburgh and Toronto Commitments, 2011"

This paper presents new insights into the analysis of the relationship between natural resource and economic development when considering a sample of oil exporting countries. The data covers 23 oil exporting countries for the period 1996-2011. We follow earlier studies and use two measures of oil dependence: oil rent and oil exports as proportion of GDP. This paper's most significant innovation is an improved econometric methodology that overcomes the constancy parameter -across countries and over time- of standard regression. We use a Panel Smooth Transition Regression model and highlight the existence of a threshold of oil dependence which determines two regimes. The threshold is around 51% of oil rent and 44% of oil exports. The low regime of oil dependence is below these thresholds whereas the high regime is located above. Considering the effect of oil incomes both on economic growth and on its determinants, the impact is positive in the low regime whereas it turns negative in the high regime. Therefore there is no resource curse as long as the fraction of oil rent is below the level of 51%. The countries, where this level is upper, present evidence of resource curse through three channels: i) the direct negative impact of oil incomes on economic growth due to the high instability of petroleum revenues which discourages in turn private sector investment ii) fluctuations in the government's resources revenues undermine the quality of government's expenditure iii) finally, high oil revenues impede the government effectiveness. Contrary to previous studies on resource curse, we also consider the role of oil as an input in the production function. From that perspective, the results show a positive contribution of fuel consumption to economic growth. Our evidence strongly suggests that oil is an engine to economic growth through domestic consumption and in the case of low oil dependence. Nonetheless in the case of high oil dependence, the oil revenues are mostly a hindrance to economic growth.

Appendix A

List of countries

Algeria	Kuwait
Angola	Malaysia
Azerbaijan	Mexico
Bahrain	Nigeria

Bolivia	Oman
Brazil	Qatar
Cameroon	Russian Federation
Ecuador	Saudi Arabia
Gabon	United Arab Emirates
Indonesia	Venezuela
Kazakhstan	Yemen

Appendix B

Data description

Variable	Description and Source
GDP	Real GDP per capita (constant 2005USD). Source: United Nation Database
Investment	Gross Fixed Capital Formation (% of GDP). Source: United Nation Database
Age dependency	Logarithm of age dependency ratio (% of working age population). Source: World Bank Indicator.
Oil rent	Oil rents are the difference between the value of crude oil production at world prices and total costs of production (% of GDP). Source: World Bank Indicator.
Oil exports	The price per unit of oil exports multiplied by the number of quantity units (% of GDP). Source: World Economic Outlook (WEO) data, IMF.
openness	Sum of imports and exports (% of GDP). Source: United Nation Database
Govex	Government consumption (% of GDP). Source: United Nation Database
Gove.effectiveness	Government Effectiveness Index. Scale from -2.5 (weak) to 2.5 (strong). Source: Worldwide Governance Indicators (WGI).
Fossil fuel consumption	Logarithm of fossil fuel consumption per capita (Kg of oil equivalent per capita). Source: World Development Indicators.

Appendix C

Summary statistics

Variable	Mean	Std. Deviation	Minimum	Maximum
Growth of GDP per capita	0.024	0.052	-0.161	0.283
Oil rent	0.247	0.222	0.003	2.095
Invest.	0.221	0.081	0.055	0.552
govex	0.143	0.067	0.011	0.647
Openness ratio	0.842	0.413	0.205	2.209
Labor	4.049	0.370	2.806	4.739

Oil exports	0.297	0.305	0.001	3.358
Fossil fuel consumption	3.481	4.583	0.058	23.071
Gove.effectiveness	-0.289	0.642	-1.462	1.240

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