

The human development-economic growth nexus: evidence from oil-producing countries

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Resumo

As economias dos países produtores de petróleo são conhecidas pelas suas particularidades. Neste estudo é analisada a relação causal entre o desenvolvimento humano e o crescimento económico em países produtores de petróleo. O modelo compreende variáveis como o produto interno bruto, índice de desenvolvimento humano, as rendas de petróleo, as exportações de bens e serviços, o rácio produção consumo de petróleo e os preços de petróleo. A amostra é composta por 15 países e um período temporal de 1990 a 2016. Foi utilizado o modelo autorregressivo com defasamento distribuído (ARDL), para analisar as relações dinâmicas de curto e longo prazo entre as variáveis. O estimador Driscoll-Kraay mostrou-se adequado para lidar com as características do painel. Os resultados reforçam a importância que desenvolvimento humano desempenha no crescimento económico tanto a curto e como a longo prazo e apoiam a hipótese de maldição dos recursos.

Palavras-chave

Crescimento económico; Desenvolvimento Humano; Índice de Desenvolvimento Humano; Rendas de Petróleo; Produção de petróleo; Energia; Macro Painel.

Resumo Alargado

O principal foco da política são as pessoas, pelo que, apostar no seu desenvolvimento deverá ser um dos principais objetivos dos seus agentes. Por toda a importância que o assunto revela, o nexus desenvolvimento humano-crescimento económico é um tema bastante debatido na literatura ao longo das últimas décadas. Neste trabalho, resolvemos ampliar o estudo aos países produtores de petróleo, devido as particularidades que apresentam. Ou seja, para além de estudarmos este indicador, também analisamos algumas variáveis do nexus energia-crescimento.

Para mensurar o desenvolvimento humano foi utilizada a variável índice de desenvolvimento humano que compreende: i) dois indicadores de educação - anos esperados de escolaridade para crianças em idade escolar e média de anos de escolaridade para adultos com 25 anos ou mais; ii) um indicador de renda para medir o padrão de vida - produto nacional bruto (PNB) per capita; e iii) um indicador de saúde - esperança média de vida à nascença. Além desta variável o modelo incorpora variáveis como: Produto Interno Bruto, rendas de petróleo, exportações de bens e serviços, rácio produção consumo de petróleo e preços de petróleo. A amostra engloba ainda 15 países e um período temporal de 1990 a 2016, que devido à falta de dados o período não pôde ser mais extenso.

A maioria das variáveis são per capita para que sejam eliminadas eventuais distorções causadas pelas diferentes taxas de crescimento populacional dos países. A análise preliminar dos dados mostrou a presença de dependência transversal e que não existem problemas associados à multicolinearidade. Os testes de raízes unitárias de primeira e segunda geração, mostram que as variáveis são $I(0)$ e $I(1)$. O teste de Hausman confirmou a hipótese de efeitos fixos no nosso painel. Os testes de especificação detetaram a presença de heterocedasticidade, dependência transversal e autocorrelação, sugerindo o estimador Driscoll-Kraay, como mais adequado para lidar com estas violações. O modelo ARDL mostrou-se bastante adequado, uma vez que existem causalidades e relações dinâmicas de curto e longo prazo entre as variáveis.

Em geral resultados são concordantes com a literatura, o desenvolvimento humano é altamente significativo, os coeficientes são positivos e têm valores elevados, tanto a curto como a longo. Revelando-se a variável da amostra que mais influencia o crescimento económico. As rendas de petróleo desempenham um efeito negativo no crescimento, reforçando a hipótese de maldição dos recursos. O rácio produção consumo de petróleo, mostrou que um aumento nos níveis de autossuficiência dos países, promove crescimento económico, principalmente a curto prazo.

Abstract

The economies of oil-producing countries are known for their peculiarities. This study analyses the causal relationship between human development and economic growth in oil-producing countries. The model comprises variables such as gross domestic product, human development index, oil rents, exports of goods and services, the ratio of oil production to oil consumption and oil prices. The sample consists of 15 countries and a period from 1990 to 2016. The autoregressive distributed lag (ARDL) model was used to analyse the dynamic short- and long-run relationships between variables. The Driscoll-Kraay estimator proved to be adequate to deal with the panel's characteristics. The results reinforce the importance that human development plays in economic growth both in the short and long run and support the hypothesis of a resource curse.

Keywords

Economic growth; Human development; Human Development Index; Oil rents; Oil production; Energy; Macro Panel.

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List of Acronyms

ARDL	Autoregressive distributed lag
CSD	Cross Section Dependence
DK	Driscoll-Kraay
ECM	Error Correction Mechanism
EG	Economic Growth
FE	Fixed Effects
GDP	Gross Domestic Product
HD	Human Development
HDI	Human Development Index
MG	Mean Group
PMG	Pooled Mean Group
RE	Random Effects
VIF	Variance Inflation Factor

1. Introduction

The relationship between human development (HD), oil production and consumption and economic growth (EG) has been widely debated in the literature (e.g., Kurtz & Brooks, 2011; Kim & Lin, 2017; Suri et al., 2011). Due to the relevance that the theme presents in the global economy, this has led several authors to seek a better understanding of the determinants behind these interactions.

