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# **How do extractive resources affect human development ? Evidence from a panel data analysis**

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a

1 **How do extractive resources affect human development? Evidence**  
2 **from a panel data analysis**

3 **Abstract**  
4

5 This paper examines the effect of extractive resources on human development. We control for  
6 institutional quality through a composite index of institutional quality. Our sample covers 42  
7 countries over the period 2009-2015. Given the small sample size, we use the bias-corrected  
8 least square dummy variable method. The results show that extractive resources have a  
9 positive and significant effect on human development. Health and education are the channels  
10 through which extractive resources affect human development. The quality of institutions  
11 improves the effect of extractive resources on health but destroys their positive effect on  
12 human development and education. This study reveals that the consideration of institutional  
13 quality must be specific to each sector (health and education) in a more in-depth analysis of  
14 the effect of extractive resources on human development.

15

16 **Key words:** Extractive resources; Human development; Resource curse; Quality of  
17 institutions, Panel

18 JEL Code: Q320; C330

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## 28 **1. Introduction**

29

30 While a wide of studies focus on the effects of natural resources on monetary aspects of  
31 human development, the interest of policy-makers in non-monetary outcomes has increased,  
32 thus strengthening the need for a better understanding of how resource abundance affects  
33 human development (Carmignani 2013). Most of studies on natural resources  
34 abundance/dependence are organized around the Auty (1993)'s resource curse theory. The  
35 resource curse thesis establishes a negative relationship between dependence on natural  
36 resources and economic growth. Yet it has long been recognized that the endowment of  
37 natural resources provides a relative advantage for the country's economic development. From  
38 a theoretical point of view, natural resources are expected to have a positive effect on human  
39 well-being through the improvement of the living standards. Quality of institutions is  
40 increasingly analyzed as one of the key conditions to turn the resource curse into a blessing.  
41 Shao and Yang (2014) developed a normative conceptual framework, introducing a variable  
42 of institutions to explain the co-existence of the resource blessing and resource curse  
43 phenomena.

44 Empirical evidences on natural resources abundance issue, ranging from the pioneer studies  
45 (Sachs and Warner 1995) to the most recent updates (Eregha and Mesagan 2016; Mejía 2020),  
46 seem to emphasis an adverse, even no effect of resource abundance on human development.  
47 Most of evidences highlighted indirect effects of resource abundance on human development.  
48 Based on these literature findings, Badeeb et al (2017) summarize the challenges for resources  
49 economists as follows: "Recent contrarian studies demonstrate that future research should  
50 better address endogeneity of dependence measures, and expand the years of study and range  
51 of empirical methodologies used." This point is widely supported by Sun et al. (2018) for  
52 whom the rationality of the natural resources metrics selection framework is the most  
53 vulnerable aspect of this formulation, as the use of different metrics inevitably produces

54 different conclusions. The authors warn that the adverse effects of resource abundance on  
55 economic development are sensitive to the empirical technique and the indicators of  
56 abundance in natural resources used. Arezki and Van DerPloeg (2007) also highlighted that  
57 the empirical evidence of the resource curse is biased because it does not take into account  
58 endogenous parameters such as the quality of institutions.

59 This paper fills the gap by addressing the following issues: Do extractive resources improve  
60 versus worsens human development? To what extent the quality of institutions in the country  
61 condition the extractive resources effect on human development? What are the channels  
62 through which extractive resources enhance versus degrade human development?

63 This paper aims to analyze the effect of extractive resources dependence on human  
64 development controlling for the quality of institutions. Specifically, the study aims to (i)  
65 analyze the effect of institutional quality in the relationship between extractive resources and  
66 human development and (ii) identify the channels through which extractive resources would  
67 affect human development. As previous authors, we are deeply thinking that the mixed  
68 effects of natural resource abundance/dependence on human development lie in the choice of  
69 variables and the type of resources to capture these effects.

70 We use extractive resources revenues as a proxy of natural resources dependence. In the  
71 sample and over the analysis period, resource dependence measured by total natural rent  
72 averages 10.8% of GDP, with a maximum of 56% for the Congo Democratic Republic and  
73 the minimum of 0.06% for Germany. The quality of institutions has been identified in  
74 literature as the channel through which natural resources affect human progress. Therefore,  
75 we introduce a country's enabling environment index in order to take into account key aspects  
76 of institutional quality largely documented in literature. To reduce multi-collinearity issues,  
77 given the small size of our sample, the country's enabling environment index is a composite  
78 score that we build using the Principal Components Analysis techniques. Finally, we dis-

79 aggregate our outcome variable into its main components to detect the channels through  
80 which resource dependence could affect human development level.

81 The rest of the paper is organized as follows: Section 2 presents the debate in literature  
82 regarding the role of natural resources in human development process. Section 3 describes  
83 methodology. Section 4 presents and discusses the results. Section 5 carries out robustness  
84 tests and analysis. Section 6 concludes the study and provides useful policy implications.

## 85 **2. Literature review**

### 86 **2.1. Theoretical background**

87

88 Literature is documented on the effects of natural resource abundance on economic  
89 development (economic growth, in particular). However, there is no consensus on the sense of  
90 the relationship between resources abundance and human development.

91 Literature on the effects of natural resources abundance/dependence on human development  
92 can be organized around three theoretical frameworks: The natural resources curse theory led  
93 by Gelb (1988); Karl (1997); Auty (2001) and updated by Van der Ploeg (2011); Alberola and  
94 Benigno (2017) and Yang et al. (2019), the endogenous development theoretical framework  
95 pioneered by Romer (1986), Lucas (1988) and Barro (1988);and the theory of institutions  
96 (North, 1991).

97 Regarding the natural resource curse, a large part of literature sustains that many resource-rich  
98 regions experience lower incomes and slower income growth rates than resource-poor  
99 regions. Douglas and Walker (2017) summarize the resource curse as follows: “A resource-  
100 rich region experiences a “resource curse” if the way that it uses its resource wealth detracts  
101 from the economic well-being of its people.” Literature identifies many possible explanations  
102 to this phenomenon. Those include disincentives to human capital formation, negative  
103 interactions between extractive industries and social institutions, economic damage from  
104 resource price volatility and adverse real exchange rate effects. These adverse effects on the

105 national economy are known as “Dutch disease”. Dutch disease refers to the effects of the  
106 discovery of huge gas deposits on the Dutch economy in the 1960s and 1970s. The extraction  
107 of these deposits generated important profits which led to the development of mining activity  
108 at the expense of other sectors of the economy. The increase in national income and demand  
109 led to inflationary pressures, while the inflow of capital resulted in a trade surplus and an  
110 appreciation of the real exchange rate. This makes the manufacturing and domestic services  
111 sectors less competitive. During the mining boom period, economic agents show a strong  
112 preference for the present which leads them to neglect the long-term growth goals. Once  
113 natural resources are exhausted, the atrophy of the productive base and the over-evaluation of  
114 the exchange rate lead to a stagnation of economic activity. The oil boom of the 1970s and  
115 1980s had similar results in countries as Saudi Arabia, Nigeria and Mexico. Dutch disease  
116 also refers to other forms of expansion which result in a trade surplus or a surplus in the  
117 capital account, generally due to foreign investment in the development of the natural  
118 resources. According to Frankel (2012), the exploitation of natural resources usually leads to  
119 the following undesirable effects: a real and significant appreciation of the currency<sup>1</sup>, an  
120 increase in public expenditure due in particular to the increased availability of tax revenue or  
121 royalties, an increase in the price of non-transferable goods and sometimes a current account  
122 deficit in spite of the increase in revenues from exports of commodities, which could lead to  
123 an explosion of foreign debt.

