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The impact of oil price volatility on economic growth in selected oil-exporting countries during the period (2000-2022) – An econometric study using dynamic panel data models

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***Abstract*---**This paper examines the impact of oil price fluctuations on economic growth in several oil-exporting countries, namely: the United States, Russia, Canada, Saudi Arabia, the United Arab Emirates, Algeria, and Iraq. These countries were selected as they are among the largest oil exporters within the OPEC organization. The period from 2000 to 2022 was chosen as the study sample. We used regression analysis for panel data based on the cointegration methodology and the error correction model for panel data. The study's results indicated a long-term equilibrium relationship between economic growth, oil prices, and other control variables. When estimating the error correction model (VECM) using the FMOLS method, the results showed that an increase in oil prices (OP) has a positive effect on

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economic growth, measured by per capita GDP in the long term for all countries in the sample. Additionally, other control variables (TFC, WF, TOP) had economically acceptable signs and also influence per capita GDP in the long term.

***Keywords*---**Oil prices, Economic growth, Oil-exporting countries, Panel data, FMOLS method.

Introduction

Oil is considered one of the most important economic resources in the world, serving as a primary source of revenue for many exporting countries. Fluctuations in oil prices play a vital role in shaping economic policies and defining the contours of economic growth in these nations. Rapid and continuous changes in global oil prices have significant impacts on public budgets, investment rates, and balance of payments. As a result, studying the impact of oil price fluctuations on economic growth is a central issue for understanding the dynamics of macroeconomics in these countries.

Research Problem:

This research paper seeks to answer the following main question:

- What are the implications of oil prices on economic growth in some exporting countries?

Research Hypotheses:

- There is a long-term equilibrium relationship between oil prices and economic growth.
- There is a positive effect of oil prices on economic growth.

Objective of the Study:

This study aims to analyze and assess the impact of oil price fluctuations on economic growth in some exporting countries using dynamic panel data models. These models provide a suitable framework for studying both long-term and short-term dynamic effects and consider temporal changes and the interrelationships between various economic variables in the countries included in the study. Additionally, the models allow for distinguishing between the individual effects of each country and the general effects shared among the countries.

The study will focus on Arab countries that heavily rely on oil revenues, such as Saudi Arabia, the United Arab Emirates, Kuwait, Iraq, and others. By employing dynamic modeling techniques, the data from these countries will be analyzed over an extended period, aiming to reach statistically supported conclusions regarding how economic growth is affected by oil price fluctuations, while considering other economic and political factors that may influence this relationship.

Importance of the Study:

The importance of this study stems from the urgent need to gain a deeper understanding of how these countries cope with oil price fluctuations and adapt to the economic challenges imposed by these variations. Furthermore, the findings of this research could provide recommendations for policymakers regarding appropriate economic policies to achieve stability and economic growth amid oil price fluctuations.

Methodology of the Study:

Given the nature of the topic and to achieve the objectives of this research while covering its various aspects, we will rely on a descriptive analytical approach to study the performance of the study variables and their development through previous studies and theoretical frameworks. The study will also adopt an econometric approach by utilizing modern econometric and statistical methods to understand the nature of the relationship between oil prices and economic growth.

Division of the Study:

The research is divided into three sections. The first section discusses previous empirical studies, while the second section addresses the theoretical relationship between oil prices and economic growth. The third section presents an econometric study of the impact of oil price fluctuations on economic growth in some exporting countries.

First Section: Previous Empirical Studies:

- Study by Adnani Khawla, Aqsam Hasna, and Muqaddim Abdul Jalil (2019): "The Impact of Oil Price Fluctuations on Algeria and Qatar (2019)" examined the effects of oil price fluctuations on growth rates in Algeria and Qatar. The study showed that the negative shocks of oil prices had a greater impact on growth than positive shocks, indicating that price fluctuations have an asymmetric effect on the economy. The study concluded that Algeria, as a rentier state, is significantly affected by changes in oil prices, whether positively or negatively. In contrast, Qatar features a diversified economy that, while also affected by oil price fluctuations, achieves substantial economic growth due to its policy of economic diversification and revitalization of non-oil sectors.
- Study by the Arab Monetary Fund on the Gulf Cooperation Council countries (2000-2019): This study aimed to measure the response of economic growth to oil price fluctuations in the Gulf Cooperation Council countries. The results indicated that economic activity was more sensitive to declines in oil prices compared to increases, reinforcing the trend towards economic diversification to reduce reliance on oil.
- Study by Belkacem Manal (2021): "The Impact of Oil Price Fluctuations on the Growth of Oil-Exporting Economies," focused on measuring the impact of oil price fluctuations on economic growth in oil-exporting countries during the period 2000-2021 using panel data. The results showed a negative relationship between oil price fluctuations and economic growth in the short term, while the