The energy-growth nexus has been the subject of numerous investigations over the last few years Ozturk, (2010), Payne, (2010), and Nguyen et al. (2019). Since Kraft & Kraft (1978), studies have intensified between energy consumption and economic growth, contributing to an enormous diversity of studies in with a variety of countries under study, periods, variables under analysis, methodologies used and type of energy. A panoply of these studies are dedicated to the oil-growth nexus (e.g., Al-mulali, 2011; Fuinhas et al., 2015). However, most focus only on the analysis of oil-exporting countries, neglecting the remain countries which produce this hydrocarbon, but are not self-sufficient. This research covers the different levels of production to analyse the role of oil production and rents in countries' economic growth.

Developing people and promoting social welfare must be the primary objective of political agents. In a broad sense, human development consists of creating opportunities that allow citizens more freedom to choose the direction they want. In other words, guaranteeing that people have access to education and that they have the possibility to acquire the necessary resources for a decent standard of living and a healthy and long life. The relationship between human development and economic growth is a subject that has been quite extensively studied. Although most studies highlight the impact that human development has on economic growth (e.g., Mustafa et al., 2017; Appiah et al., 2019), countless authors argue that this relation occurs in both directions (e.g., Ramirez et al., 1997; Ranis, 2004), i.e. economic growth also influences human development.

This research has as its main objective to understand the interactions and the determinants that involve the relationship between human development, oil rents, exports of goods and services, ratio of oil production to oil consumption, oil prices, and economic growth in oil-producing countries.

Our sample consists of 15 countries and annual data between 1990 and 2016. Given the size of the period studied, dynamic short- and long-run relationships are expected, which is why the autoregressive distributed lag (ARDL) model is used, as it proves to be appropriate to the characteristics of our panel data sample.

The work is structured as follows: Chapter 2 presents literature on the relationship between human development, energy, and economic growth; Chapter 3 comprises the methodology and preliminary data analysis; Chapter 4 shows the empirical results; Chapter 5 focuses on the discussion of results; and Chapter 6 presents the conclusion.

2. Literature Review

As human activity is the most important thing that exists, it is evident that political agents focus on the development of people. Although EG is vital to improving all essential human objectives, it is, therefore, crucial to understand whether growth has the desired effect on human development (UNDP, 1990). To better understand this effect, the Human Development Report raises the need to create an indicator that measures the complexity of the human capacities of each country with precision. Thus, in 1990, the Human Development Index was created. The Human Development Index is a quantitative index that assumes values ranging from 0 to 1, and is composed by the following indicators: (i) life expectancy at birth – health dimension; (ii) mean of years of schooling for adults aged 25 years and expected years of schooling for children of school entering age – education dimension; and (iii) gross national income per capita – standard of living dimension.

The relation between human development (HD) and economic growth (EG) is an economic theme that has been widely studied in the literature of recent years. This debate resulted in various evidence. According to Ranis (2004) and Ranis et al. (2000), the linkage between human development and economic growth occurred in two ways: on the one hand, from EG to HD, through an investment in resources, i.e. allocating national income to activities related to HD, like health and education; on the other hand, from HD to EG, suggesting that people with higher levels of health and education have better conditions to develop skills, which will materialise in more production and consequently boost growth and raise wages.

Ramirez et al. (1997), through an empirical study including several countries, confirm a bidirectional relationship between EG and HD. They highlight the importance of income equality, as well as public investment in health and education, especially among women. According to these authors, economic growth is only sustainable in the long run if human development is enhanced previously.

In this research, we focus more on the link from HD to EG. For example, Appiah et al. (2019), through an empirical study in African countries and using HDI as a measured variable of HD, note a positive and significant impact of HD on EG. Also, Mustafa et al. (2017), in a sample of Asian countries, show that human development positively influences economic growth.

Human development is the backbone of economic growth. It allows economic agents to realise and develop their comparative advantage. It leads to a more efficient allocation of individuals, allowing a higher number of individuals to specialise in the

activities in which they are most productive. This advantage increases an entity's ability to produce goods and services at a lower opportunity cost than its competitors. Lower production costs represent higher sales margins and consequently, the maximisation of profit.

According to Suri et al. (2011), the accumulation of human capital increases economic growth and human development. Ranis (2004) suggests that although human development is a broader indicator than human capital, they are very similar. Therefore, the behaviours are expected to be identical. Given the importance that education has in human capital and in many other aspects that influence economic performance, it becomes likely that it is the HDI indicator that most influences EG. Indeed, in the literature on growth, this relation occurs in several different ways. The literature suggests various evidence about this relationship. Wilson (2018), in a study of 15 European Union member states, notes that more investment in education results in increased productivity and income. Furthermore, he further concludes that a 1% increase in school enrolment rates represents an increase in GDP per capita growth of between 1 and 3%. In turn, Reimers & Klasen (2013), in a study of 95 developing countries, note a significant and positive relationship between education and agricultural production. For each additional year of education of the population, the authors estimate an increase in agricultural productivity of approximately 3.2%. They also suggest that the increase will be higher in the most technologically advanced countries. Other authors highlight the role that education plays in the most efficient use of technology. For example, a panel data study for 45 countries in sub-Saharan Africa notes that access to education positively influences the relationship between technological progress and economic growth, highlighting the contribution of the Internet to economic growth in countries with better levels of access to education (Donou-Adonsou, 2019).

For all the reasons mentioned, it is expected that education will also influence the exports of goods and services through everything it represents for a country's economy. Export is generally an expensive activity and involves additional financial resources for companies, but when it is done, the returns that successfully go to the economy are very high. It offers new opportunities and challenges to companies that are sometimes limited to small and saturated markets. It allows for scale production, increases competitiveness and reduces volatility during crises. It contributes to the economy through the development of industries, entry of foreign exchange and job creation. This variable is one of the components of GDP, so it is directly related to economic growth. In a study of 25 countries, Contractor & Mudambi (2008) note that investment in human capital has a significant and positive effect on exports of goods

and services, emphasising that the nature of this effect varies with the country's literacy rate. Also, Yüksel (2017), in a study 28 member states of the European Union, considers that there is a causal relationship between the number of exports of goods and services and the expenditure of countries on R&D.