124

125 Linked to human development, the part of the endogenous development theory which can be  
126 mobilized in this paper is more precisely the human capital accumulation theory. Education  
127 and health are identified by development economists such as Sen (1999) to be the key  
128 components of human development in its capabilities definition. As natural resources

<sup>1</sup> This appreciation takes the form of an appreciation of the nominal currency in countries with a floating exchange rate and in the form of inflows and inflation in fixed exchange rate regimes.

129 abundance is more likely to have mixed effects on human and economic development, authors  
130 highlighting the negative effects of natural resources on human development will be grouped  
131 in the resources curse framework, while authors who support the positive relationship  
132 between resource abundance/dependence and human capital accumulation will be identified  
133 to the endogenous development framework<sup>2</sup>.

134 Barro (1997; 2001) argues that human capital facilitates the absorption of superior  
135 technologies from leading countries. The author assumes that the technology-absorption effect  
136 is especially important at the secondary and higher education levels. Similarly, Aghion, et al  
137 (1998) assert that education creates better conditions for good governance by improving  
138 health and enhancing equality. Given the high degree of inequality prevailing in developing  
139 countries, education is considered as a better indicator of the median level of development  
140 (Sen 1999). It is theoretically assumed that resource abundance should induce additional  
141 investment for human capital, including education and health. As human capital (health and  
142 education) as main components of human development, we expect to have a positive effect of  
143 natural resources abundance on human development.

144 Sachs and Warner (1995; 1999) claim that natural resources tend to slow down economic  
145 growth in countries that possess or discover them. As economic development is one of the  
146 components of human development in Sen (1997)'s capabilities definition, this expected  
147 negative effect between natural resources abundance and economic growth can lead to a  
148 mixed effect<sup>3</sup>. For Zallé (2019), natural resources only affect growth in countries with very  
149 low levels of human capital. This is in line with Bravo-Ortega and De Gregorio (2005) who  
150 explain that an increase in a country's natural endowment leads to a reallocation of human

<sup>2</sup> Endogenous development refers to any development process which builds on internal resources, both social, cultural and economic, including natural, environmental and ecosystemic resources. This type of development is facilitated by the commitment and the involvement of the beneficiaries in the process.

<sup>3</sup> The Sen's capabilities theory postulates that three elements are essential to human fulfillment : the capability of people to access to a good education and his capability to have a decent standard of living and his capability to lead a long and healthy life.



151 capital from the industrial sector to the natural resources one. The reallocation of skills  
152 increases the economic growth because there is a best allocation of factors of production  
153 among economic sectors. The posture of these authors contrast with those of Barro (1997;  
154 2001) who believes that high skill is more likely to increase economic growth through  
155 productivity channel. Badeeb, and Clark (2017) argue that because the generation of natural  
156 resource wealth is not a result of production, it can occur relatively independently of other  
157 economic processes and does little to create employment. For example, the oil and gas sectors  
158 are among the world's most capital-intensive industries. Thus, this sector creates fewer jobs  
159 per unit of capital invested, and the skills required for these jobs usually do not fit the profile  
160 of a country's unemployed (Karl 1997).

161 The ambiguous relationship between natural resource abundance and human development  
162 supports our idea to dis-aggregate the human development variable (human development  
163 index) in its core components to better capture the relationship between each component with  
164 our selected resources abundance variables in the regression step.

165 A third framework which could help us to better understand the ambiguous results shown in  
166 literature is the theory related to institutional quality. Shao and Yang (2014) develop a  
167 theoretical model, introducing an institutional variable to explain the co-existence of the  
168 resource blessing and resource curse phenomena. A strong quality of institutions is a relevant  
169 factor to guarantee a better allocation and investment of revenues from natural resources  
170 (Mehlum, and Torvik 2006; Sala-i-Martin and Subramanian 2008). Rents from natural  
171 resources abundance are sometimes used to corrupt bureaucrats, civil society and local  
172 communities' leaders. These practices tend to make institutions inefficient. The weakness of  
173 institutions favors the diversion of rents from natural resources to the detriment of collective  
174 public investments from which education and health could benefit. Carbonnier (2013) argues  
175 that leaders tend to redistribute extractive rents to influential groups in order to stay in power.

176 Therefore, the weakness of institutions would reduce, even inverse the positive effects of  
177 natural resources on human development indicators.

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## 182 **2.2. Empirical evidences**

183

184 There is no empirical consensus on the effect of resources on human development. Havranek,  
185 and Zeynalov (2016)'s Meta-Analysis findings are very symptomatic of this lack of  
186 consensus. Analyzing 43 studies on natural resources abundance and economic development,  
187 the authors find that 40 percent of empirical studies showed a negative effect of natural  
188 resources on economic growth, 40 percent find no effect, and 20 percent of these studies  
189 highlight a positive effect.

190 A survey on case studies tends to confirm the meta-analysis findings. Bulte et al (2005) show  
191 that resource abundance indirectly affects measures of human welfare via its effect on the  
192 quality of institutions. But when controlling for this indirect effect, they find no evidence of  
193 any direct effect. Analyzing the country level effect in resource-rich Caspian Basin countries  
194 of Azerbaijan, Kazakhstan, Russia, and Turkmenistan, Eregha and Mesagan (2016) showed  
195 that natural resource dependence has potential impact on institutional development. However,  
196 the study found weak institutional quality to be culpable for the weak management of  
197 resources into economic development. The authors argue that natural resource endowments  
198 coupled with very strong institutional framework will not only serve as a catalyst for growth  
199 and development, but will also eradicate the curse associated with resource wealth. In  
200 contrast, poor governance is more likely to prevail in countries where institutions have not  
201 been well developed making that share of resources rent among recipients for their  
202 development is inefficient. Costantini and Monni (2008) show an adverse effect of resource  
203 abundance on human development. The channels of transmission of this negative effect are

204 both weaker institutions and reduced economic growth. Based on crowding-out effects,  
205 Gylfason (2008) emphasizes the negative relationship between natural capital and social  
206 capital. Carmignani and Avom (2010) provide evidence of a negative effect of primary  
207 commodities export dependence on social outcomes. Carmignani (2013) examines the effect  
208 of resource abundance on human development. He postulates that higher income inequality  
209 reduces human development using Sen’s Capabilities framework. Using cross-sectional data  
210 for the period 1970–2010 and controlling for a set of variables such as inequality, institutional  
211 quality, and the level of per-capita income, Carmignani (2013) concludes on the existence of  
212 negative direct effect of resource abundance on human development. The negative effect  
213 operates via income inequality. Venables (2016) notes that resource revenues are divided  
214 between investors, government, and other claimants. Yet, there is likely to be intense pressure  
215 for current spending rather than investment in assets that will be productive over time. This  
216 may explain the weak effect between natural resources revenues and human development  
217 indicators. Resource curse hypothesis is recently tested in Khan et al (2020), Pan et al (2021)  
218 and Tufail et al (2021). In their empirical investigation, the first group of authors highlighted  
219 the crowding out effect of natural resources on financial development, controlling for  
220 technological innovations, human capital, and trade openness. The last ones showed that fiscal  
221 decentralization is one of the best ways to invest resource rents in the local green economy,  
222 curbing the resource curse.

