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Relationship between Oil Exports, Renewable Energy Consumption, Agriculture Industry, and Economic Growth in Selected OPEC Countries: A Panel ARDL Analysis

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ABSTRACT

This study uses the panel ARDL method to analyze the relationship between oil exports, renewable energy consumption, agricultural industry, and economic growth in selected OPEC member countries. The study examined data from 9 OPEC countries from 1990 to 2024. The findings showed that while oil exports in OPEC countries have a positive long-term effect, they have a negative short-term impact in Nigeria and a positive short-term impact in other countries. The consumption of renewable energy has been found to have a negative long-term effect. However, the short-term impact varies from country to country, with the observation that the short-term effect is insignificant in most countries. The long-term effect of the food production index is statistically insignificant. On the other hand, the short-term effect varies significantly among countries, with a notable negative impact in some countries. Notably, Equatorial Guinea stands out from other variables, as all variables have insignificant effects in the short term. Research findings have demonstrated that oil exports play a supportive role in the economic growth of OPEC countries.

Keywords: OPEC, Oil Exports, Renewable Energy Consumption, Agricultural Industry, GDP, Panel ARDL
JEL Classifications: C13, C20, C22

1. INTRODUCTION

The idea of establishing OPEC emerged in 1949 when Venezuela proposed regular cooperation with other oil-producing countries (Iran, Iraq, Kuwait, and Saudi Arabia). However, the real push came from the multinational oil companies, known as the “seven sisters,” which began to control oil and set prices in 1959. This led to the First Arab Petroleum Congress held in Cairo in April. Congress demanded that the oil companies consult with governments when making decisions, but the companies rejected this request. Delegates gathered in Baghdad on September 10, 1960, and on September 14, 1960, OPEC was established with the founding members of Iran, Iraq, Kuwait, Saudi Arabia, and Venezuela. Over time, Qatar, Indonesia, Libya, the UAE, Algeria, Nigeria, Ecuador, Angola, Gabon, and Guinea also joined the organization. OPEC’s first headquarters in Geneva was transferred to Vienna in 1965 (OPEC, 2024a). OPEC aims to coordinate the oil policies of member countries to ensure fair and stable prices, provide regular oil supply to consumer countries, and ensure fair returns to those who invest in the sector (Fattouh and Mahadeva, 2013). In 1960, OPEC’s share of world oil production was 38.2%. By 1973, it had reached a peak of 52.8%, but then decreased to 24.9% in the 1980s. In 2004, the production was recorded as 29.6 million barrels per day, and

34.6% in 2012. Their share rose to 42.4% in 2015 and 44.1% in 2016, then fell to 26.5% in 2023. OPEC's crude oil production in 2023 averaged 27.0 million barrels per day with a fall of 700 thousand barrels per day compared to the previous year (OPEC, 2024b). Oil remains the most critical energy source for modern economies and maintains its importance despite the increasing focus on alternative energy sources. Fluctuations in oil prices have far-reaching effects on world economies and can lead to economic recession or expansion (Basher and Sadorsky, 2006). Yet the oil-exporting and oil-importing countries are affected by these changes differently. Therefore, it is crucial to examine the changes in oil prices in more detail (Bekzhanova et al., 2023).

Renewable energy is energy obtained from natural processes, including solar, wind, geothermal, hydro, and some types of biomass. According to the International Energy Agency (IEA), renewable energies provided approximately 13.2% of the world's total primary energy use in 2012, and this rate increased to 22% in 2013. In 2015, the share of renewable energy in total electricity production was over 23%, and it is expected to approach 28% by 2021 (IEA, 2015). Solar energy is the most popular renewable energy source, generating electricity through solar panels. In 2014, two of the largest solar energy markets were in Asia, and new markets continued to emerge all around the world by 2015. The wind has been used as an energy source throughout history and reached a global capacity of 197,039 megawatts at the end of 2010. In 2013, China became the leader in the wind energy market (Shahan, 2014). Hydroelectric energy is generated by the gravitational force of water turning turbines to produce electricity. By 2016, the global installed hydroelectric energy capacity reached 1,064 GW (Svendsen, 2013). Geothermal energy, generated from approximately 4,000 miles below the earth's surface, yielded electricity production of 151 TWh in 2015, with the global total geothermal capacity reaching 13.2 GW. Renewable energy has seen significant growth and progress in the world's energy sector, with IEA statistics showing that renewable energy reached its fastest level in 2015, representing more than half of the additional electricity capacity worldwide. Efforts to develop these energy sources and reduce their costs indicate that renewable energy will gain an important place in the energy world (IEA, 2015).

The food production index (2014-2016=100) measures the production of edible and nutritious food products. It does not include non-nutritious items like coffee and tea. The index, calculated by the Food and Agriculture Organization of the United Nations (FAO), compares the total agricultural production volume for each year to the base period of 2014-2016. This index is based on the price-weighted sum of production quantities of different agricultural commodities, with seed and feed quantities weighted similarly. FAO calculates indices at the national, regional, and global levels using the Laspeyres formula. The production quantity of each commodity is weighted by the average international commodity prices for the years 2014-2016 and summed for each year. This sum is compared with the average total for the base period of 2014-2016 for a given year to obtain the index (World Bank, 2024; Sartbayeva et al., 2023).

Economic growth is the continuous increase in production factors, such as the labor force, natural resources, domestic capital structure, foreign trade policy, banking and financial infrastructure, energy production and consumption, and foreign direct investment. This gradual increase provides higher returns from 1 year to the next (Neelankavil et al., 2012). Gross Domestic Product (GDP) is typically used as a measure of economic growth (Dyussembekova et al., 2023). GDP refers to the total value of final goods and services produced in an economy in a year (Somel, 2014). When this total value is calculated based on the prices of the production year, it is called Nominal GDP. The significance of economic growth has increased due to globalization, advancements in information technologies, and easier access to financial markets. Changes in economic growth reflect the economic development of a country during a specific period and provide a basis for comparison with countries with similar characteristics. As a result, economic growth has become a critical subject of analysis for both policymakers and academics (Sartbayeva et al., 2023; Issayeva et al., 2023; Abdibekov et al., 2024; Ibyzhanova et al., 2024; Abdulsahib, 2024).

