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PARADOX OF THE ABUNDANCE: HUMAN DEVELOPMENT AND EXTRACTIVISM AT GLOBAL LEVEL 2010-2015

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Abstract

Since the nineties some econometrics studies had realized about the relationship between the abundance of natural resources and human development, where some authors depending of the variables have categorized it as a curse while others as an opportunity. In this research project, analyze a balanced short panel of 142 countries for the period 2010-2015, taking as a dependent variable the Inequality-adjusted Human Development Index (IDHI), and as a proxy variable of extractivism the Total Natural Resources Rents as a percentage of the Gross Domestic Product (GDP), in addition to other control variables. The series was transformed into first differences, resulting in a significant relationship with negative slope among the variables of interest. Hence, there is a curse of abundance at global level.

Keywords: Paradox of the abundance, Human Development, Extractivism, Panel Data, Inequality.

JEL Classifications: C23, F63, L72, O15

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1. Introduction

Throughout history, various attempts have been made to explain the poor performance of countries, which are rich in natural resources. Thus, at the end of the 20th Century, an attempt has been made to empirically demonstrate their relationship by using econometric models, Sachs and Warner (1995) being the first to do so using a cross-sectional model, where it has been shown that there is an inverse relationship between economic growth and natural resources.

This was the starting point for various researchers to expand the study relating development and growth with GDP per capita. According to Fernández (2005, pp. 96-99), in this line of research, various investigations have been carried out using the per capita GDP growth as an independent variable, such as Sala-i-Martin and Subramanian (2003), Mehlum Moene and Torvik (2002), with cross-section data. While in panel data, Fernández (2005, pp. 96-99) cites the study by Manzano and Rigobon (2001).

It is considered that the increase in GDP per capita from the traditional view of development is associated with sustained growth. However, restricting development in this approach excludes factors that contribute to social welfare, such as: health, education, equity and environment. Causing the conclusions to be erroneous or overestimated from the broader vision of development.

Firstly, this article aims to expand this vision of development under the sustainable development approach by taking a sample of 142 countries in the period 2010-2015 for the construction of a balanced panel. Secondly, the Human Development Index Adjusted for Inequality (IDHI) calculated by the United Nations Development Program (UNDP) was identified as a dependent variable. Thirdly, to measure the extractivism, the Total Income of Natural Resources as a percentage of GDP was considered a proxy variable. It is worth mentioning that for the study only oil, mining and forestry activities are considered because these considered activities generate greater social and environmental conflict in the world, and their revenues generate controversy because they are linked to acts of corruption, but in turn they can be used by countries to reverse the curse. Additionally, control variables were incorporated into the model within the framework of the IDHI dimensions.

As a result, the curse hypothesis of natural resources is accepted being significant and with negative slope, in this way the results obtained from the econometric model of short panel data applied to the first differences of the series of the 142 countries in the period 2010- 2015, reaffirm the paradox of the abundance or curse of natural resources.

The present investigation is divided into four sections with the following structure. In the first section, an allusion is made to the studies that were made regarding the paradox of abundance and a review is made of the concepts needed to understand the proposed econometric model. In the second section, the methodology used is presented with its scope and limitations. In the third section the results obtained are presented. Finally, in the fourth section the conclusions are stated based on the empirical evidence.

2. Review of Literature

2.1. State of the art curse of natural resources

Since the nineties, econometric models have been used to contrast the curse hypothesis of natural resources. In the first instance, the empirical evidence showed that most of the countries in which their economy was based on the extraction of natural resources, "have succumbed in deep economic crises" (Sachs & Warner, 1995). This model used as a dependent variable the average growth of the Gross Domestic Product (GDP) per capita 1971-1989, while the independent variable related to the abundance of natural resources was the proportion of exports of the primary sector against GDP.

Several researchers developed the line of empirical study of the curse of resources, carrying in a general way the classical conception of development as the GDP per capita growth. Fernández (2005, pp. 96-99) mentions that preliminary studies have been carried out that used GDP growth per capita as a dependent variable and as a proxy for extractivism to exports of primary products with respect to GDP, Sala-i-Martin and Subramanian (2003), Mehlum Moene and Torvik (2002), through a cross section data methodology found that the variables have a significant relationship with negative slope.

The paradox of abundance presents two considerations. On the one hand, most financial institutions and researchers accept the curse hypothesis of resources, although not necessarily as an insurmountable condition. On the other hand, this condition in turn causes pathologies of a political nature as well as limited development. There is an increase in the deterioration of the terms of trade, collaterally multinational companies repatriate the benefits instead of using them in the country from which they come.

In addition, "several studies show that the abundance of natural resources is associated with low levels of democracy" (Varela, 2010, page 143). Wantchekon (1999, page 20) concludes that its results show that countries whose economies are based on the rent of natural resources increase the incumbency, that a party induces violence for political power, affecting governance and political stability. Ross (2001, page 356) finds a relationship in the export of commodities with states with less democracy.

The paradox of abundance today has been studied with more sophisticated techniques, but in some cases maintaining the essence of the initial studies. Fernández (2005, pp. 115-116), analyzing a group of twenty-six Latin American countries between 1980 and 2000, concludes that there is evidence of a negative effect of natural resources and economic growth. Natural resources were measured as the gross value added of the primary sectors with respect to GDP.

Some recent models have used the Human Development Index as a dependent variable. This is a measure that created the United Nations Development Program, which incorporates three dimensions: health, education and standard of living. Gómez and Rodríguez (2014, page 86) using a three-stage ordinary least squares model for a sample of 142 countries conclude that the curse of resources is not met using the natural capital variable. Additionally, a positive relationship between social welfare and natural resources is observed.

2.2. How to evaluate the paradox of abundance: variables used

The Index of Human Development adjusted by Inequality (IDHI) as a proxy variable to the study is composed of three dimensions: long and healthy life, knowledge, and a decent standard of living. Although this index is more complete by the dimensions that it covers, it keeps implicit the problem of not considering inequality. That is to say, the results obtained by the HDI show the potential human development if in the society the GDP was distributed equitably. So the index is adjusted in the three dimensions, and if the inequality is high in the country, it can fall in the calculated ranking. In that sense, that measurement would explain in an approximate way several dimensions of sustainable development, having as a limitation the non-consideration of environmental variables. That is why the model includes CO2 emissions per capita in tons as an environmental variable, which represents the variations and trends of the changes in CO2 in the atmosphere.