223 Besides the “resource curse effect”, some studies highlight “the resource blessing effect”.  
224 Using data on natural resource abundance and rents for a panel of 102 countries running from  
225 1970 to 1999, Stijns (2001) shows that natural resource wealth makes a positive and marked  
226 difference on human capital accumulation. Political stability does also seem to affect human  
227 capital accumulation according to the same investigation. The mechanism is as follows: Any  
228 increase in natural resource production activity will generate additional government revenues

229 and a share of these revenues is generally spent on education. However, instrumentation  
230 reveals that reverse causality running from education to natural resources does not drive the  
231 results. Davis (1995) also finds that human capital accumulation indicators tend to be higher  
232 in mineral countries than non-mineral countries.

233 Stijns (2001) shows that resource abundance is associated with high female human capital  
234 accumulation across countries. Resource abundance tends to increase health capital  
235 accumulation, in particular those of female. El Anshasy and Katsaiti (2015) examine whether  
236 economic dependence on various natural resources is associated with lower investment in  
237 health. They use panel data for 118 countries for the period 1990–2008 and control for  
238 countries' geographical and historical fixed effects, corruption, autocratic regimes, income  
239 levels, and initial health status. Their results show no compelling evidence in support of a  
240 negative effect of resources on healthcare spending and outcomes. On the contrary, higher  
241 dependence on agricultural exports is associated with higher healthcare spending, higher life  
242 expectancy, and lower diabetes rates. Similarly, healthcare spending increases with high  
243 mineral intensity.

244 One of interesting results highlighted by Stijns (2001) is that a \$1 shock to resource rents ends  
245 up generating close to  $\text{€}5$  of extra educational expenditure per year. So, in our cross-sectional  
246 study, we expect to observe similar results as most of our selected countries experienced  
247 “natural resources shocks” (mining boom, oil discovery) before our selected year study: year  
248 2009. In the terms of Stijns (2001), “Yesterday’s resource abundance translates itself into  
249 current higher human capital stocks.”

250 Recent studies on the effects of natural resources on human development are much more  
251 mixed. Kim and Lin (2017) find that natural resource dependence improves education but  
252 worsens health. Sun et al (2018) highlight the crowding-out effect of natural resources on  
253 human capital in China. Their empirical results show that the crowding-out effect can be

254 reduced by investing massive resources rents in education. Farzanegan and Thum (2020) find  
255 a significant positive effect of oil rents on the quantity of education measured by government  
256 spending on primary and secondary education. However, they find a robust and negative long-  
257 run effect of oil rents dependency on the objective and subjective indicators of quality of  
258 education. Nikzadian et al. (2019) explore the effect of oil resource rent on human  
259 development in the context of OPEC countries. Their results show that the oil rents affect the  
260 healthcare sector. However, the magnitude of the positive effect decrease when they interact  
261 oil rent variable with the government effectiveness in the regression. Authors conclude that,  
262 the key determinant in the transformation of rents from oil resources into disaster or blessing  
263 is the government effectiveness across oil exporting countries. Mejía (2020)'s results indicate  
264 that mining increases enrollment in primary school and reduces dropout rates throughout the  
265 school cycle. However, it also reduces standardized test scores and college enrollment,  
266 particularly in academic degrees and STEM fields. Rahim et al. (2021) analyze the role of  
267 human capital development in the resource curse effect mitigation. Their results show that  
268 natural resources rent deteriorate economic growth since high natural resources rent are found  
269 to inhibit economic growth of the selected countries. Authors support that human capital  
270 development is one of ways to overcome resource curse, since the interaction effect suggests  
271 that human capital and natural resources jointly exert positive impacts on economic growth.  
272 From the sustainability point of view, Ahmad et al. (2020)'s econometric results show that  
273 natural resources and economic growth increase and expand the ecological footprint. Their  
274 results suggest that natural resource exploitation, even with green technology, tends to delay  
275 achievement of SDG targets. Khan et al. (2021) investigate the role of human development  
276 and quality of institutions on the quality of the environment. Their results support that high  
277 levels of both variables are associated with high quality of the environment. Khan et al.  
278 (2021)'s results can be interpreted as the solution to Ahmad et al. (2020)'s findings: Investing

279 rents in human and institutional capital helps to mitigate the environmental damage caused by  
280 the exploitation of natural resources.

### 281 **3. Methodology and data description**

#### 282 **3.1. Variables and Model specification**

283

284 This paper aims at analyzing the effect of extractive resources on human development. The  
285 research is based on the natural resource curse theory. Although the empirical literature on  
286 the natural resource curse is abundant, this research differs from others in its use of new  
287 indicators of natural resource dependence and the institutional environment on the one hand,  
288 and the use of a human development indicator on the other. Regarding dependence to natural  
289 resource, previous studies used either the share of natural resource exports in total exports  
290 (Sachs and Warner 1995) or the share of natural in GDP (Ouoba, 2016). Both indicators do  
291 not distinguish between the share of natural resources that are subject to the curse and those  
292 that are not. Yet, the results of El Anshasy and Katsaiti (2015) showed that the exploitation of  
293 some natural resources such as agricultural and forest products and hydrocarbons is not  
294 associated with the resource curse. In contrast, the exploitation of sub-soil natural resources  
295 (gold, diamonds) is likely to lead to economic under-performance (Douglas and Walker 2017).  
296 For this reason, Bulte et al (2005) point out the relevance to distinguish between point and  
297 diffuse resources. However, the indicators mentioned above include both diffuse and point  
298 resources. This research uses the share of royalties to GDP and the share of revenues from  
299 extractive resources to GDP, both of which are sub-soil resource indicators<sup>4</sup>. This indicator is  
300 in line with weak sustainability theory, which indicates that the necessary condition of  
301 economic sustainability is met when economic royalties are equal to the royalties collected

4In this study, extractive resources include Coal, Gas, Copper, Cement, Oil, gold, silver, zinc, Sand, Pozzolan, Limestone, Clay, Iron, Nickel, Manganese, Mineral Water, Phosphate, Diamond, Granite, Cobalt, Ferroniquel, Bauxite, Salt, Potash, Limestone, Marble, Jade, Silica, Calcined Alumina, Uranium, Gypsum, Condensate, Polymetals, Phosphorite, Chromites, Chrysotile Asbestos, Quartzite, Molybdenum, Wolframite, Condensate, Ilmenite, Tin, Titanium, Magnetite, Fluorite, Barite, Molybdenum, Nefelinic Syenite, Tungsten, Mercury, Clay Loam, Vulcanites, Shale and Tuffaceous Siltstone.

302 from the extractive sector (Blignaut and Hassan 2002). Moreover, it allows checking whether  
 303 the royalties collected are likely to have a significant and positive impact on human  
 304 development and thus avoid the trap of the curse. The use of such an indicator is relevant as  
 305 royalties represent in most countries the largest share of revenues collected by governments  
 306 from the extractive sector. Beyond royalties, the share of extractive resources to GDP is also  
 307 used as an indicator of natural resource dependence. It takes into account, in addition to  
 308 royalties, other taxes related to the extractive sector (there are about 30 of them in the EITI  
 309 typology). Since this indicator only takes into account revenues related to the sector, it is also  
 310 relevant as a proxy for dependence on extractive resources. Table 1 reports statistics on the  
 311 share of different types of resources in GDP.

