A Curse or a Blessing?
Natural Resources in a Multiple Growth Regimes Analysis

October 2011

Abstract

The literature on the impact of an abundance of natural resources on economic performance remains inconclusive. In this paper we consider the possibility that countries may follow different growth regimes, and test the hypothesis that whether natural resources are a curse or a blessing depends on the growth regime to which economy belongs. We follow recent work that has used a mixture of regression method to identify different growth regimes, and find two regimes such that in one regime resources have a positive impact on growth, while in the other they have a negative impact or at best have no impact on growth. Our analysis of the determinants of whether a country belongs or not to the blessed resources regime indicates that the level of democracy plays an important role while education and economic institutions have no effect.

JEL Classification*:* O13-O47

Key words*:* Natural Resources, Mixture of regression, Multiple equilibria

1 Introduction

During the last decade the question of the impact of an abundance of natural resources on growth and its transmission channels has received substantial attention. Despite the extensive literature on the topic, no consensus has emerged on whether natural resources are a curse or a blessing. On the one hand, there is evidence of a negative marginal impact of natural resources on economic performance (see Sachs and Warner (1999), Sachs and Warner (2001), Gylfason (2001) and Leite and Weidmann (2002) among others). Different channels of transmission have been proposed to explain the curse, starting with the Dutch Disease (Corden (1984)). It has also been suggested that the curse can be due to rent-seeking behavior that increases tariffs and/or corruption, which in turn reduce growth (see Bardhan (1997) and Leite and Weidmann (2002)), and that natural resources crowd-out education (Gylfason (2001)) and quality of institutions (Sachs and Warner (1999)). On the other hand, more recent evidence rejects the curse. For instance Manzano and Rigobon (2007) find no evidence of the resource curse when adding country fixed-effects, while the results in Alexeev and Conrand (2009) support a robust positive impact of natural resources on gdp. Moreover, the success of countries such as Botswana,[1] rich in natural resources and with high growth rates, challenges the notion of curse.

Recent empirical evidence has thus started to determine conditions under which the curse can be turned into a blessing by allowing for heterogeneity in the coefficients on natural resources (see Bravo-Ortega and De-gregorio (2007), Mehlum et al. (2006), Andersen and Aslaksen (2008), Collier and Hoeffler (2009)). The common approach in those papers is to interact natural resources with variables such as education or institutions, to determine whether for instance an increase of the level of education decreases the magnitude of the curse and at some level could turned the curse into blessing. This approach allows for heterogeneity in the impact of some variables, yet they impose, without testing, common coefficients on most of the regressors included in the models, thus neglecting heterogeneity on other regressors that may have an impact on the coefficients of our variable of interest, natural resources.

This paper contributes to the literature addressing the heterogeneity in the resource curse by considering the fact that countries are heterogeneous and may follow different growth regimes or processes, and ask the question of whether the sign of the impact of natural resources depends on the growth regime that a given country belongs to. We suggest that there may be multiple growth regimes such that the marginal impact of explanatory variables on growth differs across regimes, enabling us to test whether an abundance of natural resources has a negative impact on growth in some regimes and a positive impact in other regimes. To shed light on the role of education and institutions, we employ a different strategy compared to the previous papers. We test whether education / or institutions affect the probability of

[1] Also, Norway, Canada and the United States are examples of countries rich in natural resources but do not suffer from the curse of natural resources.

a given country belonging to the blessed growth regimes. We estimate a finite mixture of regressions model, a semi-parametric method for modeling unobserved heterogeneity in the data, in which countries are sorted into regimes depending on the similarity of the conditional distribution of their growth rates given all the explanatory variables. This approach presents two main advantages. First, we relax the hypothesis of a single growth regime and allow the data to detect the number of regimes, which gives more flexibility and a better fit compared to the literature in which one growth regime is imposed. Second, instead of imposing a priori groups of countries (for instance some studies divide samples into high- and low-income countries, democracies and autocracies), we sort countries into blessed and cursed regimes in terms of their estimated posterior probability of being in one or another regime, which we endogenise and suppose to be a function of education, institutions and geographic features.

Our results indicate that the data is best generated by a model of two regimes, one in which an abundance of natural resources has a positive impact on growth and one in which it has a neutral or a negative impact depending on the measure of natural resources that we consider. We also find that more democracy increases the probability of a given country belonging to the blessed regime but economic institutions and education do not have an impact on that probability. The geographical location such as being a Sub-Saharan African or Latin-American country has no impact on the classification of countries into regimes. In the first regime the average annual growth rate is 2.32% and 42% of countries belongs to this group, while the annual growth rate in the second group is 1.5% with 58% of countries belonging to it. There is substantial heterogeneity within each group both in term of gdp levels and geographical location, indicating that democracy is not acting as a proxy for these features.

This paper is related to three strands of literature on empirics of growth. First it contributes to the literature on the relationship between natural resources and economic performance. [2] In their seminal work Sachs and Warner (1999) and Sachs and Warner (2001) provide evidence of a negative impact of natural resources on growth and find no support for the idea that geographic features or climate explain the resource curse. Further evidence on the resource curse has been provided by Gylfason (2001), Leite and Weidmann (2002), Papyrakis and Gerlagh (2004) and Papyrakis and Gerlagh (2007), who analyze both the direct impact of natural resources on growth rates and the indirect one, operating through the effect of resources on physical and human capital investments.

Our analysis follows closely the literature focusing on the conditions under which a resource curse can be turned into a blessing, thus accounting for heterogeneity. Mehlum et al. (2006) interact natural resources with an index of rule of law, ranging from 0 to 1, and find that the resource curse disappears when the index of rule of law is at least 0.93. This value decreases to 0.6 when they replace the export of primary goods in total gdp (also known as Sachs and Warner measure of natural resources) by the share of

[2] For a survey of the existing hypotheses and analyses see Ploeg (2011).

mineral production in national income. Bravo-Ortega and De-gregorio (2007) show how natural resources interact with education and find that a high level of education helps reduce the resource curse. Collier and Hoeffler (2009) investigate whether democracy can offset the resources curse, and their results indicate that a combinaison of high resource rents and democracy is growth-reducing but this negative effect can be offset by setting checks and balances in resource rich countries. Andersen and Aslaksen (2008) examine whether features of constitutions determine how an abundance of natural resources affects economic growth. They find that the curse is present in democratic presidential countries but not in parliamentary democracies, and that being parliamentary or presidential is more important than being a democracy or an autocracy. All of these papers assume that all countries follow the same growth process and allow for parameter heterogeneity only in some chosen variables. We propose a more flexible approach that considers parameter heterogeneity for all the variables of the model, so that countries can belong to different growth regimes. We then examine whether the impact of natural resources on growth differs across regimes. Furthermore, rather than imposing the interaction between resources and a particular variable, we consider several potential determinants of growth regime membership and test whether they help a given country to belong to the resource blessed regime.

