THE ENVIRONMENTAL CURSE IN OIL DEPENDENCE COUNTRIES: A MISSING DIMENSION OF THE OIL CURSE

a Basem Ertimi, b Rossanto Dwi Handoyo, c Kabiru Hannafi Ibrahim, d Fernanda Reza Muhammad

ABSTRACT

Objective: We build on prior studies by perhaps shedding light on the murky relationship in Oil-dependent countries. The study aims to expand the concept of the contractual oil curse and suggests another channel that may not be addressed as one of the oil curse channels. Accordingly, there remains little understanding of the oil curse by which the environmental dimension brings a new manifestation.

Methods: In this study a sample of 21 oil-dependent economies were analysed from 1995-2018, using the Pooled Mean Group (PMG) and a dynamic panel technique that is heterogeneous.

Results: The results empirically prove the negative influence of the connection between CO2 emissions and oil consumption. As a result, we identified a symptomatology of the oil curse via a new transmission method under the environmental domain. Depending on the transmission method, natural resources can either be a benefit or a curse. Our study found evidence supporting the concept of the oil curse taking place through the environmental channel (CO2 emissions).

Conclusion: Hence, the presence of this negative relationship has a new purpose in the debate about the oil curse and its environmental impact. Policy research needs to be conducted to understand and mitigate the oil curse.

Keywords: resource curse, oil curse, transmission channels, CO2 emissions, oil dependence countries.

Received: 28/08/2023
Accepted: 27/11/2023
DOI: https://doi.org/10.55908/sdgs.v11i12.2164

---

a Ph. D. in Economics, post-doctoral research fellow, faculty of economics and business, Universitas Airlangga, Surabaya Indonesia, senior lecturer, Faculty of Economics, University of Zawia, Libya, E-mail: b.ertimi@zu.edu.ly, Orcid: https://orcid.org/0000-0003-2101-1924

b Ph. D. in Economics, Professor, faculty of economics and business, Universitas Airlangga, Surabaya Indonesia, E-mail: rossanto_dh@feb.unair.ac.id, Orcid: https://orcid.org/0000-0002-4133-1207

c Ph. D. in Economics, Senior Lecturer, Faculty of Social and Management Sciences, Federal University Birnin Kebbi, Nigeria, adjunct professor, faculty of economics and business, Universitas Airlangga, Surabaya Indonesia, E-mail: kabiru.hannafi@fubk.edu.ng, Orcid: https://orcid.org/0000-0002-2252-5735

d Master management in economics, faculty of economics and business, Universitas Airlangga, Surabaya Indonesia, trade, promotion and market research senior analyst at Export Centre Surabaya, Ministry of Trade Republic of Indonesia, E-mail: reza@promosia.biz, Orcid: https://orcid.org/0009-0003-3643-621X
A MALDIÇÃO AMBIENTAL NOS PAÍSES DEPENDENTES DO PETRÓLEO: UMA DIMENSÃO EM FALTA DA MALDIÇÃO DO PETRÓLEO

RESUMO

Objetivo: Baseamo-nos em estudos prévios, talvez elucidando a relação obscura dos países dependentes do petróleo. O estudo pretende ampliar o conceito da maldição contratual do petróleo e sugere outro canal que pode não ser abordado como um dos canais da maldição do petróleo. Assim, ainda há pouco entendimento da maldição petrolífera pela qual a dimensão ambiental traz uma nova manifestação.

Métodos: Neste estudo, uma amostra de 21 economias dependentes de petróleo foi analisada de 1995 a 2018, utilizando o Grupo Médio Agrupado (GPM) e uma técnica de painel dinâmico heterogênea.

Resultados: Os resultados provam empiricamente a influência negativa da conexão entre as emissões de CO2 e o consumo de petróleo. Como resultado, identificamos uma sintomatologia da maldição do petróleo através de um novo método de transmissão no domínio ambiental. Dependendo do método de transmissão, os recursos naturais podem ser um benefício ou uma maldição. Nosso estudo encontrou evidências apoiando o conceito de maldição do petróleo ocorrendo através do canal ambiental (emissões de CO2).

Conclusão: Assim, a presença dessa relação negativa tem um novo propósito no debate sobre a maldição do petróleo e seu impacto ambiental. A pesquisa política precisa ser conduzida para entender e mitigar a maldição do petróleo.

Palavras-chave: maldição de recursos, maldição de petróleo, canais de transmissão, emissões de CO2, países dependentes de petróleo.

1 INTRODUCTION

The conventional narrative that links natural resources to economic development underwent a dramatic change as a result of the concept of the resource curse. The theory suggests a paradoxical position for the abundance of the natural source, the growth rate of nations with abundant natural resources, notably oil, is frequently lower than that of nations with limited resources. Generally, these resources have a pivotal role in contributing positively to economic growth. Hence, it would be reasonable to expect these countries to exhibit high growth rates and greater well-being. However, this is not always the case empirically, and neither is it historically proven, thus creating this conceptual paradox. This is a common condition impacting economic growth. This circumstance is known as the "natural resource paradox" or the "Natural Resource Curse Hypothesis" (RCH) in literature (Auty & Warhurst, 1993; Sachs & Warner, 1995).

Recently, there has been renewed interest in (RCH), which refers to a situation whose description seems even more challenging to comprehend. It is asserted that
countries with access to resources grow more slowly than those without them (Auty 2001; Bulte et al., 2005; Sala-I-Martin 1997). A result depends on various channels via which the curse may act, therefore, it is important to emphasize that the growth of an economy is not solely determined by the availability of natural resources (Badeeb et al., 2017; Henri, 2019; Van der Ploeg & Poelhekke, 2010; Frankel, 2010). An increasing corpus of research examines the significance of various transmission pathways in explaining why resource-rich economies could be afflicted by the curse (Papyrakis & Gerlagh, 2004; Ross, 2013; Wu et al., 2018). The evidence of the indirect impacts of natural resource dependence through transmission channels is somewhat inconclusive to economic growth, given the significance of the transmission channels that need to be identified to profit from the abundant natural resources. The correlation between oil reliance and growth may vary depending on the transmission channels.