Developing countries are continually looking to acquire capital and the latest technology from developed countries. This occurs in the form of inflow of foreign direct investment and can play an essential role in economic growth. Second, human capital is a determining factor in creating favourable conditions for foreign direct investment, verifying a causal relationship between both (Mohammad Sharif Karimi et al., 2013). It should be noted that the author created proxies where human capital is measured through variables such as accumulated years of secondary and higher education, human development index and school enrolment rate. In turn, Alsan et al. (2006) found a strong and positive relationship between population health and FDI inflows in developing countries.

In the literature, much emphasis is placed on the fact that women make better decisions when compared to men. Education, in addition to allowing them a better salary, also helps them to manage it more effectively. Thomas (1990) suggests that non-employment income in the mother's hands has a more considerable influence on the family's health and nutrition. The author estimates that the difference between the income being attributed to the mother instead of the father could increase child survival probability 20 times. In addition to all this, there is still a strong and negative correlation between female education and fertility (Kim, 2016), which may imply an improvement in economic growth (positive variation in GDPpc), since its calculation results from dividing GDP by the total population. Therefore, if the total population undergoes a decrease (denominator), GDPpc increases.

High levels of education develop human capacities and skills that permit: (i) increased productivity; (ii) stimulation of innovation and development; (iii) adequate selection of imported new technology and refined use and development of domestic technologies; (iv) encouragement of domestic and foreign investment; and (v) development of national entities that are important for economic growth in sectors such as the financial, political, justice, education, health, and security.

Oil-producing countries

Since Adam Smith and David Ricardo, it is believed that an abundance of natural resources such as oil, natural gas, minerals, etc. is an essential asset for countries' sustainable economic growth. However, more recently, the literature shows

that this does not always happen. Countries are often unable to transform the wealth of natural resources into economic benefits (Sachs & Warner, 1995, 1997; Ross, 2001; Sala-i-Martin & Subramanian, 2003; Fuinhas et al., 2015). In 1993 Auty designated this process as a "resource curse", and it consists of the fact that countries which are rich in natural resources register less economic growth than countries without an abundance of these resources. As an explanation for this phenomenon, the literature is quite wide, and one of the leading causes is Dutch disease, that is, countries abundant in oil specialise their economic activity only in its production (Bresser-Pereira, 2008). In the short run, the overall value of exports increases due to oil rents and allows for an appreciation of the exchange rate. However, in the long run, due to negligence in other sectors, the industry ceases to be competitive and loses market shares to international competition, leading to the country's deindustrialisation. Another major challenge for these economies is the volatility of commodity prices (Ramey & Ramey, 1995), which obliges policymakers to make their decisions based on speculation and forecasts, which leads to a high level of economic uncertainty.

Typically, countries that suffer from a resource curse have an undemocratic political system, which suggests high levels of corruption. Chang & Golden (2010) argue that the level of corruption increases according to the abundance of natural resources, the level of autocracy, and poverty in countries. According to Ross (2001), oil impedes democracy, mainly in poor countries, and one of the reasons is that these regimes charge few taxes, focusing on resource rents to sustain a budget programme based on expenditure, which reduces citizens' incentive to demand democracy. Also, much of the oil revenues generally revert to powerful groups that use them to satisfy their interests, rather than being invested in human capital or in other initiatives that help citizens and support sustainable economic growth (Badeeb et al., 2017). These elites also encourage this type of regime and try to weaken institutions.

However, there is no consensus on the role of institutions as a differentiating element in the contribution of resources to a curse or a blessing, and authors frequently cited in the literature, such as Sachs and Werner, for example, do not find any relationship between them. Numerous scientific studies consider that institutions can be the bridge between the wealth of natural resources and sustainable economic growth (Sala-i-Martin & Subramanian, 2003; Acemoglu et al., 2005; Ragnar Torvik, 2006; Robinson et al., 2006; Arezki & Van Der Ploeg, 2007; Gylfason, 2011; Ferrini, 2012; Kaznacheev, 2017). Quality institutions are essential to promote the rule of law, implement democratic regimes and suppress corruption. When they are sufficiently robust and transparent, this can help to overcome economic and political problems. For example, Kaznacheev (2017) suggests that they can eliminate Dutch disease and

overcome low oil prices. According to Costantini & Monni (2008), appropriate investment in the accumulation of human capital improves the quality of institutions and consequently ends the curse of resources.

In sum, the literature does not suggest that countries with an abundance of resources would be better off without them; however, when institutions are not strong enough, this wealth leads these countries to suffer from various types of economic and political diseases, making resources detrimental to economic growth. For example, countries like Norway (which has been the country with the highest HDI), Canada, the USA and Australia, where a significant part of their revenue comes from oil, are countries of excellence in terms of human development and economic performance, that is, countries that have managed to withdraw the benefits that resources can provide. Since oil is an exhaustible asset and the countries need to prevent its extinction, it must promote initiatives that improve sectors such as health and education, providing human development and guaranteeing long-run economic sustainability. According to Pineda & Rodríguez (2010), through a report published in the United Nations Development Program, it was proved precisely that, in a generalised way and all over the world, revenues from resources have been used in part to invest in these sectors.