As a proxy dependent variable to extractivism, the Total Income of Natural Resources is considered as a percentage of the Gross Domestic Product (RT), according to the World Bank it includes "the sum of the oil rent, the rent of the natural gas, the income of the coal (hard and soft), mineral income and forest income "(2018). The rent is calculated as the value of the production minus its total cost, so it takes into account the price of the commodity and the average of the costs including the normal return of capital, the unit rent is multiplied by the physical amount of extraction from each country and divided for GDP. It is expected that the countries that have higher income from natural resources present a lower level of development.

Additionally, control variables are included in the econometric model according to the dimensions of the HDI to avoid errors by omission of relevant variables. So it includes: the GDP per capita in international dollars of Purchasing Power Parity (PPA) expressed in constant prices of the year 2011, series obtained from the World Bank; Life expectancy at birth measured in years, according to the World Bank (2013) "refers to the number of years that a newborn would live if the mortality patterns in force at the time of birth do not change over the life of the newborn. infant"; Arithmetic mean between the expectation of years of study and average of years of study presented by the population, calculated based on the data obtained from UNDP; and, Coefficient of Human Inequality (arithmetic mean of inequalities in the three dimensions), obtained from the UNDP.

3. Methodology

In the present study, a sample of 142 countries is used worldwide that forms a balanced panel in the period 2010-2015. In general terms, there are 42 countries in Africa, 27 in the Americas, 30 in Asia, 39 in Europe, and 4 in Oceania. Similarly, according to the classification of the Human Development Index (HDI) for 2015 of the 142 countries to be analyzed, 27% of the IDH group is very high, 26% of the HDI high, 23% of the HDI average and 23 % HDI low. In this sense, a group of countries that contain diversity regarding their degree of economic and social development is analyzed. In this sense, the criteria for selecting countries consists in comparing the group of variables and countries so that the data panel is balanced. For which the different databases were compiled, identifying each country with a unique three-digit code taken from the World Bank, and the bases were compiled.

When crossing the series of variables for the model, there is a limitation that there are countries with missing data, most of the African continent. In the case that these countries are eliminated from the study sample, they would become part of the error of the model, assuming that the excluded data have similar characteristics to the complete ones and that they were excluded in a random manner, if these conditions are not met. Estimators can be biased. So to avoid these problems a simple data imputation is made for: IDHI, RT and CI.

According to the IDHI, an imputation was made for those countries that present at least three missing data. Under the assumption that inequality does not vary drastically in the period of time studied, an average of the inequality loss (IDH-IDHI) of each year is calculated, and the HDI is subtracted from the years that do not present data, such as is expressed in the formula [1]. Under these considerations, a missing value was charged for 6 countries, two values for 3 countries and three for 15 countries.

$$IDHI_{it}^{*} = IDH_{it} - \left[\frac{(IDH_{it1}-IDHI_{it1})+(IDH_{it2}-IDHI_{it2})+\cdots(IDH_{it}-IDHI_{it})}{n}\right] \quad (1)$$

The variable RT only presented two countries with a missing data each (Iceland and Venezuela). So the following formulas were applied to impute data [2], [3], respectively:

$$RT_{it}^{*} = \frac{RT_{it-1}+RT_{it-2}}{2} \quad (2)$$

$$RT_{it}^{*} = \frac{RT_{it+1}+RT_{it+2}}{2} \quad (3)$$

To conclude with the simple imputation technique, for the case of CI the following criteria were followed: i) if the series of data of the country presents a single value of repeated (constant) inequality for all years and presents is replicated for the data missing; ii) if there is one or more missing data in the middle, all the data of the extremes is averaged and the fields are filled; iii) if one or more missing data is present and there is only one end (either on the left or right with full fields), it is averaged with the following or previous data and the series is completed.

With the balanced panel we proceed to apply the methodology to select the appropriate estimators in short panel data described, among other authors, by Cameron and Trivedi (2009) and Álvarez, Perdomo, Morales and Urrego (2013). It should be mentioned that, for short panel data where the number of entities observed tends to infinity while the time is fixed, there are regular intervals of time where the errors of the econometric model are usually correlated in time, and fixed effects can be identified. Observables and treat heterogeneity through fixed effects models, additionally, estimates of dynamic models can be made, including lags, among other characteristics.

In the analysis of econometric models of short panel data, the letter is used as a subscript to denote the entities studied and the letter t that identifies the time, in addition the subscript k is included to express that the estimators differ depending on the explanatory variable. In general, the letter y is used to identify the dependent variable, X for the independent ones, β for the slopes of the model, α for the intercepts of the model, and ε for the error.

There are different types of models detailed in the following equations: Ordinary Least Squares (OLS) grouped [4]; Random Effects Model (EA) [5] where the component θ _i is estimated by means of [6]; Fixed Effects Model (EF) [7] calculated in the STATA program that presents the large means of $\bar{\bar{y}}$, $\bar{\bar{X}}$, $\bar{\bar{\varepsilon}}$; Average Population Estimator or pooled FGLS (AR1) [8] with autoregressive process of first order described in [9].

$$y_{it} = \alpha + \beta_k X_{it}^{'} + (\alpha_i - \alpha + \varepsilon_{it}) \qquad (4)$$

$$(y_{it} - \hat{\theta}_i \bar{y}_i) = (1 - \hat{\theta}_i)\alpha + (X_{it} - \hat{\theta}_i \bar{X}_i)' \beta_k + \{(1 - \hat{\theta}_i)\alpha_i + (\varepsilon_{it} - \hat{\theta}_i \overline{\varepsilon_{it}})\} \qquad (5)$$

$$\theta_i = 1 - \sqrt{\frac{\sigma_\varepsilon^2}{(T_i\, \sigma_\alpha^2 + \sigma_\varepsilon^2)}} \qquad (6)$$

$$(y_{it} - \bar{y}_i + \bar{\bar{y}}) = \alpha + \left(X_{it} - \bar{X}_i + \bar{\bar{X}}\right)' \beta_k + (\varepsilon_{it} - \overline{\varepsilon_{it}} + \bar{\bar{\varepsilon}}) \qquad (7)$$