The climate change problem is currently raising the world’s concerns because it affects billions of people’s lives. Understanding and promoting sustainable economic growth is now even more crucial in light of the issues caused by climate change. For this reason, during the past few decades, academics have continued to debate the connection between growth and natural resources. While for some nations natural resources boost their economic growth, others’ lack of development is thought to have been a result of their overreliance on these resources. What effect natural resources have on sustainable economic growth is therefore still up for debate (Liu et al., 2023).

The findings of previous studies have not all reached the same conclusion concerning how the quantity of natural resources affects long-term sustainable economic growth (Rahim et al., 2021; Xiaoman et al., 2021). The current research has therefore added to the corpus of knowledge already known in this field. Furthermore, little is known about how natural resources affect the ecology in countries that depend on oil (Xiaoman et al., 2021). Consequently, this work has contributed significantly to the context. Among the top ten carbon-intensive nations, countries with abundant natural fossil and mineral resources produce more CO₂ per unit of output than those with limited access to these resources (Chiroleu-Assouline et al., 2020).

More resources encourage more growth, which leads to greater energy consumption. Since global emissions are continuously rising despite international agreements to reduce them, including the Paris Agreement, the impact of oil resources on CO₂ emissions could be extremely important (Aşıcı & Acar, 2016). The CO₂ emissions
will increase as long as fossil fuels remain a major component of the energy supply (Abbas et al., 2022). There are three distinct mechanisms by which the carbon curse operates. Dependence on resources has many detrimental repercussions on the environment. However, the government-enforced preventive measures on the use of resources and the environment may help reduce the devastation of limited environmental resources Pozzetti et al. (2020) and reduce the use of resources with harmful effects on the environment (Abdelhady et al., 2023). The energy sector's crowding-out effects, which impede the advancement of renewable energy sources, are the first effect. The economy's predominance of fossil fuel industries, which produce significant amounts of CO₂ emissions, is responsible for the second composition effect. The third factor combines the knock-on effects with loose environmental regulations and some scepticism toward polluting behaviour across all economic sectors. The development of new sectors is slowed by these consequences, which are similar to the resource curse (Chiroleu-Assouline et al., 2020).

The correlation between CO₂ emissions and reliance on natural resources at the macroeconomic level is not one-dimensional but rather has a U-shaped nexus. A country's CO₂ emissions per unit of gross domestic product (GDP) increase with its oil resource wealth. A country with few resources is not subject to the carbon curse. As a result, there are few barriers to the growth of renewable energy sources there, the regulatory environment is strict, and the technology level is sufficient. In light of each discovery, the energy mix will be altered in favour of cleaner sources (gas in place of coal, for instance) (Aşıcı & Acar, 2016).

In this study, we argue that a significant contributing factor to CO₂ emissions is oil reliance in addition to the usual explanations. Pollution is indeed brought on by oil resources, as well as its related industries, such as energy generation (refining) and extraction. There has already been extensive discussion in the academic community about the relationship between resources and economic growth. The "Environmental Kuznets Curve" (EKC) and the resource curse, which relate pollution levels to economic growth, are both correlated with natural resources (Badeeb et al., 2020). In this study, we examine the connection between CO₂ emissions and oil resources more broadly to see the extent of the environmental curse hypothesis as the other resource curse channels, which places it at the nexus of these two disciplines. The link between CO₂ emissions and the dependence on oil resources is what causes the "carbon curse" (Chiroleu-Assouline et al.,
By incorporating oil rents into the definition of dependence, we expand on this study. Thus, oil dependence implications are taken into consideration in the context of the resource curse operating as another channel of the curse.

We aim to contribute to the discourse about halting climate change by analysing the impacts of oil reliance on emissions, which function as a further manifestation of the resource curse. Panel data spanning 21 nations from 1995 to 2018 is the foundation of our empirical study. The analysis clarifies mechanisms that until now have overlooked how oil reliance affects the ecosystem as a separate source of the oil curse. A nation with abundant natural resources (such as oil) tends to pollute more. This implies that rather than the traditional contrast between industrialized and developing nations, the distinctions between nations with abundant resources and nations with limited resources should be emphasized more in global debates on climate change. Two areas of inquiry in the cited literature are linked to this study. The relationship between economic expansion and pollutant emissions (EKC) is the first focus. The second focus explores the resource curse or the relationship between natural resources and economic growth.

In this study, we thoroughly examine the relationships between oil dependence and pollution and experimentally examine the environmental curse hypothesis to see if a larger reliance on oil predicts a higher intensity of emissions. We believe that this research is the first to suggest econometric tests of the environmental channel as another channel of the curse assumption, moving beyond a straightforward descriptive statistical analysis. The following are the primary hypotheses concerning the mechanisms at play in a carbon curse. First, the effect brought on by the oil sector's dominance causes significant CO₂ emissions. Second, the impacts of industry crowding out on the production of energy are a hindrance to the expansion of renewable energy sources. Except for those that are already afflicted, relatively few countries with ample resources can escape the carbon curse (Friedrichs & Inderwildi, 2023; Chiroleu-Assouline et al., 2020). However, studies on resource curse and EKC typically highlight the roles of institutional quality and economic growth. We focus on oil-dependent countries to emphasize the significance of a fresh angle concerning resource dependence. By assessing oil dependence impacts on emissions operating as another channel of the resource curse, the discussion on preventing climate change is what we hope to contribute to. Our empirical research is based on substantial panel data that spans the years 1995 to 2018 and includes information on 21
nations. When these data are combined, new insights are provided into systems that until now have overlooked how oil reliance affects the ecosystem as another oil curse channel.

The remaining sections are organized as follows. Section 2 examines the literature on the resource curse, its transmission channels, and its consequences on the environment. Methodological approaches are the focus of Section 3. In Section 4, we present the study result, and in Section 5, we analyse our findings and offer a discussion. In section 5, we conclude the study and provide remarks on policy and suggestions for future research.

2 THEORETICAL FRAMEWORK

2.1 THE TRANSMISSION CHANNELS OF THE RESOURCE CURSE

Some theories of transmission channels via which the phenomena present themselves have been put forth in the literature concerning the natural resource curse. According to recent resource hypothesis literature, economic growth is influenced by natural resource availability both directly and indirectly. The consequences of economic growth are still up for debate, as some research has found both positive and negative effects. This suggests that empirical studies offer inconsistent support for the RCH (Papyrakis & Gerlagh, 2004).