Recently, the visible negative effects of climate change have led to increasing concerns about environmental sustainability. Governments worldwide are now encouraging and supporting the use of renewable energy sources rather than fossil fuels to promote environmental sustainability. This shift in energy sources has been the focus of academic studies from various perspectives. In this study, we used the Panel ARDL method to analyze the relationship between oil exports, renewable energy consumption, the agricultural industry, and economic growth in selected OPEC countries.

2. LITERATURE REVIEW

Given that oil and petroleum products continue to dominate the world energy market, there is a plethora of literature on oil production and the world oil market. In addition, there are numerous academic studies regarding the different aspects of the economies of OPEC and its member countries, which play a crucial role in determining the global oil market. Considering the extensive nature of the academic literature, this study will reference only specific studies on the topic at hand.

Ftiti et al. (2016) analyzed the relationship between crude oil prices and economic growth in selected OPEC countries (United Arab Emirates, Kuwait, Saudi Arabia, and Venezuela) during the period from September 3, 2000 to December 3, 2010. They used the frequency approach of Priestley and Tong (1973) and the cointegration procedure developed by Engle and Granger (1987) to conduct their analysis. Their findings revealed that oil price shocks during fluctuations in the global business cycle and/or financial turmoil have an impact on the economic growth in OPEC countries.

Ghalayini (2011) investigated whether changes in oil prices can account for world economic growth and whether the effects of oil prices on economic growth vary among different countries and country groups. The study also discussed the reasons for these differences between oil-importing and exporting countries. The study covered the G-7 group, OPEC countries, Russia, China, and India during the period 1986-2010. Granger causality tests indicated a one-way relationship between oil prices and economic growth for G-7 countries.

Nusair (2016) analyzed the effects of oil price shocks on the real GDP of the Gulf Cooperation Council (GCC) countries using a Nonlinear Autoregressive Distributed Lag (NARDL) model. The study found asymmetry in all cases, with positive oil price changes leading to increases in real GDP, while negative oil price changes were significant only for Kuwait and Qatar, causing decreases in real GDP in these countries. Additionally, panel data analyses revealed that positive price changes had a greater effect than negative changes.

Sonmez (2016) analyzed the relationships among various economic factors (oil prices (real and nominal), real government expenditures, real exchange rates, GDP (real and nominal), M2, inflation, foreign exchange reserves, and reserve money) in Gulf Cooperation Council (GCC) countries (Bahrain, Kuwait, Oman, Saudi Arabia, UAE, and Qatar) and non-GCC oil exporters (Canada, Norway, Iran, Russia, Nigeria, and Venezuela) between 1970 and 2013. The study used a restricted Vector Error Correction Model (VECM) with the cointegration of macroeconomic variables. The findings indicated that real oil prices had a greater positive effect on the real output of the GCC countries compared to non-GCC countries due to their higher oil dependency. It was also observed that an increase in real oil prices led to a real exchange rate appreciation in GCC countries with minimal impact on the nominal exchange rate, which differed from the results for non-GCC oil exporters.

Agboola et al. (2024) examined the asymmetric and empirically significant effects of unexpected changes in oil prices on oil-exporting emerging markets using nonlinear models for eight oil-exporting countries. Various nonlinear models were developed and estimated for eight oil-exporting countries. The findings demonstrated significant evidence of asymmetry in some countries and highlighted the role of government expenditures in propagating these effects. Robustness checks with different models, including nominal oil price changes, confirmed the validity of the findings. The study also emphasized the significant effects of the asymmetric nature of GDP responses to oil price shocks on policy effectiveness.

Alam and Quazi (2003) used the Bounds Test and Autoregressive Distributed Lag procedures to investigate the long-term equilibrium relationship between capital flight and its determinants and to estimate the behaviors of capital flight from Bangladesh in both the long-term and short-term. Their findings revealed that political instability is the primary reason for capital flight. Moreover, increases in corporate income taxes, higher real interest rate differences between capital haven countries and Bangladesh, and decreasing GDP growth rates also significantly contribute to capital flight.

Zaidi and Saidi (2018) conducted a study to model the relationship between health expenditures (HE), environmental pollution (carbon dioxide emissions and nitrous oxide emissions), and economic growth in Sub-Saharan African countries using annual data for the period 1990-2015. They utilized the ARDL estimation method to analyze the long-term and short-term effects and applied the VECM Granger causality test to ascertain the direction of causality. The research findings demonstrated that economic growth has a positive long-term effect on health expenditures. However, CO_2 emissions and nitrous oxide emissions (NOE) were found to have a negative effect on health expenditures. The results indicated that a 1% increase in GDP per capita would enhance health expenditures by 0.332%, while a 1% increase in CO_2 emissions and NOE would reduce health expenditures by 0.066% and 0.577%, respectively. Furthermore, the VECM Granger causality test results revealed a unidirectional causality relationship moving from health expenditures to GDP per capita, as well as a bidirectional causality relationship between CO_2 emissions and GDP per capita, and between health expenditures and CO_2 emissions.

In their 2018 study, Da Silva et al. highlighted the significance of renewable energy in discussions about a reliable and sustainable energy future. They stressed the importance of understanding the primary factors influencing renewable energy and drawing conclusions for energy policies. The study utilized panel data covering the period 1990-2014 and specifically employed the panel-ARDL model. The analysis revealed that economic development (GDP per capita) and increased energy use promoted renewable energy development, while population growth hindered this progress. Additionally, the article examined the renewable energy potential and status in Sub-Saharan Africa. It was determined that while the region has great potential for developing renewable energy sources such as wind, biomass, solar, and hydroelectric power, this potential has not been fully utilized. It has been determined that many resources are not sufficiently utilized even though they are abundant and have high economic potential.