3. Data and Metodology

The main objective of this work is to study the impact of human development on economic growth in oil-producing countries. The selection criteria for the countries used were as follows: (i) countries that have been producing oil for a long time; and (ii) countries that do not have data breaks in the period used. The sample consists of 17 countries: Algeria, Australia, Brazil, Canada, China, Colombia, Egypt, India, Indonesia, Italy, Malaysia, Mexico, Norway, Peru, Saudi Arabia, the United Kingdom and the United States. The data are annual, and the time interval is from 1990 to 2016. However, a more extended period was desirable. The HDI variable only started to be accounted for all countries in 1990.

The data for gross domestic product – GDP (local currency unit), exports of goods and services (% of GDP), oil rents (% of GDP) and population (total of persons) were taken from World Bank data. The HDI was extracted from human development data and the oil consumption (million tonnes), oil production (million tonnes) and crude oil prices (US dollars per barrel, prices 2018) were taken from the BP Statistical Review of World Energy. The software used for econometric analysis was Stata 13.1 and EViews 9.1.

The variables were calculated as follows:

- Gross domestic product per capita (YPC) – this is the quotient between GDP and total population. The fact that it is used at constant local currency prices eliminates possible problems with exchange rates.
- Human development index (HDI) – this varies between 0 and 1 and measures two indicators of education, one of health and the other of income. Short-run and long-run effects are to be expected.
- Oil rents per capita (ORPC) – this was initially divided by 100, then multiplied by GDP and finally divided by the total population; it results in the difference between the value of crude oil production at world prices and total costs of production, expressed in constant local currency units per capita. Short-run and long-run effects are to be expected.
- Export of goods and services per capita (EXPC) – this was initially divided by 100, then multiplied by GDP and finally divided by the total population; it results in the total value of goods and services sent abroad at constant local currency units per capita.
- The ratio between oil production and consumption (SO) – this is the quotient between oil production and oil consumption. According to Fuinhas

et al. (2019), this variable measures the level of self-sufficiency of oil-producing countries helping to control for heterogeneity. It is suitable for use with per capita variables.

- Crude oil prices (P) – this is the international price of crude, expressed in 2016 US dollars, and represents the price per barrel. This variable is common to all countries and is to be expected to have short-run effects.

Most of the variables used are per capita, allowing for a more detailed analysis that takes the different rates of population growth of the countries into account, eliminating possible distortions which they cause.

Although the most critical authors consider it necessary to complement the human development index with indicators that measure other dimensions, such as social and political liberties, Dasgupta and Weale (1992), and social equality or environmental issues, Sagar and Najam (1998), the HDI continues to be used as the universal variable to measure human development, and therefore, its use makes perfect sense.

Due to the sample's extended length and the specificities of the variables that compose it, short- and long-run causalities and dynamic effects between them are expected. The econometric estimator that best fits the characteristics of our sample is the ARDL (autoregressive distributed lag), which allows analysis of variables with different integration orders, that is I(0), I(1) or both. This estimator, when applied correctly, allows for efficiency and consistency in the estimation of its variables and inference of parameters based on standard tests. The dependent variable (YPC) is explained by its past and the past of the remaining independent variables that make up the model.

Then we proceed to the specification of the model; the variables with the prefix "L", are in the form of the natural logarithm and concern the short run, while in turn, those that contain the prefix "D", are in the form of first differences of natural logarithms and correspond to the long run. In this way, the coefficients of the former relate to elasticities and the coefficient of the latter to semi-elasticities. The specifications of the equations that make up the ARDL model are as follows:

$$LYPC_{it} = \alpha_{1i} + \beta_{1i}LYPC_{it-1} + \beta_{2i}HDI_{it} + \beta_{3i}HDI_{it-1} + \beta_{4i}LORPC_{it} + \beta_{5i}LORPC_{it-1} + \beta_{6i}LEXPC_{it} + \beta_{7i}LEXPC_{it-1} + \beta_{8i}SO_{it} + \beta_{9i}SO_{it-1} + \beta_{10i}P_{it} + \beta_{11i}P_{it-1} + \varepsilon_{1it} \quad (1)$$

Equation (1) was re-parameterised giving rise to Equation (2), allowing the dynamic relationship between short and long-run to be captured.

$$\begin{aligned}
DLYPC_{it} = & \alpha_{2i} + \beta_{i21}DLYPC_{it} + \beta_{i22}DHDI_{it} + \beta_{i23}DLORPC_{it} + \beta_{i24}DLEXP_{it} + \beta_{i25}DSO_{it} \\
& + \beta_{i26}DP_{it} + \gamma_{i21}DLYPC_{it-1} + \gamma_{i22}DHDI_{it-1} + \gamma_{i23}DLORPC_{it-1} + \gamma_{i24}DLEXP_{it-1} + \gamma_{i25}DSO_{it-1} + \gamma_{i26}DP_{it-1} + \varepsilon_{2it}
\end{aligned} \quad (2)$$

where α_i , denotes the constant; β_i , γ_i , the estimated parameters; and ε_i the error term.

The fact that the sample is made up of oil-producing countries suggests that this group of countries share several common characteristics among themselves. Adding this to the use of macro panel data, the presence of Cross-Sectional Dependence (CSD) is likely, which consists of the measurement to which the variables of different countries share identical/common behaviours with each other. If CSD is not treated correctly, it can promote problems of inefficiency and distortions in the estimation of results. Table 1 shows the CD test and the descriptive statistics of the variables so that the particularities of the series are captured.