Questions surrounding natural resources have been the subject of numerous theories. According to Stijns (2005), countries' natural resource management has the biggest impact on growth potential, even if there are both helpful and destructive channels that might influence growth. Sun et al. (2018) emphasize the importance of funding public education and the development of human capital. They look at the displacement of human capital by natural resources using data from 31 Chinese regions between 1999 and 2015. The findings provide empirical support for the resource curse by demonstrating a negative association between natural resource dependence and human capital development. Sun et al. (2018) contend that spending on public education can mitigate the consequences of natural resource dependence's crowding out on the growth of human capital. In another study, Sun et al. (2019) used the same sample and technique for the same period, and showed a correlation between spending on public education and the abundance of natural resources, suggesting that natural resource serves as a source of funding for educational expenditures. They contend that a good education will increase human capital, boosting the economic growth rate (Sun et al., 2019). These analyses align with Shuai & Zhongying (2008) who examined a sample of 11 Western Chinese provinces between
1991 and 2006. They show an inverse relationship between per-capita energy consumption and economic development, contending that, among many other ways, the use of energy has stifled economic progress primarily through the input of human capital.

Conversely, Cockx & Francken's (2016) study reveals that reliance on natural resources and spending on public education as a fraction of GDP are negatively correlated. A panel of 140 nations covering the years 1995–2009 was used to arrive at this finding. They contend that the effect of the curse is lessened by the government budget on education and institutional quality for the effective and environmentally friendly management of natural resource revenues. The effect of abundant resources on education in Kern County is the focus of additional study into the education channel done by (Michieka & Gearhart, 2018). The study spans the years 1950 to 2015. The findings show that fluctuations in agriculture or oil prices have little impact on the nation's educational system. Therefore, the author has not discovered any evidence of the resource curse throughout the system of education. Alternatively, no short- or long-term association was found between education and the pricing of natural resources (oil and agricultural commodities).

The degree of human capital is arguably the most frequently cited justification for the wealth of natural resources that end up being a gift or burden in nations with abundant resources. Bravo-Ortega & De Gregorio (2005) used a panel of country data from 1970 to 1990 to establish a theoretical model that can explain how high levels of human capital can lessen the effect of the natural resource curse. Positive findings demonstrate that the curse’s impact is lessened with each increase in human capital. The authors contend that whereas the industrial sector can add additional human capital while expanding, the natural resources sector employs a fixed amount of human capital. From another viewpoint, Henri (2019) looks into how natural resource rents in Africa negatively affect macroeconomic and institutional variables. The study examines a sample of African nations between 1992 and 2016. Findings indicate that the greatest institutional issue brought on by the rents of Africa’s natural resources is corruption, and then the rule of law, poor regulation, ineffective public administration, minimum accountability, and unstable politics. Henry (2019) introduces the degree of institutional quality in a sample of 21 sub-Saharan nations for the years 1970–2014 before discussing the natural resource curse mechanisms. He examined the long-term and immediate impacts of national resources by grouping the sample according to institutional quality.
The study concludes that the sub-Saharan region is cursed mostly as a result of poor institutional quality.

A study by Kolstad & Wiig (2012) observed the link between trust and natural resource wealth in which corruption impact is found to be a crucial factor. From 1999 to 2008, 91 nations were included in the sample. The study reveals that reliance on natural resources and social trust has no direct effects, but corruption has an indirect role in the detrimental impact. Using data from a group of 31 oil-exporting countries between 1992 and 2005, Arezki & Brückner (2011) investigate the consequences of oil rent on corruption. Their findings imply that a rise in oil rentals, particularly in nations with significant levels of government involvement in the oil industry, increases a score of corruption connected to political risk facilities. Alexeev & Conrad (2011) investigate how dependence on natural resources affected social, institutional, and economic factors of nations between 1996 and 2005 using cross-country regressions in transition countries for two separate years, 1996 and 2005. The authors did not discover any proof that the availability of natural resources during this period had a negative impact on investment in both human and physical capital.

There is an intriguing perspective on the resource curse. By using panel data spanning the years 1995 to 2009, Cockx & Francken (2016) found that government investment in education and the reliance on natural resources were found to be significantly inversely correlated. Other authors have addressed how natural resources and government expenditures are related (Bhattacharyya & Collier, 2014; Cockx & Francken, 2014; El Anshasy & Katsaiti, 2015). El Anshasy & Katsaiti (2013) examine how institutional quality influences fiscal policy efficacy to examine the indirect effects of institutions on economic growth. From 1984 to 2008, they examined a sample of 47 non-resource countries and 32 countries with plentiful resources. As a result of less spending procyclicality, the results demonstrate that the physical channel is notably positive, indicating a positive impact of high-quality institutions on economic development. The curse, they claim, is connected to a low rate of institutions across all government expenditure consumption, and they also discover that this indirect relationship is only favourable for bureaucratic quality. Busse & Gröning (2013) conducted econometric analyses to examine how natural resources affect government metrics. They use a panel data collection containing 129 nations for the years 1984 to
2007. The findings show that corruption rises as a result of the export of natural resources. They conclude that corruption is mostly to blame for the government's resource curse.

Regarding the overall resource curse or its various causal routes, empirical data is not entirely consistent. Numerous unfavorable channels of transmission have been found in the literature in this field. Gylfason (2001) and Sachs & Warner (1995) argue that there will be a pressing need for competent economic management if wealth from natural resources rises significantly in nations with abundant resources. Using cross-country data and adherence to the methodology studies by Mo (2001) and Papyrakis & Gerlagh (2004) investigated how reliance on natural resources affects the economy. According to their findings, natural resource wealth does not act as a catalyst for economic growth.