3. METHODS

The panel ARDL test, proposed by Pesaran et al. (1997) and Pesaran et al. (2004), analyzes the relationship between variables in two steps. In the first step, the model investigates the long-term relationship. If a long-term relationship (cointegration) between the dependent and independent variables is established, the second step involves estimating the short-term and long-term coefficients using the ARDL method. During the analysis phase, the choice between the within-group estimator (MG) and the pooled within-group estimator (PMG) is determined through the Hausman test (1978). The advantages of the panel analysis method, as explained by Hsiao (2007), include using a larger dataset, which provides more effective estimation values. The ARDL (Autoregressive Distributed Lag) test has the advantage of not requiring variables in the model to be stationary at the same level. This flexibility allows variables to be included in the model as stationary at level I(0) or first difference I(1) (Pesaran et al., 2001). Furthermore, the ARDL method can be applied to datasets with small sample sizes, which is important considering that macro indicators for countries are usually published in annual periods.

The Panel ARDL method was utilized by Binder and Offermanns (2007) to analyze purchasing power parity in Europe, and by Da Silva et al. (2018) to study the factors influencing renewable energy use in Africa, as well as the relationship between renewable energy consumption and economic growth. Zaidi and Saidi (2018) employed the method to investigate the connection between environmental pollution, health expenditures, and economic growth in African countries.

When performing analysis on time series data, the first step is to examine the stationarity of the series. The panel data method assesses cross-sectional dependence before conducting the stationarity test. When the number of periods (T) for the data set is greater than the number of cross-sectional units (N) (T>N), cross-sectional dependence is examined with the Breusch and Pagan (1980) LM test and Pesaran et al. (2008) $LMadj$ tests. But when the number of periods (T) is smaller than the number of cross-sectional units (N), the examination is performed using the Pesaran (2004) $CDLM$ test and Pesaran (2004) CD tests. Depending on the result, you can then proceed with first-generation unit root tests or one of the second-generation unit root tests (Baltagi, 2008).

If there is no cross-sectional dependence, the first-generation unit root tests employed are Levin et al. (2002), Breitung (2005), Hadri (2000), Maddala and Wu (1999), and Choi (2001). The common second-generation unit root tests include Bai and Ng (2004), Taylor and Sarno (MADF, 1998), Breuer et al. (SURADF, 2002), Pesaran (CADF, 2007), and Carrion-i-Silvestre et al. (PANKPSS, 2005) (Pesaran, 2006).

4. DATA AND FINDINGS

The OPEC countries constitute a significant group in the world's oil-based energy supply. Because these economies heavily rely on oil production and exports, it is expected that oil plays a key role in their economic growth, regardless of their geographical locations. With rich oil reserves, it is anticipated that oil exports have a profound impact on their economic growth. However econometric analyses indicate the existence of various other factors that influence economic growth. Therefore, this study included two additional variables representing renewable energy and the agricultural industry. The primary research question of the study pertains to the influence of oil production and exports on economic growth in OPEC countries. The secondary research question explores how the utilization of renewable energy affects economic growth when examined in conjunction with oil exports. While analyzing these effects together, the study also examines the influence of the agricultural industry, which is deemed significant for these countries' economies.

The study combined the oil production with the oil export variable. The oil data was retrieved from the https://asb.opec.org/data/ASB_Data.php webpage (Accessed on: June 01, 2024). Renewable energy consumption was represented as the share of renewable energy in total energy consumption. The agricultural industry was represented by the food production index. The study's target variable was economic growth, defined as the annual increase in national income. Data for renewable energy, food production index, and economic growth were obtained from https://datacatalog.worldbank.org/(Accessed on: June 01, 2024). Nine countries with complete data were selected from OPEC countries, covering the period from 1990 to 2024. Table 1 provides a summary of the research variables and countries.

The study began with descriptive statistical analyses for each variable, providing descriptive statistics and line graphs illustrating changes in each variable over the research period. The stationarity of the variables was then examined using an appropriate panel unit root test, considering cross-sectional dependency. Lastly, the panel ARDL test was used to analyze the effect of the independent variables on the dependent variable. The Housman test was used to determine the appropriate econometric model. Additionally, short-term variable effects were analyzed by country and the results were interpreted.

The panel ARDL model for the relationship between renewable energy consumption, food production index, oil exports, and economic growth was described in this study.

$$\Delta Y = \alpha_0 + \alpha_1 \sum_{j=1}^{p} \Delta Y_{i,t-j} + \alpha_2 \sum_{j=0}^{p} \Delta X1_{i,t-j} + \alpha_3 \sum_{j=0}^{p} \Delta X2_{i,t-j} + \alpha_4 \sum_{j=0}^{p} \Delta X3_{i,t-j} + \beta_1 Y_{i,i-1} + \beta_2 X1_{i,i-1} + \beta_3 X2_{i,i-1} + \beta_4 X3_{i,i-1} + \varepsilon_{it} \quad (1)$$

In the model, the constant term α_0 represents the error term (residual), long-term effects $\beta_{1,} \beta_{2,} \beta_{3,} \beta_4$ $\beta_1, \beta_2, \beta_3, \beta_4$, and effects $\alpha_{1,} \alpha_{2,} \alpha_{3,} \alpha_4$ $\alpha_1, \alpha_2, \alpha_3, \alpha_4$

