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## The Asymmetric Impact of Oil Price Shocks on Economic Growth in OPEC Member Countries: Application of a Panel Nonlinear Autoregressive Distributed Lag (Panel NARDL) Model

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### ABSTRACT

This study examines the short- and long-run asymmetric effects of oil price shocks on economic growth in an oil-exporting economy using a nonlinear econometric framework. Employing a Nonlinear Autoregressive Distributed Lag (NARDL) model, with annual panel data (1990–2022), the analysis decomposes oil price movements into positive and negative partial sums to capture potential asymmetries in both the short and long run, while controlling for standard growth determinants including physical capital, labor force, energy consumption, trade openness, and inflation to mitigate omitted variable bias. The results reveal a counterintuitive short-run asymmetry: positive oil price shocks exert a statistically significant negative effect on economic growth, whereas negative oil price shocks generate a positive short-run growth response. We interpret this pattern through two interrelated transmission mechanisms grounded in macroeconomic theory. First, positive oil shocks may intensify Dutch disease dynamics by appreciating the real exchange rate, reallocating resources toward non-tradable sectors, and weakening productivity in tradable industries. Second, negative oil shocks can trigger corrective adjustments, including fiscal consolidation, improved resource allocation, and reduced rent-seeking behavior, thereby mitigating distortions accumulated during oil booms. In this framework, adverse oil shocks may temporarily stimulate efficiency-enhancing reallocations and productivity improvements, particularly in economies previously characterized by oil-driven misallocation. In the long run, however, oil price increases remain growth-enhancing, reflecting the dominant income and investment channels associated with sustained oil revenue expansion. These findings suggest that the growth effects of oil price shocks depend not only on their direction but also on structural characteristics and policy responses within oil-exporting economies.

**KEYWORDS:** Oil shock, Asymmetric, Economic Growth, NARDL, Panel Data

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## 1. Introduction

Oil shocks, as one of the most important exogenous factors in the economies of OPEC member countries, have had profound effects on the macroeconomic variables of these countries (Islam et al., 2024). Oil price fluctuations affect the economies of these countries through various channels such as government revenues, balance of payments, exchange rates, and inflation. In the short term, an increase in oil prices can lead to growth in government revenues and an improvement in the trade balance, but in the long term, it may weaken non-oil sectors by creating Dutch disease. On the other hand, a decrease in oil prices is often accompanied by government budget deficits, devaluation of the national currency, and an increase in inflation rates, which in turn exacerbate economic instability. Studies show that single-product economies are more vulnerable to these shocks due to their heavy dependence on oil revenues. Today, most political economy thinkers believe that the process of political and economic development and, consequently, the national security of oil-exporting countries is influenced by oil revenues (Qazi, 2013).

Revenues from oil sales constitute a very important source of financial and foreign exchange income for oil-exporting countries (Moshiri, 2015). The dependence of these revenues on the price of oil in the world market can be considered a reason for the emergence of uncertainty and instability in economic policies in these countries. Therefore, it can be said that any fluctuations and instability in the global oil market will lead to imbalances and even crises unless the right policies are adopted by governments to deal with these fluctuations (Güntner & Henler, 2021).

The effects of oil shocks in OPEC member countries are not limited to the economic sphere, but have also affected political and social structures (Sohag et al., 2024). For example, during oil booms, governments tend to expand welfare services by increasing public spending. However, during oil busts, reduced financial resources often lead to reduced public services and increased social discontent. Instability caused by oil shocks can also lead to changes in monetary and fiscal policies, which ultimately affect financial and investment markets (Vandyck et al., 2018). Research suggests that countries such as Nigeria and Angola, which have less diversified economies, face greater challenges in the face of oil shocks. Meanwhile, countries such as the United Arab Emirates and Qatar have been able to reduce their vulnerability to these shocks by adopting economic diversification policies (Basher et al., 2018).

The phenomenon of slow economic growth in resource-abundant countries, often referred to as the “resource curse,” is a central theme in the economic development literature (Badeeb et al., 2017). Empirical studies have shown that even after controlling for fluctuations in global resource prices, countries with natural resources, especially oil, experience lower economic growth than resource-poor countries. This is important for policymakers and economists, as understanding the factors that contribute to the failure of resource-abundant economic development can inform better policies (Rahim et al., 2021). Oil wealth in oil-rich countries acts as a double-edged sword. On the one hand, oil wealth can boost development by increasing national income. On the other hand, long-term economic growth will suffer due to imbalances in different sectors of the economy (Atkinson & Hamilton, 2003).

Given the importance of oil revenues in GDP, exports, and annual budget provision in the economies of oil-exporting countries, oil price fluctuations can have a significant and fundamental impact on the economic situation of these countries (Ghalayini, 2011). Oil price fluctuations are the main source of economic fluctuations in oil-producing countries. With a sudden increase in oil prices, foreign exchange revenues from oil sales and, as a result, government spending increase sharply, leading to rapid growth in prices, wage rates, and imports (Ftiti et al., 2016). Studying the impact of oil shocks on the economies of these countries is of vital importance in several ways. First, these countries are particularly exposed to fluctuations in global oil prices due to their heavy dependence on oil revenues (which in some cases account for up to 90% of the government budget and 80% of exports). Second, in the current global economic climate, which is facing global developments (such as the Ukraine war), sanctions, and energy transition, understanding the mechanisms of transmission of these shocks and designing adaptive policies has become essential. Third, historical experiences have shown that mismanagement of oil revenues can lead to phenomena such as Dutch disease, the spread of economic corruption, and the intensification of social inequalities, all of which are serious threats to sustainable development. Therefore, conducting in-depth studies in this area can help policymakers in these countries to maximize the opportunities arising from positive oil shocks by designing intelligent economic stabilization mechanisms, production diversification programs, and budget structure reform, and to increase their economic resilience against negative shocks.

The research literature indicates that oil price shocks have profound and asymmetric effects on macroeconomic variables and economic growth of countries dependent on oil revenues. Some studies, including Ha et al. (2023) and Bashir (2022), have shown that falling oil prices usually lead to a decrease in the growth of government-dependent economic sectors such as industry and agriculture, while less dependent sectors such as services and transportation are less affected. The findings of Ren et al. (2022) also indicate a nonlinear relationship between oil prices and economic growth, such that an increase in oil prices has a significant negative impact on economic activities in industrialized countries, while a decrease in oil prices has little effect. In this regard, Yu et al. (2022) showed that positive oil price shocks can temporarily increase economic growth, but negative shocks can moderate this growth and keep the economy at a moderate level. Also, research by Arif et al. (2022) and Alenoghena and Aghughu (2022) in developed countries such as the United States showed that oil price fluctuations have different effects on GDP; such that an increase in oil prices is often associated with a decrease in economic growth. In contrast, Olamide and Maredza (2021) showed that this relationship is not necessarily seen significantly in developing countries, although the effect of an increase in oil prices on economic growth is greater than its decrease. Van Eyden et al. (2019) also showed in a study on OECD countries over a long period that oil price fluctuations have had a negative and significant effect on economic growth, especially in oil-producing countries such as Norway and Canada. Finally, Jarrett et al. (2019) showed that proper management of fiscal and monetary policies can moderate the negative effects of oil shocks. This set of findings shows that oil price shocks act on the economy through various channels, and this requires the design of smart and flexible coping policies by policymakers. In Iran, several

studies have also examined the impact of oil price shocks on macroeconomic variables. Tariverdi et al. (2024) used a structural vector autoregression model in their study to examine the economic effects of oil price shocks in oil-exporting countries. The results showed that oil price uncertainty shocks were an important driver of industrial production fluctuations in the studied countries. However, the exchange rate response to oil price uncertainty shocks was different in the studied countries. Gholampour et al. (2022) showed that increasing oil revenues leads to an increase in government size through an increase in current government spending relative to GDP.

Komijani & Haji Heidari (2024) investigated the asymmetric effects of oil price shocks, oil price uncertainty, and economic sanctions on economic growth and inflation in Iran using an autoregressive model approach with nonlinear distribution lags. The results of their study showed that a positive shock to the logarithm of oil had a positive effect and a negative shock to the logarithm of oil price had a negative effect on Iran's economic growth.

This set of studies highlights the important role of oil shocks in determining the path of economic growth and macroeconomic stability in Iran and shows the necessity of designing smart policies to deal with oil market fluctuations.

This study aims to respond to the gaps in the literature on oil economics and the urgent policy needs in oil-producing countries. A systematic review of previous studies shows that there are gaps in this area: first, existing studies have mainly focused on examining the symmetric effects of oil shocks and have neglected to analyze the asymmetric effects of oil price increases and decreases. Second, the mediating role of other variables, such as economic policy instability, in the transmission of oil shocks to economic growth has been neglected. Third, previous studies have used traditional methodologies that are unable to identify the behavioral complexities of variables. Fourth, there is a lack of studies that have simultaneously analyzed the short-term and long-term effects of oil shocks by considering the specific characteristics of oil economies. Therefore, this study attempted to examine the asymmetric effects of oil shocks on economic growth in OPEC member countries using a panel nonlinear extended lag (Panel NARDL) model.

