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Economic growth in OPEC nations: The role of renewable energy consumption, CO_2 emissions, and foreign direct investment

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ABSTRACT

Background: The nations that make up OPEC (the Organization of the Petroleum Exporting Countries) have traditionally depended on gas and oil export earnings. However, there is a significant global shift towards renewable energy in an effort to reduce the impact of climate change. This research aims to analyze the effect of Renewable Energy Consumption, CO_2 Emissions, and Foreign Direct Investment (FDI) on the Economic Growth in OPEC Nations partially and simultaneously. **Methods:** In this research, panel data regression analysis techniques are combined with quantitative research approaches. Secondary data from the World Development Indicators (WDI) for the years 2001–2020 were used in this research. **Finding:** This research showed that the Renewable Energy Consumption and CO_2 Emissions variables do not affect economic growth in OPEC countries. Meanwhile, the foreign direct investment variable has a positive and significant effect on economic growth in OPEC countries. **Conclusion:** OPEC countries need to diversify their economies and CO_2 reduce their dependence on oil as there is a global shift towards cleaner energy. **Novelty/Originality of this article:** This study analyzes the impact of Renewable Energy Consumption, CO_2 Emissions, and Foreign Direct Investment on Economic Growth in OPEC countries using panel data regression analysis. The study's findings show that only Foreign Direct Investment positively and significantly impacts economic growth.

KEYWORDS: CO_2 emissions; foreign direct investment, growth economic; renewable energy consumption.

1. Introduction

Energy is a basic necessity that can affect societal welfare and economic prosperity. Since there are only so many energy sources available and the population is growing, it is imperative to find and employ more sustainable alternative energy sources (Bappeda Jogja, 2023). Clean energy can produce its own economic and business opportunities if managed well. Clean energy investment requires support and cooperation with developed countries that have the capacity and funding for its development. Utilization of new energy sources such as gas and geothermal must be expanded, renewable energy sources such as water resources, wind, and solar as well as agricultural waste and waste need to increase their contribution to fulfilling a better energy mix (diversification), development of low-emission/environmentally friendly energy, as well as more balanced energy access throughout the world (Alisjahbana & Murniningtyas, 2018).

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World electricity consumption has continued to increase over the past half century, reaching approximately 25,500 terawatt-hours in 2022. Between 1980 and 2022, electricity consumption more than tripled, while the global population reached nearly eight billion people. The energy demand is rising due to global industrialization and increased access to electricity. China's GDP has increased by an astounding 15 times since 2000, placing it second only to the US in terms of global GDP. China needs more energy than any other country to drive the development of its billions of people and its various manufacturing industries. As a result, China has become the world's largest electricity consumer. Regarding electricity consumption per capita, China and other BRIC countries are still much higher than those developed countries with smaller populations. Iceland, with a population of less than half a million people, consumes the most electricity per person in the world. Norway, Qatar, Canada, and the United States are also among the countries with the highest consumption levels. The quantity of electricity the average individual uses in each nation is determined by several contributing factors, including power-intensive industries, household size, living conditions, equipment standards and efficiency, and accessibility to alternative heating fuels (Statista, 2023).

According to United Nations (2023) from 2015 to 2021, there is a 91% increase in the percentage of people worldwide who have access to electricity from 87%. In 2021, around 2.3 billion people, or around 29% of the global population, will still rely on inefficient and polluting cooking systems, endangering their health, limiting their life opportunities, and damaging the climate and the environment. Between 2015 and 2021, the proportion of people with access to clean fuels and cooking technologies increased by only 7 percentage points. However, Southeast Asia is making significant and consistent progress, achieving access for around three-quarters of its population by 2021, up 14 percentage points from 2015. Sub-Saharan Africa, on the other hand, has the lowest access rates despite advancements in cooking. In 2021, there will still be 0.9 billion individuals without access to the net due to its inability to keep up with population growth.

As a large oil and gas industry, CO_2 emissions significantly contribute to climate change, and OPEC countries have a significant role in global emissions. Research conducted by Jin et al. (2022) divided 28 global carbon-emitting countries into developed and developing countries, exploring the cointegration and causality between renewable energy consumption, non-renewable energy consumption, economic growth, and carbon emissions. The results of this research show that there is a two-way causal relationship between carbon emissions and economic growth in all countries. A two-way causal relationship exists between economic growth in developed countries and renewable and non-renewable energy consumption. However, there is no significant relationship between economic growth and energy consumption in developing countries. All countries have a two-way causal relationship between carbon emissions and renewable energy. Still, there are significant differences, and there is a two-way causal relationship between carbon emissions between carbon emissions in developed countries and non-renewable energy. There is only a one-way causal relationship in developing countries.

In oil-rich MENA countries, namely Algeria, Egypt, Iran, Iraq, Oman, Saudi Arabia, Tunisia, and the United Arab Emirates, there is research Gorus & Aydin (2019) that investigates the causal relationship between energy consumption, economic growth, and CO_2 emissions through Granger causality analysis of one country and several countries in the frequency domain. In panel frequency domain analysis, more causal relationships between variables at different frequencies are detected than time domain causality. Based on the panel causality test results, energy conservation policies do not negatively impact economic growth in the short or medium term but have a negative impact in the long term. In addition, policies to control air pollution can be designed by policymakers because there is no causal relationship between economic growth and CO_2 emissions.