Our paper is also related to the literature that tests for the existence of multiple growth processes. Starting with the Classification Analysis and Regression Tree (named CART) proposed by Durlauf and Johnson (1995) the question of multiple growth regimes has been addressed in numerous papers. Although the CART method is an endogenous grouping method based on thresholds of splitting variables selected a priori, its disadvantage is the lack of available asymptotic properties that would be useful for drawing inference on threshold variable choices and threshold values estimations. More sophisticated clustering methods have been presented in order to make the classification as flexible as possible. Recent work has applied the mixture of regression method to address the multiple regimes hypothesis, an approach that presents a number of advantages over previously used methods (see section 2.2 below). Owen et al. (2009) apply the mixture of regression method to answer the question *Do all countries follow the same growth process?* and find that their panel data is best generated by two different growth processes. Using the same methodology, Flachaire et al. (2011) examine the direct and indirect roles of economic and political institutions in the process of development, and their results indicate that political institutions are the main determinant of which growth regime a country belongs to, while economic institutions have an direct impact on growth rates within each of the two regimes. Mixture regressions have also been used by Bos et al. (2010) and Vaio and Enflo (2011) to examine respectively, growth in the very long-run (using historical data) and the possibility of countries switching regimes. Neither of these papers considers the role of natural resources, yet the framework is obviously suited to examine the question.

The paper proceeds as follows. Section 2 presents the econometric methodology. Section 3 describes the data while section 4 presents the main results. The next section checks the robustness of the results while some concluding comments are provided in section 6.

2 Econometric specifications

2.1 Standard specification

The standard parametric specification of the framework is in the following form:

$$\begin{aligned} \mathsf{growth}_{\mathsf{i,t}} &= \beta_0 + \beta_1 \log(\mathsf{gdp}_{\mathsf{0,i,t}}) + \beta_2 \log(\mathsf{pop}_{\mathsf{i,t}} + 0.05) + \beta_3 \log(\mathsf{inv}_{\mathsf{i,t}}) + \beta_4 \log(\mathsf{educ}_{0,i,t}) \\ &\quad + \beta_5 \mathsf{NR}_{\mathsf{0,i,t}} + \beta_6 \mathsf{eco}_{\mathsf{i,t}} + \beta_7 \mathsf{dem}_{\mathsf{i,t}} + \varepsilon_{i,t} \end{aligned} \tag{1}$$

The dependent variable is the average annual growth of real gdp per capita ($growth_{i,t}$) while the independent variables are initial gdp per capita ($gdp_{0,i,t}$), the population growth rate ($pop_{i,t}$) plus a term 0.05 capturing depreciation and technological change, the average investment rate ($inv_{i,t}$), the initial level of education ($educ_{0,i,t}$), the initial endowment in natural resources ($NR_{0,i,t}$), the average level of economic institutions ($eco_{i,t}$) and the average level of democracy ($dem_{i,t}$).

We assume that the error terms ε_{it} are identically and independently distributed and follow a normal distribution with mean zero and variance σ^2. Our parameter of interest is the coefficient on the natural resources variable β_5. A negative β_5 confirms the resource curse hypothesis while a positive β_5 implies that resources are a blessing. Economic institutions have been found to be a robust determinant of growth rates in many studies[3] but there is only weak evidence that political institutions (here measured by democracy) are a robust regressor of growth rates. Political institutions (democracy), have been found to have a weak direct impact on growth but a strong indirect impact through the effect that economic institutions and policies have on growth or through their impact on the choice of policies and economic institutions in a country.[4] We expect the coefficient β_6 on economic institutions to be positive and significant while we do not expect a particular sign on the coefficient on democracy, β_7.

The specification in equation 1 assumes that there is a single growth model which explains the process of development for all countries. If the observations of our dataset are not generated by a single growth regime, the estimation of equation 1 will produce biased results. A biased estimate of the coefficient β_5 could thus lead to the wrong conclusion on whether or not there is a resource curse. For instance if for some countries β_5 is positive and for others β_5 is negative, in a single regression it may turn out insignificant. To overcome this problem we propose to use the mixture-of-regression method.

[3] See Glaeser et al. (2004) and Flachaire et al. (2011) among others.
[4] See Acemoglu et al. (2005), Eicher and Leukert (2009) and Flachaire et al. (2011).

2.2 Finite-mixture-of-regression models

Finite-mixture-of-regression models, also known as Generalized Mixture Regression Models, are semi-parametric methods for modeling unobserved heterogeneity of the population in the estimation of a regression model. We relax the hypothesis of one growth regime and assume K different homogeneous growth regimes such that the growth determinants have different marginal impacts across regimes. Thus we are able to test whether the marginal impact of an abundance of natural resources on growth differs across regimes.[5]

Let us consider $(Y, X) = (y_i, x_i)_{i=1}^{n}$ a pair of a random variable y_i and a set of explanatory variables x_i. By definition, the mixture of regression based on the density of Y conditional on X is expressed as follows:

$$f(y|x,\Theta) = \sum_{k=1}^{K} \pi_k f_k(y|x;\beta_k,\sigma_k) \tag{2}$$

where K is the number of groups or regimes, π_k is the probability of belonging to group k, and $f_k(y\,|x;\beta_k,\sigma_k)$ is a conditional probability distribution characterized by a set of parameters (β_k, σ_k) and of covariates x. Both β_k and σ_k are unknown and hence estimated. We suppose f_k is a Gaussian distribution with conditional expectations equal to $E(y|x) = x\beta_k$.

To illustrate, if $K = 1$, then all observations are generated by the same data-generating process given by:

$$y = x\beta + \varepsilon, \qquad \varepsilon \sim N(0,\sigma^2) \tag{3}$$

In this case the standard specification in equation 1 is sufficient to study the impact of natural resources on the growth rate. If $K = 2$ then a mixture of linear regressions assumes that an observation belonging to the first group and one belonging to the second group would not be generated by the same data-generating process. The mixture model with two components reduces to:

$$\begin{array}{lll} \text{Group 1:} \quad y & = x\beta_1 + \varepsilon_1, & \qquad \varepsilon_1 \sim N(0,\sigma_1^2), \\ \text{Group 2:} \quad y & = x\beta_2 + \varepsilon_2, & \qquad \varepsilon_2 \sim N(0,\sigma_2^2), \end{array} \tag{4}$$

where ε_1 and ε_2 are independent and identical normally distributed error terms within each group, with variances of σ_1^2 and σ_2^2, respectively. In this setting the impact of natural resources on growth could be different in the two regimes because the environment in which growth occurs is different across regimes. Since we are also interested in testing whether institutions and/or education help to classify countries into growth regimes, we extend the model in equation 2 by adding a set of additional variables ω, also known as *concomitant* variables, that explain group membership. *Concomitant* variables play the same role as covariates in a multinomial regression model designed to explain group membership. They

[5] Since this approach has been used before to analyze growth regimes we do not give all the steps of the functional form of the mixture of regression methods for panel data. For more details the reader is invited to refer to Owen et al. (2009).

directly affect the probability of a given country being in one or another growth regime, implying that parameter $\pi_k(.)$ becomes endogenous. The roles of standard covariates x and of concomitant variables ω are different: standard covariates help to explain variations *within groups*, whereas concomitant variables explain variations *between groups*. Equation 2 with concomitant variables becomes:

$$f(y|x,\omega,\Theta) = \sum_{k=1}^{K} \pi_k(\omega,\alpha_k) f_k(y|x;\beta_k,\sigma_k), \tag{5}$$

where α_k is a vector of parameters on concomitant variables ω and its sign helps to determine how a variation of ω impacts the probabilities of countries being in one or another regime.