312

313 Table 1-Extractive resources dependence indicators for the selected countries

Variable (% of GDP)	Obs	Mean	Std.Dev.	Min	Max
Total rents	420	10.887	10.289	.065	56.039
Coal rents	420	.39	1.886	0	25.965
Mineral rent	420	1.733	2.901	0	14.377
Gas rents	420	.688	1.376	0	9.409

314 Source: Authors, from World Development Indicators (2021)

315 Regarding human development concept, there is very little use of the HDI in analyses of the  
 316 resource curse. Carmignani (2013); Costantini and Monni (2008) used variables including  
 317 life expectancy at birth, rate of child immunization against diphtheria, pertussis, and tetanus,  
 318 and average years of education in the population as proxies of human development. However,  
 319 HDI as an indicator is relevant when looking at the specific case of the extractive sector.  
 320 Indeed, the exploitation of extractive resources is generally carried out by national or foreign  
 321 companies. These companies, because of their social responsibility, invest in basic socio-  
 322 economic infrastructure. The use of HDI and its dis-aggregation into its various components

323 (education and health) allows a better appreciation of the contribution of extractive companies  
324 in human development achievement in the natural resource-dependent countries.

325 Finally, traditional control variables such as physical capital, trade openness are used. The  
326 effect of extractive resources on development depends on the institutional context (Mehlum,  
327 Moene, and Torvik 2006). Several studies have taken into account the institutional context  
328 through governance indicators either by using a composite index or simple indicators as  
329 proxies (corruption, rule of law). The latter case is commonly used in the empirical literature.  
330 However, the choice of a few governance indicators from among many others is generally not  
331 well justified. That is why, in this research, it appeared necessary to use principal component  
332 analysis technique to identify relevant indicators from among those provided by the ICRG  
333 database. The selected indicators include democratic accountability, bureaucracy quality,  
334 government stability, law and order, level of corruption and socioeconomic conditions. These  
335 indicators are used to construct the Country's Enabling Environment Index (CEEI). Details on  
336 the Ceeindex methodology is given in section 3.3.

337 Taking into account the underlying justifications summarized above, the analysis model is  
338 formalized as follows:

$$339 Y_{it} = (ERR; X; \tau_i)(1)$$

340 The variable  $Y$  represents the human development index which equally weights income levels,  
341 health and education. Extractive resources revenues (ERR) represent the share of extractive  
342 resources revenues in the gross domestic product.  $X$  is a vector of other control variables. For  
343 robustness analyses, the core components of the HDI such as education and life expectancy  
344 are used. Equation 1 suggests estimating an empirical model as follows:

$$345 Y_{it} = \tau_i + \delta_1 ERR_{it} + \sum_{i=1}^p X_{it} + \rho_{it} \quad (2)$$

346 All the variables used in the model and their definitions are reported in Table A1 in Appendix.



### 347 **3.2. Estimation techniques**

348

349 The analysis covers 42 countries depending on extractive resources over the period 2009-  
350 2015. We do not perform unit root test as univariate unit root tests are known to lack power  
351 for samples of small or medium size (Palm et al, 2004). When the number of time periods is  
352 small (less than 10 or 15), unit root tests suffer from severe size distortions. This small time  
353 dimension ( $T=7$ ) makes the within estimator biased (Nickell, 1981). Available alternative  
354 methods include instrumental variable methods such as two stage least squares (Anderson and  
355 Hsiao 1981) and the generalized method of moments (Arellano and Bond 1991; Blundell and  
356 Bond 1998). Among these instrumental variable methods, Blundell-Bond (1998) one is  
357 considered as the most successful. However, this method uses lagged variables of at least  
358 order 2 as instruments. This further reduces the time dimension and reinforces the bias. Kiviet  
359 (1995) proposes the bias-corrected least square dummy variable. The latter is used in this  
360 research. Indeed, it has already been shown that this technique is more appropriate compared  
361 to several others, such as that of generalized moments and especially in the case of a balanced  
362 panel characterized by  $T \leq 20$ , and  $N \leq 50$ , as in our case (Judson and Owen, 1996). The  
363 relevance of such a method is proven by Bruno (2005) for unbalanced panels. In bias-  
364 corrected least square dummy variable, all control variables are assumed exogenous. To  
365 minimize biases, variables must include lags, that introduces the dynamic in the models  
366 (Wintoki, Linck, and Netter 2012). However, potential issues of simultaneity may persist. So,  
367 we consider lagged variables of order 1. In addition, we perform robustness analysis using  
368 Driscoll and Kraay (1998) technique where all variables are considered with a lag of order 1,  
369 which allows us to address potential endogeneity issues that would exist in the model.  
370 Furthermore, in this robustness analysis, the HDI is dis-aggregated into its various  
371 components such as education and health.

### 372 **3.3. Data description and sources**

373

374 Combining constraints on data availability and the criteria for defining a resource-dependence  
375 country established by the IMF and the Natural Resource Governance Institute<sup>5</sup>, we selected  
376 42 countries over the world. Both institutions consider a country as natural resources-  
377 dependence country since the contribution of these resources represents at least 25 percent of  
378 GDP, exports or tax revenues. The most popular measure of resource dependence in the  
379 literature is primary exports in percent of GDP (or GNI, or total exports). This variable was  
380 used in the seminal contributions of Sachs and Warner (1997; 2001) and in Sala-i-Martin and  
381 Subramanian (2008); Carmignani (2013). However, authors including Brunnschweiler and  
382 Bulte (2008); Arezki and Van der Ploeg (2011); Carmignani (2013) consider primary exports  
383 as a measure of resource dependence rather than resource abundance. Indeed, primary exports  
384 are a flow variable which would underestimate the extent of resource abundance for countries  
385 which use their resources domestically instead of exporting them.

386 Our countries' selection criterion refers to that last one as our two main interest variables are  
387 part of royalties and extractives resources revenues to GDP. Data cover the period 2009-2015  
388 and are from various international databases including the Extractive Industries Transparency  
389 Initiative (EITI) database, in free open access<sup>6</sup> for natural resources revenues, royalties; the  
390 world development indicators (WDI) database for our selected control variables. Those  
391 include traditional determinants of physical capital such as Gross fixed capital formation,  
392 Investment profile and GDP per capita growth. The Country's enabling environment index is  
393 built using the Natural Resource Governance definition<sup>7</sup>. This index is our own construction  
394 using the Principal Components Analysis (PCA) techniques to generate weights for

5<https://www.resourcegovernanceindex.org/>

6<https://drive.google.com/drive/folders/0B9BI74fkjArzcWtDMDE3eUtYajA>

7The Natural Governance Institute defines « Enabling environment » as the wide range of practices and processes in the government, parliament, media and civil society that are likely to either enable or disable the effectiveness of resource policies and governance.

395 aggregation. It aims to take into account issues about resource governance, transparency and  
396 quality of institutions. The index uses the following variables: democratic accountability,  
397 bureaucracy quality, government stability, law and order, level of corruption and  
398 socioeconomic conditions. The selection of these variables is based on the Natural Resource  
399 Governance Institute and International Country Risk Guide annual reports. These reports  
400 highlight the relevance of such factors in the process of transforming natural resources  
401 revenues into human assets. We aggregate the six initial variables into a single index in order  
402 to reduce high number of variables in the regression step, given the related small size of our  
403 sample. Human development variables including human development index scores, health  
404 (Life expectancy at birth) and education (Mean years of schooling and Expected years of  
405 schooling) variables are from the UNPD database. All variables are re-scaled, ranging from  
406 zero to 100 using the min-max method. The sample list of countries is given in Table A3 in  
407 Appendix.