Table 1 – Descriptive statistics and cross-sectional dependence

Variables	Descriptive Statistics					Cross-sectional dependence		
	Obs	Mean	Std. Dev.	Min.	Max.	CD-Test	Corr	Abs(corr)
LYPE	459	11.2641	2.1473	8.6398	17.4026	50.42***	0.832	0.835
HDI	459	0.7425	0.1255	0.4270	0.9510	59.23***	0.977	0.977
LORPC	459	7.2061	3.0029	0.3354	14.1364	46.08***	0.760	0.760
LEXP	459	9.8542	2.2769	6.1113	16.1216	42.65***	0.704	0.704
SO	459	2.2304	3.0362	0.0433	16.7276	7.57***	0.125	0.646
LP	459	3.6406	0.6406	2.6662	4.6057	60.60***	1.000	1.000
DLYPC	442	0.0231	0.0317	-0.1548	0.1278	10.77***	0.181	0.250
DHDI	442	0.0053	0.0036	-0.0060	0.0170	3.70***	0.062	0.180
DLORPC	442	-0.0299	0.4280	-1.9628	1.4609	52.08***	0.876	0.876
DLEXP	442	0.0283	0.1100	-0.4058	0.5070	17.17***	0.289	0.338
DSO	442	-0.0249	0.3012	-1.3349	2.4058	0.38	0.006	0.192
DLP	442	0.0219	0.2502	-0.6498	0.4525	59.46***	1.000	1.000

Notes: CD test has N (0.1) distribution and the null hypothesis (H₀): cross-section independence. *** denotes statistically significant at 1%. The Stata command *xtcd* was used for the CD test.

As we can see in Table 1, the descriptive statistics show that the macro panel is quite diverse; in turn, the CD-Test shows the presence of cross-section dependence, that is, if one country is affected by a shock, all the others will be affected, with the

exception of the DSO variable, which suggests that the oil-producing countries react independently (Fuinhas et al., 2019).

Another econometric problem that is usually associated with the study of long-run variables is multicollinearity. This occurrence can generate problems if there is a linear relationship between an independent variable and the other independent ones. This causes a problem because two or more independent variables are trying to explain the dependent variable in the same way. The correlation coefficients of the variables and the variance inflation factor (VIF) were calculated to test multicollinearity, as can be seen in the following table.

Table 2 – Matrices of correlations and VIF statistics

	LYPC	HDI	LORPC	LEXPC	SO	LP
LYPC	1.0000					
HDI	-0.0746	1.0000				
LORPC	0.8583	-0.2028	1.0000			
LEXPC	0.9704	-0.0250	0.8871	1.0000		
SO	0.2963	0.1891	0.4975	0.3664	1.0000	
LP	0.0757	0.2870	0.1246	0.1161	-0.1079	1.0000
VIF		1.91	9.16	6.47	2.05	1.38
VIF-Mean	4.19					

	DLYPC	DHDI	DLORPC	DLEXPC	DSO	DLP
DLYPC	1.0000					
DHDI	0.4888	1.0000				
DLORPC	0.1370	0.0916	1.0000			
DLEXPC	0.2326	0.1412	0.4141	1.0000		
DSO	0.0868	0.0600	0.0851	0.1596	1.0000	
DLP	0.2285	0.1381	0.8348	0.4175	0.0077	1.0000
VIF		1.03	3.42	1.27	1.05	3.47
VIF-Mean	2.05					

After analysis of the results, the coefficients whose correlation is higher than 0.8 stand out for their negative values, namely: LORPC / LYPC, LEXPC / LYPC, LEXPC / LORPC, and DLP / DLORPC. Although these values can be a problem, this hypothesis

is eliminated since the VIF values between the variables are all less than 10, a requirement so that there are no problems associated with multicollinearity.

Next, we will check the order of integration of the variables, so we proceed to the following first generation unit root tests: Levin Lin Chu (2002), Breitung (2000), Im Pesaran Shin (2003), ADF-Fisher Maddala and Wu (1999) and, ADF-Choi Choi (2001). We can see the results in Table 3.

Table 3 – Unit root test – 1st generation

Variables	LLC		Breitung	IPS		ADF-Fisher		ADF-Choi	
	CT	CC	CT	CT	CC	CT	CC	CT	CC
LYPC	0.134	-2.789***	1.482	1.053	1.663	23.725	25.985	19.982	20.091
HDI	0.309	-3.656***	3.128	2.007	0.665	19.808	37.334	29.683	95.324***
LORPC	4.19	-0.726	-0.823	0.810	-1.530 [†]	23.686	38.118	41.545	46.017 [†]
LEXPC	0.173	-4.067***	2.337	1.245	-1.343 [†]	28.957	40.978	17.856	43.457
SO	-0.935	-4.763***	-0.171	-0.172	-0.126	36.761	48.188 [†]	34.013	50.432**
LP	7.001	-1.000	3.131	2.917	1.425	8.312	14.080	6.933	12.202
DLYPC	-5.390***	-5.235***	-3.852***	-5.413***	-6.368***	92.261***	104.170***	153.150***	159.407***
DHDI	-3.792***	-4.039***	-3.704***	-5.598***	-5.792***	96.490***	98.701***	186.468***	177.196***
DLORPC	-10.367***	-12.476***	-6.809***	-11.566***	-13.910***	176.265***	230.237***	474.879***	365.523***
DLEXP	-6.180***	-7.095***	-7.406***	-7.595***	-8.455***	119.881***	137.892***	264.444***	222.300***
DSO	-5.240***	-6.340***	-1.147	-5.956***	-7.432***	98.826***	122.133***	278.359***	192.270***
DLP	-7.581***	-8.544***	-3.504***	-5.838***	-8.874***	89.725***	140.305***	167.540***	223.164***

Notes: CT represents the unit root test with constant and trend; CC represents the unit root test only with constant. The null hypotheses (H₀) are: LLC: panels contain unit roots; Breitung: panels contain unit root; IPS: all panels contain unit root; ADF-Fisher and ADF-Choi: panels contain unit root; ***, **, * denote statistical significance at 1%, 5% and 10% level, respectively; EVIEWS was used to estimate these results.