For a given number of components K we estimate the finite mixture model by maximum likelihood with the EM algorithm of Dempster et al. (1977), which is the most common approach for the maximum likelihood estimation of finite mixture models. To avoid a singularity problem we ensure that the estimated parameter of σ_k is different from zero. The number of groups K is a priori unknown and the selection of the optimal value is crucial since it gives the true number of growth regimes generated by the data. We choose the optimal value of K by minimizing the Bayesian Information Criterion (BIC) developed by Schwarz (1978), and the Corrected Information Criterion (CAIC, see Burnham and Anderson (2002)). Those criteria are defined as follow:

$$\text{BIC} = -2\hat{\ell} + (\#\text{param}) \log n \tag{6}$$

$$\text{CAIC} = -2\hat{\ell} + \frac{(\#\text{param})2n}{n - (\#\text{param}) - 1} \tag{7}$$

where $\hat{\ell}$ is the estimated value of the log-likelihood and n is the number of observations. Once parameters are estimated, we can use Bayes rule to compute the probability that a given country is allocated to a given group k. The equation is written as follows:

$$\hat{\pi}_{ik} = \frac{\pi_k(w_i,\hat{\alpha}_k) f_k(y_i|x_i\,;\hat{\beta}_k,\hat{\sigma}_k)}{\sum_{k=1}^{K} \pi_k(\omega_i,\hat{\alpha}_k) f_k(y_i|x_i\,;\hat{\beta}_k,\hat{\sigma}_k)} \tag{8}$$

For classification purposes, a given country i will be allocated in group k rather than group l if and only if $\hat{\pi}_{ik} > \hat{\pi}_{il}$.

We will apply the mixture of regression method to equation 1, using as concomitant variables average levels of economic institutions ($\overline{eco}$), democracy ($\overline{dem}$) and the initial level of education ($log(educ_{70})$), as well a Sub-Saharan Africa dummy and a Latin-America dummy to control for geographical location.

The use of the mixture of regression models has at least three advantages. First, it allows to treat endogenously unobserved heterogeneity by considering simultaneously all the covariates and allowing them to have different marginal impacts across regimes. Second, countries are sorted into regimes in terms of probabilities which are a function of concomitant variables, thus we can compare the role of education, geography and institutions in allocating countries into regimes. Finally, the number of homogeneous growth regimes is a priori unknown and are selected optimally with respect to some information criterion. This means that if there are more than two ways in which resources affect growth, we should be able to identify them. It is important to note that our approach does not consider the indirect impact of natural resource through variables such as investment or education, a question that has received substantial attention in the literature (See Gylfason (2001)). In addition our model constrains countries not to be in different regimes at different periods since the concomitant variables are constant.[6]

3 Data and descriptive statistics

We build a 5-year panel of developed and developing countries for the period 1970-2005, which yields 7 periods: 1970-1975, 1975-1980, 1980-1985, 1985-1990, 1990-1995, 1995-2000 and 2000-2005. All the variables used except education, the measures of natural resources and institutions are from the Penn World Tables (version 6.3). Education comes from Barro and Lee (2010) and is measured by the average years of schooling in the population aged over 25. Our main measure of natural resource abundance is the share of exports of primary goods in total GDP ($xgdp$) which includes fuel and non-fuel goods. This measure, first proposed by Sachs and Warner (1999), has been extensively used in the literature. The data are provided by the World Development Indicators (WDI). Non-fuels goods comprise metals and ores, agricultural raw materials and food. In our analysis we will first use the aggregate measure of natural resources ($xgdp$). Sachs and Warner (2001) argue that the natural resources effect should be linked to the magnitude of economic rents they generate and it is possible that different types of resources yield higher or lower rents[7], hence we will distinguish minerals from agricultural goods since minerals yield in general higher rents. We will hence disaggregate $xgdp$ into its three components[8]: metal and ores ($Metal - Ores$), agricultural raw materials and food ($Agri - food$) and fuel ($Fuel$). Some authors (for instance Gylfason (2001)) define the share of primary exports as natural resources intensity rather than natural resources abundance, [9] so we will also use the rent per capita,[10] as a measure for natural

[6]The question of regime migration is a complex one and has been recently addressed by Bos et al. (2010).

[7]The different types of natural resources may have a difference in term of factors intensity, ownerships and costs of extraction which may imply a difference quantities of extracted rents (See Leite and Weidmann (2002)).

[8]As documented in the World Bank data Agricultural raw materials exports correspond to the SITC section 2 excluding divisions 22, 27 (crude fertilizers and minerals excluding coal, petroleum, and precious stones), and 28 (metalliferous ores and scrap); Food exports Food comprises the commodities in SITC sections 0 (food and live animals), 1 (beverages and tobacco), 4 (animal and vegetable oils and fats) and SITC division 22 (oil seeds, oil nuts, and oil kernels); Ores and metals comprise the commodities in SITC sections 27 (crude fertilizer, minerals nes) 28 (metalliferous ores, scrap), and 68 (non-ferrous metals) and Fuel exports comprise SITC section 3 (mineral fuels).

[9]The idea behind is that a country like Norway, has a low share of exports of primary products in total GDP because it has also developed the others sectors of the economy.

[10]Rent is defined as total revenue from natural resources divided by the population. The rent is provided by the WDI and it includes rent from energy, minerals and forest. Energy refers to crude oil, natural gas and coal, and mineral refers to bauxite, copper, iron, lead, nickel, tin, zinc, gold and silver. The rent of a unit of resource is defined as the gap between its world price and its country-specific extraction costs both expressed in US dollars, the obtained measure is then multiplied by the total quantity of resources extracted.

resources abundance in the robustness section.

Turning to the measures of institutions, we distinguish political institutions from economic institutions. Political institutions refer to how political choices are made while economic institutions refer to the consistency of those choices with voluntary exchange and the protection of property rights. We measure political institutions by the index of democracy from Polity IV, and economic institutions by the index of the Economic Freedom in the world from the Fraser Institute compilation.[11] The democracy index takes into account the competitiveness of executive recruitment, the openness of executive recruitment, the constraints on the executive, and the competitiveness of political participation. It ranges between 0 and 10, with a value of 0 denoting an autocratic government and a value of 10 full democracy. Economic freedom measures the extent to which property rights are protected and the freedom that individuals have to engage in voluntary transactions. This measure takes into account the respect of personal choices, the voluntary exchanges coordinated by markets, freedom to enter and compete in markets, and protection of persons and their property from aggression by others.

Table 1 shows the descriptive statistics and data sources. Note that $\overline{eco}$, $\overline{dem}$, $log(educ_{1970})$, Sub-Afri and Latin are concomitant variables, where $\overline{eco}$ and $\overline{dem}$ are the average value of economic institutions and democracy over the period 1970-2005, $educ_{1970}$ is the level of education in 1970 and Sub-Afri and Latin are respectively dummy for Sub-Saharan Africa countries and dummy for Latin-America dummy. Table 2 shows the correlation coefficients between variables. The correlation between the growth rate and the aggregate natural resources variable ($xgdp$) is negative, in line with the resource curse theory. In addition $xgdp$ is negatively correlated with investment in physical and human capital ($\log(inv)$, $\log(educ_0)$) and these variables are in turn positively correlated with the growth rate. This suggests that there may be an indirect negative impact of natural resources on growth through the investments in physical and human capital as already found in the literature (see Gylfason (2001), Atkinson and Hamilton (2003), Papyrakis and Gerlagh (2004)). Turning to the correlations between natural resources and institutions, the natural resource measure ($xgdp$) is negatively correlated with both measures of institutions but the correlation with democracy is much higher. When we consider the disaggregated measures of natural resources only the measure of fuel ($Fuel$) is positively correlated with the growth rate, initial gdp per capita and investment in physical capital.