## 408 **4. Results and discussion**

### 409 **4.1. Multivariate analysis**

410  
411 This section analyses the general structure of our selected interest variables. Table 2 shows  
412 that there is no statistically significant correlation between the HDI and extractive resources  
413 revenues on the one hand and between extractive revenues and the components of the HDI on  
414 the other hand. The institutional environment is positively and significantly correlated with  
415 HDI and its components. In contrast, the institutional variable and extractive revenues,  
416 including royalties, vary in opposite directions, suggesting a conflicting relationship between  
417 natural resource dependence and institutional quality. The absence of a statistically  
418 significant correlation would indicate that rents from the exploitation of extractive resources  
419 are not reinvested in human development. This exploratory result could also suggest that the

420 mobilization of rents from extractive resources is not sufficient to induce observable effects  
 421 on the level of human development.  
 422 The high positive and significant relationship between royalties and extractive revenues  
 423 indicates that a great part of extractive revenues comes from royalties. In other words,  
 424 royalties seem to be the best channel through which governments capture extractive resources  
 425 rents. The very strong and significant correlations between HDI and the health and education  
 426 variables are also trivial as the two variables are the main components of HDI.  
 427 Finally, the VIF calculation showed that multicollinearity was not a problem, as all VIFs were  
 428 less than 10 (see Table A4 in appendix).

429

430 ***Table 2-Pairwise correlations matrix of interest variables***

Variables	(1)	(2)	(3)	(4)	(5)	(6)
(1) HDI	1.000					
(2) Education	0.951 *	1.000				
(3) Health	0.884 *	0.769 *	1.000			
(4) Extractive resources revenues (ERR)	0.034	0.021	0.028	1.000		
(5) Royalties	0.034	0.021	0.028	1.000 *	1.000	
(6) Ceeindex	0.519 *	0.531 *	0.461 *	-0.021	-0.021	1.000

Source: Authors

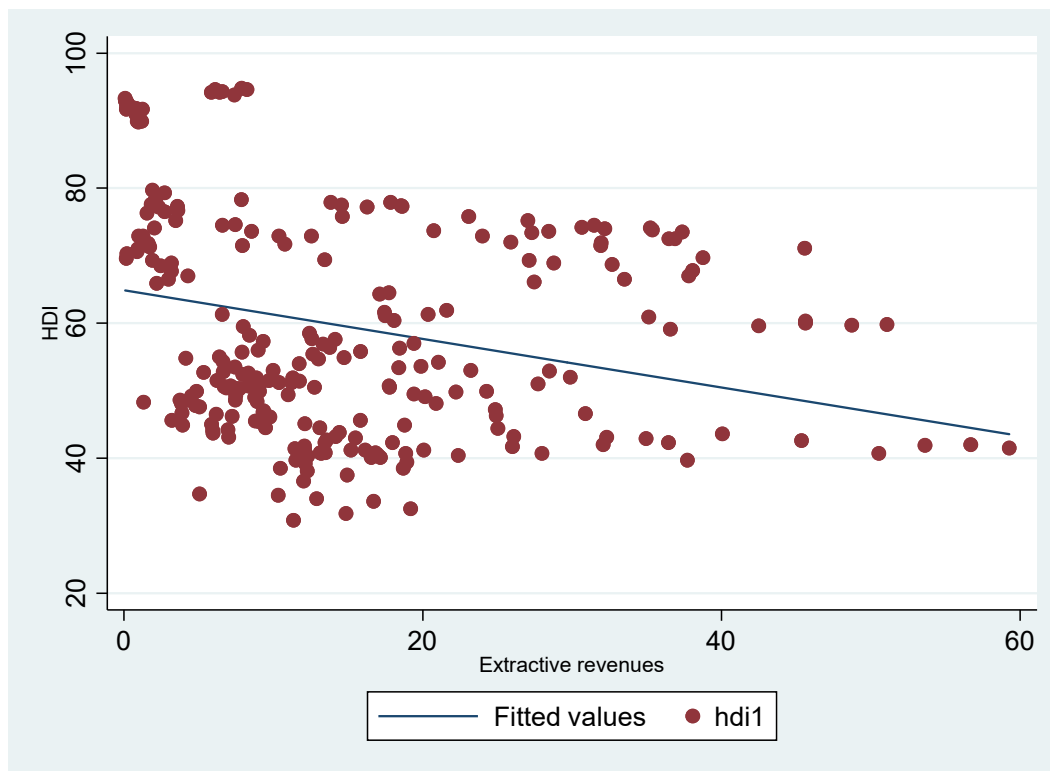
\* shows significance at the 0.05 level

431

432 Figure 1 seems to corroborate correlation tests. However, the linear fit seems to suggest an  
 433 inverse relationship between the HDI variable and extractive resources for observations close  
 434 to the fit line. However, several observations are far from the adjustment line. This would  
 435 explain why, on average, there is ultimately no statistically significant relationship between  
 436 the HDI variable and extractive resource revenues.

437 ***Figure 1-Relationship between Human Development Index and Revenues of extractive resources***

438



439

440 Source: Authors' construction using data of UNDP and EITI

441 The observation of Figure 1 reveals clusters suggesting that for a better visualization of the  
 442 relationship between our variables of interest, it might be more appropriate to group countries  
 443 by homogeneous categories. To do this, we rely on the four categories of countries defined by  
 444 the UNDP according to their level of human development. Countries with the HDI score  
 445 between 0.800 and 1 are considered as the “very high human development” countries. Those  
 446 for whom the score ranges from 0.700 to 0.799 are called “high human development”  
 447 countries. The third ones named the “medium human development” countries are those with  
 448 the HDI score ranging from 0.555 to 0.699. The term “low human development” countries is  
 449 used to design countries for whom the HDI score ranges from 0 to 0.549. Our selected  
 450 countries can be grouped in two levels of human development. The first one includes both the  
 451 UNDP’s very high and high human development. The last two sets are the middle human  
 452 development and the low human development countries. Considering our selected countries,  
 453 the first set of countries consists of 4 countries: Germany, Norway, United Kingdom and  
 454 United States. The second group includes 38 countries ranging from Burkina Faso to

455 Zimbabwe. Replication of Figure 1 by groups of homogeneous countries reveals that the  
456 general appearance of this figure is driven by group 2, which has the largest number of  
457 countries. Finally, this investigation through the distribution of countries into homogeneous  
458 clusters does not bring any new information. However, the general picture could blind  
459 country-specific trend. We check these presumptions in the following section through  
460 econometric investigations.