Table 1: Codes for research variables and countries, and explanations

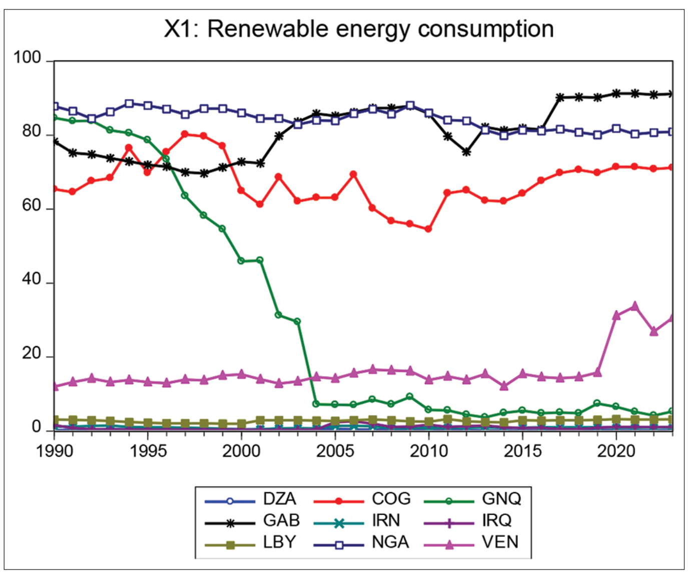
Country Code	Country	Variable	Description
COG	Congo	X1	Renewable energy consumption (% of total final energy cons.)
DZA	Algeria	X2	Food production index (2014-2016=100)
GAB	Gabon	X3	OPEC Members' crude oil exports (1,000 b/d)
GNQ	Equatorial Guinea	Y	GDP per capita growth (annual %)
IRN	Iran		
IRQ	Iraq		
LBY	Libya		
NGA	Nigeria		
VEN	Venezuela		

Table 2 provides descriptive statistics on renewable energy consumption in OPEC countries. The average values show that Congo, Gabon, and Nigeria have very high renewable energy consumption rates. However, Iran, Iraq, Algeria, and Libya exhibit very low renewable energy consumption rates. These results indicate a significant disparity in renewable energy consumption among countries during the research period. According to World Bank data, the overall average for all countries is 17.34 (https://datacatalog.worldbank.org/), while the average for OPEC countries stands at 31.52, surpassing the global average. Skewness and kurtosis values suggest that the distribution of renewable energy production rates closely resembles a normal distribution for all countries.

Graph 1 presents a thorough analysis of the changes in renewable energy consumption among OPEC countries during the research period. The graph indicates that, aside from Equatorial Guinea, the renewable energy consumption rates of the countries are relatively stable. Notably, Equatorial Guinea experienced a significant decline from 80% to 10% between 1995 and 2005. Apart from this anomaly, it can be surmised that the overall trend in renewable energy consumption among OPEC countries has remained consistent.

Table 3 presents the food production index values for OPEC countries. The average value for OPEC countries is 86.29. When looking at individual countries, Iraq has the highest food production index value, while Algeria has the lowest. Unlike the variable for renewable energy consumption, the countries do not differ significantly in the food production index value. The skewness and kurtosis values indicate that the food production index follows a distribution close to normal for all countries.

Graph 1: The time path of renewable energy consumption



An analysis of the change in the food production index for OPEC countries during the research period is provided in Graph 2. The graph reveals fluctuating trends for Iraq, decreasing trends for Venezuela and Iran after 2010, and increasing trends for other countries with low fluctuation.

In Table 4, statistical information on the oil export variable of OPEC countries shows that Iran, Iraq, and Nigeria have high average exports, while Equatorial Guinea, Congo, and Gabon have the lowest. Additionally, the minimum statistics indicate that Iran and Iraq had very low oil export years.

Graph 3 shows the time path of crude oil exports for OPEC members. A detailed analysis of the oil export data reveals that most countries have a fluctuating trend. The period between 1990 and 2000 shows significant fluctuations for Iraq. It's worth noting that Iraq's oil exports have increased steadily and rapidly after 2010. In contrast, Iran's oil exports, which had been stable until 2010, have been declining with fluctuations since then. Venezuela also exhibits a similar pattern of volatility.

The Table 5 provides descriptive statistics for the GDP change data in OPEC countries. It shows that Equatorial Guinea experienced the highest average GDP increase during the analysis period, while Venezuela had the lowest GDP change, indicating annual negative economic growth. Interestingly, apart from Iraq, other countries showed low economic growth. The minimum and maximum growth values of the countries indicate a highly volatile economic structure.

Graph 4 presents the time path for the GDP per capita growth of OPEC countries. It is noteworthy that Equatorial Guinea exhibited a volatile structure between 1990 and 2000, Libya between 2010 and 2015, and Iraq between 2000 and 2005. Additionally, there was low economic growth in Iraq in 1991, Libya in 2011 and 2020, and Venezuela in 2020. However, the time path graph indicates a relatively stable economic growth pattern in other OPEC countries.

Table 2: Descriptive statistics for renewable energy consumption

Country Code	Mean	Median	Maximum	Minimum	Standard deviation	Skewness	Kurtosis
COG	67.2085	67.6500	80.2000	54.5000	6.2979	0.1219	2.6989
DZA	0.3013	0.3000	0.6000	0.1000	0.1560	0.0606	1.6960
GAB	81.2092	81.7000	91.3000	69.7000	7.3469	−0.0962	1.5859
GNQ	29.8500	7.3000	84.7000	3.7000	31.5702	0.7388	1.8271
IRN	0.9572	0.9056	1.5000	0.4000	0.2523	0.2192	3.0434
IRQ	0.9180	0.8500	2.6000	0.3000	0.6062	1.1321	3.7247
LBY	2.7157	2.9000	3.2000	2.0000	0.3729	−0.6451	2.1470
NGA	84.2729	84.5000	88.6000	79.9000	2.7237	−0.1436	1.6691
VEN	16.2118	14.4500	33.7000	12.0000	5.5158	1.2851	2.7914
ALL	31.5161	7.3000	91.3000	0.1000	35.8561	0.5555	1.4689

Table 3: Descriptive statistics for food production index

Country Code	Mean	Median	Maximum	Minimum	Standard Deviation	Skewness	Kurtosis
COG	75.5202	75.2950	106.1300	43.3400	22.1699	−0.0140	1.4515
DZA	69.2399	59.6050	112.5000	31.0800	28.9814	0.2629	1.4550
GAB	84.7478	79.1100	105.7600	63.2200	14.0163	0.2109	1.5675
GNQ	86.0847	85.8350	104.5400	67.4700	13.1757	0.0696	1.4426
IRN	80.5904	84.5500	101.7500	50.8200	15.0262	−0.4810	2.0689
IRQ	114.4601	114.6600	149.1300	77.3100	18.4389	−0.3711	2.7824
LBY	94.3294	96.7850	109.3500	71.4000	11.1207	−0.7280	2.5709
NGA	79.7164	79.0200	119.8500	39.1500	23.5211	0.1957	1.9394
VEN	91.9322	90.4300	119.4100	70.9000	12.0103	0.0958	2.3841
ALL	86.2912	88.3850	149.1300	31.0800	22.0775	−0.1908	2.8427