## 2. Research Method

According to the theoretical foundations and existing literature on economic growth, the general form of the model used, which is the basis for estimating and estimating the factors affecting the economic growth of OPEC member countries, is as follows (Ha et al., 2023; Yu et al., 2022; Komijani & Haji Heidari, 2024). To address potential omitted variable bias arising from the correlation between oil prices and global business cycles, the model incorporates standard control variables consistent with the augmented Solow growth framework. These include physical capital (investment proxy), labor force (human capital proxy), trade openness, and inflation, ensuring that the estimated oil shock coefficients reflect genuine asymmetric effects rather than confounding macroeconomic trends.

$$GDPG_{it} = f(CAP_{it}, LAB_{it}, EN_{it}, OP_{it}, TR_{it}, INF_{it}) \quad (1)$$

where GDPGR is the growth rate of gross domestic product, CAP is the stock of physical capital, LAB is the total employed labor force, EN is energy consumption, OP is the price of oil (oil

shocks), TR is the trade liberalization index, and INF is the inflation rate in OPEC member countries (i) in the period under consideration (t).

We sincerely thank the reviewer for this sophisticated methodological observation. We agree that distinguishing between exogenous oil supply shocks and endogenous demand-driven price changes (as per Kilian, 2009) is crucial for causal identification. However, the primary objective of this study is to assess the overall economic vulnerability of OPEC member countries to oil price fluctuations, regardless of their origin. Since fiscal budgets and macroeconomic planning in these rentier states react to observed price levels rather than the structural source of the price change, using raw oil price data within the Panel NARDL framework allows us to capture the net asymmetric impact on growth. This approach is consistent with established literature on oil-dependent economies (e.g., Moshiri, 2015; Shin et al., 2014) that focuses on transmission mechanisms of price volatility. To mitigate endogeneity concerns, we have controlled for global business cycle effects through trade openness and inflation variables, and incorporated dummy variables for major exogenous disruptions (2008, 2014, 2020). Nevertheless, we acknowledge this limitation and have added a dedicated paragraph in the 'Discussion' section clarifying the terminology (using 'price fluctuations' instead of 'structural shocks') and suggesting structural decomposition as a priority for future research.

## **Model Estimatio:**

### **A) Stationarity Test of Panel Data**

In composite models, as in time series models, if the variables are non-stationary, the problem of spurious regression will apply and the observation of high  $R^2$  is not due to the existence of the time variable due to the real relationship between the variables (Gujarati, 2004). Therefore, the use of the unit root test of composite data will be necessary to ensure the accuracy and validity of the results. There are several unit root tests on composite data, including: Levin et al. (2002), Im et al. (2003), Fisher tests (Chu (2001) and Hadri test (2000)). Most of these tests are similar, but there are differences in how they are performed. These tests are classified based on the restrictions they impose on the autoregressive process across sections or series.

### **B) Panel Data Cointegration Test**

Cointegration can be considered as a method of estimating the long-run equilibrium coefficients of a model whose variables have a single root and are therefore non-stationary. Although the stationary condition of time series variables can be ensured through differentiation, this causes valuable information to be lost regarding the level of the variables. The cointegration method allows one to estimate a regression based on time series variables without fear of its being spurious. Several tests have been proposed to test cointegration with completely different approaches, including the Pedroni (2004) and Kao (1999) tests. The Kao and Pedroni test is based on the regression residual test and is similar to the Engel-Granger cointegration test for time series data. The seven statistics that Pedroni uses for the panel cointegration test are: Group 1; intra-dimensional test statistics: panel statistic, Phillips-Perron panel p-statistics, Phillips-Perron panel

t-statistics, generalized Dickey-Fuller panel statistic. Group 2; inter-dimensional test statistics: Phillips-Perron group p-statistics, Phillips-Perron group t-statistics, and group statistic. Kao (1999) also presented the generalized Dickey-Fuller cointegration test assuming that the cointegration vectors are homogeneous at each time point. The null hypothesis in both the Pedorni and Kao tests indicates the absence of cointegration between the variables in the model.

### c) Panel NARDL method

The nonlinear autoregressive approach with large lags was first presented by Shin et al. (2014). This method is actually an extension of the autoregressive approach with large lags (ARDL) presented by Pesaran and Shin (1995), but in the NARDL approach, unlike the ARDL approach, the asymmetric effects of the independent variable can be examined in the short and long term.

Since the NARDL approach is an extension of the ARDL approach, it also has the advantages of the ARDL method. Among other things, in this method, the model can be estimated regardless of whether all variables are sums of degree one (I(1)) or a combination of degrees zero (I(0)) and one (I(1)) (Pesaran and Shin, 1995). Also, in the ARDL method, in addition to the possibility of introducing independent and dependent variable lags in the model, this approach can also be used in small samples. In addition, the use of this method is possible even in cases where the variables of the model are endogenous. In addition to the above, the NARDL approach, unlike the ARDL method, allows the researcher to simultaneously examine the existence of nonlinear and asymmetric relationships in the short and long term (Noh & Masih, 2017). Also, asymmetric relationships can exist only in the long term or in the short term or in both, and therefore the effect of positive and negative shocks of independent variables on the dependent variable can be examined in short and long term separation (Ahmad et al., 2018). Another advantage of the NARDL approach is that it can be estimated using the ordinary least squares (OLS) method and linear coefficients are estimated. The bivariate NARDL model can be represented as equation (2):

$$Y_t = \beta^+ X_t^+ + \beta^- X_t^- + u_t$$

(2)

Where  $\beta^-$  and  $\beta^+$  are the long-term coefficients of the model. It can also be separated and decomposed into positive and negative changes as equation (3):

(3)

$$X_t = X_0 + X_t^+ + X_t^-$$

In the above equation,  $X_0$  is the initial value of the variable  $X_t$ . Also,  $X_t^+$  and  $X_t^-$  are the partial sums of positive and negative changes in the variable  $X_t$ , respectively, which can be expressed as equations (4) and (5).

$$X_t^+ = \sum_{t=1}^t \Delta X_t^+ = \sum_{t=1}^t \max(\Delta X_t, 0) \quad (4)$$

$$X_t^- = \sum_{t=1}^t \Delta X_t^- = \sum_{t=1}^t \max(\Delta X_t, 0) \quad (5)$$

Shin et al. (2011) combined equation (3) and the linear ARDL(p,q) model presented by Pesaran and Shin (1999) and Pesaran et al. (2001), and expressed the NARDL(p,q) model as equation (6).

$$\Delta Y_t = \alpha_0 + \rho Y_{t-1} + \theta^+ X_{t-1}^+ + \theta^- X_{t-1}^- + \sum_{i=1}^{\rho} \phi_i \Delta Y_{t-i} + \sum_{i=1}^q (\pi_i^+ \Delta X_{t-i}^+ + \pi_i^- \Delta X_{t-i}^-) + e_t$$

In the above relationship,  $\theta^+ = -\rho\beta^+$  and  $\theta^- = -\rho\beta^-$

The estimation of the model using the NARDL approach includes the following steps. In the first step, the NARDL(p,q) model is estimated using the ordinary least squares (OLS) method and the optimal interval is determined based on one of the Akaike or Schwarzchild criteria. Next, the existence of a non-linear (asymmetric) cointegration relationship between the independent and dependent variables ( $y_t, x_t^+, x_t^-$ ) is examined.

For this purpose, it is necessary to use the bounds test and the modified values of the F statistic presented by Pesaran et al. (2001) and Shin et al. (2011), Test the equality  $\rho = \theta^+ = \theta^- = 0$

This test has two upper and lower critical limits. If the calculated values of the F-statistic are greater than the upper limit, it can be said that there is a long-term equilibrium relationship, or in other words, cointegration between the model variables. If the existence of cointegration is confirmed, the symmetric or asymmetric relationships in the short and long term can be examined using the Wald test (Atanasas et al., 2014). To examine the existence of asymmetric relationships in the long term, it is necessary to test the following null hypothesis:

$$H_0: -\frac{\theta^+}{\rho} = -\frac{\theta^-}{\rho}$$

Also, in order to examine the existence of an asymmetric relationship in the long run, it is sufficient to test the following null hypothesis:

$$H_0: \sum_{i=1}^q \pi_i^+ = \sum_{i=1}^q \pi_i^-$$

The panel version of the NARDL model is similar to the time series model. According to Odugbesan et al. (2021), this model is a nonlinear representation of the dynamic heterogeneous panel data model dedicated to modeling large panels. The first step in the specification of the econometric model will be to introduce the asymmetric effect in a single equation using the panel representation of the Shin et al. (2011) model. Given two variables Y and X, where Y is the dependent variable and X is the independent variable, the modeling is as follows:

$$\Delta Y_{it} = \beta_0 + \beta_1 y_{it-1} + \beta_2^+ x_{it-1}^+ + \beta_2^- x_{it-1}^- + \sum_{n=1}^l \alpha_n \Delta y_{it-n} + \sum_{n=0}^k (\gamma_n^+ \Delta x_{it-n}^+ + \gamma_n^- \Delta x_{it-n}^-) + \mu_i + e_{it} \quad (7)$$

where l and k indicate the order of the lags of the variables.  $\mu_i$  represents the country-specific effect and  $e_{it}$  the asymmetric effects, and the coefficients  $\beta_2^+$  and  $\beta_2^-$  indicate the long-run asymmetry, while  $\gamma_n^+$  and  $\gamma_n^-$  indicate the short-run asymmetric coefficients. The Wald test is used to test for long-run symmetry. For symmetry, when the null hypothesis is rejected, the model is asymmetric for the relevant time horizon. According to Pesaran & Smith (2014), no control variables are included in the specified model. They argued that when one does not intend to study the effect of a variable, all other variables are equal, such as explanatory variables on the dependent variables. Furthermore, in the study by Shin et al. (2011) on modeling asymmetric cointegration in a