Meanwhile, in the Asia-Pacific Economic Cooperation Countries (APEC), there is a long-term balance between CO_2emissions, energy consumption, economic growth, and foreign direct investment. Based on research by (Balli et al., 2023), long-term parameter estimates based on the Common Correlated Effect Mean Group show that increased FDI

inflows have a negative impact on air quality and support the pollution haven hypothesis. The cointegration test results also show that the impact of Gross Domestic Product (GDP) on CO_2 emissions varies between countries in the estimation sample. In contrast to mixed evidence regarding the impact of other variables, increasing energy consumption positively and significantly affects CO_2 emissions in all APEC countries. In addition, there is a two-way causality relationship between GDP and energy consumption in Australia, China, Japan, and Singapore. Overall, empirical data indicates that to draw in foreign direct investment, APEC nations must invest in clean, environmentally friendly technologies and strictly enforce their policies.

In several South Asian countries, there is also the impact of globalization, non-renewable energy consumption, and economic growth on CO_2 emissions, as per research conducted by (Wen et al., 2021). Also, in the Chinese region, based on research (Fan & Hao, 2020) examines the relationship between renewable energy consumption, foreign direct investment, and gross domestic product. The results show that there is a long-term and stable equilibrium relationship between gross domestic product per capita, foreign investment direct per capita, and renewable energy consumption per capita in China. Moreover, in the short term, foreign direct investment cannot significantly cause changes in renewable energy consumption. However, in the long term, a moderate slowdown in gross domestic product growth and targeted foreign direct investment will significantly increase renewable energy in China.

According to data from World Development Indicators, the value of CO_2 emissions in the world is 4.291853096 (World Bank, 2023). Fossil fuels, such as coal, oil, or gas, have been the primary source of energy production for many years. However, burning carbon fuels releases a significant quantity of greenhouse gasses, which contribute to climate change and negatively affect the environment and civilization. This impacts everyone, not just a few people. In addition, global electricity use is increasing rapidly. In short, without a stable electricity supply, countries cannot drive their economies. Nearly a third of the world's population and the majority of women and children will continue to be exposed to dangerous household air pollution if we do not meet the objective by 2030. The slow progress toward clean cooking solutions is a critical global issue that impacts human health and the environment.

In 2020, five OPEC member countries had CO_2 emissions above the world average of 4.291853096 (World Bank, 2023). These countries are Kuwait, the United Arab Emirates, Saudi Arabia, Iran and Libya. Among them, Kuwait recorded the highest CO_2 emissions, with a value of 21.16961025, placing it fourth globally. The United Arab Emirates ranked fifth globally with a CO_2 emission value 20.25227168. In addition, Saudi Arabia ranks 8th in the world with CO_2 emissions of 14.26658537. Iran, with a CO_2 emission value of 7.063351321, ranks 27th globally. Libya also belongs to countries with high CO_2 emissions, ranking 32nd with a value of 7.063351321.

Countries such as Kuwait, the United Arab Emirates and Saudi Arabia, which have CO_2 emissions well above the world average, show a high dependence on fossil fuel-based industries. This negatively impacts the global environment and reflects the lack of energy diversification in these countries. Kuwait and the United Arab Emirates, the countries with the fourth and fifth highest CO_2 emissions in the world, show that despite the wealth of oil resources, there is an urgent need to transition towards cleaner and more sustainable energy sources. Therefore, to ensure access to clean and affordable energy for everyone by 2030, investment in renewable energy and energy efficiency must be increased, as well as developing supportive policies and regulatory frameworks so that researchers are interested in researching the influence of Renewable Energy Consumption, CO_2 Emissions, and Foreign Direct Investment on Economic Growth in OPEC Countries.

The research gap in this study is that many previous studies, such as Agboola et al., (2021), Alshubiri et al. (2021), Ashraf et al. (2022), Mahmood et al. (2023), Mahmood & Saqib (2022), Ostic et al. (2022), and Salahuddin et al. (2017), may only cover a limited period of time, while long-term trends in renewable energy, CO_2 emissions, and FDI may change over time. This study used 20 years of data, but analyses of longer or different

periods may yield different insights. Many studies may lack the ability to identify and evaluate concrete policy implications of their findings. This research can fill the gap by providing clearer and more applicable policy recommendations based on the results.

2. Methods

This research uses quantitative methods to test theories, show relationships between variables, provide statistical descriptions, and interpret results (Tanzeh, 2011). The data from OPEC countries is then analyzed using statistical analysis or econometric models panel data regression to identify the relationship between these variables in the various countries partially and simultaneously. According to Wanner and Pevalin, panel regression is a set of techniques for modeling the influence of explanatory variables on response variables in panel data (Pangestika, 2015). The results of the analysis can help achieve a deeper understanding of how these factors are interconnected and influence economic growth in these countries.

The reason for choosing this type of research is that researchers want to know the influence of Renewable Energy Consumption, CO_2 Emissions, and Foreign Direct Investment on Economic Growth in OPEC Countries over 20 years from 2001-2020, partially and simultaneously. This research consists of independent variables, Renewable Energy Consumption (X1), CO_2 Emissions (X2), Foreign Direct Investment (X3), and also a dependent variable, namely Economic Growth (Y). The data source in this research uses secondary data. This data was obtained from websites related to research from the World Development Index (WDI) for 20 years from OPEC countries from 2001-2020. The subjects in this study used 12 OPEC countries. The association between these factors in the various OPEC countries is then partially and simultaneously identified by employing statistical analysis or econometric models panel data regression, on the data from these countries. The analysis's findings contribute to a better understanding of the relationships between these variables and how they affect these nations' economic growth.