After examining the results obtained, we can verify that the variables in differences are I(0) and in level they are I(1), which proves that the nature of the variables is adequate for the use of this model. We proceed to the second generation unit root tests (CIPS), according to Pesaran (2007). This test is known to be more robust for heterogeneity and to test the hypothesis of non-stationarity. The results can be seen in Table 4.

Table 4 – Unit root test – 2nd generation

Variables	2 nd generation	
	CIPS (Zt-bar)	
	CT	CC
LYPC	1.406	-0.939
HDI	0.835	-0.138
LORPC	-0.504	0.105
LEXP	-0.370	-1.945
SO	-1.660	-0.905
LP	17.778	18.533
DLYPC	-2.307***	-3.252***
DHDI	-3.007***	-4.792***
DLORPC	-5.229***	-7.336***
DLEXP	-3.586***	-5.273***
DSO	-3.586***	-5.582***
DLP	17.778	18.533

Notes: the null hypothesis (H₀): series are I(1); *** denotes statistical significance at 10%; the Stata command *multipurt* was used for CIPS.

According to the results of this test, we are led to the acceptance of the null hypothesis in which the variables are I(1). The crude oil price variable again shows that it is common to all countries, both in level and in differences. The results obtained in this test are consensual with those of the first generation, which strengthens the hypothesis that there is no second-order integration.

4. Results

As our sample is composed of panel data and for an extended period of time, it is necessary to use appropriate econometric techniques that allow the phenomenon of heterogeneity and with the decomposition of short and long-run phenomena to be dealt with. In order to deal with this situation correctly and to understand which dynamic estimator is best suited to our panel, we tested the following estimators: mean group (MG); pooled mean group (PMG) and fixed effects (FE).

The Hausman test was used to distinguish the nature of our panel, i.e. whether we are in the presence of fixed effects (FE) or random effects (RE). This test has a null hypothesis (H₀): that the best model is that of random effects. If this hypothesis was accepted, it is necessary to resort to further tests with the pooled OLS regression, confronting the presence of random effects with the non-presence of panel effects. Nevertheless, according to the statistics of the Hausman test, ($X^2_9 = 67.10$), it is statistically significant at 1%, which leads to the rejection of the null hypothesis, suggesting the presence of fixed effects, i.e. there are signs of correlation between the individual effects of the countries and dependent variables.

Table 5 shows the tests for the dynamic estimators MG, PMG, FE and the respective results of the Hausman tests, of which the main objective is to compare the three models and help to understand what is most appropriate.

Table 5 – Heterogeneous estimators and Hausman tests

Dependent variable: DLYPC			
Variables	MG	PMG	FE
Constant	1.879***	0.296	0.319***
HDI	10.324**	4.762***	4.193***
LORPC	0.629	-0.086***	-0.112***
LEXP	0.413	0.221***	0.347***
SO	0.752	0.021	0.038
LP	-1.169	0.049**	-0.007*
ECM	-0.226***	-0.059*	-0.057***
DHDI	2.195***	2.817***	2.819***
DLORPC	-0.018*	-0.025***	-0.016***
DLEXP	0.055**	0.065***	0.009*
DSO	-0.024	-0.032	0.010***
DLP	0.020	0.038***	0.319***
Hausman tests	MG versus PMG	PMG versus FE	MG versus FE
Chi2(12)	-32.010	0.000	0.000
Prob>Chi2	n.a.	1.000	1.000

Notes: The null hypothesis (H₀) for Hausman test: difference in coefficients not systematic; ECM denotes error correction mechanism and n.a. denotes not available; ***, **, * denote statistical significance at 1%, 5%, and 10% level, respectively; the Stata command *xtpmg* was used, and Hausman (with the options *sigmamore*, *alleqs*, and *constant*) was used.

According to the results, the Hausman test proved that the most appropriate model is the FE, rejecting the presence of heterogeneity in the slope of the parameters. It should be noted that the SO variable is not significant for any of the models. The negative sign of X^2 , although not frequent, reinforces the rejection of the MG estimator.

Following good econometric practices, it is necessary to use tests that allow possible violations to be identified in these assumptions in the sense of specification. Autocorrelation, cross-section dependence and heteroskedasticity are generally the most common violations. In order to identify the nature of the violations present in the model, it is advised to carry out the following specification tests: (i) Modified Wald to control the heteroskedasticity of the residues; (ii) Pesaran, Frees and Friedman to analyse the presence of contemporaneous correlation among cross-sections; (iii) Breusch-Pagan LM, to verify the existence of correlation between errors and to test the independence between crosses; and (iv) Wooldridge to assess the existence of a serial correlation.

After the nature of the violations is identified, the FE estimator with greater robustness to deal with them will be chosen. Table 6 shows the respective results.