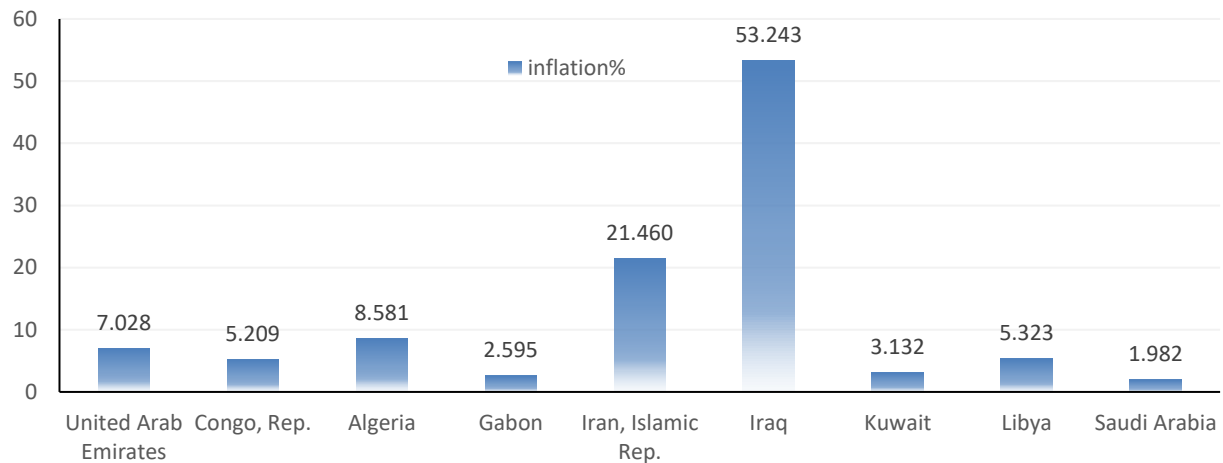
nonlinear ARDL model, the asymmetric link between some variables is tested without including control variables in their regression. A similar method was used by Ewodo-Amougou et al. (2023) The threshold cointegration and causality are used. The equations are estimated using a Pooling Mean Group (PMG) or Moving Average (MG) estimator. These estimators are suitable for long-term panel data, as they provide a good estimate of long-term as well as short-term dynamics. In this study, the following model was used to investigate the asymmetric effects of oil shocks on economic growth in OPEC member countries:

$$LN\text{GDPG}_{it} = \alpha + \beta_1^+ LN\text{OP}_{it}^+ + \beta_1^- LN\text{OP}_{it}^- + \beta_2 LN\text{LAB}_{it} + \beta_3 LN\text{CAP}_{it} + \beta_4 LN\text{TR}_{it} + \beta_5 LN\text{INF}_{it} + \beta_6 LN\text{EN}_{it} \quad (8)$$

The data used in this study was collected from the World Bank website as a panel for 9 OPEC member countries (UAE, Congo, Algeria, Gabon, Iran, Iraq, Kuwait, Libya, and Saudi Arabia) during the years 1990-2022. All variables are measured at annual frequency to ensure data consistency and comparability across OPEC member countries, given that key macroeconomic indicators (e.g., physical capital formation, trade liberalization index) are predominantly reported annually in international databases. While annual data aggregate within-year fluctuations, they are appropriate for examining medium-term structural relationships and asymmetric adjustment mechanisms in oil-dependent economies, consistent with prior panel studies in this literature (Moshiri, 2015; Shin et al., 2014). The term 'short-run' in our NARDL specification refers to error-correction dynamics within the annual time unit, not intra-annual fluctuations. Eviews 13 software was used to estimate the model.

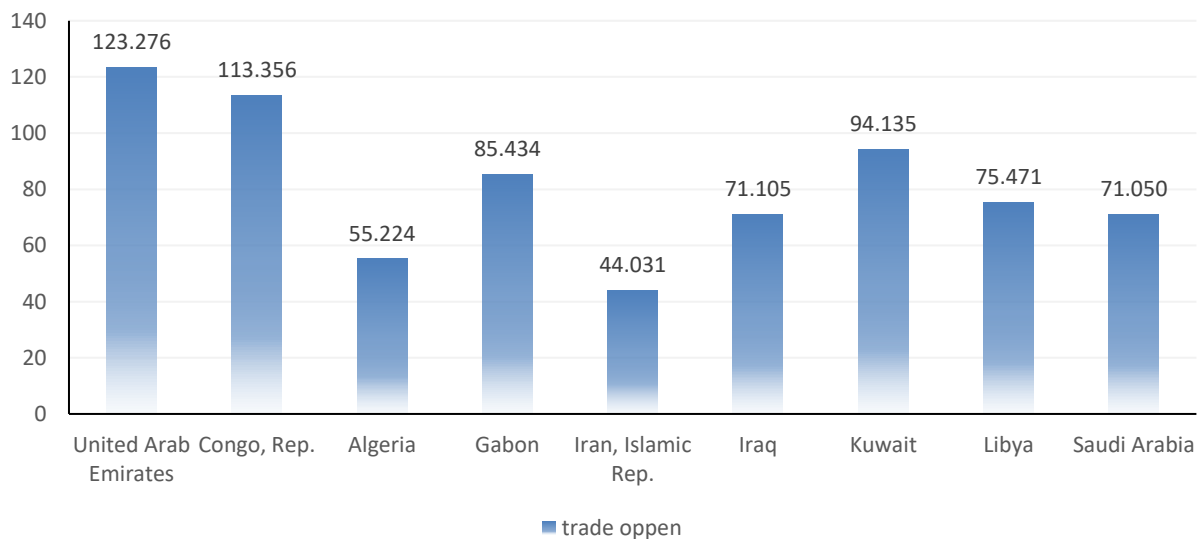
### 3. Results

In this section, an attempt was first made to examine the research variables for the countries under study. Based on the data collected, the average inflation rate of OPEC member countries during the period 1990 to 2022 shows significant differences (Figure 1). Iraq has the highest rate among these countries with an average inflation rate of 243.53 percent, which is probably due to the long-term political and economic instability in the country. After that, Iran is in second place with an average inflation rate of 21.460 percent, which is a reflection of international sanctions and domestic challenges to the country's economy. Algeria and the United Arab Emirates are in the next ranks with rates of 581.8 and 028.7 percent, respectively. In contrast, countries such as Saudi Arabia (1.982%), Kuwait (132.3%), and Gabon (595.2%) have experienced the lowest inflation rates, indicating economic stability and efficient financial management in these countries.



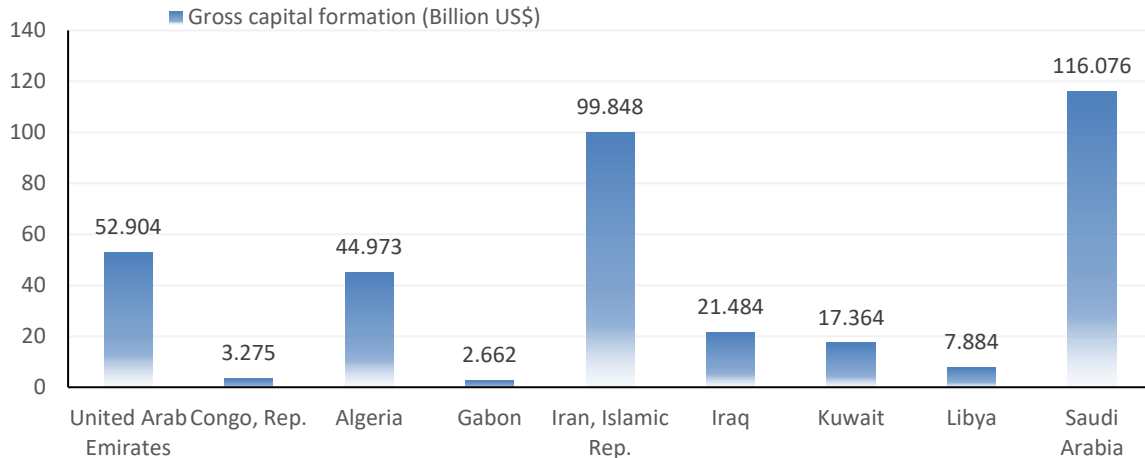
**Fig (1).** Average inflation rate during the period under review in OPEC member countries

The average trade liberalization rate (as a percentage of GDP) of OPEC member countries over the period 1990–2022 is shown in Figure 2. The United Arab Emirates has the highest level of trade liberalization at 123.27 percent, indicating a highly open economy dependent on international trade, particularly in the oil and services sectors. This is followed by Congo at 113.356 percent and Kuwait at 13.94 percent, indicating the important role of trade in these countries' economies. In contrast, Iran at 44.03 percent and Algeria at 55.22 percent have experienced the lowest levels of trade liberalization, likely due to protectionist policies and trade restrictions in these countries. Countries such as Iraq (71.10 percent), Libya (75.47 percent), and Saudi Arabia (71.05 percent) fall in the middle of this spectrum.