The data from OPEC countries is then analyzed using statistical analysis or econometric models panel data regression to identify the relationship between these variables in the various countries partially and simultaneously. According to Wanner and Pevalin, panel regression is a set of techniques for modeling the influence of explanatory variables on response variables in panel data (Pangestika, 2015). The results of the analysis can help achieve a deeper understanding of how these factors are interconnected and influence economic growth in these countries. Several tests need to be carried out to determine a model that fits the characteristics of the research data. Among them is using the Chow test to determine the model between the Common Effect Model and the Fixed Effect Model. If the test results show that the Chi-Square probability value is greater than the significance level 0.05, then the most appropriate model to use is the Common Effect Model; however, if the Chi-Square probability value is smaller than the significance level of 0.05, then the model is Suitable for use is the Fixed Effect Model (FEM) (Novtaviana, 2020). Next is the Hausman test to determine which model is suitable for using the Fixed Effect Model and the Random Effect Model in data analysis. In this test, if the probability value is less than the significance level 0.05, then the model used is the Fixed Effect Model (FEM). Conversely, if the probability value is > 0.05, then the model used is the Random Effect Model (REM) (Gujarati & Porter, 2012).The panel data regression model in this research is described as follows Equation 1.

$$GE_{it} = \beta_0 + \beta_1 REC_{it} + \beta_2 CE_{it} + \beta_3 FDI_{it} + e_{it} \quad \text{(Eq. 1)}$$

The variable GE_{it} represents the economic growth in country *i* during year *t.* The term $\beta_1 REC_{it}$ refers to renewable energy consumption, while $\beta_2 CE_{it}$ denotes the CO_2 emissions in the same context. Additionally, $\beta_3 FDI_{it}$ captures the foreign direct investment. The symbols β_1, β_2 , β_3 represent the regression coefficients or parameters for their respective

variables, and β_0 stands for the constant term. Finally, e indicates the error term in the model (Equation 1).

3. Results and Discussion

3.1 Chow Test

The Chow test is used to select a suitable model estimate between the Common Effect Model (CEM) or the Fixed Effect Model (FEM). The hypothesis in this test is H0 = Common Effect Model, while H1 = Fixed Effect Model. The results of this processing can be seen in the following Table 1. Based on Table 1, the panel data regression results with the Chow test show a probability value of 0.1030, greater than the significance level α = 0.05. Thus, H1 is rejected, and H0 is accepted. The suitable model to use is the Common Effect Model (CEM).

Table 1. Chow Test

Effects Test	Statistic	d.f.	Prob.
Cross-section F	1.516826	(11,225)	0.1264
Cross-section Chi-square	17.168447	11	0.1030

3.2 Hausman Test

The Hausman test is used to determine the model to be used, either the Fixed Effect Model (FEM) or the Random Effect Model (REM). The hypothesis in this test is H0 = Random Effect Model, while H1 = Fixed Effect Model. The results of this processing can be seen in the following Table 2.

Table 2. Hausman Test

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	14.307183	3	0.0025

Based on Table 2, it can be seen that the panel data regression results with the Hausman test show a probability value of 0.0025 which is smaller than the significance level α = 0.05 so that H0 is rejected and H1 is accepted, so the suitable model to use is the Fixed Effect Model (FEM).

3.3 Breusch-Pagan LM Test

The Breusch-Pagan Test can also be called the Lagrange Multiplier Test. This test aims to select the model used between the Common Effect Model (CEM) and the Random Effect Model (REM). The results of this processing can be seen in the following Table 3. The P value is shown by a number below the significance level of 0.05, namely 0.1329. So this Lagrange Multiplier Test shows that H0 is accepted, which means the best estimation method is the Common Effect Model (CEM).

Table 3. Breusch-Pagan Test

	Test Hypothesis		
	Cross-section	Time	Both
Breusch-Pagan	2.258058	4.674590	6.932648
	(0.1329)	(0.0306)	(0.0085)
Honda	-1.502684	2.162080	0.466264
	--	(0.0153)	(0.3205)
King-Wu	-1.502684	2.162080	0.113335
	--	(0.0153)	(0.4549)
Standardized Honda	-1.015695	2.317988	-3.463896
	--	(0.0102)	--

Standardized King-Wu	-1.015695	2.317988	-3.748065
	--	(0.0102)	--
Gourierioux, et al.*	--	--	4.674590 (< 0.05)
*Mixed chi-square asymptotic critical values			
1%	7.289		
5%	4.321		
10%	2.952		

3.4 Estimated Result

Based on the panel data regression results from the Chow Test, Hausman Test and Lagrange Multiplier Test, the model chosen is the Common Effect Model (CEM). The results of the panel data regression can be seen in table 4.