[11]These two measures are used in Flachaire et al. (2011) where authors explain how political and economic institutions enhance differently the economic development of countries

4 Results and discussion

4.1 Standard model results

We start by reproducing some of the results found in the literature in cross section analysis, reported in Table 3 column (1). The dependent variable, the growth rate and the explanatory variables (except for initial gdp, education and natural resources) are averaged for the entire 35-year period. We measure initial gdp, education and natural resources at the starting year 1970. We use the aggregate measure of natural resources ($xgdp$). In this and all subsequent tables NR always denotes natural resources, which can be measured in different ways. The coefficient on natural resources is negative and significant at the conventional level 1%, suggesting that an abundance of natural resources reduces growth. The coefficient on NR (-0.044) is roughly comparable to that in Sachs and Warner (2001), table 2 columns (2) and (3), where the resource curse hypothesis is analyzed for the period 1970-1989. One issue with the cross-section data is the low number of observations (71 obs) due to the limitation of the number of countries. The low number of observations may also be a problem when estimating the mixture model since the number of parameters increases with the number of growth regimes K, requiring more observations. One possibility to increase the number of observations in growth regressions is to use panel data. Thus the rest of the paper is based on panel data.

We report in columns (2)-(4) of table 3 respectively the pooled, the fixed effects and the random effects estimations when using panel data. The coefficient on natural resources is negative in almost all columns but it is never significant. This confirms the results in Manzano and Rigobon (2007) who find that the resource curse hypothesis disappears once panel data with fixed-effects are used. Turning now to the other variables in the regression, the negative signs on initial gdp $\log(gdp)$ are consistent with the beta-convergence hypothesis between countries and the coefficients on the economic institutions, eco, have the expected sign and are significant at the 1% level. Not surprisingly more democracy does not stimulate growth, as already found in previous work.[12] The Hausman test of the appropriateness of the random-effects model gives a low p-value of 0.001 which suggests that the random-effects model is less appropriate than the fixed-effects one.

It is well-known fact that both institutional quality and educational attainment may be determined by economic performance, and the literature on natural resources has also discussed the problem of causality between natural resources and economic performance. For instance the denominator of our main measure for NR is gdp per capita. Thus if two countries export the same amount of natural resources, the country with a lower level of gdp per capita will be resource rich while that with a higher level of gdp will be considered as resource poor. To deal with this possible endogeneity, we use IV estimation with

[12] Barro (1996), Glaeser et al. (2004) and Flachaire et al. (2011) support that the empirical evidence does not establish a direct link between political institutions and economic performance.

the first lags of education, NR and both institutions as instruments. The last two columns in table 3 present estimation results with instrumental variables for the pooled and random-effects models. The estimations in column (5) are close to those in column (2) except that education and democracy now become insignificant. The estimates in columns (4) and (6) are very similar. In all specifications the coefficient of the variable of interest, natural resources, remains insignificant.

These results support neither a resource curse nor a resource blessing when using standard models on panel data. One possible cause for the absence of significant coefficients on natural resources is that there exists unobserved heterogeneity in the data. In fact the assumption that all countries follow the same growth regime may be too constraining, raising a doubt on the estimates and enabling us to figure out whether natural resources are a curse or a blessing. Hence we suppose that our data could be generated by multiple growth regimes, and that an abundance of natural resources may have different marginal impacts across regimes. Under this assumption we apply the mixture of regression method to take into account heterogeneity. Although the panel fixed-effect takes into account the heterogeneity in the constant term the mixture of regression method has the advantage of taking into account endogenously the heterogeneity on the explanatory variables by allowing them to have different marginal impacts across growth regimes.

4.2 Mixture-of-regression results

We next estimate the mixture model with concomitant variables and allow the number of groups K to vary between 1 and 4, estimating 4 models. As in the previous panel data estimations, our dependent variable is the annual rate of growth averaged over five-years and the standard covariates are the initial gdp per capita, the population growth rate averaged over five-years, the initial level of education, the initial quantity of natural resources, and the five-years average of investment, economic institutions and democracy. As concomitant variables we use the average level of democracy and of economic institutions over the 35-year period, the initial level of education in 1970, a Sub-Saharan Africa dummy and a Latin-America dummy. We report the values of the BIC and CAIC in table 4. Both of the information criteria are minimized for K=2, allowing us to select the model with two growth regimes as the model that best fits the data. According to the two test statistics, the two-regime model presents a substantial improvement over estimating a single regime model (BIC=2282.6 for K=2 versus BIC=1353.8 for K=1). Recall that the estimations of the model where K=1 is reported in column (2) of table 3, where we found no impact of natural resources on growth rate.

Table 5 shows the estimated parameters of the selected mixture model. The coefficients on natural resources support our hypothesis that an abundance of natural resources has different impacts on growth across regimes. While there is a resource blessing in the first regime, an abundance of natural resources is neutral in the second regime. We also test whether the coefficients on NR are statistically different across regimes, reporting the Wald test in column 3. The null hypothesis under which the coefficients on NR are equal across the two growth regimes is statistically rejected by the Wald test at the 5% level. The coefficients on initial income, on investment in physical and human capital and on institutions are also statistically different across regimes. Investments in physical and human capital have a positive and significant impact on growth for the first group, but education does not affect growth for the second one. Economic institutions are beneficial for growth in both regimes while political institutions do not matter for the second regime but affect negatively the growth rate in the first group. Recent literature has tried to explain why it has been so difficult to find a robust positive effect of political institutions on growth and suggests that in contrary to the economic institutions their impact on growth may be indirect. For instance Acemoglu et al. (2005) propose the *hierarchy of institutions hypothesis* , which indicates that political institutions set the stage in which economic institutions and policies operate. The results in Flachaire et al. (2011) find support for the *hierarchy of institutions hypothesis* when using the mixture-of-regression approach in a panel of developped and developping countries covering.

We turn now to the coefficients on the concomitant variables. Recall that the concomitant variables play the same role as covariates in the multinomial logit estimations, so that only the signs of the coefficients have an interpretation. Our group of reference here is the first one, the one for which resources have a positive impact on growth. The results show a negative and very significant coefficient on democracy, indicating that an increase of the level of democracy decreases the probability for a given country to be in the second regime rather than in the first regime. Both economic institutions, education and the geographical location do not affect the regime membership probability.

We find that 42% of countries are in the first group against 58% in the second group. Table 6 shows the classification of countries into growth regimes with their respective probability. Some countries from different regions and countries with different levels of development follow the same growth process. For instance Bangladesh, Botswanna and the Republic of Congo and Mali are in the same group as most of the Western countries, while Ireland and Portugal are in the same group as most of poor countries.

The bottom panel of Table 6 reports the average values of the dependent and main independent variables for the two groups as well as the within group standard deviations in parenthesis. The average growth rate is equal to 2.32% for the first group against 1.50% for the second group. The standard deviation is much lower in the first group than in the second group which could be explained by the high diversity of countries in the latter group. The average value of exports of primary goods is twice as low in the first group as in the second. Regarding institutions, there is only a small difference on the average values of economic institutions but the level of democracy is much higher in the first group than in the resource blessing group.