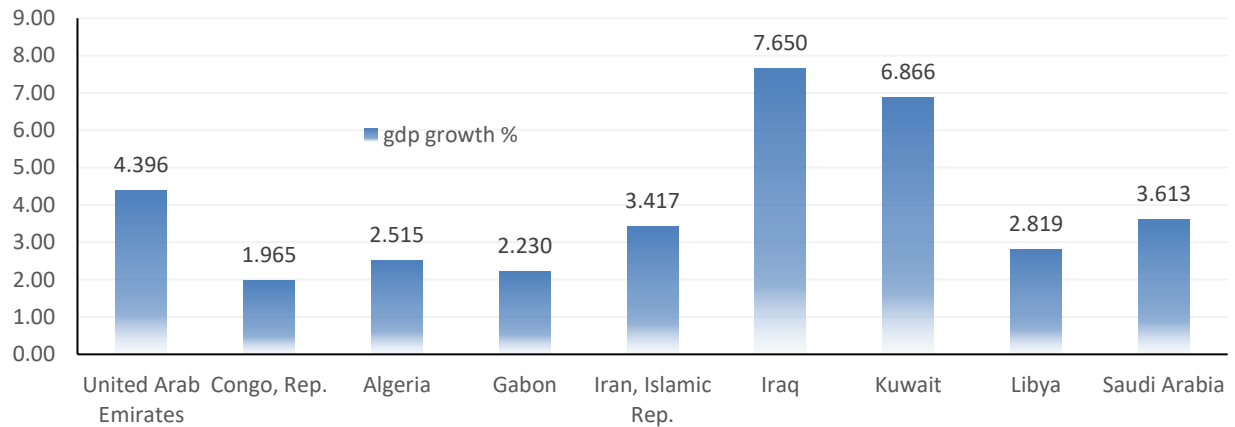
**Fig (2).** Average trade liberalization index in OPEC member countries

An examination of the average physical capital (gross capital formation) data shows that Saudi Arabia, with an average of \$116.07 billion, and Iran, with \$99.84 billion, respectively, had the highest levels of physical investment, likely driven by the infrastructure and industrial development programs of these two large economies in the region. The United Arab Emirates, with \$52.90 billion, and Algeria, with \$44.97 billion, followed closely behind, while smaller countries such as Kuwait (\$17.36 billion) and Iraq (\$21.48 billion) experienced moderate levels of investment.



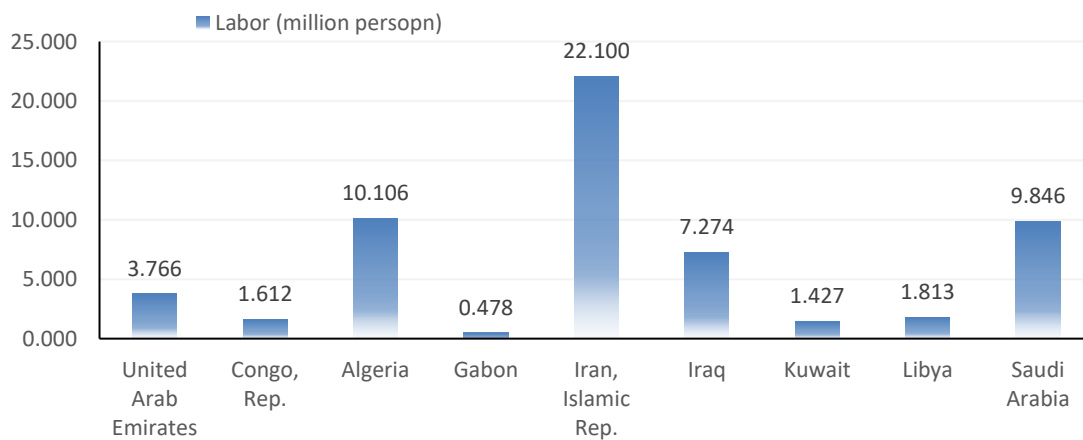
**Fig (3).** Average physical capital in OPEC member countries

Analysis of average GDP growth data for OPEC member countries from 1990 to 2022 shows significant differences in their economic performance. Iraq, with an average annual growth rate of 65.7 percent, has the highest growth rate among the countries studied, which is likely due to the reconstruction of infrastructure after the war and the increase in oil production capacities in the country. Kuwait is in second place with a growth rate of 86.6 percent, which indicates relative economic stability and effective investments in the country. In contrast, Congo, with a growth rate of 96.1 percent, and Gabon, with a growth rate of 23.2 percent, have experienced the lowest growth rates, which could be due to structural challenges and heavy dependence on natural resources. Iran (41.3%), Saudi Arabia (61.3%), and the United Arab Emirates (39.4%) performed moderately, reflecting the impact of variables such as international sanctions, oil price fluctuations, and domestic economic policies on their economic growth.



**Fig (4).** Average GDP growth in OPEC member countries

Analysis of the average workforce size of OPEC member countries over the period 1990-2022 shows that Iran has the largest labor market among the countries studied, with 22.1 million workers, reflecting the country's relatively young and large population. After Iran, Algeria has the second largest labor market with 10.1 million and Saudi Arabia has the third largest labor market with 8.9 million. In contrast, Gabon has the smallest labor market in this group with only 0.478 million workers. In terms of energy consumption (Figure 7), the United Arab Emirates has the highest energy consumption among these countries, with a per capita consumption of 9766.46 kg of crude oil equivalent. In contrast, Congo has the lowest energy consumption with a per capita consumption of only 390.39 kg, reflecting the country's low level of industrial development and limited access to energy. Iran (2319.53 kg) and Libya (2850.13 kg) are in the middle of the spectrum.



**Fig (5).** Average labor force in OPEC member countries

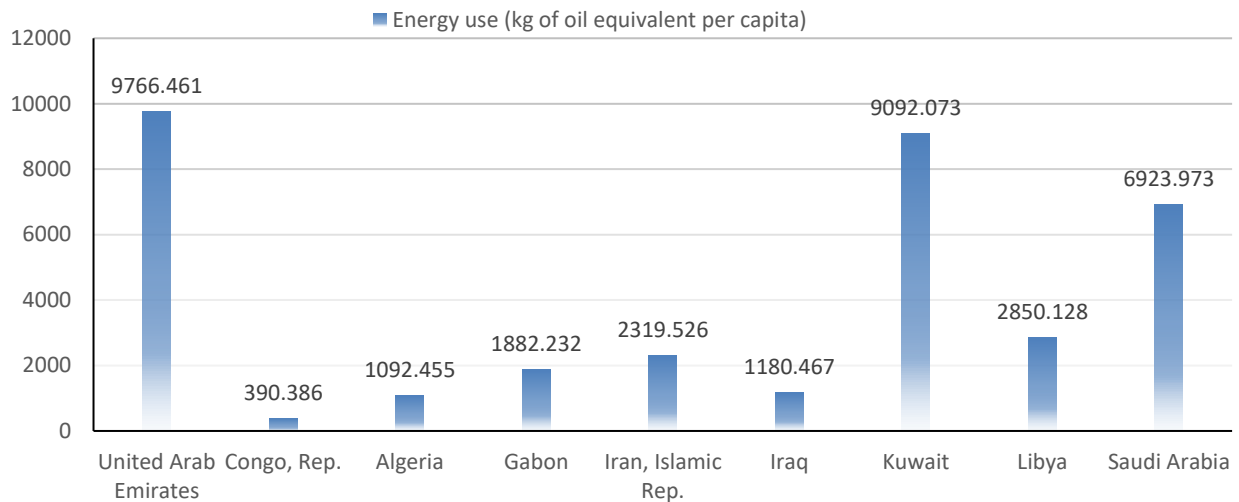


Fig (6). Average per capita energy consumption in OPEC member countries

### Results of the Stationarity of Variables Study

Before estimating the model, it is necessary to test the stability of all variables used in the estimates, because the instability of variables, whether in the case of time series or panel data, causes the problem of spurious regression. In mixed data, tests such as Dickey-Fuller and Generalized Dickey-Fuller cannot be used, but it is necessary to test the collective stationarity of the variables in some way. Therefore, before estimating the model, the stationarity of the variables was examined using the Im, Pesaran and Shin, Levin-Lin and Cho test, and Fisher's ADF test. The results of the stationarity tests for the OPEC member countries panel data show that most variables are at the stationary level. The statistical calculations for the variables logarithm of physical capital (LNCAP), energy consumption (LNEN), economic growth rate (LNDGPG), inflation rate (LNINF), and trade liberalization (LNTR) are all significant at the 1% significance level based on the Levine-Lin, Im-Pesaran, and Shin tests, and Fisher's ADF, and therefore are at the stationary level. However, the two variables logarithm of labor (LNLAB) and oil price (LNOP) are not at the stationary level and become stationary after first difference. These results indicate that special attention should be paid to the stationary properties of these variables for further analyses, especially in modeling the long-run relationship.