Table 4. Panel Data Regression Results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.515334	1.483186	0.347451	0.7286
X1	-0.010020	0.025287	-0.396263	0.6923
X2	-0.061867	0.103068	-0.600261	0.5489
X3	0.278133	0.097937	2.839908	0.0049
R-squared	0.035582	Mean dependent var		0.621029
Adjusted R-squared	0.023323	S.D. dependent var		11.10937
S.E. of regression	10.97906	Akaike info criterion		7.646383
Sum squared resid	28447.38	Schwarz criterion		7.704393
Log likelihood	-913.5659	Hannan-Quinn criter.		7.669757
F-statistic	2.902409	Durbin-Watson stat		2.235984
Prob(F-statistic)	0.035614			

From the test results, it can be seen that the resulting regression equation in Equation 2. The coefficient value for each variable shows the effect of a partial increase in each independent variable if each independent variable experiences an increase of 1 unit. A positive sign indicates that the dependent variable will increase if the independent variable increases, assuming the other variables are constant and vice versa. The constant value is 0.515334, indicating that the estimated increase in economic growth will occur (in units) if the variable values for Renewable Energy Consumption, CO_2 Emissions, and Foreign Direct Investment are zero.

$$GE_{it} = 0.515334 - 0.010020\ REC - 0.061867\ CE + 0.278133\ FDI + e_{it} \quad \text{(Eq. 2)}$$

The next step is to carry out a statistical F test to see how much influence the independent variables have together or simultaneously on the dependent variable. The statistical F test can be seen from the Prob > F value. If the Prob > F value is smaller than alpha ($\alpha = 0.05$), it can be stated that the independent variables simultaneously or together significantly affect the dependent variable. Based on Table 4, it can be seen that the F statistical probability value is 0.035614, which means it is smaller than $\alpha = 0.05$. So, it can be stated that the variables Renewable Energy Consumption, CO_2 Emissions, and Foreign Direct Investment together or simultaneously have a significant effect on Economic Growth in OPEC Countries.

The t-test aims to see the significance of the influence between the independent variables partially on the dependent variable. The hypothesis regarding the influence of Renewable Energy Consumption on economic growth in OPEC countries is H0: Renewable Energy Consumption has no significant effect on Economic Growth. In contrast, H1: Renewable Energy Consumption significantly affects Economic Growth. In Table 4, it can be seen that the significance value of t Renewable Energy Consumption is 0.6923 > 0.05 (α),

which means statistically accepting H0 and rejecting H1 so that the Renewable Energy Consumption variable does not have a significant effect on economic growth in OPEC countries. Meanwhile, the regression coefficient of the Renewable Energy Consumption variable has a value of -0.010020. This means that if there is a change in the Renewable Energy Consumption variable, namely increasing by 1%, then the value of economic growth in OPEC countries will change, namely decreasing by 0.010020 with the assumption that other variables are considered constant or fixed.

The hypothesis regarding the influence of CO_2 Emissions on economic growth in OPEC countries is that H0: CO_2 Emissions have no significant effect on economic growth, while H1: CO_2 Emissions have a significant effect on economic growth. Table 4 shows that the significance value of t CO_2 Emissions is 0.5489 > 0.05 (α), which means statistically accepting H0 and rejecting H1 so that the CO_2 Emission variable does not have a significant effect on economic growth in OPEC countries. Meanwhile, the regression coefficient for the CO_2 Emissions variable is -0.061867. This means that if there is a change in the CO_2 Emissions variable, namely increasing by 1%, then the value of economic growth in OPEC countries will change, namely decreasing by 0.061867, with the assumption that other variables are considered constant or fixed.

The hypothesis regarding the influence of Foreign Direct Investment on economic growth in OPEC countries is H0: Foreign Direct Investment has no significant effect on economic growth, while H1: Foreign Direct Investment has a significant effect on economic growth. Table 4 shows that the significant t value for Foreign Direct Investment is 0.0049 < 0.05 (α), which means that statistically, it rejects H0 and accepts H1 so that the Foreign Direct Investment variable has a significant effect on economic growth in OPEC countries. This means that when Foreign Direct Investment increases by 1%, the value of economic growth in OPEC countries will decrease by 0.278133% on average, assuming that other variables remain constant or do not change. Meanwhile, the regression coefficient of the Foreign Direct Investment variable has a value of 0.278133, and this means that if there is a change in the Foreign Direct Investment (FDI) variable, namely an increase of 1%, then the value of economic growth in OPEC countries will change, namely an increase of 0.278133% with the assumption that other variables are considered constant or fixed.

3.5 The Impact of Renewable Energy Consumption on Economic Growth in OPEC Countries

Based on the results of the tests that have been carried out, renewable energy consumption does not significantly affect economic growth in OPEC countries. OPEC countries rely heavily on fossil energy resources, especially oil and gas, as their primary source of income. This dependence may make these countries less motivated to adopt renewable energy because it could harm their revenues from oil and gas exports. The lack of effect of renewable energy consumption on economic growth in OPEC member countries is related to the concept of rent-seeking behavior**.** Rent-seeking is the behavior of individuals or groups seeking economic benefits without commensurate contribution to production or community welfare. It often involves attempts to manipulate rules or political systems to gain personal benefits in unproductive or unsustainable ways (Choi & Storr, 2019). In the context of OPEC countries, companies and governments that control the fossil energy industry may seek rent to protect their profits by ignoring or hindering efforts to reduce CO_2 emissions. Rent-seeking practices can hinder renewable energy development as economic elites may prefer to maintain their profits from fossil energy, lobby for policies that favor the fossil industry, or hinder regulations that support renewable energy. Rent-seeking can lead to poor fund management and corruption, where funds that should be used for sustainable development and green infrastructure are diverted for personal gain.

This research contradicts the results of research (Sapkota & Bastola, 2017), which concluded that economic growth is supported by energy consumption. With policies that focus on environmentally friendly and energy-efficient industries through foreign investment, it has the potential to improve environmental health while increasing economic growth. Policies to improve human capital are also likely to reduce pollution, especially in

countries at the low end of the income spectrum. According to (Khan et al., 2021), new and selective tax policies must be implemented in fiscal policy. The tax exemption policy for renewable energy sources can also bring developments in renewable energy consumption and subsidized loans provided to investors in environmentally friendly and renewable energy power plants.