$$y_{it} = \alpha + \beta_k X_{it}^{'} + (\alpha_i - \alpha + \mu_{it}) \qquad (8)$$

$$\mu_{it} = \rho_1 \mu_{it-1} + \varepsilon_{it} \qquad (9)$$

The grouped OLS model assumes that there is no unobserved heterogeneity (invariant component over time, but variant in individuals) includes variations within (for an individual over time) and between (for all individuals in a single time), the estimators are consistent if EF prevails over EA. For the case of AD, the invariant component over time can be treated as if it were random and is exogenous (it is not related to the regressors), the estimators are consistent if EA prevails over EF. The EF model assumes that the invariant component generates heterogeneity since it is related to the regressors, so it is eliminated through the calculation of means, the estimators are consistent if EF prevails over EA. Finally, AR1, being a variation of grouped MCOs, generates consistent estimators if EA prevails over EF, in this case an autoregressive process of first order errors is defined since they depend on their first lag.

To select the indicated model that allows calculating the best estimators for a short panel, according to Álvarez, Perdomo, Morales and Urrego (2013, page 374) one must start by performing the Breusch and Pagan test that allows choosing between grouped OLS and EA or EF. As a null hypothesis it is established that there is no evidence of constant components (invariant in time) in the error, if the hypothesis is accepted, the estimators obtained by grouped OLS are more adequate than those obtained by EA or EF. Under this scenario, if errors also present a significant first lag, AR1 prevails over grouped OLS.

However, it is common that the hypothesis of the aforementioned test was rejected, so it is pertinent to identify whether the invariant component over time causes endogeneity in the model. In this sense, the Hausman test is applied, which states as a null hypothesis that there is no endogeneity in the model since the estimators obtained by EA and EF do not vary enough, there are no systematic differences. If the null hypothesis is accepted, the EF model prevails over EA.

In the event that the hypothesis is rejected, the fixed-effect model is adequate. If additional autoregressive problems arise, it is possible to perform a transformation to the model variables, to analyze the first differences. So the following equation is defined [10], as we observe the intercept of the model is eliminated, however, if the constant is significant, it implies that the original model presents a time trend described in equation [11] where δ must be included in equation 10.

$$(y_{it} - y_{it-1}) = (X_{it} - X_{it-1})'\beta_k + (\varepsilon_{it} - \varepsilon_{it-1}) \quad (10)$$

$$\delta t - \delta(t-1) = \delta \quad (11)$$

Under these specifications, the following model is analyzed [12] where IDHI is the Human Development Index Adjusted for Inequality, LNRT is the Natural Logarithm of the Total Income of Natural Resources as a percentage of GDP, LNRPIBper is the Natural Logarithm of the Gross Domestic Product per capita measured in international dollars constant PPA 2011, ES is the Life Expectancy at birth measured in years, ED is the arithmetic mean between the expectation of years of study and the average years of study of the population, LNCI is the Natural Logarithm of the Human Inequality Coefficient, and LNCO is the Natural Logarithm of CO2 Emissions per capita in tons.

$$(IDHI_{ij} - IDHI_{ij-1}) = \beta_1(LNRT_{ij} - LNRT_{ij-1}) + \beta_2(LNPIBper_{ij} - LNPIBper_{ij-1}) + \beta_3(ES_{ij} - ES_{ij-1}) + \beta_4(ED_{ij} - ED_{ij-1}) + \beta_5(LNCI_{ij} - LNCI_{ij-1}) + \beta_6(LNCO_{ij} - LNCO_{ij-1}) + (\mu_{ij} - \mu_{ij-1}) \quad (12)$$

Para simplificar la nomenclatura se reescribe la ecuación [12] como la siguiente [13]:

$$D\_IDHI_{il} = \beta_1 D\_LNRT_{il} + \beta_2 D\_LNPIBper_{il} + \beta_3 D\_ES_{il} + \beta_4 D\_ED_{il} + \beta_5 D\_LNCI_{il} + \beta_6 D\_LNCO_{ij} + D\_\mu_{il} \quad (13)$$

4. Results

4.1. Results of the Econometric Model of short panel data

As a summary, when executing the econometric model in the Stata version 14.0 program without transforming the model into first differences. There is evidence of one (or several) components that vary between individuals, but not in the time present in the error, which implies that there is heterogeneity not observed in the model. Therefore, the fixed effects and random effects models prevail over the grouped MCO model. In addition, through the Hausman test it is observed that the appropriate model that provides better estimators is the Fixed Effects. However, because the series have a unit root, that is, they are stationary (variance and constant average over time) in first differences, it is necessary to transform them to avoid spurious regressions (finding false relationships due to trend factors).

In that sense, an estimate of fixed effects is made by first differences, subtracting the first lag in time to each panel observation and estimating by OLS. When transforming the variables, the interpretation of the estimators changes, such that, for example, the coefficient of D_LNRT in the grouped OLS model expresses how much the difference (in two consecutive years) of the IDHI (β_1 / 100) changes when increases in 1% the difference of the natural logarithms (percentage variation) of the total rents of natural resources with respect to GDP. That is, it approaches the impact of a percentage variation that has the weight of the rents towards the variation in units of the IDHI. For the variables that do not present logarithm, it is considered as a change in the increase in units against a change of the same type.

This is because in general terms the estimators are explained as follows [14] and [15]:

$$\beta_k = \frac{\Delta E\left(\frac{y}{x}\right)}{\Delta \ln(x)} \approx \frac{\Delta E\left(\frac{y}{x}\right)}{\frac{\Delta x}{x}} \qquad (14)$$

$$\frac{\beta_k}{100} \approx \frac{\Delta E\left(\frac{y}{x}\right)}{100 * \frac{\Delta x}{x}} \qquad (15)$$

If the process of selecting better estimators and analysis of invariant component over time is replicated, there is no evidence of constant effects in the model. Therefore, MCO and FGLS prevail over fixed or random effects. Additionally, to verify if the estimators are appropriate, it is evidenced in the Hausman test with a confidence level of 95% that the random effects prevail in first differences. Giving the green light, to the analysis of the estimators obtained by MCO and FGLS.