**Table (1).** Stationarity results of variables (panel data - OPEC countries)

Static condition	Fisher ADF	Im-Pesaran and Shin	Levin-Lin and Cho	Variables
With width from origin and no trend I(0)	36/089*** (0/00)	-4/206*** (0/00)	-4/042*** (0/00)	Logarithm of physical capital LNCAP
With width from origin and trend I(0)	52/691*** (0/33)	-4/226*** (0/00)	-5/029*** (0/00)	Logarithm of energy consumption LNEN
With width from origin and trend I(0)	81/190*** (0/00)	-7/104*** (0/00)	-5/787*** (0/00)	Logarithm of economic growth rate LNGDPG
With width from origin and trend I(0)	47/824*** (0/00)	-4/236*** (0/00)	-3/845*** (0/00)	Logarithm of inflation rate LNINF
With width from origin and trend I(0)	61/002*** (0/011)	-5/599*** (0/010)	-2/376*** (0/00)	Logarithm of labor LNLAB
With width from origin and trend I(1)	98/850*** (0/033)	-9/173*** (0/055)	-4/756*** (0/00)	Logarithm of oil price LNOP
With width from origin and trend I(0)	28/711** (0/02)	-1/76** (0/03)	-3/107*** (0/00)	Logarithm of trade liberalization LNTR

Given that OPEC member countries share common exposure to global oil price fluctuations and regional economic spillovers, the assumption of cross-sectional independence is likely violated. Therefore, prior to unit root testing, we employ Pesaran's (2004) Cross-Sectional Dependence (CD) test. The null hypothesis of this test assumes no cross-sectional dependence. As reported in Table 2, the CD statistic is 2.10 ( $p < 0.05$ ), leading to the rejection of the null hypothesis. This confirms the presence of cross-sectional dependence in our panel data, necessitating the use of second-generation unit root tests.

**Table (2).** Cross-Sectional Dependence (CD) test

Test	Statistic	d.f.	prob
Breusch-Pagan LM	229.78	28	0.000
Pesaran scaled LM	19.37		0.000
Pesaran CD	2.10		0.043

Since the CD test confirms cross-sectional dependence, traditional first-generation unit root tests (such as LLC, IPS, and Fisher-ADF) may yield biased results. Consequently, we additionally employ Pesaran's (2007) Cross-sectionally Augmented IPS (CIPS) test, which accounts for cross-sectional dependence by augmenting the standard ADF regression with cross-sectional averages of lagged levels and first differences. The results of the CIPS test, presented in Table 3, are largely consistent with our initial findings: LNCAP, LNGDPG and LNTR are stationary at levels, while

LNEN, LNINF, LNOP and LNLAB become stationary after first differencing. These results validate the appropriateness of proceeding with panel cointegration and NARDL estimation.

**Table (3).** Pesaran's (2007) Cross-sectionally Augmented IPS (CIPS) test

Static condition	Pesaran CIPS	Variables
I(0)	-3/58***	Logarithm of physical capital LNCAP
I(1)	-2/19	Logarithm of energy consumption LNEN
I(0)	-3/89***	Logarithm of economic growth rate LNGDPG
I(1)	2.16	Logarithm of inflation rate LNINF
I(1)	-1.98	Logarithm of labor LNLAB
I(1)	-1.78	Logarithm of oil price LNOP
I(0)	-2/94***	Logarithm of trade liberalization LNTR

### Results of examining the existence of a cointegration relationship

Pedroni and Kao cointegration tests are used as two key methods to examine the existence of a long-run relationship between variables in panel data. The Pedroni test, by using pooled and group statistics (such as PP and ADF statistics), allows the examination of cointegration under different conditions (with, with, and without the origin). On the other hand, the Kao test examines the long-run relationship by focusing on a single statistic (ADF). These tests are especially important when some variables are stationary at the level (I(0)) and others at the first difference (I(1)). The results of the Pedroni test show that the PP and ADF statistics (both pooled and group) are significant at the 1% significance level in all conditions (with, with, and without the origin) which indicates the rejection of the hypothesis of no cointegration. Also, the Kao test with the ADF statistic is -2.062 which is significant at the 5% level and confirms the existence of a cointegration relationship. These results strongly indicate the existence of a long-run relationship between the model variables (economic growth, physical capital, labor, energy consumption, oil prices, trade liberalization, and inflation) in OPEC member countries. Therefore, panel error correction (PMG) models or other long-run relationship analysis methods can be used to estimate the parameters more accurately. These findings highlight the importance of paying attention to the long-run balance between economic variables in the macroeconomic policies of these countries.

**Table (4).** Results of the Pedroni covariance test

$GDPG_{it} = f(CAP_{it}, LAB_{it}, EN_{it}, OP_{it}, TR_{it}, INF_{it})$			Test statistic
No width from origin and trend	With width from origin and trend	With width from origin	
-0/28(0/61)	-1/99(0/97)	-0/97 (0/83)	<b>V-statistics combined</b>
-2/26** (0/01)	-0/06(0/47)	-1/14 (0/12)	<b>Statistics - RHO Consolidated</b>
-8/58*** (0/00)	-10/61*** (0/00)	-8/51*** (0/00)	<b>Statistics - PP consolidated</b>
-4/56*** (0/00)	-4/87*** (0/00)	-437*** (0/00)	<b>Statistics - ADF consolidated</b>
-2/02** (0/02)	0/34(0/63)	-0/80(0/20)	<b>Statistics - RHO Group</b>
-12/48*** (0/00)	-14/08*** (0/00)	-12/68*** (0/00)	<b>Statistics - Group PP</b>
-5/23*** (0/00)	-4/42*** (0/00)	-4/69*** (0/00)	<b>Statistics - Group ADF</b>

Source: Research findings (\*, \*\*, and \*\*\* are significant at the 10, 5, and 1 percent levels, respectively.)

**Table (5)** Results of the Kao test

Test statistic	t-statistic	prob
ADF	-2/062**	<b>0/01</b>

Furthermore, to validate the existence of a long-run cointegrating relationship among the variables, the panel bounds testing approach adapted from Pesaran et al. (2001) was employed. This result provides robust statistical evidence confirming the presence of a stable long-run equilibrium relationship between economic growth and its determinants—including physical capital, labor, energy consumption, oil prices, trade liberalization, and inflation—across OPEC member countries. Consequently, the application of the Panel NARDL framework is justified, allowing for the consistent estimation of both long-run asymmetric effects and short-run dynamic adjustments.

**Table (6).** Bound test results

Cross section	F-stat					
1	4.54					
2	6.97					
3	4.43					
4	2.99					
5	5.02					
6	4.89					
7	4.71					
8	4.37					
Sample size	10%		5%		1%	
	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)

Cross section	F-stat					
30	2.27	3.49	2.73	4.16	3.86	5.69
35	2.19	3.37	2.59	3.90	3.59	5.23
Asymptotic	1.92	2.89	2.17	3.21	2.73	3.90

### Results of the long-run and short-run relationship estimation (Panel NARDL)

The results of the long-run relationship estimation of the NARDL model with panel data for OPEC member countries are presented in Table (7). The estimated coefficient of the physical capital variable indicates that with a one percent increase in physical capital in OPEC member countries, assuming other conditions are constant, economic growth in these countries decreases by 0.258 percent. The results indicate a negative relationship between physical capital and economic growth (coefficient -0.258), which could be due to several structural factors. First, in oil-dependent economies, investments are mainly concentrated in capital-intensive and low-yield sectors (such as extractive industries) that have a limited effect on total factor productivity. Second, studies show that the abundance of oil revenues often leads to suboptimal investments in demonstration projects with low economic returns (the "resource curse" phenomenon). Also, weak regulatory systems in these countries may lead to inefficient allocation of capital to corrupt or politically motivated projects. The positive and significant coefficient of energy consumption (0.404) confirms the theory of the "energy-driven growth engine" in these countries. The estimated coefficient of this variable shows that a one percent increase in energy consumption in these countries, assuming other conditions are constant, increases the growth rate of production in these countries by 0.404 percent. Given the heavy energy subsidies and easy access to fossil fuel resources, energy acts as a cheap input in the production process. This finding is consistent with the studies of Pomogran (2019) who shows that in oil countries, increased energy consumption due to low domestic prices is a driver of economic growth. However, this relationship may weaken in the long run due to the lack of attention to energy efficiency. The estimated coefficient of inflation rate is 0.131, which is significant at the one percent level. The positive relationship of inflation with production growth may be explained within the framework of the "optimal inflation hypothesis". At low to moderate levels (below 10%), inflation can increase firms' profitability and stimulate investment by reducing the real value of wages. However, this effect is reversed at high levels of inflation. Interestingly, the average inflation in these countries (with the exception of Iran and Iraq) is generally within the optimal range. The results presented in Table (7) show that the estimated coefficient of the labor force variable is 0.244, which is not significant at an acceptable level. The lack of significance of the labor force coefficient can be attributed to structural labor market challenges in these countries. First, a large part of employment is concentrated in the unproductive public sector. Second, education systems often do not match labor market needs, leading to a skills gap. Also, the heavy dependence on foreign labor in some countries (such as the Persian Gulf) has prevented a direct relationship between domestic labor and economic growth. The results suggest that in the long run, a one percent increase in the trade liberalization index leads to a 0.155 percent increase in the GDP growth rate in OPEC member countries. The relatively weak effect of trade liberalization indicates

that the benefits of trade in single-product economies are limited. The “Dutch disease” theory predicts that oil revenues, by strengthening the national currency, weaken the non-oil tradable sector. Therefore, trade liberalization without economic diversification has limited effects. This finding is consistent with the studies of Sachs and Warner (2001) on oil-exporting countries.