relationship remained positive in the long term, as these countries' economies heavily depend on oil revenues.

- Study by Abdul Salam Shaikhawi (2020): "The Impact of Oil Price Fluctuations on Economic Growth in Algeria - An Econometric Study During the Period (1990-2015)," this study examined the impact of oil price fluctuations on economic growth in Algeria for the period 1990-2020 using an Autoregressive Distributed Lag (ARDL) model. The study found a significant short-term impact of oil price fluctuations on economic growth, with a long-term equilibrium relationship between the two variables.
- Study by Boukhtir Jabar and Atia Abdul Salam (2018): "Modeling the Relationship between Oil Price Fluctuations and Economic Growth Using Panel Data - A Case Study of Arab OPEC Member Countries during the Period (2000-2016)," aimed to model the relationship between oil price fluctuations and economic growth in Arab OPEC member countries during the period 2000-2016. The study employed panel data methodology and showed a long-term relationship between oil prices and economic growth, with oil prices positively influencing economic growth in these countries. A random effects model was used as the most suitable model to estimate the relationship.

Second Section: Theoretical Relationship Between Oil Prices and Economic Growth

Oil is considered one of the most important natural resources and is essential to the global economy. There is a theoretical relationship between oil prices and economic growth. Some theorists, such as Thomas Malthus, economist Rebinsky, and American Theodore Roosevelt, argue that oil acts as an obstacle to growth. They claim that when oil prices rise, economies—especially those that heavily rely on oil as a primary resource—may suffer. For example, rising oil prices increase production and transportation costs for companies, leading to higher prices for goods and services. This can result in inflation and a slowdown in economic growth.

On the other hand, some argue that oil is a driver of growth, including John Stuart Mill, Harold Hotelling, and Milton Friedman. Proponents of these theories believe that natural resources do not always hinder growth for resource-rich countries. There are countries capable of effectively managing and utilizing their revenues from extracting fossil fuels, despite fluctuations in the prices of these resources.

In general, it can be said that there is a mutual influence between oil prices and economic growth, where this relationship depends on various factors such as supply and demand for oil, and the economy's response to these changes.

Third Section: Measuring the Impact of Oil Price Fluctuations on Economic Growth in Some Oil-Exporting Countries during the Period (2000-2022):

In our study of the impact of oil prices on economic growth in some oil-exporting countries, we selected seven countries as a sample: the United States, Russia, Canada, Saudi Arabia, the United Arab Emirates, Algeria, and Iraq. Our choice of these countries was based primarily on two considerations: first, they are among

the largest oil-exporting countries recognized by OPEC; second, data on the study variables are available from the World Bank database (World Bank data, 2024). The study period was chosen from the year 2000 to 2022.
The method of handling panel data initially relies on testing the possibility of an effect among the sample countries, followed by discussing and analyzing the results of estimating the model that fits the sample data. After that, we aim to determine the integration levels of the variables and test the long-term relationship if it exists (Baltagi, 2015, pp. 16-21). Based on the above, we will attempt to follow the following methodology:

1. Analytical Form of the Study Model:

The study model is defined based on data in the form of panel data, which pertains simultaneously to a homogeneous group of units over a specific period. In this case, the model takes the following form:

$$Y_{it} = \beta_0 + \beta_1 X_{1it} + \beta_2 X_{2it} + \ldots + \varepsilon_{it}$$

$$i=1.2....N \quad t=1.2....T$$

According to the model structure, the analytical form of our study model is defined as follows:

$$\mathrm{PGDP}_{\mathrm{it}} = \beta_0 + \beta_1 \mathrm{OF}_{\mathrm{it}} + \beta_2 \mathrm{TFC}_{\mathrm{it}} + \beta_3 WF_{\mathrm{it}} + \beta_4 \mathrm{TOP}_{\mathrm{it}} + \varepsilon_{it}$$

$$i=1.2....N \quad t=1.2....T$$

i :Represents the country (N is the number of countries, where in our study there are 7 countries)
t : Represents time (T is the number of years, where the study spans 23 years from 2000 to 2022)

ε_{it} :The random term.

$PGDP_{it}$:Represents the per capita GDP of the country i in the period t , it represents the dependent variable in the model..
OF_{it} :Represents the oil prices for the country i in the period t .
TFC_{it} :Represents the gross fixed capital formation for the country i in the period t .
WF_{it} :Represents the labor force for country i in the period t .
TOP_{it} :Represents the trade openness of the country i in the period t .

2. Identifying the Suitable Model for the Sample Data:

1.2. Estimating the Study Model:

Based on the longitudinal nature of the study data, we distinguish among three models: (Pooled), (Fixed), and (Random). The first two models are estimated using Ordinary Least Squares (OLS), while the last model is estimated using Generalized Least Squares (GLS). The results are summarized and recorded in the following tables:

Table 1: Results of Estimating the Pooled

Dependent Variable: PGDP
Method: Panel Least Squares
Date: 03/31/24 Time: 06:22
Sample: 2000 2022
Periods included: 23
Cross-sections included: 7
Total panel (balanced) observations: 161

Variable	Coefficient	Std. Error	t-Statistic	Prob.
OP	107.5378	37.19754	2.890993	0.0044
TFC	0.018173	0.001928	9.424436	0.0000
WF	-111.6790	48.32262	-2.311112	0.0221
TOP	20914.32	3388.616	6.171936	0.0000
C	-4335.460	4100.647	-1.057262	0.2920

R-squared	0.609475	Mean dependent var	24372.13
Adjusted R-squared	0.599462	S.D. dependent var	19933.13
S.E. of regression	12615.30	Akaike info criterion	21.75377
Sum squared resid	2.48E+10	Schwarz criterion	21.84947
Log likelihood	-1746.179	Hannan-Quinn criter.	21.79263
F-statistic	60.86560	Durbin-Watson stat	0.046769
Prob(F-statistic)	0.000000		

Table 2: Results of Estimating the Fixed Model

Dependent Variable: PGDP
Method: Panel Least Squares
Date: 03/31/24 Time: 06:26
Sample: 2000 2022
Periods included: 23
Cross-sections included: 7
Total panel (balanced) observations: 161

Variable	Coefficient	Std. Error	t-Statistic	Prob.
OP	96.03542	10.58883	9.069499	0.0000
TFC	0.006772	0.001355	4.999399	0.0000
WF	787.0598	161.7446	4.866065	0.0000
TOP	1839.983	1543.302	1.192238	0.2351
C	-19474.15	5916.093	-3.291724	0.0012

Effects Specification

Cross-section fixed (dummy variables)

R-squared	0.974419	Mean dependent var	24372.13
Adjusted R-squared	0.972714	S.D. dependent var	19933.13
S.E. of regression	3292.645	Akaike info criterion	19.10265
Sum squared resid	1.63E+09	Schwarz criterion	19.31318
Log likelihood	-1526.763	Hannan-Quinn criter.	19.18813
F-statistic	571.3831	Durbin-Watson stat	0.386536
Prob(F-statistic)	0.000000		

Table 3: Results of Estimating the Random Model

Dependent Variable: PGDP
Method: Panel EGLS (Cross-section random effects)
Date: 03/31/24 Time: 06:27
Sample: 2000 2022
Periods included: 23
Cross-sections included: 7
Total panel (balanced) observations: 161
Swamy and Arora estimator of component variances