As already discussed in the section 4 above, the endogeneity issue is important in the literature but still finding good institutions for natural resources and in particular for institutions remains difficult. Also we are not aware of a procedure that allows to estimate mixture models using instrumental variables and proceed in two step. This last point could be an interesting contribution in the mixture of regression framework. To consider the endogeneity problem we perform a standard IV estimations for each of the group derived previously from the mixture of regression estimation. We use as instruments one-period lags of education, natural resources and institutions. The results are reported in Table 7 and show that coefficients are very closed to those reported in Table 5.

5 Robustness Analysis

To test the robustness of our results we run a number of further estimations. First, we use different measures for natural resources, the disaggregated components of our main measure $xgdp$ and the rent per capita in logs. Second, we use alternative measures of political institutions which we have found to be important for the classification of countries into growth regimes. Lastly, we will include an interaction term between natural resources and education.

5.1 Alternative measures for natural resources

Table 8 shows additional evidence on the existence of two growth regimes when we use alternative measures of natural resources, as the information criterion selection always gives 2 growth regimes. We first focused on the disagragated measures of $xgdp$, our main measure of natural resource abundance in the previous estimations. It is important to shed light on how the different components of $xgdp$ affect growth in a multiple growth regime analysis. There may be different reasons to believe that the different components of $xgdp$ may have different impacts on growth across regimes. For example mineral sectors yield in general higher rents than agricultural sectors and fuel sectors (see Sachs and Warner (2001)). Leite and Weidmann (2002) mention that although those components are different in term of factor intensity, they also have differences in term of ownership and in term of time of extraction, implying different costs and different processes, and thus different rents.

We report the estimations of the K=2 mixture models in table 9. For $Metal-Ores$, the results support the existence of a resource blessing in the first regime and a resource curse in the second regime. The level of democracy helps to split countries into regimes, with more democracy increasing the probability for a given country to be in the resources blessed regime. The Wald test, which is not reported, rejects the hypothesis of the equality of the coefficients on natural resources across regimes. Similarly, when we consider agricultural raw and food (Agri-Food) as the measure of natural resource abundance, we find again a resource blessing in the first regime and resources curse in the second regime. For Fuel we have no effect of natural resources on growth in the second regime and a positive one in the first. In all cases the level of democracy is an important determinant of the probability for countries to be classified into regimes, while education and regional dummies tend to play no role. Only in the case of Fuel the Latin American dummy decreases the probability to be in the resources blessing regime. Note that the magnitude of the coefficient on natural resources in absolute value is higher for $Metal - Ores$ than for $Agri - food$ and $Fuel$. One possible explanation is that mineral sectors yield in general higher rents than agricultural sectors and fuel sectors due to the difference in term of costs and in term of capital intensity as already mentioned in the previous paragraph.

Considering rent per capita as our measure of resources, we find resource blessing in the first group but no impact in the second one. As before, the level of democracy enhances the classification of countries into regimes, while the Sub-Africa dummy is now significant indicating that being a Sub-Africa country reduces the probability to belong to the blessed resource group.

5.2 Alternative measures for democracy

Our second specification to check the robustness of our results is to change the measure of democracy that we find important in the classification of countries. We replace the Polity IV measure with data from Golder (2005). These data provide measures for a wide range of institutions including regime type, the electoral system and the assembly size. Data are available for a large number of countries over the 1946-2000. We use *demautoc*, a dummy which is equal to 1 for democracies and 0 for autocracies. As explanatory variable we take the initial value of *demautoc* at the beginning of each period and as concomitant variable the value in 1970. We will also add to the concomitant variables a dummy denoted $presdem_{70}$ which is equal to 1 for presidential democracies in 1970 and 0 for parliamentary or mixed democracies. [13] Results are reported in table 10. We find again two growth regimes whereby an abundance of natural resources is beneficial in one regime and negative or neutral in the other. Being a democracy remains a key determinant of the probability of being in the blessed regime but the type of democratic system does not matter for the classification of countries into regimes. These results differ from the conclusion in Andersen and Aslaksen (2008), where the authors interact in a single growth regime natural resources resources with institutional features. They provide evidence that the curse is present in presidential democracies but not in parliamentary democracies, while being an autocracy does not explain the curse.

[13] See Persson (2005) for the role of constitutions on economic development and Andersen and Aslaksen (2008) for natural resources and constitutions.

5.3 Education and natural resources

Education has been found to be important in the resource curse literature (see Gylfason (2001) and Bravo-Ortega and De-gregorio (2007)) but our previous results do not show that education helps to split countries into blessed and cursed regimes. One explanation could be that education has a different role, from that of institutions. Following Bravo-Ortega and De-gregorio (2007) who interact education and natural resources in order to examine whether an increase in the level of education decreases the negative impact of natural resources on growth, we add the term $(\log(educ) * NR)$ to the regressors. For ease of computation we also exclude all the concomitant variables that where never significant in the previous estimations. The values of the information criteria are not reported, but the model with two growth regimes is again selected for each of the measures of natural resources we consider.

The estimations of the selected models are reported in table 11. Our result that natural resources have a positive impact in one regime but a negative or neutral effect in the other is robust, and democracy still helps to split countries into regimes. When we use the aggregated measure $xgdp$ and the rent per capita $Rent$ as the measures of natural resource the coefficient on the interact term (log(educ)*NR) indicates that more education decreases the marginal effect of natural resource on growth in the blessed regime (or group 1). However, when we replace the measure of natural resource by $Ores - Metal$ results show that more education decreases the resource curse. There are no other important changes in the coefficients on the other explanatory variables.

6 Conclusion

This paper has tested a new hypothesis that has not yet been addressed by the literature that has tried to understand the conditions under which natural resources can be a blessing. We go beyond existing studies and test whether the impact of natural resources depends on the growth regime to which an economy belongs. To do so we consider that countries may follow different growth processes or regimes such that the marginal impact of explanatory variables on growth differs across regimes, enabling us to test whether natural resources are a curse or a blessing within each regime.

Our results indicate that for the period 1970-2005 the data is best fitted by a model of two regimes. In one regime an abundance of natural resources has a significant positive impact on growth, while in the other regime an abundance of natural resources does not enhance growth. The analysis of the determinants of whether a country belongs or not to the blessed resources regime indicates that the level of democracy plays a crucial role, while education and economic institutions have no effect. We also find that the form of government (such as being parliamentary or presidential democracy) matters less for the regime membership than being democratic or autocratic. Moreover, once we control for the degree of democracy being a Sub-Saharan African or a Latin-American does not seem to be relevant to determine whether a country belongs to the blessed regime.

The policy implication of this analysis is that, resource rich countries that have suffered from their endowment in natural resources should try to figure out how to move to the resource blessed regimes, thus changing the environment in which growth occurs. External aid aimed at improving education (although it has benefits in itself) will not help countries to use their natural resource endowments in a growth-enhancing manner but promoting democracy (parliamentary or presidential) would increase the probability of the resource rich countries to be in the environment in which natural resources could be beneficial for their development. This last point supports the 'neocon agenda' defined by Selden (2004) that emphasizes the importance of encouraging democratic institutions in resource-rich economies.