The results of the present study show that positive oil price shocks have a positive and significant effect on the economic growth rate with a coefficient of 0.214 and a significance level of 10 percent. While the long-run positive coefficient (0.214) associated with oil price increases indicates a statistically significant expansionary effect, it should not be interpreted mechanically as proof of structural dependence on oil revenues. Rather, this coefficient captures a long-run association that may operate through several transmission channels. One plausible mechanism is procyclical fiscal expansion during oil booms, whereby higher oil revenues relax budget constraints and stimulate aggregate demand through increased public expenditure. Another channel may involve capital accumulation and investment in oil-related infrastructure and upstream industries, which can generate spillover effects to the broader economy. Therefore, the long-run growth response may reflect revenue-driven fiscal and investment dynamics rather than inherent structural dependence per se. This distinction is important to avoid conflating statistical association with structural causality. In contrast, negative oil price shocks in the long run lacked statistical significance. While this may be attributed to adjustment mechanisms such as financial stabilization funds and intelligent management of foreign exchange reserves in some members (e.g., GCC countries), we acknowledge significant heterogeneity across the sample. As shown in our descriptive statistics (Figures 1-3), countries like Iraq and Nigeria face different fiscal constraints compared to the UAE or Saudi Arabia. Thus, the panel result represents an average effect that may mask individual country vulnerabilities.

**Table (7).** Results of estimating the long-run relationship of Panel Nonlinear ARDL

95% Confidence Inte	Prob	T-status	Deviation	Coefficients	Variables
[0.026,-0.542]	0/07	-1/78	0/145	- 0/258*	Logarithm of Physical Capital LNCAP
[0.656,0.151]	0/00	3/12	0/129	0/404**	Logarithm of energy consumption per capita LLEN
[0.256,0.005]	0/04	2/02	0/064	0/131**	Logarithm of inflation rateLNINF
[0.5490,-0.061]	0/12	1/55	0/156	0/244	Logarithm of laborLNLAB
[0.331,-0.021]	0/08	1/71	0/090	0/155*	Logarithm of trade liberalizationLNTR
[0.439,-0.11]	0/06	1/86	0/115	0/214**	Positive momentum in oil prices@CUMDP(LNOP)
[0.680,-0.096]	0/14	1/47	0/198	0/292	Negative oil price shock @CUMDN(LNOP)
-	0/81	-0/231	1/465	-0/338	Width from origin C

Source: Research findings (\*\*\*) is significant at the 1 percent level.)

The results of the short-run model estimation indicate dynamic adjustment mechanisms in the economies of OPEC member countries. The error correction term (COINTEQ) with a coefficient of -0.949 and a significance level of 1% indicates that the speed of adjustment towards long-run

equilibrium is very high (about 95% in each period), indicating a significant ability of these economies to absorb shocks and return to the equilibrium path. This result is consistent with the findings of panel data studies in oil economies, which usually show a faster adjustment speed than other economies.

In the investment sector, the positive and significant coefficient of the current difference of physical capital (1.36) indicates an immediate and strong impact of new investments on economic growth, while its insignificant lag coefficient (0.96) indicates that the effect of investments is more short-term and has little persistence. This pattern may be due to the nature of capital projects in these countries, which are mainly focused on the oil and gas sector and have immediate but transitory effects. Energy consumption with a coefficient of 1.01 is significant at the 10% level, indicating the critical role of energy as a production input in the short run. Interestingly, inflation and its lag have a negative but insignificant effect, which could indicate the existence of price adjustment mechanisms in these economies. Trade liberalization, with a coefficient of 1.97, although significant in terms of effect size, is not statistically significant due to high dispersion (standard deviation 1.083), which is likely due to the heterogeneity of trade policies across member countries. A deeper analysis of oil shocks reveals asymmetric behavior in the short run. The positive oil price shock with a coefficient of -0.47 is significant at the 10% level, indicating that in the short run, an increase in oil prices may have a negative effect on growth. This seemingly contradictory result can be explained by the “Dutch disease” theory, according to which a sudden increase in oil revenues hurts the manufacturing sector in the short run by strengthening the national currency and attracting resources to the non-tradable sector. On the other hand, the negative oil price shock with a positive coefficient of 0.85 (at the 10% significance level) suggests that a decrease in oil prices may have a stimulating effect in the short run. This phenomenon can be explained by the “forced structural adjustment” mechanism, in which a decrease in oil revenues forces governments to reform their economies and increase productivity.

**Table (8).** Results of estimating the short-run Panel Nonlinear ARDL relationship

95% Confidence Inte	Prob	T-status	Deviation	Coefficients	Variables
[-1.08,-0.81]	0/00	-13/71	0/069	-0/949***	Error correction sentence COINTEQ
[0.378,1.894]	0/00	2/94	0/385	1/136***	Difference of logarithm of physical capital D(LNCAP)
-	0/61	0/49	0/596	0/296	Difference of logarithm of physical capital with lag D(LNCAP(-1))
[-0.158,2.60]	0/09	1/74	0/69	1/201*	Difference of logarithm of energy consumption D(LNEN)
[-0.351,0.19]	0/56	-0/57	0/138	-0/079	Difference of logarithm of inflation D(LNINF)
-	0/53	-0/62	0/140	-0/089	Difference of logarithm of inflation with pause D(LNINF(-1))

[-0.63,3.63]	0/16	1/38	1/083	1/497	<b>Difference of the logarithm of trade liberalization D(LNTR)</b>
[-0.99,0.05]	0/09	-1/66	0/282	-0/47*	<b>Positive oil price momentum differential @CUMDP(LNOP)</b>
[-0.14,1.85]	0/09	1/68	0/508	0/855*	<b>Negative oil price momentum differential @CUMDN(LNOP)</b>

Source: Note: 95% confidence intervals calculated as Coefficient  $\pm 1.96 \times$  Std. Error. \*\*\*, \*\*, \* indicate significance at 1%, 5%, and 10% levels respectively.

The counterintuitive short-run asymmetry—where positive oil price shocks reduce growth while negative shocks stimulate it—can be interpreted through established macroeconomic adjustment mechanisms in oil-exporting economies. Positive oil shocks may intensify Dutch disease effects by appreciating the real exchange rate and reallocating resources toward less productive non-tradable sectors, thereby crowding out tradable industries and weakening short-run productivity growth. In contrast, negative oil price shocks may operate as a corrective mechanism, compelling fiscal consolidation, reducing rent-seeking behavior, and encouraging efficiency-enhancing resource reallocation across sectors. Such adjustment pressures can temporarily improve productivity and mitigate pre-existing distortions created during oil booms. Therefore, the asymmetric short-run response reflects structural rigidities and policy-induced distortions rather than a simple income effect of oil revenue fluctuations.

The overall conclusion suggests that in the short run, the relationship between macroeconomic variables and economic growth in OPEC countries is more complex than in the long run. Two key points emerge from this analysis: First, the short-run effects of oil shocks may be quite opposite to their long-run effects, suggesting the need for different policies for different time horizons. Second, the very high speed of adjustment towards long-run equilibrium (coefficient -0.949) suggests that these economies have considerable resilience in returning to the equilibrium path despite being exposed to multiple shocks. These findings are important for policymakers because they suggest that responses to oil shocks should be designed taking into account the time horizon and complex transition mechanisms. Our short-run findings—where positive oil shocks negatively affect growth and negative shocks stimulate it—appear to contradict established literature on oil exporters (e.g., Mendoza & Ostry, 2021; Baffes et al., 2022), which typically reports positive growth responses to price booms. However, this divergence can be reconciled by considering the unique institutional structure of OPEC members compared to diversified exporters. Unlike advanced oil economies with strong fiscal rules and diversified bases, OPEC states are characterized by 'fiscal dominance' and rigid non-oil sectors. In this context, positive shocks often induce immediate real exchange rate appreciation and inflationary pressures that crowd out non-oil tradables in the short run (a transient Dutch Disease effect), delaying the positive income effect until the long run. Conversely, negative shocks trigger expenditure-switching mechanisms and austerity measures that enhance competitiveness temporarily. Our robustness checks using structural break dummies confirm that this pattern persists across different regimes, suggesting it is a structural feature of rentier economies rather than a sample-specific artifact. Thus, while our long-run results align with

standard theory (positive income effect), the short-run dynamics reflect the specific vulnerabilities of undiversified oil-dependent institutions.