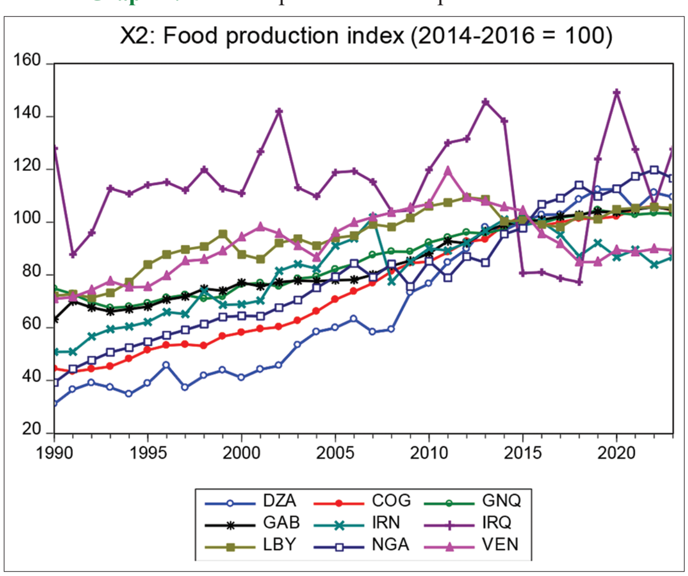
Table 4: Descriptive statistics for OPEC Members' crude oil exports

Country Code	Mean	Median	Maximum	Minimum	Standard Deviation	Skewness	Kurtosis
COG	236.1659	243.9194	309.3590	144.9200	43.0574	−0.6605	2.7141
DZA	592.1614	568.6000	1253.5000	279.4000	231.3743	0.7305	3.1890
GAB	245.3432	226.7057	352.0161	174.0678	52.0642	0.7783	2.4571
GNQ	127.2772	120.4279	275.1369	0.7140	87.7704	−0.0159	1.7166
IRN	2036.0650	2269.3600	2684.1000	404.4894	669.1379	−1.1223	2.8824
IRQ	1929.6240	1895.4100	3968.2450	39.0000	1268.4540	0.0242	1.9810
LBY	1005.0190	1100.3100	1399.5400	288.3879	320.9006	−1.2289	3.4905
NGA	1930.2930	1929.3690	2464.1200	1388.2600	298.7144	0.0292	1.8662
VEN	1567.7340	1602.3550	2243.9000	438.1734	500.9581	−1.0216	3.3344
ALL	1074.4090	841.9100	3968.2450	0.7140	923.2683	0.7703	2.8099

Table 5: Descriptive statistics for GDP per capita growth

Country Code	Mean	Median	Maximum	Minimum	Standard deviation	Skewness	Kurtosis
COG	2.0724	2.3005	11.6370	−6.6140	4.9554	−0.0236	2.2504
DZA	2.5927	3.0675	7.2000	−5.1000	2.3831	−1.0919	4.8975
GAB	2.2288	2.6515	7.0920	−8.9430	3.4110	−1.0806	4.5268
GNQ	17.1494	7.3670	147.9730	−9.1100	33.3524	2.5140	9.5218
IRN	3.4799	2.9745	18.0800	−3.7470	4.5783	0.9501	4.3206
IRQ	7.2611	5.5030	81.7870	−50.6000	22.1772	0.8638	6.5540
LBY	1.8738	0.0580	86.8270	−50.3390	21.1388	1.5066	9.7789
NGA	4.6314	3.8495	14.6040	−1.7940	3.9891	0.6153	2.8867
VEN	−0.9729	1.1715	18.2870	−29.9950	10.7745	−1.0678	3.8709
ALL	4.4796	3.0860	147.9730	−50.6000	16.3569	3.8754	31.4362

Graph 2: The time path of the food production index



Graph 3: The time graph of OPEC Members' crude oil exports

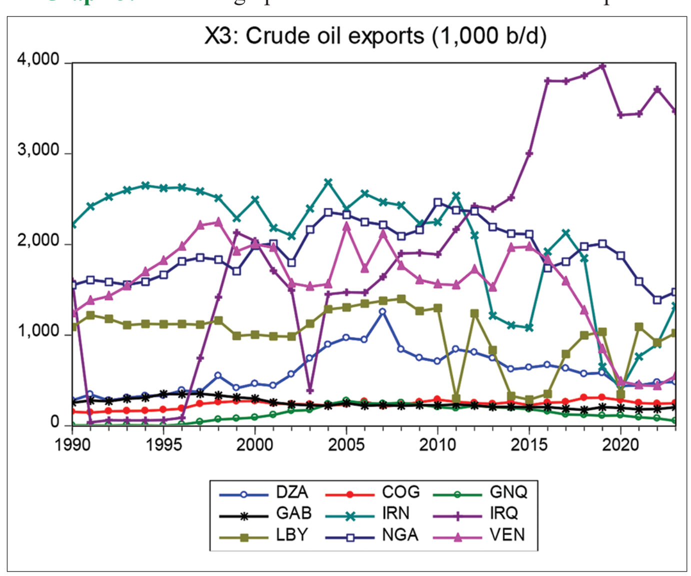


Table 6 presents the research data's cross-sectional dependency and unit root test results. The Breusch-Pagan LM test revealed cross-sectional dependency for all four variables. To check for stationarity, the CADF test was used, determining that variable Y