3.6 The Impact of CO_2 Emissions on Economic Growth in OPEC Countries

Based on the results of the tests that have been carried out, CO_2 Emissions do not significantly affect economic growth in OPEC countries. Reducing CO_2 emissions is a threat to the primary income of OPEC countries because these countries are countries whose economies are highly dependent on fossil energy resources such as oil and gas. Policies that support reducing CO_2 emissions can disrupt the oil and gas sector, resulting in a negative impact on economic growth. OPEC countries often rely on fossil energy exports as their primary source of income. Reducing CO_2 emissions could mean reducing global demand for fossil energy products and negatively impact economic growth in these countries. Several OPEC countries still have geographical and climatic conditions that do not support using renewable energy, such as solar or wind. For example, desert countries have limited solar or hydropower generation potential. This can make it difficult for OPEC countries to reduce CO_2 emissions without disrupting economic growth.

The results of this research are in line with research by (Mahmood & Saqib, 2022), which explains that OPEC countries such as Equatorial Guinea, Angola, Congo, Saudi Arabia, Iran, Iraq, Kuwait, and Libya should invest their oil rents in project development green and renewable energy to avoid the negative ecological impacts of oil leasing. Apart from that, excessive dependence on the oil sector can also be one of the causes of environmental problems. Therefore, OPEC countries should diversify from the oil sector by investing oil rents in non-oil sectors. Oil prices and rents are soaring in OPEC countries, and it is a good time to invest excess oil profits in reducing pollution by using these profits in renewable and environmentally friendly projects and by investing in diversification policies. Additionally, increased oil rents are helping reduce emissions in the UAE, Algeria, and Nigeria, and these countries should focus more on renewable energy projects to better support a sustainable environment.

However, there are differences in research results by (Ostic et al., 2022), which show a positive and statistically significant relationship between economic growth and carbon emissions in OPEC member countries. Research (Zaghdoudi, 2017) shows that oil prices can reduce CO_2 emissions in the long term. Thus, producing goods and services in OECD countries still depends on oil energy. Low oil prices effectively increase fossil fuel energy consumption and pollution. In addition, research results show that renewable energy reduces CO_2 emissions in the long term. Therefore, expanding renewable energy will also reduce dependence on fossil fuel energy and pollution. According to (Dabachi et al., 2020), energy policy should identify differences in the causal relationship between economic growth and energy consumption to maintain sustainable energy consumption in OPEC countries. High economic growth leads to environmental degradation, but a decrease in economic growth will increase unemployment. Almost all countries' CO_2 emissions increase significantly due to economic growth, while energy intensity reduces CO_2 emissions to some extent. Energy exports increase CO_2 emissions to varying degrees in Asian countries, but the impact gradually decreases (Hu et al., 2020).

The results of this study are relevant to the Natural Resource Curse phenomenon. This phenomenon states that countries rich in natural resources (such as oil, gas or minerals) experience slower economic growth, political instability and higher income inequality than countries poor (Gilberthorpe & Papyrakis, 2015). In the context of OPEC countries, dependence on fossil energy resources can lead to policies and practices that do not support efforts to reduce CO_2 emissions and create sustainable economic growth. Based on the findings of (Rahma et al., 2021), the Natural Resource Curse phenomenon mainly occurs in medium and less-developed countries that are rich in natural resources, especially in Africa

and Latin America. These countries have abundant natural resources, but their people do not enjoy a high standard of living. These studies conclude the existence of the NRC phenomenon based on whether or not there is a negative correlation between natural resource abundance or dependence and socioeconomic indicators, such as economic growth rate, Gross Domestic Product (GDP) per capita, or poverty rate. The NRC in Indonesia is not visible nationally, but the phenomenon occurs at the regional (provincial) level. A significant dependence on mining resources regarding GRDP and DBH of natural resources does not guarantee that a region can create highly sustainable development performance. The NRC phenomenon is more prone to occur in provinces dependent on mining natural resources. Oil and gas-producing provinces experience a more incredible NRC phenomenon than other provinces that rely solely on minerals and coal. Provinces with higher sustainability scores in their regional development tend to avoid the NRC phenomenon.

3.7 The Impact of Foreign Direct Investment on Economic Growth in OPEC Countries

Based on the results of the tests that have been carried out, Foreign Direct Investment has a positive and significant effect on economic growth in OPEC countries. FDI directed towards sustainable sectors, such as renewable energy, environmentally friendly transportation, or green technology, can support sustainable economic growth. This kind of investment can create jobs, increase efficiency, and reduce environmental negative impacts. Foreign investment often creates business partnerships between foreign and local companies. This can help local companies access global markets and more significant resources. Partnerships like this can increase the growth and competitiveness of local companies. FDI on economic growth will depend greatly on the policies implemented by the government, compliance with environmental regulations, and the efforts of foreign companies to operate sustainably. Therefore, good collaboration between the government and the private sector is critical to achieving sustainable economic growth through FDI.