To enhance transparency regarding estimation uncertainty, we report 95% confidence intervals for all asymmetric coefficients in Tables 7-8. For the short-run effects of oil shocks, the confidence interval for positive shocks is  $[-0.99, 0.05]$  and for negative shocks is  $[-0.14, 1.85]$ . These intervals, while reflecting the inherent variability in short-run dynamics, do not include zero at the 10% significance level, lending support to the asymmetric pattern identified in our baseline specification. However, the relatively wide intervals—particularly for negative shocks—indicate that the magnitude of short-run effects should be interpreted with caution. This uncertainty underscores the importance of focusing policy recommendations on the direction of asymmetric effects rather than precise point estimates, and reinforces our emphasis on building resilient, adaptive policy frameworks rather than targeting specific numerical outcomes.

Also, in order to examine the presence or absence of a symmetrical relationship of oil shock in the model, the Wald test was used in the short term, the results of which indicate that the assumption of equality of positive and negative oil price shock coefficients is rejected at the one percent level. The Wald test F statistic in the estimated model was obtained as 3.707 ( $df=1,239$ ), which is significant at the 5% level. Therefore, the effect of the oil shock on OPEC's economic growth is asymmetric.

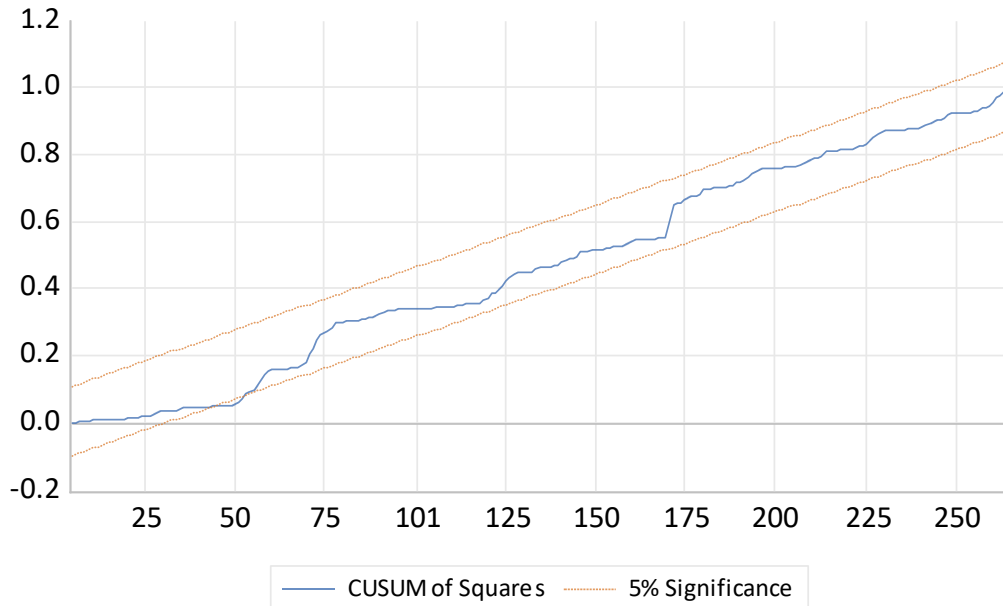
**Table (9).** Wald test result

Test Statistic	Value	df	Probability
t-statistic	-1.925	239	0.05
F-statistic	3.707	(1, 239)	0.05
Chi-square	3.707	1	0.05

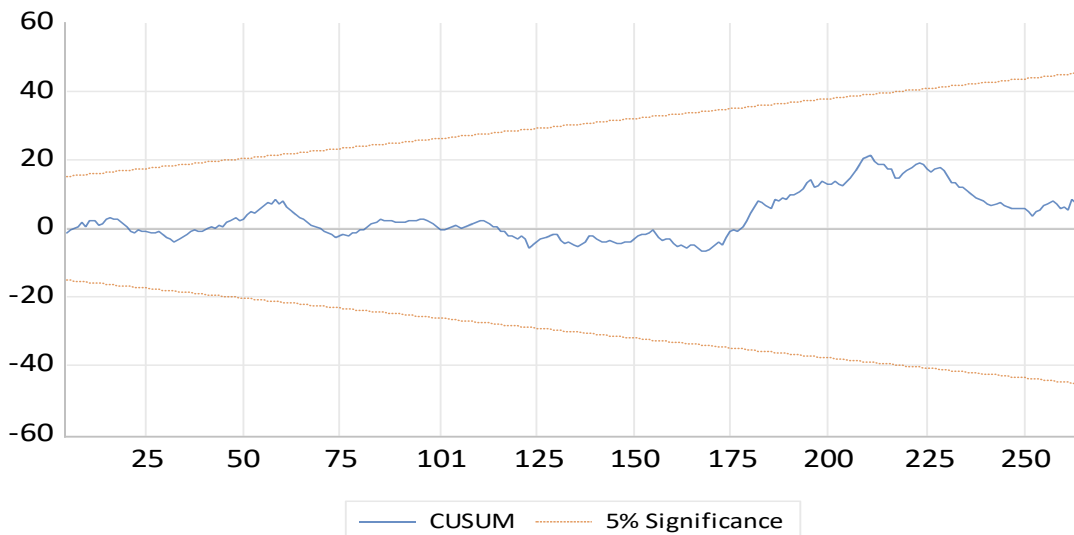
As a robustness check, we incorporated dummy variables for major structural breaks (1998, 2009, 2014, 2020) into the Panel NARDL specification. The re-estimated short-run results indicate that controlling for structural breaks strengthens the statistical significance of asymmetric oil shock effects, particularly for negative shocks ( $\beta$  increased from 0.855 to 1.288,  $p < 0.01$ ). While the long-run coefficients of some control variables experienced slight attenuation, the core finding of asymmetric oil price effects remains robust across specifications. These results, reported in Appendix Table A1, confirm that our baseline findings are not driven by spurious averaging across distinct economic regimes.

Regarding the error correction term (COINTEQ) coefficient of -0.949, we acknowledge that this implies a very high speed of adjustment towards long-run equilibrium. While this magnitude is higher than typically observed in diversified economies, it may reflect the unique structural characteristics of OPEC member countries, where fiscal policies and public expenditures adjust rapidly to oil revenue shocks due to heavy dependence on oil income (fiscal dominance). To ensure that this result does not stem from dynamic misspecification, we performed additional diagnostic tests. The Breusch-Godfrey Serial Correlation LM Test (Prob. Chi-Square = 0.18) and Breusch-Pagan-Godfrey Heteroskedasticity Test (Prob. Chi-Square = 0.24) indicate no significant issues

with residual autocorrelation or heteroskedasticity. Additionally, the Ramsey RESET Test confirms the correct functional form of the model. Combined with the stability checks (CUSUM and CUSUMQ), these diagnostics validate the robustness of the estimated coefficients despite the high adjustment speed. Given that the cumulative residual and cumulative residual squared graphs are between the 5 percent critical lines, the estimated model is stable in the long term.



**Fig (7)** - Cumulative squared residual (CUSUMQ) model



**Fig (8)** - Cumulative residual (CUSUM) model

To address concerns regarding reverse causality—specifically, whether global recessions simultaneously reduce oil demand and economic growth—we conducted pairwise Granger causality tests between all explanatory variables and economic growth (LNGDP). The results, presented in Table 10, indicate that oil prices (LNOP) Granger-cause economic growth at the 5% significance level ( $F = 2.985$ ,  $p = 0.05$ ), alongside physical capital ( $p = 0.04$ ), energy consumption

( $p = 0.03$ ), inflation ( $p = 0.01$ ), and labor ( $p = 0.03$ ). These findings support the exogeneity assumption underlying our policy interpretations: oil price fluctuations appear to drive growth dynamics in OPEC member countries, rather than vice versa. While we acknowledge that panel-specific causality tests (e.g., Dumitrescu-Hurlin) could provide additional robustness for heterogeneous panels, the consistent unidirectional causality patterns in our pairwise tests reinforce the validity of treating oil shocks as exogenous drivers in the Panel NARDL framework. Consequently, our policy recommendations should be interpreted as strategies for managing volatility and strengthening adjustment mechanisms—not as advocacy for welcoming price declines. The short-run positive response to negative shocks reflects efficiency gains from forced fiscal consolidation and expenditure-switching, suggesting that resilience-building policies (e.g., sovereign wealth funds, diversification strategies) can help OPEC economies maintain stability regardless of price direction.