Another channel is discussed by Gylfason (2001) and Gylfason & Zoega (2006) who take into account natural resource wealth that depletes human and physical capital, leading to slower and longer-term. Gylfason (2002) underlines the need for such connections while examining the transmission mechanisms from reliance on natural wealth to detrimental growth of the economy. According to the earlier study, countries with natural resource endowments have an overly inflated level of self-assurance that they are going to thrive regardless of whether they invest in human capital and education or not, and a lack of education helps justify the adverse effects of having access to natural resources. The latter study quantifies the relationship between natural resources and growth in the economy and provides evidence of the adverse consequences of inequality. Additionally, a wealth of resources may contribute to increased corruption Brollo et al. (2013) and Vicente (2010) but this is dependent upon the strength of the institutional framework. According to Wadho (2014), even though 124 countries' perceptions of corruption might resemble a piece of the second channel, for Gylfason (2002), human capital, and corruption outcomes are communicated simultaneously (Bhattacharyya & Hodler, 2010). According to Van Der Ploeg & Poelhekke (2010), terms of trade (volatility) served as the primary conduit for the resource curse in 83 nations from 1960 to 2000. Iimi (2007) found that the primary economic driver of Botswana's resource curse is the Dutch disease. The necessity of investment is emphasized by Gylfason and Zoega (2006) and Atkinson & Hamilton (2003) who also present multiple channels of transmission for 91 countries covering the years 1980-1995. Additionally, they claim that

1 See also, Stiglitz, Humphreys, Sachs, Stiglitz, Soros and Humphreys.
physical assets are outweighed by natural resources and that this has a negative impact on economic progress.

Papyrakis & Gerlagh (2007) compile various channels in which resource reliance can be reduced through the influence of education on long-term development. One method of transmission is the fact that non-wage income from resource exploitation deters people from gaining expertise to increase their income. One puts less attention on additional expenditures to earn bigger salaries when they receive windfalls like pocket royalties payouts. Another factor is the decrease in demand for education in the resource sectors; the market value of natural resources increases with education costs and decreases with education returns. According to Brunnschweiler & Bulte (2008), the efficiency of institutions distinguishes between dependence on natural resource richness and endogenous to it. They discover that while resource scarcity is a blessing for progress, resource dependence is a hindrance. Both Cotet & Tsui (2013) and Alexeev & Conrad (2009) argue that natural resources are not a curse. On the other hand, nations with substantial oil reserves show faster revenue growth. The empirical data support the claims made by Arin & Braunfels (2018) that instead of being a curse, natural resource wealth is a blessing (Humphreys et al., 2007; Koitsiwe & Adachi, 2015; Mehrara, 2009; Moshiri & Hayati, 2017; Philippot, 2010; Zagozina, 2014). Other recent articles have covered many transmission channels.

Despite the importance of transmitting channels of the RCH, the Scopes of most of the existing studies are limited to either political channels or economic channels. The environmental dimension can be considered as another resource curse channel that is operating exclusively at the international or global scale. Accordingly, there remains little understanding of the RCH by which CO₂ emissions bring a new manifestation of the RCH and shape the prospect of environmental resource growth - nexus. As such, it provides some gaps in the existing empirical research.

3 METHODOLOGY

3.1 DATA AND VARIABLE DEFINITIONS

In this study, we used secondary data sourced from the World Bank and Global Carbon Atlas. The data comprises 21 countries for the period 1995-2018. Table 1 shows the list of countries analysed in this study, while Table 2 shows the study variables, their
definition, and sources. Additionally, to achieve the stated objectives of the study, the study employs an econometric technique for the analysis.

Table 1. List of Oil-dependent Countries

<table>
<thead>
<tr>
<th>Oil Dependence Countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iraq</td>
</tr>
<tr>
<td>Libya</td>
</tr>
<tr>
<td>Algeria</td>
</tr>
<tr>
<td>Venezuela</td>
</tr>
<tr>
<td>Angola</td>
</tr>
<tr>
<td>Sudan</td>
</tr>
<tr>
<td>Kuwait</td>
</tr>
<tr>
<td>Qatar</td>
</tr>
<tr>
<td>Yemen</td>
</tr>
<tr>
<td>Nigeria</td>
</tr>
<tr>
<td>Oman</td>
</tr>
<tr>
<td>Iran</td>
</tr>
<tr>
<td>Russia</td>
</tr>
<tr>
<td>United Arab Emirates</td>
</tr>
<tr>
<td>Azerbaijan</td>
</tr>
<tr>
<td>Gabon</td>
</tr>
<tr>
<td>Congo, Rep.</td>
</tr>
<tr>
<td>Chad</td>
</tr>
<tr>
<td>Ecuador</td>
</tr>
<tr>
<td>Saudi Arabia</td>
</tr>
<tr>
<td>Kazakhstan</td>
</tr>
</tbody>
</table>

Source: Developed by the Authors based on the sample countries

Table 2. List of Research Variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Definition</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>RGDPG</td>
<td>GDP growth (%). The annual percentage growth rate of GDP, in constant 2010 US dollars</td>
<td>WDI</td>
</tr>
<tr>
<td>RD</td>
<td>Oil rents as % of GDP</td>
<td>World Bank</td>
</tr>
<tr>
<td>Invs</td>
<td>Share of GDP (Gross Capital Formation) in 2010 Constant Prices</td>
<td>WDI</td>
</tr>
<tr>
<td>Open</td>
<td>The sum of the average of imports and exports in % of GDP</td>
<td>WDI</td>
</tr>
<tr>
<td>Gov</td>
<td>Government Share of GDP unit: % in 2010 Constant Prices</td>
<td>WDI</td>
</tr>
<tr>
<td>Inst</td>
<td>Values of Rule of Law Index in 2018</td>
<td>(<a href="http://www.globalcarbonatlas.org/en/CO2-emissions">http://www.globalcarbonatlas.org/en/CO2-emissions</a>)</td>
</tr>
<tr>
<td>CO₂</td>
<td>carbon dioxide (CO₂) emissions per capita</td>
<td></td>
</tr>
</tbody>
</table>

Source: Developed by the Authors based on the study variables

3.2 ECONOMETRIC MODELLING

This study employed the PMG estimation framework. It was introduced by Pesaran et al. (1999) by using yearly data for the whole period instead of averaging the data from 1995 to 2018. This study makes use of the Pooled Mean Group (PMG), the Mean Group (MG), and the Dynamic Fixed-Effect (DFE) estimators to assess how oil rents affect growth in the economy. It also incorporates an interaction term involving CO₂ emissions and oil reliance (RD*CO₂).