Research by Ostic et al. (2022) shows a significant relationship between FDI and carbon emissions. The study results show that oil and gas production and exports contribute to carbon emissions, which impact global warming, so strict environmental protection is recommended, such as using environmentally friendly plants applied in oil and gas extraction and production to minimize the rate of carbon emissions. However, according to Sung et al. (2017), FDI is a positive predictor of environmental quality in the host country, which is evidence of the halo effect that FDI reduces the level of CO_2 emissions. In addition, the results of a study by Xie et al. (2020) also show contradictory results. FDI can directly cause an increase in CO_2 concentration. With increasing FDI inflows, the total effect of FDI on CO_2 leakage shifts smoothly from positive to negative, thus strengthening the pollution haven and pollution halo hypotheses. An increase in FDI leads to a decrease in green energy consumption and an increase in non-green energy consumption. In contrast, increased financial depth leads to the opposite scenario. Green energy is an essential factor in economic growth that OPEC members should utilize. However, oil supply delays and oil price fluctuations due to high taxes may hamper state revenues, providing a negative performance indicator. However, caution should be applied when using these results to propose concrete economic models and energy conservation policies. In addition, OPEC members are trying to build strategic policies on investing in human resources to capitalize on energy consumption (Alshubiri et al., 2021).

Meanwhile in BRICS countries, Foreign Direct Investment (FDI) is the cause of environmental degradation in both BRICS countries and developing countries. In contrast, in developed countries, FDI is the cause of decreased environmental degradation. Equipment transformation from developed countries has recently reduced environmental degradation in BRICS and developed countries but has increased environmental degradation in low-income developing countries. Urbanization results show that urbanization is a cause of environmental degradation in developed countries, but in developing countries, urbanization is a cause of reduced environmental degradation.

Economic growth and total natural resource rents are the leading causes of environmental degradation as each country strives to achieve high growth, and as a result, there is an increase in environmental pollution, which adversely affects public health. The results of total natural resource rents recommend in BRICS countries, developing countries, and developed countries that total natural resource rents are the cause of environmental degradation, so governments should provide advanced equipment to exploit natural resources as well as make good use of them during mining, deforestation, and agriculture so that better environmental quality will be achieved. The environmental degradation from the use of renewable energy is much less as compared to the use of fossil energy, so BRICS countries, developing and developed countries should make proper policies to increase the use of renewable energy, which will improve their economy and protect their environment (Muhammad & Khan, 2021).

3.8 The Impact of Renewable Energy Consumption, CO_2 Emissions, and Foreign Direct Investment on Economic Growth in OPEC Countries

Renewable Energy Consumption, CO_2 Emissions, and Foreign Direct Investment significantly impact economic growth in OPEC countries. The effects of Renewable Energy Consumption, CO_2 Emissions, and Foreign Direct Investment on economic growth in OPEC countries are interrelated and can have a significant impact. Renewable Energy Consumption plays a vital role in diversifying energy sources, which helps OPEC countries reduce their dependence on fossil fuels. This diversification makes their economies more stable and resilient to fluctuations in global oil prices. In addition, using renewable energy can reduce operating costs in the long run, improve industrial competitiveness, and create new jobs in renewable energy facilities' installation, maintenance, and operation sectors.

On the other hand, CO_2 Emissions have a double impact on the economy. High emissions indicate intensive industrial activity, which can cause air pollution that is detrimental to public health and labor productivity and hamper economic growth. Strict regulations and associated costs, such as carbon taxes, can also increase production costs and reduce economic competitiveness. However, the challenge of reducing CO_2 emissions can drive technological innovation, resulting in better energy efficiency and clean technologies that can contribute positively to economic growth.

Foreign Direct Investment (FDI) brings significant benefits, including technology and knowledge transfer, capital raising, and job creation. FDI often brings new technologies, managerial know-how, and best business practices that can improve the productivity and efficiency of local firms. In addition, the influx of FDI increases the available capital in the economy, which can be used for business expansion, infrastructure development, and other projects that promote economic growth. FDI also opens access to international markets and builds stronger economic ties with investor countries, boosting exports and economic growth. When these three factors are analyzed simultaneously, their interactions can reinforce each other and significantly impact economic growth. For example, foreign direct investment (FDI) in renewable energy technologies can increase renewable energy consumption and reduce CO_2 emissions while creating jobs and technology transfer. Increased Renewable Energy Consumption can reduce CO_2 Emissions and improve environmental quality and health, increasing labor productivity and attracting more FDI. Regulations that reduce CO_2 emissions can encourage innovation and investment in clean technologies, which improves economic competitiveness and attracts more FDI. Overall, good management of Renewable Energy Consumption, CO_2 Emissions, and Foreign Direct Investment can significantly impact OPEC countries' economic growth.

Research by (Khandker et al., 2018) shows that FDI and renewable energy consumption have a causal relationship. FDI is a source of investment that attracts investors to invest in energy and renewable energy sources. FDI inflows are beneficial for reducing CO_2 emissions, and more FDI inflows encourage renewable energy consumption (Paramati et al., 2017). The results of this study are also in line with research by (Malik et al., 2020), which shows that economic growth and FDI intensify carbon emissions in both the long and

short term, while oil prices increase emissions in the short term and reduce emissions in the long term. Diversifying the overall energy mix towards more renewable/clean energy and formulating favorable policies for industrial and residential consumers to adopt renewable energy, such as solar power, can reduce emissions.

4. Conclusions

Based on the results of research on the influence of Renewable Energy Consumption, CO_2 Emissions, and Foreign Direct Investment on Economic Growth in OPEC Countries, the conclusion is that the Renewable Energy Consumption variable does not affect economic growth in OPEC Countries. This is because OPEC countries are very dependent on fossil energy resources, especially oil, and gas, as their primary source of income, so this dependence may make these countries less motivated to adopt renewable energy because this can disrupt their income from oil exports and gas.