Table 1. Econometric model results in first differences.

Variable	**MCO1**	**MCO2**	**EA**	**EF**	**AR1**
D_LNRT	-0.00225874**	-0.00283018***	-0.00225874***	-0.00182891*	-0.0023863***
D_LNPIBper	0.03924341***	0.04320574***	0.03924341***	0.03569143***	0.03993007***
D_ES	0.00118802*	0.00239404***	0.00118802*	-0.00200161	0.00166028***
D_ED	0.01531526***	0.01657023***	0.01531526***	0.01557564***	0.01631815***
D_LNCI	-0.12204844***	-0.12260749***	-0.12204844***	-0.12294369***	-0.12285915***
D_LNCO	0.00518019**	0.00461045**	0.00518019**	0.00209871	0.00594765**
_cons	0.00094882***		0.00094882***	0.00209925***	0.00074197***
r2	0.79422393	0.83203204		0.79156729	
r2_b			0.83419958	0.75419641	
r2_w			0.78874806	0.79156729	

*Notes: *, ** and *** significant 10%, 5% and 1% respectively. The results obtained from the econometric data model of short panel in Table 1 applied to the first differences of the series of the 142 countries in the period 2010-2015, reaffirm the paradox of the abundance or curse of natural resources. In all the models, the percentage growth rates of the relationship between natural income and GDP negatively affect the growth of the IDHI. Being significant at 5% for OLS grouped with constant term (trend), and significant at 1% if a first order autoregressive process (AR1) is applied. Source: World Bank, United Nations Development Program and CDIAC. Elaboration: Authors.*

Following the methodological scheme, Table 1 is presented as a comparative summary, where the results of the regressions are shown in: i) OLS grouped with cluster errors; ii) MCO grouped without constant with cluster errors; iii) Random effects with cluster errors; iv) Fixed effects with cluster errors; v) Grouped FGLS estimation or estimator of the average population with first order autoregressive process (AR1) and robust errors. Additionally, cluster or robust errors are established, depending on the case, by evidence of heteroscedasticity in the model described in the following subsection. This type of error is used since there is evidence of heterocedasticity in the model, as seen in the previous section due to the distribution of the data.

Table 1 shows the signs and expected significance of the econometric model of short panel data applied to the first differences of the series of the 142 countries in the period 2010-2015. Where the paradox of abundance of natural resources is identified. It can be seen that in all D_RT models it is significant, for example in 5% for OLS grouped with constant term, and 1% if a first order autoregressive process (AR1) is applied. In the same way, in all the models, the r2 is greater than 0.79, expressing that the variability of the X explains in a good way the variability of Y. Additionally, the analysis is consistent with economic theory, since the percentage growth of the GDP per capita PPP at constant prices positively affects the growth of the IDHI. Both the change in the years of schooling and in the years of life expectancy positively affect the growth of the IDHI, although life expectancy varies its level of significance depending on the model.

On the other hand, compared to a percentage increase in the coefficient of human inequality, the growth of the IDHI is negatively affected. This variable being the most significant. Finally, the variations of the per capita emissions of C02 positively affect the IDHI variations, that is, the countries increase their development at the cost of negative impacts on the ecological environment. Table 2 presents the interpretation of the betas for the grouped MCO model.

Table 2: Interpretation of the BSO grouped model in first differences.

Variable	Nomenclature B	Significant in:	Value B	Interpretation
D_LNRT	β_1	5%	-0.00226	In contrast to a 1% increase in the differences in LNRT, it is expected that, on average, the IDHI differences will decrease by 0.000023.
D_LNPIBper	β_2	1%	0.03924	In contrast to an increase of 1% in the differences of LNPIBper, it is expected that, on average, the IDHI differences will increase by 0.000392.
D_ES	β_3	10%	0.00118	In contrast to a unitary increase in the ES differences, it is expected that, on average, the IDHI differences will increase by 0.00118.
D_ED	β_4	1%	0.01531	In contrast to a unitary increase in ED differences, it is expected that, on average, IDHI differences will increase by 0.01531.
D_LNCO	β_5	5%	0.00518	In contrast to a 1% increase in the LNCO differences, it is expected that, on average, the IDHI differences will increase by 0.000052.
D_LNCI	β_6	1%	-0.12204	In contrast to a 1% increase in the LNCI differences, it is expected that, on average, the IDHI differences will be decreased by 0.00122.

Note: The results in Table 2 show that the variable D_IDHI is more sensitive to percentage changes in the difference of the natural logarithm of the Human Inequality Coefficient (CI), and more susceptible to unit changes in the difference of years of education than the years of life expectancy. Additionally, although there is a significant and negative relationship between extractivism, its impact is not so representative, leaving open the possibility that countries will reverse this situation. Source: World Bank, United Nations Development Program, CDIAC. Elaboration: Authors.

Table 3 shows the results of different tests applied to the econometric model. According to Ramsey's omitted variables test, the null hypothesis that the model has no omitted variables is accepted. It is important to point out that it does not necessarily refer to variables not considered in the model, but that they can also be the same regressors expressed in different powers. The test was obtained after the OLS regression grouped with constant term and cluster errors. When the presence of heteroscedasticity in the model is evaluated, after running a regression of fixed effects, by means of the Wald test, we obtain that the model presents heterocedasticity, that is, different sigma squared for each individual. Because of this, it is essential to apply robust standard errors or clusters so that the inference is not wrong. If the Wooldrifge test that evaluates the first-order autocorrelation to the panel data is applied, the null hypothesis is rejected, showing that this type of autocorrelation exists. Therefore, the estimation by FGLS with process AR1 is the most appropriate.

Table 3: Test applied to the model in first differences.