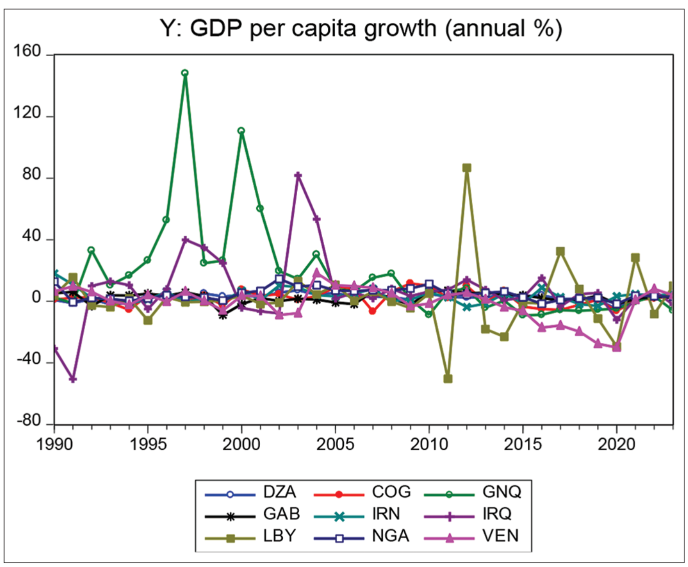
Table 6: The cross-section dependence and unit root test results

Variable	Cross-Section Dependence		Level		First diference	
	t-Statistics	P-value	t-Statistics	P-value	t-Statistics	P-value
X1	202.9224	0.0000	21.2278	0.2681	112.323	0.0000
X2	652.3821	0.0000	21.6796	0.2465	100.826	0.0000
X3	270.9916	0.0000	16.5936	0.5512	93.4941	0.0000
Y	66.4189	0.0015	95.9222	0.0000	212.098	0.0000

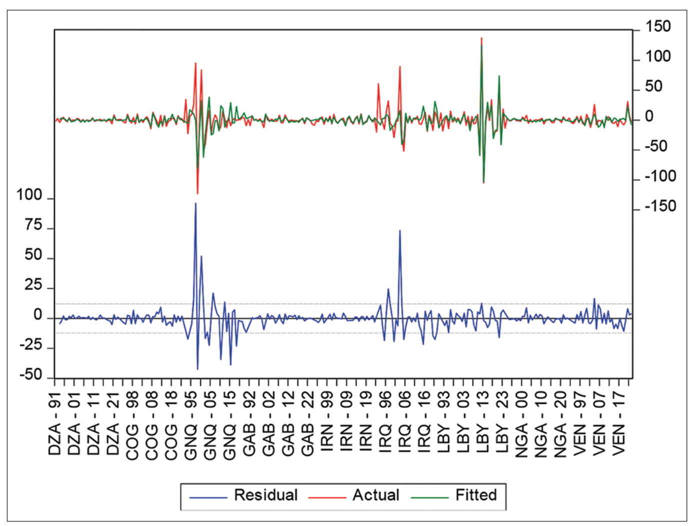
Table 7: The panel ARDL analysis findings for the research model

Variable	Coefficient	Standard Error	t-Statistic	Prob
Long run equation				
DX1	−0.8385	0.2589	−3.2388	0.0014
DX2	0.1238	0.1218	1.0166	0.3104
DX3	0.0106	0.0032	3.3166	0.0011
Hausman testi: Chi-square (2) =4,2311; P=0.2376				
Short run equation				
COINTEQ01	−0.6483	0.0686	−9.4553	0.0000
D(DX1)	−0.9892	1.9946	−0.4960	0.6204
D(DX1(−1))	−0.1897	1.5791	−0.1201	0.9045
D(DX2)	0.5381	0.4740	1.1354	0.2574
D(DX2(−1))	0.4276	0.5100	0.8383	0.4027
D(DX3)	0.0031	0.0172	0.1800	0.8574
D(DX3(−1))	0.0060	0.0045	1.3359	0.1829
C	2.4540	0.7127	3.4431	0.0007
Mean dependent var	−0.0992	SD, dependent var		19.1305
SE, of regression	12.1664	Akaike info criterion		6.1849
Sum squared resid	32860.5600	Schwarz criterion		7.1176
Log likelihood	−843.4515	Hannan-Quinn criter,		6.5583

Graph 4: The time graph for the GDP per capita growth



Graph 5: The line graph of the observation, estimation, and residual values according to the research model



was stationary at the level, while variables X1, X2, and X3 were stationary at the first difference.

Table 7 presents the panel ARDL analysis findings for the research model. The Hausman test was conducted to choose between the within-group estimator (MG) and the pooled within-group estimator (PMG), and the PMG estimator was chosen as the more suitable one. Based on the AIC findings for lag number selection, an ARDL (1, 2, 2, 2) lag structure was deemed appropriate. The error correction coefficient of −0.6483 indicates a long-term relationship between the variables, with the error correction term being between 0 and −1 pointing to convergence towards the equilibrium. This suggests that 64.8% of short-term shocks can be eliminated within a year, and equilibrium is reached approximately 1.52 years (about 1 year 6 months) after a short-term shock. Notably, renewable energy consumption has a negative long-term effect, while oil export has a positive effect. Short-term effects across all OPEC countries were deemed insignificant. In the short term, when all OPEC countries are considered collectively, it was concluded that no variable has a significant effect. However, separate effect analyses were conducted for each country, and the findings are outlined in Table 8.