Table 6 – Specification tests

Test	Statistics
Modified Wald's test	326.17***
Pesaran's test	4.597***
Frees' test	0.187***
Friedman's test	56.934***
Breusch-Pagan LM's test	n.d.
Wooldridge's test	34.406***

Notes: The null hypothesis (H₀) for Modified Wald test: $\sigma(i)^2 = \sigma^2$ for all I; the H₀ for Pesaran's/Friedman's/Frees' and Breusch-Pagan LM's tests: residuals are not correlated; the H₀ for Wooldridge test: no first-order autocorrelation; *** denotes statistical significance at 1% level.

The results lead to the rejection of the null hypothesis for all tests except for the Breusch-Pagan LM, which cannot be tested because the correlation matrix of residuals was singular. According to the Modified Wald test, the presence of heteroscedasticity was detected. The Pesaran, Frees, and Friedman tests proved the existence of cross-sectional dependence, and finally, the Wooldridge test showed the presence of serial autocorrelation. Complementing the violations detected in the specification tests with the fact that the sample comprises an extended period, the estimator that allows greater robustness in the estimation of the results is Driscoll-Kraay (1998), Hoechle (2007), and Santiago et al. (2018). Table 7 shows the estimation of the FE, FE Robust and Driscoll-Kraay (FE D.-K.).

Table 7 – Estimation results

Dependent variable: DLYPC			
Variables	Models		
	FE	FE Robust	FE D.-K.
Constant	0.3190 ^{***}	0.3190 ^{***}	0.3190 ^{***}
DHDI	2.8198 ^{***}	2.8198 ^{***}	2.8198 ^{***}
DLORPC	-0.0165 ^{***}	-0.0165 ^{**}	-0.0165 ^{***}
DLEXP	0.0097	0.0097	0.0097
DSO	0.0105 ^{***}	0.0105	0.0105 ^{**}
DLP	0.0407 ^{***}	0.0407 ^{**}	0.0407 ^{**}
LYPC(-1)	-0.0571 ^{***}	-0.0571 ^{***}	-0.0571 ^{***}
HDI(-1)	0.2393 ^{***}	0.2393 ^{**}	0.2393 ^{***}
LORPC(-1)	-0.0064 [*]	-0.0064	-0.0064 ^{***}
LEXP(-1)	0.0198 ^{***}	0.0198 [*]	0.0198 ^{***}
SO(-1)	0.0022	0.0022	0.0022
LP(-1)	-0.0004	-0.0004	-0.0004
Statistics			
N	442	442	442
R ²	0.2771	0.2771	0.2771
R ² _a	0.2300	0.2586	
F	F(11,414)=14.43 ^{***}	F(11,16)=28.46 ^{***}	F(11,25)=15.86 ^{***}

Notes: ^{***}, ^{**}, ^{*} denote statistical significance at 1%, 5%, and 10% level, respectively.

In this table, we can observe the short-run semi-elasticities, which are direct reading, and are represented by the differences of variables. In turn, long-run elasticities need to be calculated by dividing the coefficients of the independent variables by the coefficient of the dependent variable (YPC), both lagged and multiplied by (-1). The individual results can be seen in Table 8.

Table 8 – Elasticities, short-run impacts and speed of adjustment

Dependent variable: DLYPC			
Variables	Models		
	FE	FE Robust	FE D.-K.
Short-run semi-elasticities/impacts			
DHDI	2.8198 ^{***}	2.8198 ^{***}	2.8198 ^{***}
DLORPC	-0.0165 ^{***}	-0.0165 ^{**}	-0.0165 ^{***}
DLEXPC	0.0097	0.0097	0.0097
DSO	0.0105 ^{***}	0.0105	0.0105 ^{**}
DLP	0.0407 ^{***}	0.0407 ^{**}	0.0407 ^{**}
Long-run elasticities/impacts			
HDI(-1)	4.1931 ^{***}	4.1931 ^{***}	4.1931 ^{***}
LORPC(-1)	-0.1119 [*]	-0.1119	-0.1119 ^{***}
LEXPC(-1)	0.3476 ^{***}	0.3476 ^{**}	0.3476 ^{***}
SO(-1)	0.0388	0.0388	0.0388 [*]
LP(-1)	-0.0071	-0.0071	-0.0071
Speed of Adjustment			
ECM	-0.0571 ^{***}	-0.0571 ^{***}	-0.0571 ^{***}

Notes: ^{***}, ^{**}, ^{*} denote statistical significance at 1%, 5%, and 10% level, respectively.

The elasticities and semi-elasticities allow an understanding of the impact that the independent variables have on economic growth, in the short and long run, respectively. The HDI variable, which has very strong impacts on economic growth can be highlighted. It shows an elasticity superior to 4 and a semi-elasticity superior to 2.

The values of error correction mechanisms or adjustment speed are negative and highly significant for all models, which suggests the presence of long-run cointegration between the variables. The fact that the coefficient is low means that in the event of a shock, the economy will be slow to reach the new equilibrium state.

5. Discussion of results

The main objective of this work is to understand how human development interacts with economic growth through a panel composed of oil-producing countries and their data, mainly per capita. The diagnostic tests performed in the previous sections showed the presence of heteroskedasticity, cross-sectional dependence, contemporaneous correlation, first-order autocorrelation, and a mix of $I(0)$ and $I(1)$ variables. The nature of the countries that make up the panel is quite diverse and includes: (i) small and large oil producers; and (ii) developed and developing countries. Once short- and long-run effects are verified, it is proven that the use of dynamic panel techniques is appropriate.