Test	**Null hypothesis (Ho)**	**Prob>"Estadístic"**	**Result**
Test Ramsey	Model does not have omitted variables	0.2206	Ho is accepted
Test de Wald	Sigma (i) ^ 2 = Sigma ^ 2 for all i	0.0000	Ho is accepted
Test Wooldridge	No first-order autocorrelation	0.003	Ho is accepted
Test Breusch y Pagan	Var(u)=0	1.000	Ho is accepted
Test Hausman	Non-systematic difference in the coefficients	0.0717	Ho is accepted

Note: The results in Table 3 show that the Ho is accepted that the model does not present omitted variables, it is accepted that the model presents problems of heteroscedasticity, so it is used in the estimations cluster or robust errors, it is accepted that the model presents autocorrelation in first-order errors, so an autoregressive process must be applied, Ho of the Breusch Test and Pagan is accepted, so that MCO prevails over EF or EA, and Ho of the Hausman test is accepted. Estimators obtained by EA are more suitable than those of EF. Source: World Bank, United Nations Development Program, CDIAC. Elaboration authors.

Collaterally, Table 3 shows the result of the Breusch and Pagan test where the null hypothesis is accepted that there is no unobservable component invariant in time that generates heterocedasticity. Therefore, estimation prevails by grouped OLS, rather than fixed or random effects. To verify the validity of the estimators, the Hausman test is performed, in which, against a confidence level of 95%, the random effects model prevails over the fixed effects model.

To verify that there is not high collinearity between the regressors, the inflation factor of the variance applied is calculated after running the regression of OLS grouped with constant terms. An inflation greater than 10 implies that said variable generates collinearity. As the values border on 1, the non-existence of collinearity is intuited. To complement the analysis, we present the correlation matrix of the regressors Table 4, which shows that for all cases, the correlation does not exceed 0.26 between CO2 emissions and GDP per capita. So, it corroborates the non-existence of strong collinearity.

Table 4: Correlation matrix of the regressors.

	D_LNRT	**D_LNPIBper**	**D_ES**	**D_ED**	**D_LNCI**	**D_LNCO**
D_LNRT	1.000					
D_LNPIBper	0.0994	1.000				
D_ES	0.1659	0.0656	1.000			
D_ED	0.0245	0.0270	0.0030	1.000		
D_LNCI	-0.0732	-0.0285	-0.0515	0.0418	1.000	
D_LNCO	0.0474	0.2583	0.1115	0.0334	0.0152	1.000

Note: Table 4 shows that the independent variables do not have a strong correlation with each other, being the highest between D_LNCO and D_LNPIBper of 0.26. Source: World Bank, United Nations Development Program, Carbon Dioxide Information Analysis Center (CDIAC). Elaboration authors.

4.2. Descriptive analysis of the study variables.

When relating the averages of the IDHI and total rents of the natural resources (RT) as a percentage of GDP, there is a negative relationship between the variables. In Figure 1, it can be seen that European countries are in the upper left with higher levels of development and lower RT, while as the income of natural resources increases, the IDHI is lower (except for Norway) , this happens in most countries in Africa, America and Asia, with their different exceptions.

The majority of countries in Africa are below the average of IDHI and above the average of RT, that is, they show a paradox of abundance of natural resources. In Asian countries such as Kazakstan and Azerbaijan the relationship becomes diffuse, having a large weight of extractive exports but at the same time counting on an above-average development. In Central America, the exception is Trinidad and Tobago, while in America, Chile presents a behavior different from the trend.

It can be seen that the relationship between the variables can be better estimated through a logarithmic rather than a linear form. Evidence that is addressed for the implementation of the econometric model and its functional form, discussed in the next section. In general, it can be observed that there is a negative relationship but little accentuated. Moreover, if only the countries of the Asian continent were considered, the relationship would be positive, that is to say, although there is a strong dependence on natural resources, development processes are promoted, but this exceptionality is due to the development policies endogenous carried out since the decade of the 60s.