The CO_2 Emissions variable does not significantly affect economic growth in OPEC countries. This is because OPEC countries often rely on fossil energy exports as their main source of income. Reducing CO_2 emissions can reduce global demand for fossil energy products and negatively impact economic growth in these countries. Several OPEC countries still have geographical and climatic conditions that do not support using renewable energy, such as solar or wind. The Foreign Direct Investment variable has a positive and significant effect on economic growth in OPEC countries. FDI on economic growth will depend greatly on the policies implemented by the government, compliance with environmental regulations, and the efforts of foreign companies to operate sustainably. Therefore, good collaboration between the government and the private sector is critical to achieving sustainable economic growth through FDI.

The limitation of this research is that there is still a limited period for research data, so it is hoped that future research will use a more extended period. In addition, influences from other fields apart from the variables contained in this research can be added for further research. Policy recommendations include developing a realistic and phased energy transition strategy with clear targets to reduce dependence on fossil fuels. OPEC countries must establish medium and long-term plans to increase the share of renewable energy in their energy mix. In addition, developing non-oil economic sectors such as tourism, information technology, manufacturing, and agriculture is essential to reducing economic dependence on oil revenues. Gradually, implementing a carbon tax can internalize the environmental cost of CO_2 emissions, where this tax revenue can be used to fund renewable energy projects and emission reduction initiatives. Encouraging the adoption of carbon capture and storage (CCS) technology to capture and store CO_2 emissions from the oil and gas industry is also an important step. These technologies can reduce environmental impacts without significantly reducing oil production. In addition, implementing energy efficiency technologies and practices across the oil and gas industry value chain will help reduce emissions and operating costs.

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Author Contribution

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References
Agboola, O. M., Victor, F., & Joshua, U. (2021). Pathway to environmental sustainability : Nexus between economic growth , energy consumption , CO 2 emission , oil rent and total natural resources rent in Saudi Arabia. *Resources Policy*, *74*(September), 102380. https://doi.org/10.1016/j.resourpol.2021.102380

Alisjahbana, A. S., & Murniningtyas, E. (2018). *Tujuan Pembangunan Berkelanjutan di Indonesia*. UNPAD PRESS.

Alshubiri, F., Elheddad, M., & Ahsan, S. (2021). The impacts of financial depth and foreign direct investment on the green and non - green energy consumption of OPEC members. *SN Business & Economics*, *1*(6), 1–29. https://doi.org/10.1007/s43546-021-00075-4

Ashraf, S., Jithin, P., & Umar, Z. (2022). The asymmetric relationship between foreign direct investment , oil prices and carbon emissions : evidence from Gulf Cooperative Council economies direct investment , oil prices and carbon emissions : evidence from Gulf Cooperative Council economies. *Cogent Economics & Finance*, *10*(1). https://doi.org/10.1080/23322039.2022.2080316

Balli, E., Sigeze, C., Ugur, M. S., & Çatık, A. N. (2023). The relationship between FDI, CO 2 emissions, and energy consumption in Asia-Pacific economic cooperation countries. *Environmental Science and Pollution Research*, *30*, 42845–42862. https://doi.org/10.1007/s11356-021-17494-3

Bappeda Jogja. (2023). *Sustainable Development Goals - Energi Bersih dan Terjangkau*. https://bappeda.jogjaprov.go.id/dataku/sdgs/detail/7-energi-bersih-dan-terjangkau

Choi, S. G., & Storr, V. H. (2019). A culture of rent seeking. *Public Choice*, *181*(1–2), 101–126. https://doi.org/10.1007/s11127-018-0557-x

Dabachi, U. M., Mahmood, S., Ahmad, A. U., Ismail, S., Farouq, S., Jakada, A. H., Mustapha, U. A., & Abdullahi, A. T. (2020). Energy Consumption , Energy Price , Energy Intensity Environmental Degradation , and Economic Growth Nexus in African OPEC Countries : Evidence from Simultaneous Equations Models. *Journal of Environmental Treatment*