The modelling of this long-term relationship is based on the estimation of an Autoregressive Distributed Lag (ARDL) model, the ARDL (p, q, q, …, q) developed by (Pesaran et al., 1999). It is expected that the following equation can be used to specify an Autoregressive Distributive Lag, ARDL (p,q):
\[ Y_{it} = \sum_{j=1}^{p} \varphi_{ij} Y_{i,t-j} + \sum_{j=0}^{q} \delta_{ij} X_{i,t-j} + \vartheta_i + \varepsilon_{it} \]  

(1)

Where:

\[ i=1, 2..., \text{while } N \text{ represents the country number; } t=1..., \text{ and } T \text{ represents the time; } j \text{ represents the number of lags; } X_{it} \text{ represents the variable vectors associated with economic growth and } \vartheta_i \text{ represents the countries’ specific fixed effect. The following re-parametrization of Equation (2) is done to account for the adjustment coefficient and long-run dynamics:} \]

\[ \Delta Y_{it} = \varphi_i(Y_{i,t-1} - \theta_i X_{i,t-1}) + \sum_{j=1}^{p-1} \varphi'_{ij} \Delta Y_{i,t-j} + \sum_{j=1}^{q-1} \delta'_{ij} \Delta X_{i,t-j} + \vartheta_i + \varepsilon_{it} \]  

(2)

Where:

\[ Y_{it} \text{ is the dependent variable, with } \varphi_i \text{ represents the long-run dynamics adjustment coefficient, } \theta_i \text{ represents the correlation of equilibrium in the long-run between } Y_{it} \text{ and } X_{it}. \varphi'_{ij} \text{ and } \delta'_{ij} \text{ denote the coefficients in the short-run that relate to growth in the economy with its past values, as well as the explanatory variables of interest } X_{it}. \text{ A long-term association between economic growth and oil reliance can be established if the coefficient of } \varphi_i \text{ is negative and significant, which means that } Y_{it} \text{ and } X_{it} \text{ are cointegrated.} \]

With zero means and } \sigma_i^2 > 0 \text{ variances, the disturbance terms are considered to be independently distributed over } i \text{ and } t. \text{ Additionally, it is also anticipated that } \varphi_i < 0 \text{ for all } i's. \text{ As a result, } Y_{it} \text{ and } X_{it} \text{ have a relationship in the long run that is described as:} \]

\[ Y_{it} = \theta' X_{it} + \eta_{it}; i = 1, 2, ..., N; t = 1, 2, ..., T. \]

\[ \theta_i = -\beta_i/\theta_i \] \text{ represents the long-run coefficients } k \times 1 \text{ vector, with non-zero means, } \eta_{it} \text{'s are stationary (together with the fixed effects). As a result, Equation (2) may be expressed as follows:} \]

\[ \Delta Y_{it} = \varphi_i \eta_{it-1} + \sum_{j=1}^{p-1} \varphi'_{ij} \Delta Y_{it-j} + \sum_{j=0}^{q-1} \delta'_{ij} \Delta X_{it-j} + \vartheta_i + \varepsilon_{it} \]  

(3)

Where:
the coefficient of the error correction term is $\varnothing_i$, describing the adjustment rate toward the equilibrium in the long-run and $\eta_{i,t-1}$ stands for the error correction term given in Equation (3). This parameter is predicted to be significantly negative, indicating that variables approach a long-run equilibrium. Three estimating strategies were utilized to estimate Equation (3): the MG suggested by Pesaran & Smith (1995) the PMG suggested by Pesaran et al. (1999) and the DFE estimator. The Pooled Mean Group (PMG) estimator, introduced by Pesaran et al. (1999), enables coefficients in the short run but requires that coefficients, in the long run, be the same across the cross-section.

4 RESULTS AND DISCUSSION

4.1 DESCRIPTIVE STATISTICS

Table 2 lists the elements that were employed in this study's growth regression. Table 3 displays the descriptive data, such as the standard deviation, mean, and minimum and maximum values. From 1995 to 2018, the dataset is comprised. Oil rents in the nation range from a minimum of 25.46% to a maximum of 76.43%. The table also displays the values of the other control variables.

Table 3. Variable Descriptive Statistics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Obs</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>RGDPG</td>
<td>672</td>
<td>3.85</td>
<td>8.16</td>
<td>-62.07</td>
<td>123.8</td>
</tr>
<tr>
<td>RD</td>
<td>672</td>
<td>25.46</td>
<td>15.00</td>
<td>0</td>
<td>76.43</td>
</tr>
<tr>
<td>Invs</td>
<td>672</td>
<td>25.26</td>
<td>9.02</td>
<td>0</td>
<td>77.89</td>
</tr>
<tr>
<td>Open</td>
<td>672</td>
<td>74.44</td>
<td>34.62</td>
<td>0.020</td>
<td>213.28</td>
</tr>
<tr>
<td>Inst</td>
<td>672</td>
<td>-4.81</td>
<td>.94</td>
<td>-2.32</td>
<td>2.036</td>
</tr>
<tr>
<td>Gov</td>
<td>672</td>
<td>26.78</td>
<td>15.21</td>
<td>7.38</td>
<td>181.4</td>
</tr>
<tr>
<td>CO$_2$</td>
<td>672</td>
<td>8.42</td>
<td>9.63</td>
<td>.035</td>
<td>47.65</td>
</tr>
</tbody>
</table>

Source: Calculated by the Authors based on the study data using STATA 17.
Notes: The variables are defined as follows: economic growth (RGDPG), the oil rents as % of GDP (RD), openness as a percentage of GDP (Open), gross capital formation expressed as a percentage of GDP (Invs), Values of Rule of Law index (Inst), government expenditure as a percentage of GDP (Gov), and CO$_2$ carbon emissions.

4.2 TESTS FOR THE UNIT-ROOT, MULTICOLLINEARITY, AND CROSS-SECTIONAL DEPENDENCE

The analysis of the effects of oil rents on growth in the economy was done using the PMG, MG, and DFE estimators. The terms of interaction between CO$_2$ emissions and reliance on oil (RD*CO$_2$) were also included to confirm the GMM estimation's findings.