Figure 1: Relationship between IDHI and RT 2010-2015

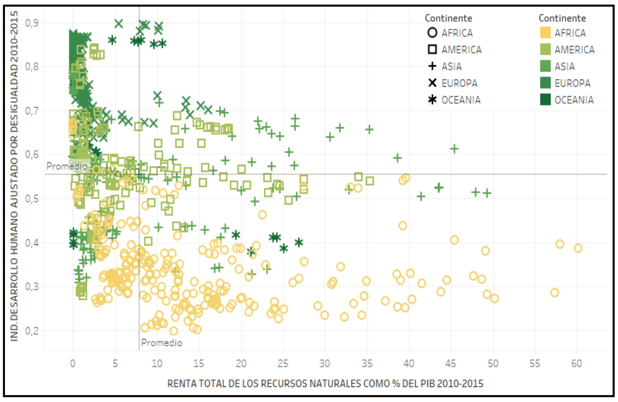


Figure 2: Relationship between IDHI and PIBper 2010-2015

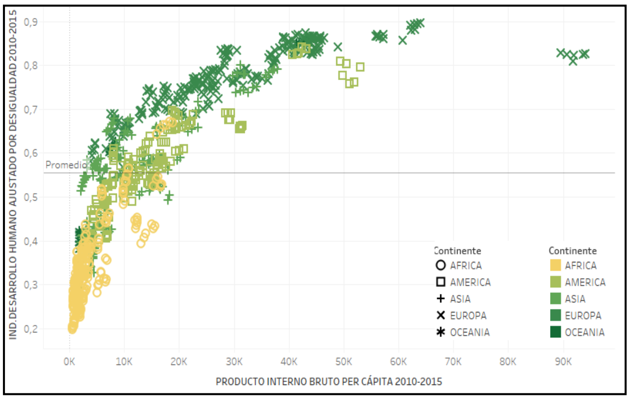


Figure 3: Relationship between IDHI and ES 2010- 2015

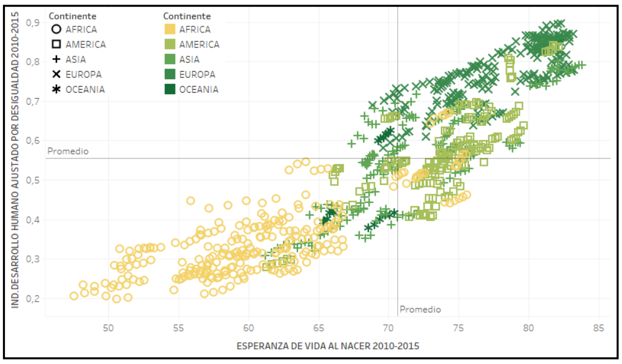


Figure 4: Relationship between IDHI and ED 2010-2015

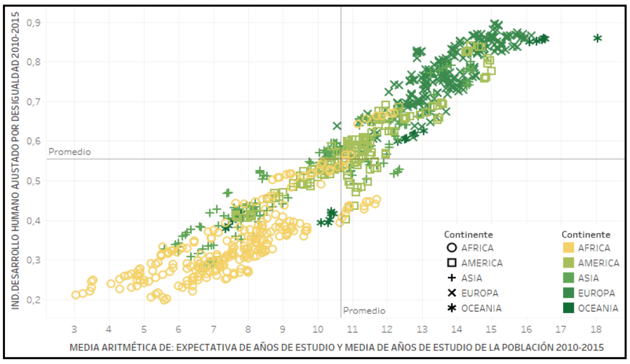


Figure 5: Relationship between IDHI and CI 2010-2015

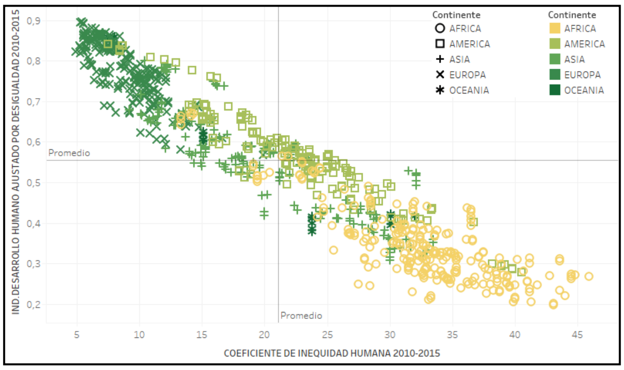
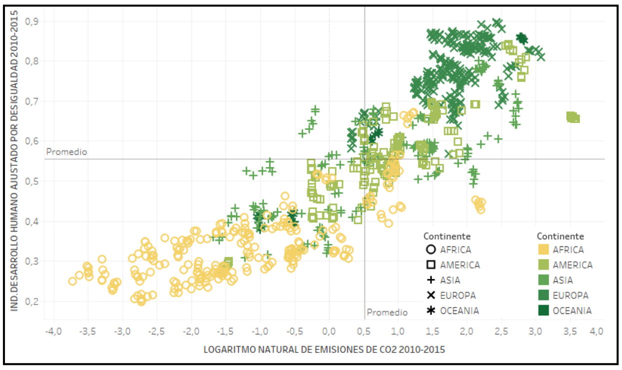


Figure 6: Relationship between IDHI and CO 2010-2015



Note: In Figures 1, 2, 3, 4, 5 and 6 the relationship between the dependent variable IDHI and all the independent variables for all the years of the study are presented graphically. It is observed that the IDHI has a negative relationship with RT and CI, while the relationship is positive for PIBper, ES, ED and CO, additionally, a logarithmic functional form for RT and PIBper is evidenced. It is worth mentioning that in order to graph per capita CO2 emissions, a logarithmic scale was used due to the significant data variation caused by the United States and China. Source: World Bank, United Nations Development Program, Carbon Dioxide Information Analysis Center (CDIAC). Elaboration authors.

When examining the relationship between the IDHI and GDP per capita PPP constant prices, (Figure 2), it is observed as a general rule, as higher levels of GDP per capita correspond to a higher rate of human development adjusted for inequality. This is due to the fact that people and the government having more income can allocate a higher proportion of them to health and education spending, which are dimensions of the HDI. In addition, it can be seen that African countries are below the average GDP per capita, as well as certain countries in Asia and America. While the countries of the center, such as Europe, have a higher GDP per capita. Additionally, it is observed that the dispersion of data at the country level can be treated through a logarithmic form.

The IDHI variable is directly related to the Life expectancy at birth, that is, the higher the IDHI, the higher the life expectancy at birth, as can be seen in Figure 3. Europe has more life expectancy at birth, where Czechoslovakia, Iceland, Norway and Germany have on average 83, 83, 82 and 81 years respectively. Followed by Asia where Japan, Israel and Korea stand out on average 84, 82 and 82 years respectively. It is observed that the dispersion between countries can be captured by means of a linear relationship between the variables.

Figure 4 shows that as the arithmetic mean increases in the expectation of years of study and average of years of study of the population, the IDHI value is higher. This series presents less dispersion in the data than the previous relationship and could be expressed in a linear relationship. Similar results are observed at the continent level, where the countries of Africa have a lower average in the education indicator and the European countries have higher levels. Additionally, Australia is against the trend of Oceania presenting high levels of education. Collaterally, the countries of America and Asia are located in the middle of the relationship, except in special cases.

The coefficient of human inequality expresses the average of inequality in the three dimensions of the HDI. So, its relationship with the IDHI is inverse. That is, the greater the inequality, the IDHI presents lower values (see Figure 5). It can be seen that the data show a distribution consistent with the results presented in the previous subsections. That is, African countries have higher levels of human inequality while European countries have less inequality. At the same time, there are countries in America and Asia that are located by the average of the relationship.

Figure 6 shows the relationship between the averages of the IDHI and the annual emissions of C02 per capita. Due to the fact that there are countries with very high emissions such as the United States and countries with low emissions, the graph is presented in logarithmic scale of base 10. It is observed that as countries present higher C02 emissions in turn corresponds to higher levels developmental. African countries, due to their limited productive structure, with low industrialization, present lower levels of emissions. Followed by countries of America and Asia, where the United States is located as the largest emitter of C02. To some extent, this implies a critique of the prevailing development model worldwide, where despite trying to find a sustainable framework, the reality implies that pollution increases to improve people's well-being. At the same time, it demonstrates the limitations that the human development index has when it does not include an ecological dimension in its calculation.

4.3. Comparative analysis of the paradox of abundance in countries of extremes

To visualize the paradox of abundance in the country level, Table 5 is presented, which expresses a comparison of the following countries: Congo and Liberia, countries with the highest average total income of natural resources as a percentage of GDP of the entire sample; Norway, Switzerland and Denmark are considered because they have the highest IDHI average in the sample.

From Table 5 several conclusions are obtained. In the first instance it is evident how the countries with the highest average total income of natural resources belong to the African continent and at the same time have a lower level of development. In the same way, the percentage of exports of fuels and minerals with respect to the total exported is excessively high. C02 emissions per capita are lower compared to the rest of the selected countries.