Table 8: Cross-section short run coefficients

Variables	DZA	COG	GNQ	GAB	IRN	IRQ	LBY	NGA	VEN
COINTEQ01	**−0.9402****	**−0.7424****	**−0.4802****	**−0.7929****	**−0.5536****	**−0.6823****	**−0.8674****	**−0.3601****	**−0.4158****
D(DX1)	6.5237	**0.4269****	−2.3853	**0.2004***	0.8864	1.302	−15.629	−0.0767	−0.1515
D(DX1(-1))	6.1369	**0.1799****	−1.6838	**0.1021****	−2.8227	5.9885	−9.7614	**−0.2304****	**0.3837****
D(DX2)	0.0149	**0.3176***	4.2769	**0.4358****	**0.2101****	**−0.3342****	−0.0172	**0.1105****	**−0.1713****
D(DX2(-1))	**0.0565****	**0.5207****	4.3654	0.02	**0.1967****	**−0.2581****	**−0.9445****	**0.0862****	**−0.1947****
D(DX3)	**−0.0021****	**0.0787****	−0.1164	**0.0228****	**0.0028****	**0.0005****	**0.0312****	**−0.0001****	**0.0105****
D(DX3(-1))	**0.0014****	**0.0378****	0.0037	**−0.0075****	**−0.003****	**0.0021****	**0.0054****	**−0.0013****	**0.0154****
C	**2.3318****	**1.472***	5.9503	**1.9629****	**1.7836****	6.0292	1.309	**1.5938***	−0.3469

Coefficient values found to be significant at the $p<0.01$ (**) or $p<0.05$ (*) levels are written in bold.

The estimation and residual value findings of the research model are depicted in Graph 5. Significant fluctuations are evident in both the observation-estimation values and residual values for Equatorial Guinea, Iraq, and Libya. This indicates the necessity of closely monitoring the relevant periods from various perspectives for these three countries. In contrast, the model demonstrates successful data-estimation compatibility for the other countries.

The short-term effect coefficient findings for the countries, as per the research model, are detailed in Table 8. Notably, the error correction term takes a value between −1 and 0 for all countries, indicating convergence towards the equilibrium value. The absence of a significant effect of any variable for Equatorial guinea raises questions about the various factors influencing economic growth in the country. Additionally, it is observed that the food production index has a negative effect on Iraq, Libya, and Venezuela, while it has a positive effect on the other countries. Renewable energy consumption has a positive effect for Congo, Gabon, and Venezuela, a negative effect for Nigeria, and its effect is statistically insignificant for Algeria, Iran, Iraq, and Libya. Furthermore, it is noteworthy that the short-term effect of oil export is statistically significant for all countries.

5. CONCLUSION AND RECOMMENDATIONS

An analysis conducted in OPEC countries found that oil exports have a positive long-term effect on economic growth. However, the short-term impact of oil exports varies among countries. In Nigeria, the short-term effect is negative, while it is positive in other OPEC countries. It has been observed that renewable energy consumption generally has a negative long-term effect on economic growth, but the short-term effect varies among countries and is not statistically significant in most cases. The long-term effect of the food production index is not statistically significant, but it shows negative effects for some countries in the short term. The insignificance of the short-term effects of all variables, especially in Equatorial Guinea, indicates that the economic structure of this country is different from others.

The findings suggest that oil exports support economic growth in OPEC countries. However, to comprehensively understand this effect, a deeper analysis of causality relationships is needed. Evaluating the relationship between oil exports and economic growth for each country separately, considering the economic structures and dynamics of different OPEC countries, and developing specific analysis models for these countries can provide more detailed and useful information. Focusing future research on these aspects will make significant contributions to both the literature and the decision-making processes of policymakers and lead to more effective design and implementation of energy policies in OPEC countries.

REFERENCES

Abdibekov, S.U., Gridneva, Y.E., Kaliakparova, G.S., Amankeldi, N.A., Perneyeva, G.A., Kulbay, B.S., Myrzabekkyzy, K. (2024), The relationship between energy consumption, agricultural and industrial production, and economic growth: ARDL border value approach in the case of Kazakhstan. International Journal of Energy Economics and Policy, 14(3), 79-86.

Abdulsahib, A.S. (2024), Role of export, ımport and gross capital formation in Iraq: A granger causality approach. International Journal of Economics and Financial Issues, 14(5), 102-108.

Agboola, E., Chowdhury, R., Yang, B. (2024), Oil price fluctuations and their impact on oil-exporting emerging economies. Economic Modelling, 132, 106665.

Alam, I., Quazi, R. (2003), Determinants of capital flight: An econometric case study of Bangladesh. International Review of Applied Economics, 17(1), 85-103.

Available from: https://asb.opec.org/data/ASB_Data.php [Last accessed on 2024 Jun 01].

Available from: https://datacatalog.worldbank.org [Last accessed on 2024 Jun 01].

Bai, J., Ng, S. (2004), A PANIC attack on unit roots and cointegration. Econometrica, 72(4), 1127-1177.

Baltagi, B. (2008), Econometric Analysis of Panel Data. 4th ed. West Sussex, England: John Wiley and Sons.

Basher, S.A., Sadorsky, P. (2006), Oil price risk and emerging stock markets. Global Finance Journal, 17(2), 224-251.

Bekzhanova, S., Tayauova, G., Akhanov, S., Tuleshova, G.B., Bolganbayev, A., Moldogaziyeva, G.M. (2023), The relationship between gold and oil prices and the stock market returns of kazakh energy companies: Comparison of the pre-COVID-19 and post-COVID-19 periods. International Journal of Energy Economics and Policy, 13(5), 8-14.

Binder, M., Offermanns, C. (2007), International İnvestment Positions and Exchange Rate Dynamics: A Dynamic Panel Analysis. Cesifo Working Paper, 2095.

Breitung, J. (2005), A parametric approach to the estimation of cointegration vectors in panel data. Econometric Reviews, 24(2), 151-173.

Breuer, J.B., McNown, R., Wallace, M. (2002), Series-specific unit root tests with panel data. Oxford Bulletin of Economics and Statistics, 64(5), 527-546.

Breusch, T.S., Pagan, A.R. (1980), The Lagrange multiplier test and its applications to model specification in econometrics. The Review of Economic Studies, 47(1), 239-253.

Carrion-i-Silvestre, J.L., del Barrio-Castro, T., Lopez-Bazo, E. (2005), Breaking the panels: An application to the GDP per capita. The Econometrics Journal, 8, 159-175.

Choi, I. (2001), Unit root tests for panel data. Journal of International Money and Finance, 20(2), 249-272.

Da Silva, P.P., Cerqueira, P.A., Ogbe, W. (2018), Determinants of renewable energy growth in Sub-Saharan Africa: Evidence from panel ARDL. Energy, 156, 45-54.