Testing using panel unit root was conducted to validate each data series for nonstationary because it is necessary to determine the degree of stationarity of the variables. The degree of stationarity in the data for all variables was checked using unit root testing proposed by Levin, Lin, and Chu (LLC) and IM, Pesaran, and Shin (IPS). For each of the variables used in this study, the integration order must be determined. At first integrated order I (1) for both LLC and IPS, the results in Table 4 for both tests indicate stationary variables. This shows that there is a variable-specific combination of
order integration (I (1) and I (0)). In short, the stationarity results demonstrate that, in the first difference, no variables have any unit roots. Hence, the ARDL panel will be used in light of these findings.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Prob.</th>
<th>VIF</th>
</tr>
</thead>
<tbody>
<tr>
<td>RD</td>
<td>.1460919</td>
<td>0.000</td>
<td>1.11</td>
</tr>
<tr>
<td>Invs</td>
<td>.1234221</td>
<td>0.003</td>
<td>1.08</td>
</tr>
<tr>
<td>Open</td>
<td>.0028382</td>
<td>0.857</td>
<td>1.36</td>
</tr>
<tr>
<td>Inst</td>
<td>-.4403345</td>
<td>.885</td>
<td>2.89</td>
</tr>
<tr>
<td>CO2</td>
<td>-.0032679</td>
<td>0.025</td>
<td>2.95</td>
</tr>
<tr>
<td>Gov</td>
<td>-.096895</td>
<td>0.000</td>
<td>1.19</td>
</tr>
<tr>
<td>Mean VIF</td>
<td></td>
<td></td>
<td>1.76</td>
</tr>
</tbody>
</table>

Source: Calculated by the Authors based on the study data using STATA 17.

Note: *** and ** indicate the significance levels of 1% and 5%, respectively.

In this study, the presence of the multicollinearity issue amongst the explanatory variables is also evaluated using the Variance Inflation Factor (VIF). Variance inflation factor (VIF) testing is needed to see if there is any multicollinearity or correlation between the variables that contribute to the explanation. After completing a linear regression analysis to calculate the variance inflation factor (VIF), the findings are shown in Table 5. These results support the absence of severe multicollinearity. Furthermore, in each case, the value of VIF is less than the acceptable value of 10. As a result of these findings, the independent variables can be expected to influence economic growth. The variables in question are therefore uncorrelated with one another.
The cross-sectional dependence testing was done to examine the cross-sectional reliance in terms of errors. The panel data models tend to show strong cross-sectional reliance in the error terms owing to the incorporation of common shocks and unobserved components, which ultimately become an element of the residual term (Baltagi, 2008). As a result, the estimated coefficients become inconsistent and inefficient. Hence, to avoid this problem, the error term's dependence must be checked. Cross-sectional dependency testing was performed to examine the cross-section dependence hypothesis (Pesaran, 2015). As shown in Table 6, the null hypothesis of no cross-section dependency is rejected at the 1% level of significance for all variables.

Table 6. Cross-section Dependence Test by Pesaran (2004)

<table>
<thead>
<tr>
<th>Variables (in levels)</th>
<th>Pesaran CD stats</th>
</tr>
</thead>
<tbody>
<tr>
<td>RGDPG</td>
<td>12.177 *** (0.000)</td>
</tr>
<tr>
<td>RD</td>
<td>3.592 *** (0.000)</td>
</tr>
<tr>
<td>Invs</td>
<td>1.912 *** (0.056)</td>
</tr>
<tr>
<td>Open</td>
<td>0.929 *** (0.353)</td>
</tr>
<tr>
<td>Inst</td>
<td>2.543 *** (0.011)</td>
</tr>
<tr>
<td>CO₂</td>
<td>2.914 *** (0.004)</td>
</tr>
<tr>
<td>Gov</td>
<td>3.029 *** (0.002)</td>
</tr>
</tbody>
</table>

Source: Calculated by the Authors based on the study data using STATA 17.
Note: *** indicates the significance levels of 1%.

To select among the estimators of MG, PMG, and DFE, Hausman testing was used to see whether there is a substantial difference among them. The MG estimator is ineffective if the homogeneity hypothesis is true, although it consistently estimates the long-run coefficient means. It is feasible to ascertain how heterogeneity has impacted the means of the coefficients by applying the Hausman-type testing on the disparity among the PMG and MG or DFE estimators, given the long-run slope homogeneity, which makes the pooled estimators reliable and efficient.

Two Hausman tests were carried out in this instance. Both MG and PMG estimators were contrasted in the first testing. The Hausman test result is shown in Table 7. According to the table, when using the test to compare MG with PMG, because the chi-square coefficient is negligible, the null hypothesis—that the PMG is more efficient—is accepted. This implies that PMG is preferred to MG. The outcomes of the second Hausman test, which gives us the option of using either the PMG or DFE, indicate that the testing is statistically not significant. The PMG estimator performs better than the DFE estimator if the null hypothesis is accepted. As a result, the study focuses on the
4.3 RESULTS AND DISCUSSION

Table 7 presents the outcomes. The basic specification is expanded to include oil rents and CO₂ emission interaction terms to reflect the importance of CO₂ emissions in the correlation between oil rents and growth in the economy. The effect of oil rents on economic growth is examined using this approach concerning CO₂ emissions. The estimation equation that includes the interaction term between oil rents and CO₂ emissions is what this analysis is primarily focused on. The study hypothesises that CO₂ emissions can operate as another channel beyond the traditional channels. Hence, the interaction term should be negative, according to the research. Henceforth, CO₂ emissions can even turn the resource from a blessing to a curse.

Using the interaction term, the study analyses whether oil rent's effect on growth depends on CO₂ emissions. The empirical results show that growth is negatively and significantly impacted by oil reliance and emissions of CO₂. This unfavorable consequence is indicated by the interaction term's negative sign connecting carbon dioxide emissions and oil dependence. The interaction term between carbon dioxide emissions and reliance on oil captures how oil dependence influences the extent to which CO₂ releases contribute to economic growth. This result supports the hypothesis that emissions of carbon dioxide and dependence on oil interact to affect the growth in the economy of oil-dependent nations. As a result, the oil curse in countries with high oil dependence is revealed by a strongly negative term of interaction between oil dependence and emissions of CO₂. Hence, the study discovered an environmental dimension symptom of the oil curse that comes from a new transmission route.