## 461 **4.2. Econometric results**

462 Estimation of the effect of extractive resources on the human development index was done  
463 using the bias-corrected least square dummy variable<sup>8</sup>. The bias is corrected using Blundell-  
464 Bond, Anderson and Hsiao and Blundell and Bond. Results show that the auto-regressive  
465 nature of the HDI is confirmed for all regressions. The positive and statistically significant  
466 coefficients of the initial HDI indicate that there is no convergence in human development. In  
467 addition, extractive resources have a positive and significant effect on the HDI. Results  
468 highlight empirical evidence that extractive resources contribute to improving the level of  
469 human development in the selected countries. However, the positive effect would be observed  
470 in countries with less endowment in natural resources. Pérez and Claveria (2020) observed a  
471 tenuous negative association between average growth in human development and the relative  
472 weight of mineral rents in ten African countries with the highest share of mineral exports  
473 compared to total exports. Using the Quantile Regression (QR) technique, Mignamissi and  
474 Kuete (2020) showed that the total of resource rents seem to have a positive influence on  
475 human happiness for QR before the 50<sup>th</sup> quantile. However, for quantiles over the 50<sup>th</sup>, the  
476 effect tends to be negative. The authors conclude that countries which have few natural  
477 resources apply the best management mechanisms compared to countries which are highly  
478 endowed with them. These results are consistent with work that shows that resource-rich  
479

<sup>8</sup>Royalty analysis did not produce relevant results and these were not reported in the table.

480 countries are not always victims of the resource curse (Stijns 2006; 2001; Barro 1997; 2001)  
481 but are at the opposite end of the scale of those who find that most resource-rich countries  
482 are (Redmond and Nasir 2020; Douglas and Walker 2017; Venables 2016; Carbonnier 2013;  
483 Costantini and Monni 2008). This result may be partly explained by the fact that most of the  
484 work on the resource curse uses the growth rate instead of the human development index.  
485 These analyses reveal that the issue of the curse in empirical work is a statistical mirage, as  
486 James (2015) points out. Taking into account the institutional environment, the results showed  
487 that resources curse is explained by the institutions quality due to its negative effect on human  
488 development. The negative effect of interaction variable on human development reinforces  
489 this finding. The finding also corroborates that of Mehlum et al (2006), who demonstrate the  
490 importance of the quality of the institutional environment to ward off the resource curse. They  
491 showed that more natural resources push aggregate income down, when institutions are  
492 grabber friendly, while more resources raise income, when institutions are producer friendly.  
493 Therefore, human development in resources-rich countries depends on the quality of  
494 institutions.

495 Regarding control variables, results reported in Table 3 show that GDP per capita has a  
496 positive and significant effect on HDI. This result suggests that human development in the  
497 developing countries will not be able to “catch up” with that of the developed nations (Saha  
498 and Zhang, 2017). The growth of income is needed in improving human development level.

*Table 3-Effect of extractive resources revenues on HDI*

Variables	(1) Blundell-Bond	(2) Blundell-Bond	(3) Arrelano-Hsiao	(4) Arrelano-Hsiao	(5) Arellano-Bond	(6) Arellano-Bond
Human development (lag)	<b>0.927***</b> (0.0255)	<b>0.929***</b> (0.0255)	<b>0.921***</b> (0.0274)	<b>0.922***</b> (0.0275)	<b>0.918***</b> (0.0269)	<b>0.919***</b> (0.0270)
Extractive resources revenues (ERR)	<b>0.00432*</b> (0.000840)	<b>0.0245**</b> (0.00243)	<b>0.00408*</b> (0.000825)	<b>0.0241**</b> (0.00237)	<b>0.00398</b> (0.000815)	<b>0.0240**</b> (0.00234)
Physical capital	0.187 (0.164)	<b>0.182*</b> (0.164)	0.194 (0.164)	<b>0.189*</b> (0.164)	0.199 (0.162)	<b>0.194*</b> (0.162)
Trade	0.0698 (0.0862)	0.0685 (0.0865)	0.0691 (0.0852)	0.0678 (0.0854)	0.0696 (0.0842)	0.0683 (0.0843)
Ceeindex	<b>-0.0410**</b> (0.0124)	<b>-0.0486**</b> (0.0124)	<b>-0.0338**</b> (0.0124)	<b>-0.0411**</b> (0.0123)	<b>-0.0298**</b> (0.0123)	<b>-0.0371**</b> (0.0122)
GDP per capita (log)	<b>0.586**</b> (0.246)	<b>0.581**</b> (0.245)	<b>0.600**</b> (0.252)	<b>0.596**</b> (0.252)	<b>0.604**</b> (0.249)	<b>0.600**</b> (0.249)
ERR* Ceeindex		<b>-0.0404**</b> (0.00407)		<b>-0.0398**</b> (0.00398)		<b>-0.0397**</b> (0.00393)
Observations	233	233	233	233	233	233
Number of id	39	39	39	39	39	39

Source: authors Standard errors in parentheses\*\*\* p<0.01, \*\* p<0.05, \* p<0.1



## 502 **5. Robustness analysis**

503

504 The robustness analysis consisted of estimating the effect of extractive resources on health  
505 and education, both essential components of HDI as well as Driscoll and Kraay's estimation  
506 technique.

507 Regarding health outcome, results show a persistent phenomenon whereas extractive resources  
508 have an adverse effect on life expectancy (see Table 4). This effect is significant for the  
509 estimation (2), (4) and (6). Thus, analyzing the specific case of health, it appears that the  
510 previous health condition affects positively and significantly the level of health observed in  
511 the present. However, the results reveal that extractive resources degrade the health of  
512 populations. Similar results were highlighted by Cockx and Francken (2016) who showed that  
513 natural resource dependence exerts an adverse effect on health care expenditure. This result  
514 could reflect the failure of some States to invest extractive resource rents in the health sector.  
515 Several studies have already shown that resource-rich countries invest less in the health sector  
516 (Venables 2016; El Anshasy and Katsaiti 2015; Cockx and Francken 2014; 2016; Carbonnier  
517 2013; Birdsall et al, 2001). Yet, as Hartwick (1977) points out, the best way to manage  
518 exhaustible extractive resources is to reinvest in human capital, including health and  
519 education. As indicated by Zafar et al (2019) and Ahmed et al (2020), human capital reduces  
520 environmental deterioration as it stimulates societies' readiness to use environment-friendly  
521 technologies which in turn improved human health.

522 The effect of extractive resources on health improves when taking into account the  
523 institutional environment. An improvement in the quality of institutions is therefore essential  
524 for extractive resource rents to be used in financing health sector.

*Table 4-Effect of extractive resources revenues on Health*

Variables	Dependent variable : Health					
	(1)	(2)	(3)	(4)	(5)	(6)
	Blundell-Bond		Arrelano-Hsiao		Arellano-Bond	
Health (lag)	<b>0.911***</b> (0.0132)	<b>0.910***</b> (0.0133)	<b>0.901***</b> (0.00749)	<b>0.900***</b> (0.00751)	<b>0.901***</b> (0.00787)	<b>0.901***</b> (0.00790)
Extactive resources revenues (ERR)	-0.000189 (0.0215)	<b>-0.0356**</b> (0.00674)	-0.0187 (0.0122)	<b>-0.0387**</b> (0.00381)	-0.0187 (0.0128)	<b>-0.0385**</b> (0.0400)
Trade	0.00667 (0.0232)	0.00684 (0.0233)	0.0846 (0.0131)	0.0867 (0.0131)	0.0830 (0.0138)	0.0850 (0.0138)
Ceeindex	0.0237 (0.0406)	0.0229 (0.0411)	0.0185 (0.0235)	<b>0.0175**</b> (0.00237)	0.0188 (0.0247)	<b>0.0178**</b> (0.00249)
GDP per capita (log)	0.0391 (0.0910)	0.0397 (0.0914)	0.0671 (0.0517)	0.0681 (0.0519)	0.0653 (0.0542)	0.0663 (0.0545)
Co2 emissions	0.000194 (0.0147)	0.000373 (0.0147)	-0.00143 (0.00838)	-0.00126 (0.00840)	-0.00132 (0.00879)	-0.00114 (0.00883)
Human capital	0.0583 (0.0445)	0.0589 (0.0447)	<b>0.0719***</b> (0.0255)	<b>0.0727***</b> (0.0255)	<b>0.0710***</b> (0.0268)	<b>0.0719***</b> (0.0269)
ERR*Ceeindex		0.0566 (0.00113)		<b>0.0618**</b> (0.00642)		<b>0.0616**</b> (0.00675)
Observations	194	194	194	194	194	194
Number of id	39	39	39	39	39	39