Dyussembekova, Z., Aidarova, A.B., Balapanova, E., Kuatova, D., Seitkhamzina, G., Bolganbayev, A. (2023), The effect of freight and passenger transportation and energy production on economic growth in the framework of macro-economic indicators: The case of Kazakhstan. International Journal of Energy Economics and Policy, 13(6), 74-80.

Engle, R., Granger, W. (1987), Co-ıntegration and error correction: Representation, estimation, and testing. Econometrica, 55(2), 251-276.

Fattouh, B., Mahadeva, L. (2013), OPEC: What difference has it made? Annual Review of Resource Economics, 5(1), 427-443.

Ftiti, Z., Guesmi, K., Teulon, F., Chaouachi, S. (2016), Relationship between crude oil prices and economic growth in selected OPEC countries. The Journal of Applied Business Research, 32(1), 11-22.

Ghalayini, L. (2011), The interaction between oil price and economic growth. Middle Eastern Finance and Economics, 13(21), 127-141.

Hadri, K. (2000), Testing for stationarity in heterogeneous panel data. The Econometrics Journal, 3(2), 148-161.

Hausman, J.A. (1978), Specification tests in econometrics. Econometrica, 46, 1251-1271.

Hsiao, C. (2007), Panel data analysis-advantages and challenges. Test, 16(1), 1-22.

Ibyzhanova, A., Sultanova, Z., Aliyeva, Z.T., Tastanbekova, K., Abdibekov, S.U., Mustafayeva, B., Myrzabekkyzy, K. (2024), The effect of energy production and foreign trade on the economic growth of Turkic Republics: A study using panel data analysis method. International Journal of Energy Economics and Policy, 14(2), 126-134.

IEA. (2015), World Energy Outlook 2015. Available from: https://iea.blob.core.windows.net/assets/5a314029-69c2-42a9-98ac-d1c5deeb59b3/WEO2015.pdf

Issayeva, G., Dyussembekova, Z., Aidarova, A.B., Makhatova, A.B., Lukhmanova, G., Absemetova, D., Bolganbayev, A. (2023), The relationship between renewable energy consumption, CO_2 emissions, economic growth, and industrial production index: The case of Kazakhstan. International Journal of Energy Economics and Policy, 13(6), 1-7.

Levin, A., Lin, C.F., Chu, C.S.J. (2002), Unit root tests in panel data: asymptotic and finite-sample properties. Journal of Econometrics, 108(1), 1-24.

Maddala, G.S., Wu, S. (1999), A comparative study of unit root tests with panel data and a new simple test. Oxford Bulletin of Economics and Statistics, 61(S1), 631-652.

Neelankavil, J.P., Stevans, L.K., Roman, F.L. Jr. (2012), Correlates of economic growth in developing countries: A panel cointegration approach. International Review of Applied Economics, 26(1), 83-96.

Nusair, S.A. (2016), The effects of oil price shocks on the economies of the Gulf Co-operation Council countries: Nonlinear analysis. Energy Policy, 91, 256-267.

OPEC. (2024a), Brief History. Available from: https://www.opec.org/opec_web/en/about_us/24.htm [Last accessed on 2024 Aug 03].

OPEC. (2024b), Annual Report. Available from: https://www.opec.org/opec_web/static_files_project/media/downloads/AR%202023.pdf [Last accessed on 2024 Aug 03].

Pesaran, M.H. (2004), General diagnostic tests for cross section dependence in panels. Cambridge Working Papers. Economics, 1240(1), 1.

Pesaran, M.H. (2006), Estimation and inference in large heterogeneous panels with a multifactor error structure. Econometrica, 74(4), 967-1012.

Pesaran, M.H. (2007), A simple panel unit root test in the presence of cross-section dependence. Journal of Applied Econometrics, 22(2), 265-312.

Pesaran, M.H., Shin, Y., Smith, R.J. (2001), Bounds testing approaches to the analysis of level relationships. Journal of Applied Econometrics, 16(3), 289-326.

Pesaran, M.H., Shin, Y., Smith, R.P. (1997), Pooled Estimation of Long-Run Relationships in Dynamic Heterogeneous Panels. University of Cambridge: Department of Applied Economics, Cambridge.

Pesaran, M.H., Ullah, A., Yamagata, T. (2008), A bias-adjusted LM test of error cross-section independence. The Econometrics Journal, 11(1), 105-127.

Priestley, M.B., Tong, H. (1973), On the analysis of bivariate non-stationary processes. Journal of the Royal Statistical Society: Series B (Methodological), 35(2), 153-166.

Sartbayeva, G., Balapanova, E., Mamytkanov, D., Talimova, L., Lukhmanova, G., Myrzabekkyzy, K. (2023), The relationship between energy consumption (renewable energy), economic growth and agro-industrial complex in Kazakhstan. International Journal of Energy Economics and Policy, 13(6), 227-233.

Shahan, Z. (2014), History of Wind Turbines. Renewable Energy World. Available from: https://www.renewableenergyworld.com/storage/grid-scale/history-of-wind-turbines/#gref

Somel, C. (2014), Makro İktisada Giriş. İstanbul: Yordam Kitap.

Sonmez, S. (2016), The Macroeconomic Response to Oil Price Shocks from 1970-2013. Dissertation, The New School.

Svendsen, T.M. (2013), Hydroelectric Power in Present and Future Energy Systems. (Unpublished Master's thesis) University of Bergen. Available from: https://hdl.handle.net/1956/6777

Taylor, M.P., Sarno, L. (1998), The behavior of real exchange rates during the post-Bretton Woods period. Journal of International Economics, 46(2), 281-312.

World Bank. (2024), Metadata Glossary. Available from: https://databank.worldbank.org/metadataglossary/world-development-indicators/series/AG.PRD.FOOD.XD [Last accessed on 2024 Jun 04].

Zaidi, S., Saidi, K. (2018), Environmental pollution, health expenditure and economic growth in the Sub-Saharan Africa countries: Panel ARDL approach. Sustainable Cities and Society, 41, 833-840.