Variable	Coefficient	Std. Error	t-Statistic	Prob.
OP	106.4172	10.22034	10.41229	0.0000
TFC	0.009474	0.001154	8.212878	0.0000
WF	363.7044	116.5724	3.119987	0.0022
TOP	1892.215	1541.407	1.227590	0.2215
C	-4489.283	8726.054	-0.514469	0.6077

Effects Specification

	S.D.	Rho
Cross-section random	19981.08	0.9736
Idiosyncratic random	3292.645	0.0264

Weighted Statistics

R-squared	0.740787	Mean dependent var	836.9496
Adjusted R-squared	0.734141	S.D. dependent var	6617.892
S.E. of regression	3412.289	Sum squared resid	1.82E+09
F-statistic	111.4554	Durbin-Watson stat	0.348899
Prob(F-statistic)	0.000000		

Unweighted Statistics

R-squared	-0.558949	Mean dependent var	24372.13
Sum squared resid	9.91E+10	Durbin-Watson stat	0.006395

Source: Prepared by the researchers based on the outputs of Eviews 12.

2. Testing for the Possibility of an Individual Effect in the Model:
We conduct a test for the possibility of an individual effect within the sample data based on a Fisher-type test, where the null hypothesis fits a homogeneous model, i.e., there is no individual effect in the studied sample. The statistic for this test is represented by (William, Económétrie, 2005, p. 277):

$$F(N-1\ ,\ NT-N-K)=\frac{(R^2{}_{MNC}-R^2{}_{MC})/(N-1)}{(1-R^2{}_{MNC})/(NT-N-K)}$$

N : Represents the number of individuals (in our case, 7 countries).

T : The length of the proposed time series for the study (in our case, 23 years).

K :The number of external variables in the model (in our case, 4).

R^2_{MC} : Represents the adjusted coefficient of determination of the restricted model, which is under the null hypothesis. In this case, it is a model without effect, or an effect-free model **(Pooled** $R^2_{MC}=0.60$.).

R^2_{MNC} : Represents the adjusted coefficient of determination for the unrestricted model, which corresponds to the alternative hypothesis. In this case, it matches Model **(Fixed)**) ($R^2_{MNC}=0.97$).

$$F(7-1\ ,\ 161-7-4)=\frac{(0.97-0.60)/(7-1)}{(1-0.97)/(161-7-1)}\cong 3.085$$

When conducting this test, we obtain a calculated Fisher statistic value of $F_C = 3.085$, while the tabulated statistic is $F_{(7,150)}=2.21$. Therefore, we reject the null hypothesis (H_0) at a significance level of 5% and conclude that there is an individual effect within the sample data.

3. Testing for the Type of Effect:

After establishing the presence of an individual effect in the model, we will use the Hausman test to determine the type of effect. The following table illustrates the result of this test:

Table 4: Result of the Hausman Test

Correlated Random Effects - Hausman Test
Equation: Untitled
Test cross-section random effects

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	15.543049	4	0.0037

Source: Prepared by the researchers based on the outputs of Eviews 12.

Table 4 shows that the calculated statistic for the Hausman test $\chi^2_C=15.54$ is large compared to the tabulated statistic, and the p-value of 0.0037 is less than the commonly accepted significance levels of 1%, 5%, and 10%. Therefore, we reject the null hypothesis and acknowledge that there is a correlation between the explanatory variables and the individual effect. Consequently, the appropriate model for the sample data is of **the fixed effects type**, which provides us with consistent estimates in this case. Thus, the countries in the sample agree on the coefficients of the explanatory variables but differ in the values of the constant term, with this difference being determined based on the values of the explanatory variables for each country.

4. Evaluation of the Fixed Effects Model:

Based on the results of the previous tests, the model that fits the data of our study sample is the fixed effects model. Based on the estimation results shown in Table 2, the model can be written as follows:

$$\mathrm{PGDP}_{\mathrm{it}} = -1947.15 + 96.03542\mathrm{OF}_{\mathrm{it}} + 0.006772\mathrm{TFC}_{\mathrm{it}} +$$
$$\Rightarrow 787.0598WF_{\mathrm{it}} + 1839.98\mathrm{TOP}_{\mathrm{it}} + e_{it}$$

We observe from the results of the statistical significance tests (Student's t-tests) for the parameter estimates of the model that they are statistically acceptable at the 1% significance level. Additionally, the Fisher test for the overall significance of the model indicates acceptance of the explanatory power of this model at the 1% significance level. Furthermore, the value of the adjusted coefficient of determination is $R^2 = 0.97$, which is an excellent value.