Source: authors

Standard errors in parentheses

\*\*\* p&lt;0.01, \*\* p&lt;0.05, \* p&lt;0.1

528 Regarding the education variable, results reported in Table 5 show a persistent phenomenon.  
529 The stock of educational capital accumulated in the past has a positive effect on the current  
530 level of education. Extractive resources exert a positive and significant effect on education.  
531 This result is in line with those of Stijns (2006) who highlights that natural resources  
532 abundance tends to favor human capital accumulation in particular education as extractive  
533 activities require high skills. Previously, Stijns (2001) showed that a \$1 shock to resource  
534 rents ends up generating close to  $\phi 5$  of extra educational expenditure per year. This result  
535 reflects the increase in public spending on education induced by extractive resource rents. In  
536 fact, in countries with abundant natural resources, the budget constraint is much less rigid  
537 because of the significant contribution of natural resource rents to government revenues.

538 In addition, taking into account the interaction between institutional environment and  
539 extractive resources, the effect is negative (estimation 4). This result reveals the fact that  
540 dependence on extractive resources negatively affects the quality of the institutional  
541 environment which in turn reduces the level of education. This finding is in line with the  
542 analysis carried out by Baena et al (2012) who show that natural resources can lead to the  
543 degradation of institutions or that poor institutional quality can lead to poor management of  
544 natural resources.

545 In addition, physical capital has a negative impact on educational attainment. This result may  
546 reflect the fact that education and physical capital are two conflicting factors in resource  
547 allocation. Ouoba (2020) showed that the trade-off between human and physical capital could  
548 explain the resource curse experienced by most resource-rich countries. Therefore, increases  
549 in human capital could either raise or lower the returns on physical capital, depending on the  
550 degree of substitution between the two forms of capital in both production and consumption.

*Table 5-Effect of extractive resources revenues on Education*

Variables	Dependent variable : Education					
	(1)	(2)	(3)	(4)	(5)	(6)
	Blundell-Bond		Arrelano-Hsiao		Arellano-Bond	
Education (lag)	<b>0.908***</b> (0.0441)	<b>0.910***</b> (0.0436)	<b>0.866***</b> (0.0553)	<b>0.870***</b> (0.0551)	<b>0.914***</b> (0.0599)	<b>0.917***</b> (0.0595)
Extractives resources revenues (ERR)	<b>0.0134*</b> (0.00367)	<b>0.0176**</b> (0.00107)	<b>0.0825*</b> (0.00343)	<b>0.0163**</b> (0.00995)	<b>0.0159*</b> (0.00377)	<b>0.0170**</b> (0.00109)
Ceeindex	0.0124 (0.0523)	0.0545 (0.0518)	<b>-0.0598*</b> (0.0519)	<b>-0.0164**</b> (0.0515)	0.0139 (0.0560)	0.0465 (0.0553)
GDP per capita (log)	0.0646 (0.0990)	0.0630 (0.0980)	0.0689 (0.102)	0.0674 (0.101)	0.0552 (0.109)	0.0526 (0.108)
Trade	-0.0250 (0.0376)	-0.0257 (0.0374)	-0.0315 (0.0364)	-0.0319 (0.0362)	-0.0295 (0.0395)	-0.0300 (0.0392)
Physical capital	<b>-0.0136**</b> (0.00707)	<b>-0.0172**</b> (0.00700)	<b>-0.0989**</b> (0.00690)	<b>-0.0126**</b> (0.00686)	<b>-0.0154**</b> (0.00766)	<b>-0.0181**</b> (0.00757)
Population growth	-0.0160 (0.0612)	-0.0132 (0.0607)	-0.0130 (0.0608)	-0.0936 (0.0605)	-0.0147 (0.0662)	-0.0112 (0.0654)
ERR* Ceeindex		-0.00293 (0.00179)		<b>-0.0273**</b> (0.00167)		-0.00282 (0.00183)
Observations	233	233	233	233	233	233
Number of id	39	39	39	39	39	39

Source: authors

Standard errors in parentheses

\*\*\* p&lt;0.01, \*\* p&lt;0.05, \* p&lt;0.

554 In order to further analyze robustness, the Driscoll-Kraay technique was used. This technique,  
555 similar to the previous ones, allows to take into account issues of endogeneity by using lags  
556 variables (Cerra and Saxena 2008). Results are summarized in Table 6. Results show a  
557 positive effect of extractive resources revenues on human development. This finding is  
558 consistent with our previous results using the bias-corrected least square dummy method (see  
559 Table 3). Similarly, the signs of our interest variables do not change depending on the  
560 estimation method. Overall, most of the other variables signs remain and some are now  
561 having significant effects. For example, trade openness affects negatively health of  
562 populations but contribute to education level and human development improvement. These  
563 results are in line with theory and facts. For example, several epidemics have become  
564 pandemics with globalization. The example that perfectly illustrates this is COVID-19, which  
565 very quickly became a global epidemic because of globalization. Moreover, trade openness  
566 can lead to skill accumulation, forming wage price signals, stimulating human capital  
567 investment and thus promoting human capital accumulation (Bonfatti and Ghatak, 2013). As  
568 extractives industries are technology-intensive, trade is conducive to the promotion of human  
569 capital because of the introduction of a lot of capital and technology-intensive equipment  
570 bringing more technology imitation and learning opportunities (Kan and Luo, 2010).  
571 Furthermore, CO<sub>2</sub> emissions degrade the health conditions of people. Natural resources  
572 depletion due to extraction is associated with CO<sub>2</sub> emissions which affect negatively health  
573 outcomes. This result is similar to that found by Ali and Ahmad (2014). Environmental  
574 regulation is also an important component as resource extraction induces CO<sub>2</sub> emissions that  
575 have consequences on the health of populations. Finally, investing revenues from the  
576 extractive sector in sectors such as health and education is fundamental for the improvement  
577 of human development. The effect of the institutional environment is not the same across

578 sectors (education and health). Future research could take into account the specificity of each  
579 sector in terms of governance for further analysis.