Our analysis has only considered the direct impact of natural resources, future works on the link between natural resources and economic development should consider the indirect mechanism of the curse in a multiple growth regimes analysis by modeling a system of simultaneous equations using a mixture of regression approach. Also the two step stage method in the mixture model framework remains suited for the endogeneity issue.

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Variable	Obs.	Mean	SD	Min	Max	Description	Data source
growth	498	1.82	2.75	-13.60	11.07	Average annual growth rate	PWT 6.3
$\log(gdp)$	498	8.77	1.01	6.43	10.64	Log of initial real GDP per capita	PWT 6.3
$\log(pop + 0.05)$	498	1.89	.16	1.49	2.33	Log of population growth + technology growth + depreciation rate	PWT 6.3
$\log(inv)$	498	3.01	.50	1.25	4.05	Log of investment rate	PWT 6.3
$\log(educ)$	498	1.58	.68	-1.64	2.57	Log of initial average years of education of the total population aged over 25	Barro and Lee 2010
dem	498	5.83	3.99	0	10	Political institutions: degree of democracy (Polity IV)	www.systemicpeace.org, Polity IV project
eco	498	6.01	0.81	2.68	8.66	Economic institutions: index of Economic Freedom of the World	www.freetheworld.com, version 2009
xgdp	498	12.92	12.43	.23	76.07	Initial level of exports of primary goods over total gdp	World Development Indicators(2010)
Metal-Ores	492	2.14	5.74	< 0000	55.44	Initial level of exports of metal and ores over total gdp	World Development Indicators(2010)
Agri-food	498	6.92	7.25	.001	44.15	Initial level of exports of agriculture and food goods over total gdp	World Development Indicators(2010)
Fuel	482	4.01	9.08	< 0000	63.12	Initial level of exports of fuel over total gdp	World Development Indicators(2010)
$\log(educ_{1970})$	91	1.58	0.89	-1.64	2.39	Log of initial average years of education of the total population aged over 25	Barro and Lee 2010
$\overline{dem}$	91	5.19	3.54	0	10	Political institutions: degree of democracy (Polity IV)	www.systemicpeace.org, Polity IV project
$\overline{eco}$	91	1.01	1.07	4.31	8.14	Economic institutions: index of Economic Freedom of the World	www.freetheworld.com, version 2009

Table 1: Data descriptive and sources

	growth	$\log(gdp)$	$\log(pop)$	$\log(inv)$	$\log(educ)$	dem	eco	xgdp	Metal-Ores	Agri-Food	Fuel
growth	1.00										
$\log(gdp)$	0.06	1.00									
$\log(pop)$	-0.21	-0.66	1.00								
$\log(inv)$	0.24	0.58	-0.43	1.00							
$\log(educ)$	0.11	0.77	-0.59	0.45	1.00						
dem	0.07	0.63	-0.62	0.38	0.63	1.00					
eco	0.26	0.58	-0.41	0.33	0.51	0.46	1.00				
xgdp	-0.07	-0.16	0.33	-0.06	-0.12	-0.28	-0.08	1.00			
Metal-Ores	-0.16	-0.06	0.19	-0.06	-0.04	-0.20	-0.01	0.45	1.00		
Agri-Food	-0.04	-0.31	0.27	-0.11	-0.15	-0.13	-0.05	0.52	-0.01	1.00	
Fuel	0.03	0.04	0.13	0.02	-0.05	-0.18	-0.07	0.68	-0.01	-0.08	1.00

Table 2: Coefficients of correlation

Variable	Cross-Section Ols (1)	Panel Data Ols (2)	FE (3)	RE (4)	OlS-IV (5)	RE-IV (6)
log(gdp)	-1.150^{***} (0.311)	-1.469^{***} (0.219)	-5.130^{***} (0.509)	-2.298^{***} (0.276)	-1.454^{***} (0.263)	-2.483^{***} (0.334)
log(pop+0.05)	-0.911 (1.652)	-5.151^{***} (1.035)	-5.858^{***} (1.669)	-6.305^{***} (1.276)	-5.592^{***} (1.157)	-6.364^{***} (1.448)
log(inv)	1.420^{***} (0.432)	1.402^{***} (0.280)	2.109^{***} (0.520)	1.590^{***} (0.360)	1.526^{***} (0.340)	1.918^{***} (0.423)
log($educ$)	0.619 (0.314)	0.637^{**} (0.285)	0.252 (0.628)	0.972^{***} (0.373)	0.515 (0.381)	1.182^{**} (0.496)
NR	**-0.044***** **(0.012)**	**-0.006** **(0.009)**	**0.019** **(0.019)**	**-0.002** **(0.013)**	**-0.032** **(0.019)**	**-0.009** **(0.013)**
eco	0.606^{**} (0.266)	0.991^{***} (0.142)	1.409^{***} (0.216)	1.363^{***} (0.175)	0.815^{***} (0.176)	1.064^{***} (0.239)
dem	-0.005 (0.081)	0.092^{**} (0.040)	-0.131^{**} (0.054)	-0.069 (0.046)	-0.085 (0.0565)	-0.032 (0.078)
Constant	4.899 (4.721)	13.34^{***} (2.864)	18.97^{***} (3.485)	19.84^{***} (3.565)	15.03^{***} (3.209)	21.48^{***} (3.866)
time dummies	..	..	..	..	..	
nobs	71	498	498	498	388	388
ncountries	71	91	91	91	83	83
R-squared	0.44	0.23	0.36	0.32	0.25	0.22
Hausman test				< 0.001 (3)-(4)		

Table 3: Standard estimations. We use the aggregate measure of exports of primary goods $xgdp$ for the natural resources variable. Time dummies are include for panel data estimations. For Hausman test, the p-value is reported. For IV estimation, first lags of log(educ), NR, eco and dem are used as instruments. Standard Errors are in parenthesis, *** significant at 1%, ** significant at 5%.

	BIC	CAIC
K=1	2353.8	2368.8
K=2	**2280.3**	**2316.3**
K=3	2299.4	2356.4
K=4	2304.3	2382.3

Table 4: Panel data: selection of the mixture models. BIC and CAIC criterion are reported. K is the number of regimes. We use the aggregate measure of natural resources *xgdp* to measure NR. Selected model in bold.

Variable	Mixture		Wald test	
	group 1 (42%)	group 2 (58%)	statistic	p-value
Intercept	15.409*** (2.791)	13.092*** (4.149)	0.22	0.64
log(*gdp*)	−1.937*** (0.247)	−1.255*** (0.311)	3.05	0.08
log(pop+0.05)	−3.476*** (0.929)	−5.935*** (1.507)	1.91	0.17
log(*inv*)	2.542*** (0.261)	0.640 (0.413)	14.64	< 0.001
log(*educ*)	1.348*** (0.278)	0.501 (0.423)	2.662	0.1
NR	**0.036*** (0.009)**	**-0.015 (0.014)**	**8.29**	**0.004**
eco_5	0.311** (0.129)	1.298*** (0.212)	15.53	< 0.001
dem_5	−0.201*** (0.040)	−0.039 0.058	5.143	0.023
time dummies	..	..		
Concomitant				
Intercept	-	1.880 (2.962)		
$\overline{eco}$	-	−0.145 (0.509)		
$\overline{dem}$	-	−0.297** (0.128)		
log($educ_{1970}$)	-	0.053 (0.545)		
Sub-Afri	-	0.737 (0.851)		
Latin	-	5.084 (2.882)		
R^2	0.56	0.26		

Table 5: Panel data: estimation results of the selected mixture model in table 4 where the measure of natural resources is *xgdp*. There are 91 countries and 498 observations. Time dummies are include. Standard errors in parenthesis. *** significant at 1%, ** significant at 5%.