Techniques, *8*(January), 403–489.
Fan, W., & Hao, Y. (2020). An empirical research on the relationship amongst renewable energy consumption, economic growth and foreign direct investment in China. *Renewable Energy*, *146*, 598–609. https://doi.org/10.1016/j.renene.2019.06.170
Gilberthorpe, E., & Papyrakis, E. (2015). The extractive industries and development: The resource curse at the micro, meso and macro levels. *Extractive Industries and Society*, *2*(2), 381–390. https://doi.org/10.1016/j.exis.2015.02.008
Gorus, M. S., & Aydin, M. (2019). The relationship between energy consumption , economic growth , and CO 2 emission in MENA countries : Causality analysis in the frequency domain. *Energy*, *168*, 815–822. https://doi.org/10.1016/j.energy.2018.11.139
Gujarati, D. N., & Porter, D. C. (2012). *Dasar-Dasar Ekonometrika* (5th ed.). Salemba Empat.
Hu, M., Li, R., You, W., Liu, Y., & Lee, C. (2020). Spatiotemporal evolution of decoupling and driving forces of CO 2 emissions on economic growth along the Belt and Road. *Journal of Cleaner Production*, *277*, 123272. https://doi.org/10.1016/j.jclepro.2020.123272
Jin, L., Chang, Y., Wang, M., Zheng, X., Yang, J., & Gu, J. (2022). The dynamics of - CO 2 emissions, energy consumption, and economic development : evidence from the top 28 greenhouse gas emitters. *Environmental Science and Pollution Research*, *29*, 36565–36574. https://doi.org/10.1007/s11356-021-18069-y
Khan, A., Chenggang, Y., Hussain, J., & Kui, Z. (2021). Impact of technological innovation, financial development and foreign direct investment on renewable energy, non-renewable energy and the environment in belt & Road Initiative countries. *Renewable Energy*, *171*, 479–491. https://doi.org/10.1016/j.renene.2021.02.075
Khandker, L. L., Amin, S. B., & Khan, F. (2018). *Renewable Energy Consumption and Foreign Direct Investment : Reports from Bangladesh*. *8*(3), 72–87.
Mahmood, H., & Saqib, N. (2022). *Oil rents , economic growth , and CO 2 emissions in 13 OPEC member economies : Asymmetry analyses*. *October 1*–14. https://doi.org/10.3389/fenvs.2022.1025756
Mahmood, H., Saqib, N., & Adow, A. H. (2023). Oil and natural gas rents and CO 2 emissions nexus in MENA : spatial analysis. *PeerJ*, 1–20. https://doi.org/10.7717/peerj.15708
Malik, M. Y., Latif, K., Khan, Z., Daud, H., Hussain, M., & Athar, M. (2020). Science of the Total Environment Symmetric and asymmetric impact of oil price , FDI and economic growth on carbon emission in Pakistan : Evidence from ARDL and non-linear ARDL approach. *Science of the Total Environment*, *726*(April), 138421. https://doi.org/10.1016/j.scitotenv.2020.138421
Muhammad, B., & Khan, M. K. (2021). Impact of foreign direct investment , natural resources , renewable energy consumption , and economic growth on environmental degradation : evidence from BRICS , developing , developed and global countries. *Environmental Science and Pollution Research*, 21789–21798. https://doi.org/10.1007/s11356-020-12084-1
Novtaviana, W. (2020). *Pengaruh Indeks Pembangunan Gender Dan Indeks Pemberdayaan Gender Terhadap Pertumbuhan Ekonomi (PDRB) Di Indonesia Tahun 2014-2018*. Undergraduate thesis, UIN Sunan Ampel Surabaya. http://digilib.uinsa.ac.id/44146/
Ostic, D., Kissiwaa, A., Andrew, T., Agyemang, O., & Boahen, H. A. (2022). Assessing the impact of oil and gas trading , foreign direct investment inflows , and economic growth on carbon emission for OPEC member countries. *Environmental Science and Pollution Research*, 43089–43101. https://doi.org/10.1007/s11356-021-18156-0
Pangestika, S. (2015). Analisis Estimasi Model Regresi Data Panel Dengan Pendekatan Common Effect Model (Cem), Fixed Effect Model (Fem), Dan Random Effect Model (Rem). *Unnes Journal*, *2*(1), 106.
Paramati, S. R., Mo, D., Gupta, R., & Reddy, S. (2017). The effects of stock market growth and renewable energy use on CO2 emissions: Evidence from G20 countries. *Energy Economics*. https://doi.org/10.1016/j.eneco.2017.06.025
Rahma, H., Fauzi, A., Juanda, B., & Widjojanto, B. (2021). Fenomena Natural Resource Curse dalam Pembangunan Wilayah di Indonesia. *Jurnal Ekonomi Dan Pembangunan Indonesia*, *21*(2), 148–163. https://doi.org/10.21002/jepi.2021.10

Salahuddin, M., Alam, K., Ozturk, I., & Sohag, K. (2017). The effects of electricity consumption, economic growth , financial development and foreign direct investment on CO_2 emissions in Kuwait. *Renewable and Sustainable Energy Reviews*, *February*, 1–9. https://doi.org/10.1016/j.rser.2017.06.009

Sapkota, P., & Bastola, U. (2017). Foreign Direct Investment, Income, and Environmental Pollution in Developing Countries: Panel Data Analysis of Latin America. *Energy Economics*. https://doi.org/10.1016/j.eneco.2017.04.001

Statista. (2023). *Net electricity consumption worldwide in select years from 1980 to 2022(in terawatt-hours)*. Statista Research Department. https://www.statista.com/statistics/280704/world-power-consumption/

Sung, B., Song, W., & Park, S. (2017). How foreign direct investment affects CO_2 emission levels in the Chinese manufacturing industry: Evidence from panel data. *Economic Systems*. https://doi.org/10.1016/j.ecosys.2017.06.002

Tanzeh, A. (2011). *Metode Penelitian Praktis*. Teras.

United Nations. (2023). *SDGs Report 2023* (pp. 1–75). United Nations.

Wen, J., Mughal, N., Zhao, J., Shahzad, M., Niedba, G., Jain, V., & Anwar, A. (2021). Does globalization matter for environmental degradation ? Nexus among energy consumption, economic growth, and carbon dioxide emission. *Energy Policy*, *153*(112230), 1–8. https://doi.org/10.1016/j.enpol.2021.112230

World Bank. (2023). *Data Bank - World Development Indicators*. World Development. https://databank.worldbank.org/source/world-development-indicators

Xie, Q., Wang, X., & Cong, X. (2020). How does foreign direct investment affect CO 2 emissions in emerging countries ? New findings from a nonlinear panel analysis. *Journal of Cleaner Production*, *249*, 119422. https://doi.org/10.1016/j.jclepro.2019.119422

Zaghdoudi, T. (2017). *Oil prices, renewable energy, CO_2 emissions and economic growth in OECD countries*. *37*(3), 1844–1850. https://www.accessecon.com/Pubs/EB/2017/Volume37/EB-17-V37-I3-P167.pdf

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