However, we note that the Durbin-Watson (DW) statistic indicates the presence of first-degree autocorrelation in the residuals, which renders the parameter estimates inconsistent (non-convergent). Nevertheless, it is preferable not to use the Durbin-Watson test to detect residual autocorrelation, as it is not effective in the case of panel data. We can rely on the statistics from the residual autocorrelation tests between the countries, as shown in Table 5:

Table 5: Results of Residual Autocorrelation Tests

Residual Cross-Section Dependence Test
Null hypothesis: No cross-section dependence (correlation) in residuals
Equation: Untitled
Periods included: 23
Cross-sections included: 7
Total panel observations: 161
Note: non-zero cross-section means detected in data
Cross-section means were removed during computation of correlations

Test	Statistic	d.f.	Prob.
Breusch-Pagan LM	129.8744	21	0.0000
Pesaran scaled LM	15.71956		0.0000
Pesaran CD	3.018010		0.0025

Source: Prepared by the researchers based on the outputs of Eviews 12.

We observe from Table 5 that all the statistics of these tests are significant at the 1% level, leading to the rejection of the null hypothesis: \(H_0: \text{no autocorrelation} \), and acceptance of the alternative hypothesis: \(H_1:

\text{there is autocorrelation} \), which states that the model suffers from a problem of residual autocorrelation. In this case, the parameter estimates are unbiased, meaning they are consistent; however, they lose the property of being the least variable, i.e., they are not the best estimates. This indicates that the model is not acceptable in a measurement sense, and better estimations must be sought (Baltagi, Kao, & Peng, 2016, pp. 03-06). As we found previously $R^2 \succ DW$, this is an indication of a spurious regression in the model, primarily due to the instability of the time series being studied.

3. Estimating the Long-Term Relationship Between Oil Prices and Economic Growth:

To estimate the long-term relationship between the study variables, we first need to test the stationarity of the time series for the model variables using the following statistical tests: (Levin, Lin, and Chu test), (Breitung test), (Im, Pesaran, and Shin test), and (Maddala and Wu test).

1.3. Study of the Stationarity of the Time Series for the Study Variables:

- Table 6: Results of the Stationarity Test for PGDP

Panel unit root test: Summary
Series: PGDP
Date: 03/25/24 Time: 04:02
Sample: 2000 2022
Exogenous variables: Individual effects, individual linear trends
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0 to 1
Newey-West automatic bandwidth selection and Bartlett kernel

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	0.66966	0.7485	7	152
Breitung t-stat	0.99897	0.8411	7	145
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	1.04886	0.8529	7	152
ADF - Fisher Chi-square	10.4707	0.7270	7	152
PP - Fisher Chi-square	6.09368	0.9641	7	154

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

Table 7: Results of the Stationarity Test for D(PGDP)

Panel unit root test: Summary
Series: D(PGDP)
Date: 03/25/24 Time: 04:18
Sample: 2000 2022
Exogenous variables: Individual effects, individual linear trends
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0 to 1
Newey-West automatic bandwidth selection and Bartlett kernel

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-6.67424	0.0000	7	145
Breitung t-stat	-3.02500	0.0012	7	138
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-4.40771	0.0000	7	145
ADF - Fisher Chi-square	41.8728	0.0001	7	145
PP - Fisher Chi-square	36.7590	0.0008	7	147

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

Source: Prepared by the researchers based on the outputs of Eviews 12.