Table 5: Comparative paradox of abundance in selected countries (2010-2015).

N°	Country	IDHI average	RT average	Average weight of X (minerals and fuels)	Average Emissions C02 per capita
1	Congo	0,410	45,74	72,4%*	0,50
2	Liberia	0,275	45,04	-	0,22
3	Noruega	0,889	8,49	71,1%	10,95
4	Suiza	0.867	0,01	5,8%	4,71
5	Dinamarca	0.862	1,24	9,2%	6,81

*Note: * Averages for the period 2010-2014. The countries with the highest average total income of natural resources as a percentage of GDP have a strong dependence on mineral and fuel exports, their levels of human development are below the world average and their CO2 emissions are reduced. Otherwise, it happens with the countries that present greater human development, with the exception of Norway. Source: World Bank, United Nations Development Program, CDIAC. Elaboration authors.*

The countries with the highest level of development are located in Europe, with Switzerland and Denmark presenting indicators according to the paradox of abundance, since their natural resource income does not exceed 2% of GDP and their fuel exports do not exceed 10%. % of the total, while its development is above the world average. Norway is a special case, a country that has managed to counteract the curse of abundance and present high levels of development despite having a representative average of income from natural resources and extractivist oil and mining exports. In turn, the countries of Europe have greater pollution expressed in higher levels of CO2 per capita, which implies that they present a higher degree of industrialization.

One of the limitations of the study lies in using all the dimensions of sustainable development for the analysis of the paradox of the abundance of natural resources. In the development of the previous chapter, an attempt was made to incorporate governance and ecological variables into the study, which were not significant for the IDHI but relevant if analyzed in comparison to the HDI. Under this antecedent, Table 6 presents indicators for the countries of the extremes that broaden the spectrum of study and are relevant for the analysis.

Table 6 incorporates into the analysis the ecological footprint and biocapacity measured in gha (biologically productive hectares) per person. Where it is observed that the average ecological footprint (biologically productive land required by the population to produce the resources required for consumption) is lower for less developed countries and increases the number of hectares required per person if a higher level of development is presented. In turn, the biocapacity (capacity of the biosphere to regenerate and provide natural resources for life) of the countries with lower IDHI is greater than developed countries, except in the case of Norway. If the ecological footprint is subtracted from biocapacity, it can be seen that African countries are surpluses while European countries are deficient, so they need their resources to satisfy their needs.

Table 6: Comparative ecological and governance variables in selected countries (2010-2015).

N°	Country	Average Ecological Footprint (gha) per cápita	Average Biocapacity (gha) per cápita	Average perception of corruption	Average perception of political stability
1	Congo	1,16	11,07	-1,17	-0,42
2	Liberia	1,21	2,59	-0,66	-0,55
3	Noruega	5,84	7,58	2,21	1,27
4	Suiza	5,19	1,10	2,11	1,35
5	Dinamarca	6,59	4,36	2,33	0,98

Note: Table 6 expands the spectrum of study to descriptive level including variables that contribute in this type of analysis but in the model were not significant. Regarding ecological sustainability, it is observed that the countries with the greatest extractivism require fewer hectares to produce their resources needed for consumption that is expressed in the ecological footprint, while their levels of governance have a negative perception. On the other hand, European countries have better levels of governance but require greater natural resources for their subsistence. Source: World Bank, Global Footprint Network. Elaboration authors.

Additionally, variables corresponding to the governance dimension were incorporated. The data was obtained from the World Bank, and corresponds to the perceptions of the population, a measure that can vary between -2.5 and 2.5 because it is normalized. It can be seen that, on average, the perception of corruption and political stability is lower in countries with greater rents of natural resources and consequent less development. While the perceptions are favorable for the cases, in which the development of the countries is higher.

4.4. Strategies to overcome the curse of abundance

The State has a fundamental role to overcome the "curse of resources", thus optimizing the creation of an inclusive and decentralized State. As Acosta and Schuldt put it, "It is not the State that defines the role of society and its organizations, but it is these that must define the role of the State" (2000, page 264). Therefore, it is necessary for it to rethink policies in society and in the market in order to achieve a sustained and equitable development.

In a timely manner in the case of abundance paradox, according to OXFAM (2009, pp. 4-5) states that to overcome the curse of natural resources countries that have abundant endowment must: a) establish legal and fiscal regulations for the sector extractivist in favor of the interests of the population; b) encourage mechanisms of participation of civil society in the decision-making of the extractive industry; c) transparently publish the resources obtained from the industry; present in detail the destination of the income received by the state for these activities; among others.

Following the case of Norway as one of the countries that has managed to reverse the curse of resources, Wirth and Ramírez (2017, page 240) indicate that the success of the country is due to four instruments applied: a) training of Norwegian human talent, b) privilege to the state oil extraction company c) preference to local suppliers for granting future licenses, and d) research and development agreements with academia and industry.

Collaterally, policies in favor of development in general must be applied. Acosta and Schuldt (2000, pp. 265-266) mention that it is necessary to carry out: i) an agrarian and urban reform to promote production, consider the environmental factor, and avoid the concentration of land; ii) an educational reform must be carried out to ensure and promote access to education; iii) tax reform, to improve fiscal autonomy with a progressive approach; iv) constant combat against corruption.

5. Conclusion

To contribute to the current debate on the relationship between human development and extractivism, it was proposed to broaden the vision of development overcoming the traditional analysis of per capita GDP growth. In this sense, the sustainable development approach is proposed, with the limitation of finding an indicator that encompasses all its dimensions. In spite of that, the selection of the Index of Human Development adjusted by inequality (IDHI) managed to collect effects of a social nature, having as restrictions its reduced time series and not considering ecological aspects.

To perform the econometric analysis on short panel data it was necessary to transform the variables into first differences. Following the accepted conventional methodology, it is observed that the model in first differences does not present an unobserved component invariant in time, so the OCO group estimate prevails before that of fixed or random effects. Additionally, we accept the hypothesis that the random effects prevail over the fixed ones, so that it is verified that the OLS estimators are adequate. In this sense, the econometric model applied to the 142 countries of the study indicates that extractivism has a negative and significant relationship with human development worldwide in the 2010-2015 period.