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*Table 6-Driscoll-Kraay estimation*

Variables	Human development		Health		Education	
	(1)	(2)	(3)	(4)	(5)	(6)
Extractive resources revenues (ERR)	<b>0.0104***</b>	<b>0.239***</b>	<b>-0.190**</b>	0.168	-0.0883	<b>0.149***</b>
	(0.0020)	(0.0259)	(0.00694)	(0.132)	(0.00570)	(0.0244)
Physical capital	<b>-2.519***</b>	<b>-2.522***</b>			<b>-0.517**</b>	<b>-0.515**</b>
	(0.6014)	(0.598)			(0.169)	(0.165)
Trade	<b>0.7831***</b>	<b>0.777***</b>	<b>-0.596**</b>	<b>-0.596**</b>	<b>0.445**</b>	<b>0.440**</b>
	(0.2932)	(0.2977)	(0.465)	(0.466)	(0.140)	(0.143)
Ceeindex	3.088***	3.058***	<b>0.780***</b>	<b>0.799***</b>	<b>0.502***</b>	<b>0.481***</b>
	(0.212)	(0.213)	(0.0283)	(0.0212)	(0.0344)	(0.0269)
GDP per capita (log)	<b>9.288***</b>	<b>9.283***</b>	<b>3.397***</b>	<b>3.394***</b>	<b>1.464***</b>	<b>1.458***</b>
	(0.1935)	(0.1971)	(0.272)	(0.270)	(0.0131)	(0.0158)
Human capital			<b>1.113***</b>	<b>1.125***</b>		
			(0.0299)	(0.0330)		
ERR*Ceeindex		<b>0.0418***</b>		0.0278*		<b>-0.0249***</b>
		(0.0042)		(0.0220)		(0.00399)
Co2 emissions			<b>-0.475***</b>	<b>-0.482***</b>		
			(0.0477)	(0.0528)		
Population growth					<b>-0.966***</b>	<b>-0.975***</b>
					(0.0401)	(0.0366)
Constant	<b>-27.031***</b>	<b>-26.759***</b>	<b>30.13***</b>	<b>29.96***</b>	<b>-6.045***</b>	<b>-5.826***</b>
	(2.567)	(2.672)	(4.056)	(4.171)	(0.674)	(0.747)
Observations	271	271	232	232	271	271
R-squared	0.786	0.786	0.713	0.713	0.793	0.796
Number of groups	39	39	39	39	39	39

Source: authors Standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

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## 584 **6. Conclusion and policy implications**

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586 This study aimed to analyze the effect of extractive resources on human development in 42  
587 countries over the period 2009-2015. Given the weakness of the time dimension and the  
588 potential issues of endogeneity, the bias-corrected least square dummy variable and the  
589 Driscoll-Kraay methods were used. Similarly, given the importance of the institutional  
590 environment in explaining the relationship between extractive resources and human  
591 development, a composite index of institutional quality was constructed using the PCA  
592 method.

593 The results show that extractive resources have a positive and significant effect on the HDI.  
594 The effect is still small and is attributable to the low average level of these resources. In-depth  
595 analysis by taking into account the institutional environment shows that the effect is negative.  
596 This reflects the negative effect that resources have on the institutional quality. Resources  
597 extraction would degrade the quality of institutions, which in turn affect negatively human  
598 development.

599 In addition, analyses of robustness across HDI components such as education and health, and  
600 the Driscoll-Kraay technique, show that the results are broadly stable. However, the way that  
601 extractive resources revenues affect the quality of institutions depends on the sector under  
602 consideration (health or education).

603 The results suggest that the resource curse is related to the quality of the institutions and the  
604 sector considered. This curse can be further countered by using these resources to improve the  
605 quality of institutions which in turn would serve a good management of resources for the  
606 benefit of human development. Ultimately, improving the quality of institutions must be a  
607 prerequisite for the exploitation of extractive resources for the benefit of human development.



608 Compliance with EITI principles of transparency and revenue management policies would be  
609 essential to generate better governance and minimized rent seeking. Environmental regulation  
610 is also an important component insofar as resource extraction is accompanied by CO<sub>2</sub>  
611 emissions that have consequences on the health of populations. Therefore, governments  
612 should promote more efficient price mechanisms and environmental management systems to  
613 help minimizing impacts on environment and health. Finally, the orientation of revenues from  
614 the extractive sector towards sectors such as health and education is fundamental for the  
615 improvement of human development. These investments are necessary to ensure inter-  
616 generational equity in the extractive sector.

617 The effect of the institutional environment is not the same across sectors (education and  
618 health). Future research could take into account the specificity of each sector in terms of  
619 governance for further analysis.

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## 846 **Appendix**

847 *Table A 1-List of variables*

<b>Variables</b>	<b>Definition</b>	<b>source</b>
HDI	Human development index	UNDP,
Health	Life expectancy at birth index	2019
Education	Average years of schooling index, a proxy of human capital	
Physical capital	Gross fixed capital formation(%GDP)	WDI, 2019
Extractive resources revenues	Extractives resources revenues over the GDP	EITI, 2019
Trade	sum of exports and imports over the GDP	WDI, 2019
Ceeindex		
GDP per capita (log)	Gross Domestic Product per capita in logarithm	WDI, 2019
Ceeindex	Country’s enabling environment index	Authors
CO2 emissions	CO2 emissions (metric tons per capita)	WDI, 2019
GDP per capita growth	Gross Domestic Product per capita growth	WDI, 2019

848 Source: authors

849 *Table A 2-Descriptive statistics*

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Variable	<b>Obs</b>	<b>Mean</b>	<b>Std. Dev.</b>	<b>Min</b>	<b>Max</b>	<b>Skewness</b>	<b>Kurtosis</b>
Ceeindex	294	6.214	.890	3.059	8.093	-0.355	3.06
GDP per capita growth	294	2.304 23.41	4.070	-22.330	17.995	-1.352 -0.143	11.744 2.784
Physical capital	273	7	7.378	8.951	48.412		
HDI	294	0.597	0.1632	0.308	0.948	0.472	2.26
Extractive resources revenues (ERR)	294	3.568	35.232	4.09e- 06	438.182	11.304	132.634

				0.00002	2597.02	11.426	134.86
ERR*Ceeindex	294	20.96	210.045	5	1		
Health	294	0.698	0.1264	0.42	0.953	0.142	2.302
Education	294	0.442	0.228	0.0933	0.94	0.467	2.264
Co2 emissions	252	3.268	6.316	0.0280	36.091	3.324	15.413
GDP per capita (log)	294	7.802	1.426	5.699	11.543	0.756	2.933
		70.10				-6.210	59.307
Trade	271	3	25.873	0.1674	165.646		
Population growth	294	2.054	1.076	-1.853	3.974	-0.637	2.906

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853 *Table A 3-List of selected countries*

Country name	Country name	Country name
Albania	Guinea	Norway
Azerbaijan	Honduras	Papua New Guinea
Burkina Faso	Indonesia	Peru
Cameroon	Iraq	Philippines
Colombia	Kazakhstan	Senegal
Congo	Liberia	Sierra Leone
Congo, DR	Madagascar	Tanzania
Cote d'Ivoire	Malawi	Togo
Dominican Republic	Mali	Trinidad & Tobago
Ethiopia	Mongolia	Ukraine
Gabon	Mozambique	United Kingdom
Germany	Myanmar	United States
Ghana	Niger	Yemen
Guatemala	Nigeria	Zambia

854 Source: authors

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856 Table A4. Multicollinearity test

857

Variables	HDI Equation	Health Equation	Education Equation
HDI (lag)	4.84		
Health(lag)		3.49	
Education (lag)			5.06
Ceeindex	1.36	1.47	1.51
GDP per capita growth			
Physical capital	1.05		1.07
Extractive resources revenues (ERR)	1.02	1.01	1.03
Human capital		4.97	
Co2 emissions		3.24	
GDP per capita (log)	4.38	5.04	3.5
Trade	1.07	1.12	1.11
Population growth			2.13
Mean VIF	2.29	2.91	2.20

858 Source: Authors

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