Table 9: Results of the stationarity test for D(OP)

Panel unit root test: Summary
Series: OP
Date: 03/25/24 Time: 05:24
Sample: 2000 2022
Exogenous variables: Individual effects, individual linear trends
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0
Newey-West automatic bandwidth selection and Bartlett kernel
Balanced observations for each test

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	0.05504	0.5219	7	154
Breitung t-stat	-1.67386	0.0471	7	147
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	1.00232	0.8419	7	154
ADF - Fisher Chi-square	6.05257	0.9651	7	154
PP - Fisher Chi-square	6.59173	0.9493	7	154

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

Table 8: Results of the stationarity test for OP

Panel unit root test: Summary
Series: D(OP)
Date: 03/25/24 Time: 05:25
Sample: 2000 2022
Exogenous variables: Individual effects, individual linear trends
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0
Newey-West automatic bandwidth selection and Bartlett kernel
Balanced observations for each test

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-8.33590	0.0000	7	147
Breitung t-stat	-7.32945	0.0000	7	140
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-5.96372	0.0000	7	147
ADF - Fisher Chi-square	54.9738	0.0000	7	147
PP - Fisher Chi-square	55.5393	0.0000	7	147

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

Source: Prepared by the researchers based on the outputs of Eviews 12.

- Table 10: Results of the Stationarity Test for TFC

Panel unit root test: Summary
Series: TFC
Date: 03/25/24 Time: 04:33
Sample: 2000 2022
Exogenous variables: Individual effects, individual linear trends
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0 to 4
Newey-West automatic bandwidth selection and Bartlett kernel

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	1.01669	0.8453	7	149
Breitung t-stat	0.26336	0.6039	7	142
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	0.87984	0.8105	7	149
ADF - Fisher Chi-square	12.0531	0.6020	7	149
PP - Fisher Chi-square	5.68287	0.9739	7	154

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

- Table 11: Results of the Stationarity Test for D(TFC)

Panel unit root test: Summary
Series: D(TFC)
Date: 03/25/24 Time: 04:33
Sample: 2000 2022
Exogenous variables: Individual effects, individual linear trends
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0 to 1
Newey-West automatic bandwidth selection and Bartlett kernel

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-4.14706	0.0000	7	145
Breitung t-stat	-1.27757	0.1007	7	138
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-3.57566	0.0002	7	145
ADF - Fisher Chi-square	36.2281	0.0010	7	145
PP - Fisher Chi-square	38.3521	0.0005	7	147

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

Source: Prepared by the researchers based on the outputs of Eviews 12.

- Table 12: Results of the Stationarity Test for WF

Panel unit root test: Summary
Series: WF
Date: 03/25/24 Time: 05:20
Sample: 2000 2022
Exogenous variables: Individual effects, individual linear trends
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0 to 3
Newey-West automatic bandwidth selection and Bartlett kernel

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-0.81639	0.2071	7	144
Breitung t-stat	-0.75322	0.2257	7	137
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-1.69252	0.0453	7	144
ADF - Fisher Chi-square	23.3370	0.0550	7	144
PP - Fisher Chi-square	14.3708	0.4225	7	154

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

- Table 13: Results of the Stationarity Test for D(WF)

Panel unit root test: Summary
Series: D(WF)
Date: 03/25/24 Time: 05:21
Sample: 2000 2022
Exogenous variables: Individual effects, individual linear trends
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0 to 1
Newey-West automatic bandwidth selection and Bartlett kernel

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-3.73382	0.0001	7	143
Breitung t-stat	-1.03348	0.1507	7	136
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-5.16078	0.0000	7	143
ADF - Fisher Chi-square	50.1826	0.0000	7	143
PP - Fisher Chi-square	66.4049	0.0000	7	147

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

Source: Prepared by the researchers based on the outputs of Eviews 12.

- Table 14: Results of the Stationarity Test for TOP

Panel unit root test: Summary
Series: TOP
Date: 03/25/24 Time: 05:53
Sample: 2000 2022
Exogenous variables: Individual effects, individual linear trends
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0 to 2
Newey-West automatic bandwidth selection and Bartlett kernel

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-0.75912	0.2239	7	150
Breitung t-stat	1.05593	0.8545	7	143
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	0.61723	0.7315	7	150
ADF - Fisher Chi-square	7.35599	0.9201	7	150
PP - Fisher Chi-square	12.9574	0.5299	7	154

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

- Table 15: Results of the Stationarity Test for D(TOP)

Date: 03/25/24 Time: 05:54
Sample: 2000 2022
Exogenous variables: Individual effects, individual linear trends
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0 to 2
Newey-West automatic bandwidth selection and Bartlett kernel

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-6.32067	0.0000	7	143
Breitung t-stat	-3.03782	0.0012	7	136
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-6.21719	0.0000	7	143
ADF - Fisher Chi-square	61.1416	0.0000	7	143
PP - Fisher Chi-square	116.844	0.0000	7	147

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

Source: Prepared by the researchers based on the outputs of Eviews 12.