The estimation's result considers how the interaction between oil rents and CO₂ emissions (RD*CO₂) affects economic growth. It is observed that oil rents have a significant negative impact on growth, enter negative, and is significant at a 5% level. Additionally, the interaction between oil rents and CO₂ emissions also has a negative and significant effect and is statistically significant at the 1% level. This implies that the presence of both oil rents and CO₂ emissions hinders economic growth, indicating a counterproductive relationship.
The results suggest that when the CO\textsubscript{2} emissions are conceded, a country has a 0.23\% greater chance of causing a more adverse impact on economic growth and operating as another resource curse channel. These results clearly show that the resource curse occurs in oil-dependent nations, and since oil negatively affects growth, CO\textsubscript{2} emissions inflate the negative effect of oil dependency. All in all, these findings offer compelling proof that countries that are part of the carbon dioxide emissions transmission channel are more likely to experience the resource curse.

It can be suggested that CO\textsubscript{2} emission is among the central explanations for the oil curse in oil-dependent nations. Thus, the oil curse can be partially explained by the CO\textsubscript{2} emissions in those countries. The study has found evidence supporting the oil curse concept taking place through CO\textsubscript{2} emissions.

The results of the estimations are consistent with a long-term connection since the coefficient of the error correction term is negative and significant at 1\%. In other words, the speed of error-correction process adjustment shows negative and statistically significant values. The findings suggest that over time, oil rents may affect economic growth. The link is negative, indicating that rising oil rents may, at a 1\% level of importance, bring a negative impact on the economy in the long run. These outcomes align with those of the MG model.

According to the MG results, the term of interaction between (RD*CO\textsubscript{2}) is negative and statistically significant at the 1\% level. These findings line up with those of PMG, however, the coefficient is negligible. As a result, the study discovered an environmental dimension symptom of the oil curse that comes from a new transmission route. This finding reinforces the claim that the interaction between CO\textsubscript{2} emissions and oil dependence affects economic growth. This proves that carbon dioxide emissions worsen the environmental effects of oil reliance on the growth of the economy.

Theoretically, economic growth has the potential to affect carbon emissions through three primary channels: scale, composition, and technique (Ahmad et al., 2021). The scale effect implies that as production increases, more resources are required in the early stages of development, resulting in greater waste and pollution. The composition effect suggests that the level of pollution and the types of raw materials used in the manufacturing process depend on the economic sectors of a country. For instance, countries with a larger services sector tend to generate less pollution. Therefore, changes in the economic structure, in conjunction with economic development, can have an impact.
on the environment. The third pathway, known as the technique effect, proposes that the adoption of advanced and environmentally friendly technologies can lead to the production of goods that require fewer resources and produce less pollution, even during periods of substantial economic growth (Hassan et al., 2019).

The existing body of literature examining the empirical link between economic growth and CO$_2$ emissions is extensive and characterized by substantial debate and controversy. The Environmental Kuznets Curve (EKC) is a commonly used concept for examining how economic growth and pollution levels are related. It proposes a relationship between GDP and environmental quality that takes the shape of an inverted u. However, the results of studies on this topic have been inconsistent. Some studies support the EKC by demonstrating that as income increases, environmental degradation decreases (Pata, 2018; Song et al., 2019; Yang et al., 2021; Onofrei et al., 2022). On the contrary, some studies challenge its validity. For example, Akbostanci et al. (2009) conducted a study using data from Turkey spanning 1992 to 2001. Their findings did not support the EKC hypothesis when analyzing both panel and time series data. Similarly, Wang & Ye (2017) employed a spatial econometric approach to examine the relationship between income and environmental quality in China. Their results indicated that income consistently leads to an increase in CO$_2$ emissions, suggesting that environmental degradation does not decline with rising income levels. In other studies, Ibrahim (2021), Ibrahim et al. (2021a), Ibrahim et al. (2021b), and Ibrahim et al. (2022) a similar finding prevailed in the African countries and world samples.

Moreover, some studies have found incomplete support for the EKC across their entire sample. Al-Mulali et al. (2015) discovered that the EKC holds for upper-middle and high-income countries but not for low and lower-middle-income countries. Similarly, Guangyue & Deyong (2011) tested the EKC using regional carbon emissions data for China. Their findings revealed that the EKC applies to the central and eastern regions of China but not to the western region.

Our findings, which are in line with certain studies, indicate that the EKC may not apply uniformly across various income levels or regions. The connection between economic growth and environmental degradation is subject to variation and is influenced by factors like income levels, regions, and specific country circumstances. Factors such as the structure of the economy, energy mix, policy frameworks, and institutional arrangements play a significant role in shaping this relationship. Developing countries,
for instance, often experience rapid economic growth accompanied by a rise in emissions as they industrialize and expand their infrastructure. In contrast, developed countries may exhibit a more nuanced relationship, with some experiencing a decoupling of emissions from economic growth due to factors such as energy efficiency measures and renewable energy investments (Wang et al., 2023). A recent study by Li et al. (2023) has found that the decline in emissions can be attributed to shifts in the industrial structure of emerging economies, specifically observed in various regions. Examples include Asia (India, Indonesia, Jordan, and Thailand), Africa (South Africa), Latin America and the Caribbean (Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Guatemala, Peru, and Uruguay), and Europe (Moldova). In line with that, Piłatowska et al. (2020) found that during periods of economic expansion, there is a positive correlation between economic growth and CO\textsubscript{2} emissions. However, this correlation does not hold during recessionary periods, suggesting that the relationship between economic growth and CO\textsubscript{2} emissions is contingent upon the state of the economy.

Considering the investment variable, the findings show that investment has a negligible favorable effect on growth. However, the result is inconsistent with that of MG, where the coefficient is negative and also significant in DFE estimation. Additionally, it is noted that government spending and institutional quality have long-term negative coefficients that are not significant. However, the coefficient of openness exerts a positive sign at a 1% level of significance.