Regarding the empirical results, four facts should be highlighted: (1) the coefficients of the oil rents variable (ORPC) shows negative values in the short and long run; (2) the coefficients of the human development index variable (HDI) are very high; (3) the variable crude oil prices (P) is not statistically significant in the long run; and (4) the variable exports of goods and services (EXPC) is not statistically significant in short run.

Oil rents (ORPC) are the total net value referring to the revenues obtained from oil sales of the exterior and result from the difference between the total value of crude oil production at world prices and the total production costs. Their coefficients are negative and statistically significant, which confirms the hypothesis of a resource curse. They are harmful to economic growth in both the short and long run. An explanation is the fact that an increase in production costs or a drop in world prices directly reduces producers' marginal profit. However, when the opposite effect occurs, and marginal profits increase, a new problem also arises since the additional revenue causes an increase in inertia in the economic structure that will create more dependence. In other words, it increases the need for countries to turn to the foreign market to import non-productive goods for luxury consumption, instead of using that additional value to diversify the economy, promoting the production of other types of goods and contributing to the reduction or elimination of possible trade deficits.

Exports of goods and services (EXPC) are positive and highly significant, but only in the long run. They are one of the variables that most influence economic growth, although significance in the short run was also expected. There are authors who have had similar results. For example, Fuinhas et al. (2016), only achieved short-run statistical significance in a model composed of the variable oil consumption and for a long period of time, about 40 years. Therefore, as our sample has a shorter time span

and does not have this variable, it may be one of the reasons for this variable not having any type of significance. Once this hypothesis is verified, the possibility of the curse will be reinforced.

Regarding crude oil prices (P), the results are consistent with what was stated above. The signal is contrary to that of oil rents and significant in the short run, i.e. it promotes economic growth. The justification refers to the fact that an increase in oil prices immediately represents additional revenue for these countries.

The ratio between oil production and consumption (SO) reveals to have explanatory power for the model, especially in the short run. Considering the significance and signals of the coefficients, an increase in the countries' level of self-sufficiency provides economic growth, which proves the dependence that these countries have on oil. The use of this self-sufficiency measure proved to be essential for a better understanding of the economic performance in the oil-producing countries.

The ECM or adjustment speed is low and approximately 6%. This figure suggests that if the economy suffers a shock, its recovery will be slow and it will take a long time to reach the new equilibrium state. The reasons refer to the fact that the economy of oil-producing countries is uncompetitive and dependent on a small number of sectors which, due to their apathy, end up harming the remainder.

The human development index (HDI) proves to be highly significant and positive, which is in line with other authors' findings (Ramirez et al., 1997; Ranis et al., 2000; Mustafa et al., 2017; Appiah et al., 2019). The elasticities are greater than 2 and 4, in the short and long run, respectively. These values are far from being a problem. Indeed, the literature points to several expected reasons for this finding, as was previously seen in the literature review section. Human development proves to be the major driver of the economy and an increase in the living standards of the inhabitants of a country will be strongly reflected in economic growth, especially in the long run, and the reason is simple. A return on investment in HD takes a few years to materialise. For example, if we consider the area of education, the country only begins to have a return on investments when students have benefited from them, i.e. when they become part of the active population and contribute their knowledge in the labour market. In turn, if we consider the increase in household income, the situation is similar. With regard to health, the expected effect may be faster if we take into account a direct investment in the construction of infrastructures or in the purchase of new equipment. On the other hand, it may be slower if we take into account that health conditions improve, mainly through the additional knowledge of its professionals.

6. Conclusion

This dissertation contributes to the literature with a new approach to the human development-economic growth nexus in oil-producing countries, through a panel composed of the human development index variable as a measure of human development, oil prices and rents, exports of goods and services and the ratio of oil production to oil consumption. The sample also includes 15 countries and annual data from 1990 to 2016.

The ARDL model proved to be quite adequate due to the presence of causalities and dynamic short- and long-run relationships between variables. The results were consistent with the literature on the energy-economic growth nexus. Oil rents contribute negatively to economic growth, reinforcing the hypothesis of the resource curse. Exports of goods and services promote long-run economic growth. The control variable, the ratio of production to oil consumption, proved to have the highest level of dependence on the production of hydrocarbons that countries experience and that an increase in the level of self-sufficiency increases economic growth. The increase in oil prices was also positive since the countries under analysis are mainly exporters of this raw material.

Concerning human development, it proved, as expected, to be the primary driver of economic growth. These results reinforce the importance that human development has for the economy. As the main objective of policymakers is to ensure social well-being, it makes even more sense to invest in initiatives that promote the quality of life of their citizens. In addition to fulfilling their main objective, they still manage to reconcile all of this with the added value of economic growth.

In short, the selected countries should direct more revenues to invest in human development, for example, using oil revenues or only the additional revenue generated by the price increase, depending on the capacity of each country. This type of initiative will enable: (i) diversification of the domestic economy; (ii) improvement in the quality of its institutions; and (iii) increased economic competitiveness. If political agents take all this into account, in the long run, most of the problems mentioned in this work will be reduced or even eliminated. Countries considered to be poor and less developed are facing a higher challenge. The greater the country's economic growth, the higher the investment capacity. This is like a vicious cycle, i.e., the poorest countries, in addition to having less investment capacity, will also experience less economic growth because they have less human development. The motto is as follows: "strong societies are not built with weak people".

In future studies, it is suggested that a proxy for human development be created composed of additional dimensions which are considered relevant, such as, indicators that allow social equality and environmental issues to be measured. It will also be relevant to use a panel composed of more countries and to extend the period if the data allow it.

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