Group 1		Group 2			
Country	proba	Country	proba	Country	proba
Australia	0.99	Algeria	1	Paraguay	1
Austria	0.99	Argentina	1	Peru	1
Bangladesh	0.84	Bahrain	1	Philippines	1
Belgium	0.94	Bolivia	1	Portugal	0.95
Benin	0.52	Brazil	0.99	Sierra Leone	0.67
Botswana	0.75	Cameroon	0.99	Syria	1
Canada	0.99	Central African Rep,	1	Tanzania	0.74
China	0.97	Chile	1	Thailand	0.99
Congo.Rep,	0.96	Colombia	0.85	Togo	1
Cyprus	0.99	Costa Rica	0.98	Trinidad Tobago	1
Denmark	0.99	Cote d'Ivoire	0.97	Uganda	0.58
Finland	0.98	Dominican Rep,	0.99	Uruguay	1
France	0.99	Ecuador	1	Venezuela	0.99
Germany	0.99	Egypt	0.99	Zambia	1
Greece	0.97	El Salvador	1	Zimbabwe	1
India	0.99	Fiji	0.99		
Israel	0.99	Ghana	1		
Italy	0.99	Guatemala	1		
Japan	0.99	Guyana	1		
Korea.Rep,	0.99	Haiti	0.99		
Malaysia	0.95	Honduras	1		
Mali	0.87	Hungary	0.99		
Netherlands	0.99	Indonesia	0.99		
New Zealand	0.91	Iran	1		
Norway	0.99	Ireland	0.96		
Pakistan	0.99	Jamaica	1		
Poland	0.93	Jordan	1		
Senegal	0.74	Kenya	1		
Singapore	0.99	Lesotho	0.93		
South Africa	0.91	Malawi	1		
Spain	0.99	Mauritius	0.99		
Sri Lanka	0.89	Mexico	1		
Sweden	0.99	Mozambique	1		
Switzerland	0.99	Nepal	0.94		
Tunisia	0.99	Nicaragua	1		
Turkey	0.99	Niger	0.99		
UK	0.99	Panama	1		
US	0.99	Papua New Guinea	1		
Group 1		Group 2			

Means of key variables by group		
	Group 1	Group 2
growth	2.55 (1.87)	1.24 (3.17)
NR	8.78 (11.36)	16.21 (12.27)
$\log(\text{educ}_0)$	1.79 (0.71)	1.42 (0.61)
eco_5	6.37 (1.08)	5.72 (0.98)
dem_5	7.57 (3.51)	4.44 (3.82)

Table 6: Classification obtained from the selected mixture model with *xgdp* as the measure of natural resources. The numbers are the group membership posterior probabilities

	Group 1	Group 2
Intercept	18.20***	14.51***
	(2.858)	(4.575)
log(pop+0.05)	−4.345***	−6.273***
	(0.995)	(1.655)
$\log(\text{gdp}_0)$	−2.102***	−1.055***
	(0.267)	(0.358)
$\log(\text{inv}_5)$	2.513***	0.636
	(0.280)	(0.452)
$\log(\text{educ}_0)$	1.490***	0.271
	(0.309)	(0.548)
$\mathbf{NR_0}$	**0.027******	**-0.028**
	(0.012)	**(0.018)**
dem_5	−0.232***	−0.012
	(0.057)	(0.077)
eco_5	0.378**	0.965***
	(0.149)	(0.278)
Observations	183	224
R-squared	0.56	0.27
Under test.	< 0.001	< 0.001
Weak instr.	51.5	86.0

Table 7: Panel data: IV estimations by groups, from the classification obtained in Table 6. Standard errors in parenthesis. Time dummies are include. For under identification test, the p-value is reported. For weak instruments tests, the value of the first-stage-F statistic is reported. Standard errors in parenthesis. *** significant at 1%, ** significant at 5%

	Xgdp Components			
	Metal-Ores	Agri-food	Fuel	Rent
	(1)	(2)	(3)	(4)
K=1	2315.8	2350.4	2281.1	2595.3
	[2330.8]	[2365.4]	[2296.1]	[2610.3]
K=2	**2241.9**	**2280.7**	**2200.3**	**2475.9**
	[2277.9]	**[2316.7]**	**[2236.3]**	**[2511.9]**
K=3	2263.9	2289.7	2209.4	2477.3
	[2320.9]	[2346.7]	[2266.4]	[2534.3]
K=4	2278.2	2305.9	2216.6	2498.6
	[2356.2]	[2383.9]	[2294.6]	[2576.6]

Table 8: Panel data: goodness of fit with alternative measures of natural resources. BIC and CAIC (in brackets) are reported for each measure. Selected models are in bold.

	Metal-Ores		Agri-Food		Fuel		Rent	
	*group*1 (π_1=41%)	*group*2 (π_2=59%)	*group*1 (π_1=36%)	*group*2 (π_2=64%)	*group*1 (π_1=40%)	*group*2 (π_2=60%)	*group*1 (π_1=36%)	*group*2 (π_2=64%)
Intercept	12.556*** (4.216)	16.182*** (2.574)	17.444*** (3.321)	15.824*** (4.054)	8.745*** (2.709)	17.439*** (4.186)	14.081*** (2.639)	−1.465 (2.624)
log(*gdp*)	−2.194*** (0.237)	−1.144*** (0.309)	−2.282*** (0.294)	−1.562*** (0.319)	−1.636*** (0.253)	−1.638*** (0.322)	−1.942*** (0.227)	−1.005*** (0.345)
$\log(pop+0.05)$	−3.624*** (0.869)	−5.813*** (1.518)	−3.679*** (0.876)	−5.953*** (1.462)	−1.586 (0.873)	−8.109*** (1.595)	−3.295*** (0.915)	−0.073 (0.607)
log(*inv*)	2.971*** (0.286)	0.337 (0.396)	2.582*** (0.445)	0.502 (0.377)	2.604*** (0.319)	0.979** (0.409)	2.966*** (0.313)	0.580 (0.344)
log(*educ*)	1.302*** (0.259)	0.427 (0.443)	1.811*** (0.372)	0.588 (0.405)	0.479 (0.314)	0.958** (0.429)	1.304*** (0.303)	0.769 (0.400)
NR	**0.279*** (0.079)**	**-0.062*** (0.023)**	**0.072*** (0.020)**	**-0.048** (0.022)**	**0.075*** (0.016)**	**0.032 (0.018)**	**0.091** (0.041)**	**0.025 (0.091)**
eco	0.405*** (0.126)	1.371*** (0.212)	0.391*** (0.131)	1.315*** (0.205)	0.439*** (0.139)	1.531*** (0.206)	0.248 (0.143)	1.429*** (0.223)
dem	−0.128** (0.059)	−0.197*** (0.038)	−0.193*** (0.041)	−0.015 (0.059)	−0.059 (0.044)	−0.128** (0.059)	−0.178*** (0.040)	0.038 (0.06)
time dummies	..	..	..	..	..	..	..	..
Concomitant								
Intercept	-	3.051 (4.538)	-	4.144 (3.562)	-	−5.617 (3.872)	-	−1.116 (3.593)
$\overline{eco}$	-	−0.334 (0.526)	-	−0.512 (0.589)	-	1.414 (0.726)	-	0.518 (0.664)
$\overline{dem}$	-	−0.312** (0.129)	-	−0.315** (0.130)	-	−0.587*** (0.199)	-	−0.362** (0.158)
$\log(educ_{70})$	-	0.142 (0.559)	-	0.432 (0.569)	-	−0.392 (0.677)	-	−0.537 (0.659)
Sub-Afri	-	0.972 (0.914)	-	1.485 (1.028)	-	0.648 (0.985)	-	2.374** (1.193)
Latin	-	5.582 (2.938)	-	4.911 (2.896)	-	4.651*** (1.489)	-	4.951 (3.205)
R^2	0.59	0.26	0.61	0.24	0.38	0.33	0.57	0.22