Table 7. Pool Mean Group Estimation PMG of ARDL (2,2,2,1,1)

<table>
<thead>
<tr>
<th>Variable</th>
<th>PMG Coefficient</th>
<th>Prob.</th>
<th>MG Coefficient</th>
<th>Prob.</th>
<th>DFE Coefficient</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Long run results</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RD</td>
<td>-.1241 ***</td>
<td>(0.000)</td>
<td>-2.496</td>
<td>(0.672)</td>
<td>.1608**</td>
<td>(0.027)</td>
</tr>
<tr>
<td>Invs</td>
<td>.1621***</td>
<td>(0.001)</td>
<td>-.0975</td>
<td>(0.522)</td>
<td>.1336***</td>
<td>(0.011)</td>
</tr>
<tr>
<td>Open</td>
<td>.6794***</td>
<td>(0.000)</td>
<td>.04704</td>
<td>(0.936)</td>
<td>.2371***</td>
<td>(0.012)</td>
</tr>
<tr>
<td>Inst</td>
<td>.1739</td>
<td>(0.181)</td>
<td>.4812</td>
<td>(0.415)</td>
<td>-3.7773***</td>
<td>(0.017)</td>
</tr>
<tr>
<td>CO\textsubscript{2}</td>
<td>-4.4059***</td>
<td>(0.024)</td>
<td>-22.455**</td>
<td>(0.026)</td>
<td>.5049**</td>
<td>(0.029)</td>
</tr>
<tr>
<td>Gov</td>
<td>-.1123</td>
<td>(0.145)</td>
<td>.09746</td>
<td>(0.706)</td>
<td>-.1645***</td>
<td>(0.005)</td>
</tr>
<tr>
<td>CO\textsubscript{2}*RD</td>
<td>-.2385***</td>
<td>(0.001)</td>
<td>-4.7955</td>
<td>(0.602)</td>
<td>-.0018</td>
<td>(0.982)</td>
</tr>
<tr>
<td><strong>Short run results</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ECT</td>
<td>-.6295***</td>
<td>(0.000)</td>
<td>-1.019***</td>
<td>(0.000)</td>
<td>-1.1241</td>
<td>(0.000)</td>
</tr>
<tr>
<td>D(RD)</td>
<td>-.0984</td>
<td>(0.880)</td>
<td>-1.744</td>
<td>(0.369)</td>
<td>.0801*</td>
<td>(0.087)</td>
</tr>
<tr>
<td>D (Invs)</td>
<td>.2249**</td>
<td>(0.045)</td>
<td>.3632**</td>
<td>(0.025)</td>
<td>.0327</td>
<td>0.656</td>
</tr>
<tr>
<td>D (Open)</td>
<td>.2696</td>
<td>(0.143)</td>
<td>.0580</td>
<td>(0.897)</td>
<td>.2388</td>
<td>(0.114)</td>
</tr>
<tr>
<td>D (Inst)</td>
<td>-.0152</td>
<td>(0.933)</td>
<td>-1.3510</td>
<td>(0.762)</td>
<td>37609</td>
<td>0.278</td>
</tr>
<tr>
<td>D (CO\textsubscript{2})</td>
<td>11.791</td>
<td>(0.110)</td>
<td>5.117</td>
<td>(0.291)</td>
<td>2.449</td>
<td>(0.000)</td>
</tr>
<tr>
<td>D (Gov)</td>
<td>-.4002***</td>
<td>(0.001)</td>
<td>-4.4557**</td>
<td>(0.022)</td>
<td>-.4293</td>
<td>(0.000)</td>
</tr>
<tr>
<td>D (CO\textsubscript{2}* RD)</td>
<td>.3275</td>
<td>(0.782)</td>
<td>-2.049</td>
<td>(0.444)</td>
<td>.0024</td>
<td>0.971</td>
</tr>
<tr>
<td>Constant</td>
<td>.2455</td>
<td>(0.287)</td>
<td>-9.619</td>
<td>(0.172)</td>
<td>.0139</td>
<td>(0.773)</td>
</tr>
</tbody>
</table>
The results are very similar and further support the hypothesis that the resource curse occurs conditionally on transmission channels. These results clearly show that the resource curse occurs in oil-dependent nations, and since oil negatively affects growth, CO₂ emissions deepen the adverse effect of dependency on oil.

It can be suggested that CO₂ emission is among the central explanations for the oil curse. Thus, the oil curse can be partially explained by the CO₂ emissions in those countries. It can be concluded that CO₂ emissions contribute substantially to the resource curse effect.

5 CONCLUDING REMARK

In literature, the natural resources curse is explained to take place through many channels. Hence, accounting for these channels is important for establishing the link between resource reliance and the growth of the economy. This study looks into how a nation's reliance on oil resources can be a significant element in the oil curse that affects such nations. High oil dependence may have negative consequences on economic growth through the environmental channel due to an increase in CO₂ emissions. In our research, we discovered evidence that the oil curse operates via an environmental channel.

The level of dependence on oil and its effects on the environment were not taken into account in earlier research. As a result, to address the literature gap, research across multiple countries is essential to understand the interaction between environmental sustainability and economic growth—or, to be more precise, their dependence on oil. In contrast to other research, this study explores the link between oil dependence and the environment and the economy.

Oil reliance and CO₂ emissions interact negatively and are statistically significant. Thus, it is possible to conclude that raising CO₂ emissions in these economies worsens the adverse effects on the environment on the economy. Such a damaging link sheds new insight into the controversy surrounding the oil curse. The study has significant policy
contributions and puts forward policy implications. Important policy implications have been offered by the results. To achieve greater economic growth, economic policy should integrate better use of natural resources. Corporate social responsibility and sustainability standards can help businesses make money and cut costs. To encourage the development of sustainable economies, governmental authorities should enact environmental legislation and monitor compliance. In this regard, we propose numerous policy measures, including boosting low-carbon energy incentives and lowering energy use intensity. Also, governments ought to support companies that are making research and development efforts to lower renewable energy costs. With their heavy dependence on oil income, governments can also be considered making money through the imposition of carbon taxes and fees. Governments should strive for the nation's "green" economic goals and the decrease of air pollution, low-carbon technology investments, clean tech, and the environment.

In addition, the government's policies for climate change, sustainable development, and biodiversity need to include strategies for resource management and efficiency. The country's vulnerability to climate change would eventually be decreased by making sure that a larger portion of funds for climate change adaptation reaches local communities, creating sound policies and vital mechanisms for their implementation, as well as establishing a long-term climate change strategy. Future studies can seize the benefits of broadening the analysis by including case-by-case national comparisons and incorporating additional transmission channels, such as information and communication technology. The 23-year study period has limits, which is another critical point to note.
REFERENCES