In the econometric model of panel data with the variables transformed into first differences, it was found that the most representative variable that explains the Human Development Index Adjusted by inequality is the coefficient of human inequality with a higher level of significance. The results are in tune with the economic literature of paradox of abundance.

Through the descriptive analysis it was shown that European countries have better results in the selected indicators, so that their high levels of development correspond to high levels of GDP per capita, life expectancy at birth, years of schooling and expectation of study, lower coefficient of human inequality, and consequent lower participation of total rents of natural resources. Otherwise, the countries of the African continent in all the analyzed variables presented worse indicators below the average in those that contribute to well-being and above the average in the share of incomes and inequity.

If the analysis is taken to the study of specific cases of countries, it can be observed how the curse of resources affects negatively at the individual level, where when incorporating ecological and governance variables, the results are consistent. Being the countries with more income of natural resources with respect to their GDP and less developed those that have greater perception of corruption and political vulnerability. In addition, it is observed that there may be exceptional cases that break the trend, leaving as a long-term challenge to counteract the curse of natural resources, through improving the institutions and mechanisms of collective participation in the countries.

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ANNEXES

Annex 1: Descriptive statistics of the selected countries.

Variable	**Obs**	**Media**	**Desv. Est.**	**Min**	**Max**
IDHI	852	0,555	0,192	0,198	0,897
RT	852	7,80	10,49	0,00	60,12
PIBper	852	15.278,24	15.546,59	593,06	94.088,59
ES	852	70,61	8,49	47,56	83,79
ED	852	10,66	2,97	3,05	18,05
CO	852	3,95	4,79	0,02	36,04
CI	852	21,10	10,58	4,90	45,90

Source: World Bank, United Nations Development Program, CDIAC. Elaboration: Authors.

Annex 2: List of countries selected for the study.

N°	**Country**	**Code**	**N°**	**Country**	**Code**
1	Afganistán	AFG	45	Estonia	EST
2	Albania	ALB	46	Ethiopia	ETH
3	Angola	AGO	47	Fiji	FJI
4	Argentina	ARG	48	Finland	FIN
5	Armenia	ARM	49	France	FRA
6	Australia	AUS	50	Gabon	GAB
7	Austria	AUT	51	Georgia	GEO
8	Azerbaijan	AZE	52	Germany	DEU
9	Bahamas	BHS	53	Ghana	GHA
10	Bangladesh	BGD	54	Greece	GRC
11	Belarus	BLR	55	Guatemala	GTM
12	Belgium	BEL	56	Guinea	GIN
13	Belize	BLZ	57	Guinea-Bissau	GNB
14	Benin	BEN	58	Guyana	GUY
15	Bhutan	BTN	59	Haiti	HTI

16	Bolivia (Plurinational State of)	BOL	60	Honduras	HND
17	Bosnia and Herzegovina	BIH	61	Hungary	HUN
18	Botswana	BWA	62	Iceland	ISL
19	Brazil	BRA	63	India	IND
20	Bulgaria	BGR	64	Indonesia	IDN
21	Burkina Faso	BFA	65	Iran (Islamic Republic of)	IRN
22	Burundi	BDI	66	Iraq	IRQ
23	Cabo Verde	CPV	67	Ireland	IRL
24	Cambodia	KHM	68	Israel	ISR
25	Cameroon	CMR	69	Italy	ITA
26	Canada	CAN	70	Jamaica	JAM
27	Central African Republic	CAF	71	Japan	JPN
28	Chad	TCD	72	Jordan	JOR
29	Chile	CHL	73	Kazakhstan	KAZ
30	China	CHN	74	Kenya	KEN
31	Colombia	COL	75	Kiribati	KIR
32	Comoros	COM	76	Korea (Republic of)	KOR
33	Congo	COG	77	Kyrgyzstan	KGZ
34	Congo (Democratic Republic)	COD	78	Lao People's Democratic Republic	LAO
35	Costa Rica	CRI	79	Latvia	LVA
36	Croatia	HRV	80	Lebanon	LBN
37	Cyprus	CYP	81	Lesotho	LSO
38	Czechia	CZE	82	Liberia	LBR
39	Côte d'Ivoire	CIV	83	Lithuania	LTU
40	Denmark	DNK	84	Luxembourg	LUX
41	Dominican Republic	DOM	85	Madagascar	MDG

42	Ecuador	ECU	86	Malawi	MWI
43	Egypt	EGY	87	Mali	MLI
44	El Salvador	SLV	88	Mauritania	MRT
89	Mauritius	MUS	116	Slovakia	SVK
90	Mexico	MEX	117	Slovenia	SVN
91	Moldova (Republic of)	MDA	118	Solomon Islands	SLB
92	Mongolia	MNG	119	South Africa	ZAF
93	Montenegro	MNE	120	Spain	ESP
94	Morocco	MAR	121	Sri Lanka	LKA
95	Mozambique	MOZ	122	Suriname	SUR
96	Nepal	NPL	123	Sweden	SWE
97	Netherlands	NLD	124	Switzerland	CHE
98	Nicaragua	NIC	125	Tajikistan	TJK
99	Niger	NER	126	Tanzania (United Republic of)	TZA
100	Nigeria	NGA	127	Thailand	THA
101	Norway	NOR	128	Togo	TGO
102	Pakistan	PAK	129	Trinidad and Tobago	TTO
103	Panama	PAN	130	Tunisia	TUN
104	Paraguay	PRY	131	Turkey	TUR
105	Peru	PER	132	Uganda	UGA
106	Philippines	PHL	133	Ukraine	UKR
107	Poland	POL	134	United Kingdom	GBR
108	Portugal	PRT	135	United States	USA

109	Romania	ROU	136	Uruguay	URY
110	Russian Federation	RUS	137	Uzbekistan	UZB
111	Rwanda	RWA	138	Venezuela (Bolivarian Republic of)	VEN
112	Sao Tome and Principe	STP	139	Viet Nam	VNM
113	Senegal	SEN	140	Yemen	YEM
114	Serbia	SRB	141	Zambia	ZMB
115	Sierra Leone	SLE	142	Zimbabwe	ZWE

Source: World Bank. Elaboration: Authors.