Table 9: Panel data: estimations of the selected models in Table 8 for alternative measures of natural resources. Time dummies are include. Standard errors in parenthesis. *** significant at 1%, ** significant at 5%. Data for fuel for Honduras and Malawi are not available, which reduces the number of countries to 89 for the estimation of the models with fuel.

	xgdp		Metal-Ores		Rent	
	*group*1 (π_1=45%)	*group*2 (π_2=55%)	*group*1 (π_1=43%)	*group*2 (π_2=57%)	*group*1 (π_1=41%)	*group*2 (π_2=59%)
Intercept	16.824^{***}	11.407^{***}	16.958^{***}	11.955^{***}	19.015^{***}	-3.774
	(3.295)	(4.218)	(2.919)	(4.389)	(2.743)	(2.845)
$\log(gdp)$	-2.016^{***}	-1.446^{***}	-2.271^{***}	-1.449^{***}	-2.324^{***}	-1.044^{***}
	(0.287)	(0.327)	(0.243)	(0.328)	(0.251)	(0.377)
$\log(pop + 0.05)$	-3.559^{***}	-5.222^{***}	-3.823^{***}	-5.068^{***}	-4.445^{***}	0.088
	(1.036)	(1.410)	(1.002)	(1.437)	(0.919)	(0.616)
$\log(inv)$	2.489^{***}	0.979^{**}	3.138^{***}	0.608	2.956^{***}	0.509
	(0.296)	(0.417)	(0.293)	(0.398)	(0.314)	(0.366)
$\log(educ)$	1.287^{***}	0.823^{**}	1.135^{***}	0.855^{**}	1.339^{***}	0.806
	(0.339)	(0.416)	(0.265)	(0.426)	(0.353)	(0.422)
NR	**0.039*****	**-0.018**	**0.278*****	**-0.086*****	**0.088***	**0.119**
	(0.01)	**(0.017)**	**(0.079)**	**(0.033)**	**(0.045)**	**(0.104)**
eco	0.201^{***}	1.306^{**}	0.346^{***}	1.319^{***}	0.273	1.762^{***}
	(0.135)	(0.214)	(0.132)	(0.22)	(0.165)	(0.252)
demautoc	-1.328^{***}	-0.169	-1.302^{***}	-0.117	-1.120^{***}	0.226
	(0.322)	(0.399)	(0.291)	(0.393)	(0.314)	(0.455)
time dummies	..	..	..	..	..	..
Concomitant						
Intercept	-	0.512	-	0.624	-	0.299
		(0.396)		(0.385)		(0.501)
demautoc_{70}	-	-1.882^{***}	-	-2.058^{***}	-	-2.575^{***}
		(0.700)		(0.671)		(0.899)
pres_{70}	-	-1.916	-	-1.971	-	-3.445
		(2.215)		(2.339)		(2.533)
Sub-afri	-				-	2.783^{**}
						(1.356)
Latin	-	-4.766^{**}	-	4.733^{**}	-	5.223^{**}
		(2.128)		(2.151)		(2.434)
R^2	0.53	0.28	0.59	0.28	0.54	0.25

Table 10: Panel data: estimations with alternative measures of institutions. We replace the variable *dem* by a binary variable demautoc which takes the value of 1 for democracies and 0 for autocracies. The variable pres in the concomitant variable is equal to 1 for presidential democracies and 0 for parliamentary or mixed democracies. Time dummies are include. Standard errors in parenthesis. *** significant at 1%, ** significant at 5%, * significant at 10%

Variable	Xgdp		Ores-Metal		Rent	
	$group1$ (42%)	$group2$ (58%)	$group1$ (π_1=41%)	$group2$ (π_2=59%)	$group1$ (π_1=50%)	$group2$ (π_2=50%)
Intercept	14.952^{***} (2.732)	13.367^{***} (4.205)	16.060^{***} (2.559)	13.922^{***} (4.269)	3.056^{**} (1.492)	7.929 (4.917)
$\log(gdp_0)$	-1.985^{***} (0.243)	-1.272^{***} (0.313)	-2.192^{***} (0.234)	-1.218^{**} (0.311)	-1.810^{***} (0.232)	-1.013^{***} (0.385)
$\log(pop + 0.05)$	-3.355^{***} (0.919)	-5.749^{***} (1.551)	-3.608^{***} (0.866)	-6.019^{***} (1.512)	0.115 (0.3)	-4.306^{**} (1.738)
$\log(inv)$	2.544^{***} (0.259)	0.707 (0.421)	2.969^{***} (0.278)	0.441 (0.404)	2.957^{***} (0.239)	0.569 (0.454)
$\log(educ)$	1.754^{***} (0.329)	0.039 (0.568)	1.333^{***} (0.256)	0.022 (0.478)	2.437^{***} (0.286)	-0.509 (0.736)
NR	**0.098*** (0.032)**	**-0.065 (0.045)**	**0.388** (0.192)**	**-0.232*** (0.079)**	**0.962*** (0.168)**	**-0.222 (0.261)**
$\log(educ) * NR$	**-0.039** (0.019)**	**0.032 (0.027)**	**-0.069 (0.111)**	**0.123** (0.055)**	**-0.402*** (0.077)**	**0.159 (0.174)**
eco	0.290^{**} (0.127)	1.305^{***} (0.217)	0.407^{***} (0.126)	1.339^{***} (0.214)	0.398^{***} (0.151)	1.527^{***} (0.246)
dem	-0.186^{***} (0.039)	-0.039 (0.059)	-0.192^{***} (0.038)	-0.046 (0.060)	-0.140^{***} (0.040)	0.055 (0.070)
time dummies	..	..	..	..	..	..
Concomitant						
Intercept	-	1.438^{***} (0.546)	-	1.597^{***} (0.562)	-	0.396 (0.599)
$\overline{dem}$	-	-0.343^{***} (0.092)	-	-0.363^{***} (0.095)	-	-0.228^{**} (0.091)
Latin	-	4.683 (2.483)	-	5.329^{**} (2.623)	-	5.037 (2.672)
Sub-afri					-	0.411 (0.730)
R^2	0.27	0.56	0.28	0.59	0.28	0.57

Table 11: Panel data: stimation results of the mixture model with the interact term between education and natural resource. Time dummies are include. Standard errors in parenthesis. *** significant at 1%, ** significant at 5%. We include to the concomitant variables a Latin American dummy Latin and a Sub-African dummy Sub-afri to controle for geography.