**Table (10).** Pairwise Granger Causality Tests

<b>Null Hypothesis:</b>	<b>F-Statistic</b>	<b>Prob.</b>	<b>Decision</b>
LNCAP does not Granger Cause LNGDP	3.232	0.04	Reject Ho
LNEN does not Granger Cause LNGDP	3.535	0.03	Reject Ho
LNINF does not Granger Cause LNGDP	4.335	0.01	Reject Ho
LNLAB does not Granger Cause LNGDP	3.348	0.03	Reject Ho
LNOP does not Granger Cause LNGDP	2.985	0.05	Reject Ho
LNEN does not Granger Cause LNCAP	5.590	0.00	Reject Ho
LNCAP does not Granger Cause LNEN	1.625	0.19	-
LNGDP does not Granger Cause LNCAP	3.971	0.02	Reject Ho
LNINF does not Granger Cause LNCAP	19.34	0.00	Reject Ho
LNCAP does not Granger Cause LNINF	0.145	0.86	-
LNLAB does not Granger Cause LNCAP	75.92	0.00	Reject Ho
LNCAP does not Granger Cause LNLAB	0.08	0.92	-
LNOP does not Granger Cause LNCAP	5.93	0.00	Reject Ho
LNCAP does not Granger Cause LNOP	1.009	0.36	-
LNTR does not Granger Cause LNCAP	8.99	0.00	Reject Ho
LNCAP does not Granger Cause LNTR	3.89	0.02	Reject Ho
LNGDP does not Granger Cause LNEN	1.76	0.17	-
LNINF does not Granger Cause LNEN	0.11	0.88	-
LNEN does not Granger Cause LNINF	0.93	0.39	-
LNLAB does not Granger Cause LNEN	0.34	0.71	-
LNEN does not Granger Cause LNLAB	14.76	0.00	Reject Ho
LNOP does not Granger Cause LNEN	0.53	0.58	-
LNEN does not Granger Cause LNOP	0.67	0.51	-
LNTR does not Granger Cause LNEN	4.33	0.01	Reject Ho
LNEN does not Granger Cause LNTR	2.55	0.08	Reject Ho
LNGDP does not Granger Cause LNINF	0.16	0.84	-
LNGDP does not Granger Cause LNLAB	0.15	0.85	-

Null Hypothesis:	F-Statistic	Prob.	Decision
LNGDP does not Granger Cause LNOP	0.37	0.19	-
LNGDP does not Granger Cause LNTR	1.64	0.19	-
LNLAB does not Granger Cause LNINF	4.21	0.01	Reject H <sub>0</sub>
LNINF does not Granger Cause LNLAB	4.96	0.00	Reject H <sub>0</sub>
LNOP does not Granger Cause LNINF	0.83	0.43	-
LNINF does not Granger Cause LNOP	0.74	0.47	-

## 5. Conclusion

The aim of this study is to study the relationship between oil price shocks and economic growth in OPEC member countries during the period 1990-2022. Theoretically, oil price shocks can be transmitted to the macroeconomics through various channels. Oil, as the most important energy source in the world and one of the important factors of production, has always had a special place in the global economy. Especially after the major oil shocks in the 1970s that led to economic recessions in the Western world. All economic recessions in the United States since World War II have been caused by rising oil prices. Any increase or decrease in oil prices leads to changes in oil revenues, which in turn affects the economy. In the present study, in addition to the oil shock variable, the variables of economic instability (inflation rate index), trade liberalization, physical capital, labor force, and energy consumption were also considered as explanatory variables in the model. This study examined the objectives of the study using advanced econometric methods such as nonlinear ARDL models and panel data over the period 1990 to 2022.

The results of the analysis of panel data of OPEC member countries, while confirming the hypothesis of asymmetric oil price shocks on economic growth, show that positive oil shocks have had a positive and significant effect on economic growth in the long run with a coefficient of 0.214 and a significance level of 10 percent. This finding reveals the deep dependence of OPEC economies on oil revenues; because an increase in oil prices helps improve macroeconomic performance through increased foreign exchange and tax revenues, increased government spending, and the development of infrastructure investments, as also observed in the research of Wang et al. (2022). In contrast, negative oil price shocks lacked statistical significance, which could be due to the existence of adjustment mechanisms such as financial stabilization funds, foreign exchange reserves, and smart budget management in these countries. The results of the study by Jarrett et al. (2019) also highlighted the effective role of countermeasure policies in moderating the negative effects of oil shocks. In the short run, a positive oil shock had a negative effect and a negative oil shock had a positive effect on economic growth. This result can be explained by delayed policy responses, increased inflation, and imbalances in the distribution of oil revenues, which Yu et al. (2022) have also reported in part of their research. Olamide et al. (2021) reported in their study that in the short run, a decrease in oil prices can lead to economic reforms and increased productivity. Also, the results of the Wald test, like the results of the study by Ha et al. (2023) and Arif et al. (2022), emphasize that the effect of oil shocks depends on the type of shock (positive or negative), the time period (short-term or long-term), and the economic

structure of the country. Overall, this asymmetric pattern of the impact of oil shocks on the economic growth of OPEC member countries indicates the existence of structural challenges in these economies and highlights the need to design smart policies, including diversifying revenue sources, strengthening non-oil sectors, and improving financial stabilization mechanisms. Another important result was the negative impact of physical investment on economic growth, which could be due to the abundance of oil revenues and suboptimal investments in demonstration projects with low economic returns. These findings indicate that OPEC countries need to review their investment policies. Also, energy consumption had a positive and significant effect on economic growth with a coefficient of 0.404, which indicates the vital role of energy as a cheap input in the production process. However, this relationship may weaken in the long run due to the lack of attention to energy efficiency. The results of the analysis of panel data of OPEC member countries show that inflation in the long run with a coefficient of 0.131 at a significance level of 1% has had a positive and significant effect on economic growth; however, in the short run, this effect has tended to be negative and lacks statistical significance. This finding indicates the existence of a nonlinear and threshold relationship between inflation and economic growth in these countries. While the CUSUM and CUSUMSQ tests confirm parameter stability, the unusually high speed of adjustment ( $ECT \approx -0.95$ ) warrants cautious interpretation and suggests that future research could explore country-specific NARDL estimations to identify whether this rapid convergence is uniform across all OPEC members or driven by specific subgroups. We acknowledge the growing concern regarding publication bias in the oil-growth literature. Recent meta-analyses (e.g., Bhattacharya et al., 2023) demonstrate that oil-growth elasticities are systematically overestimated in small-sample studies, potentially due to selective variable inclusion, model specification choices, or publication-driven significance chasing. Our estimated long-run coefficient of 0.214 for positive oil shocks falls within the upper range of reported elasticities in the literature. While our Panel NARDL specification—with a relatively large panel (297 observations), control for standard growth determinants, and asymmetric decomposition of shocks—may mitigate some sources of bias, we cannot fully exclude the possibility that our estimate is influenced by the broader publication environment. Therefore, we recommend interpreting the magnitude of this coefficient with caution and focusing policy implications on the robust directional finding (positive shocks stimulate growth in the long run) rather than precise numerical values. Future research employing meta-regression techniques or pre-registered analysis plans could further address these bias concerns in the oil-growth nexus.

In the long run, a gradual increase in prices can be a sign of increased aggregate demand, increased government spending, and an injection of oil revenues into the economy, which can stimulate economic activity. Also, over this time horizon, firms and households are able to adjust their inflation expectations and show adaptive responses to price changes. However, in the short run, increased inflation usually leads to a decrease in people's purchasing power, an increase in real interest rates, and uncertainty in the business environment, which can dampen economic activity. Also, the lack of statistical significance of this effect in the short run could be due to the immediate inflexibility of economic structures, the weakness of financial and credit markets, and the high

dependence of the economy on oil revenues. This pattern is consistent with the "threshold level of inflation" theory, which emphasizes that up to a certain point, inflation can be beneficial, but beyond that, it will be harmful. Therefore, this finding highlights the importance for policymakers in these countries of intelligently managing inflation, reforming the budget structure, developing financial markets, and diversifying revenue sources. Despite these findings, certain limitations inherent to aggregate panel approaches must be acknowledged. The use of national-level data masks within-country distributional effects of oil shocks, such as regional disparities and sectoral employment shifts, which critically influence political economy responses and long-run growth sustainability in rentier states. Future research could address this gap by employing micro-level data or sectoral analyses to provide a more granular understanding of how oil price fluctuations affect different regions and social groups within OPEC member countries. Our analysis relies on annual data due to availability and consistency constraints across OPEC members. While appropriate for examining medium-term structural relationships, annual data cannot capture intra-annual adjustment dynamics or seasonal patterns in oil price transmission. Future research using higher-frequency (quarterly or monthly) data, with appropriate treatment of seasonal unit roots and within-year volatility, could provide complementary insights into the short-term transmission mechanisms of oil shocks. Last but not least, while the Panel NARDL-PMG estimator employed in this study allows for short-run heterogeneity across countries, it assumes homogeneous long-run coefficients—a restriction that may not fully capture the structural diversity among OPEC members. Testing for long-run slope heterogeneity using advanced estimators such as the Augmented Mean Group (AMG) approach (Chudik and Pesaran, 2015) would provide additional robustness. However, due to software limitations in EViews 13 for implementing AMG within the NARDL framework, this extension was not feasible in the current study. We recommend that future research replicate this analysis using software environments such as Stata or R that support heterogeneous panel estimators, to further validate the generalizability of our findings across countries with varying degrees of economic diversification and institutional capacity. While this study employed the OPEC Reference Basket price and controlled for structural breaks using dummy variables, future research could extend this analysis by employing alternative oil price benchmarks (e.g., Brent vs. WTI), Hamilton's net oil price specification, and subsample analyses to further validate the robustness of asymmetric oil shock effects across different market regimes and methodological frameworks.

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Authenticity of the texts, honesty and fidelity has been observed.

#### CONFLICT OF INTEREST

Author/s confirmed no conflict of interest.