The results of all the tests shown in tables (14, 12, 10, 8, 6) indicate the acceptance of the null hypothesis, meaning that the time series of the study variables (PGDP, OP, TFC, WF, TOP) are non-stationary at their original levels at a significance level of 1%. When applying first-order differences, all the results of the tests shown in tables (15, 13, 11, 9, 7) rejected the null hypothesis and accepted the alternative hypothesis, which states that the time series of the study variables (PGDP, OP, TFC, WF, TOP) are stationary at the first difference I(1).

Testing for Cointegration of Panel Data:

After verifying the stability of the time series for the study variables, we can state that these series are potentially cointegrated of order (Hurlin & Mignon, 2006, pp. 23-28). To check for the existence of cointegration, we perform the Pedroni test, which is considered one of the most well-known tests in this field. This test is based on the null hypothesis that there is no cointegration among the variables, while the alternative hypothesis claims the existence of cointegration among the variables. The results are presented in Table 16.

Table 16: Results of the Pedroni Test for Cointegration

Pedroni Residual Cointegration Test
Series: PGDP OP TFC WF TOP
Date: 03/31/24 Time: 09:47
Sample: 2000 2022
Included observations: 161
Cross-sections included: 7
Null Hypothesis: No cointegration
Trend assumption: No deterministic trend
User-specified lag length: 1
Newey-West automatic bandwidth selection and Bartlett kernel

Alternative hypothesis: common AR coefs. (within-dimension)

	Statistic	Prob.	Weighted Statistic	Prob.
Panel v-Statistic	0.534263	0.2966	0.521650	0.3010
Panel rho-Statistic	0.466690	0.0096	1.012534	0.0444
Panel PP-Statistic	-1.121806	0.0310	-0.452993	0.0253
Panel ADF-Statistic	-1.707637	0.0439	-1.826366	0.0339

Alternative hypothesis: individual AR coefs. (between-dimension)

	Statistic	Prob.
Group rho-Statistic	2.201639	0.0062
Group PP-Statistic	0.084693	0.0337
Group ADF-Statistic	-1.698651	0.0447

Source: Prepared by the researchers based on the outputs of Eviews 12.

Cointegration Testing Using Pedroni:

The Pedroni cointegration test is shown in Table 16, which utilizes seven statistics for testing cointegration. Most of the Pedroni test statistics reject the null hypothesis of no cointegration at the 5% significance level, confirming the existence of cointegration among the study variables in the long run.

Consequently, the results of the Pedroni test demonstrate that there is a cointegration relationship between the variables, indicating that the estimated relationship among the cointegrated series within the study model represents a long-term structural equilibrium relationship rather than spurious regression. The estimated model is referred to as a Vector Error Correction Model (VECM).

To estimate the VECM for the long-term relationship, we employ the Fully Modified Ordinary Least Squares (FMOLS) method developed by Pedroni in 2000. This method is distinguished by its ability to handle endogeneity of explanatory variables, autocorrelation of errors, and potential heteroskedasticity of parameters in the long run. FMOLS provides approximately unbiased estimates with the least variance, thereby ensuring consistency (Pedroni, 2000, pp. 96-100). The results are illustrated in Table 17.

3.3. Estimation of the Error Correction Model Using FMOLS:

Table 17: Results of Error Correction Model Estimation Using FMOLS

Dependent Variable: PGDP
Method: Panel Fully Modified Least Squares (FMOLS)
Date: 03/31/24 Time: 10:03
Sample (adjusted): 2001 2022
Periods included: 22
Cross-sections included: 7
Total panel (balanced) observations: 154
Panel method: Pooled estimation
Cointegrating equation deterministics: C
Coefficient covariance computed using default method
Long-run covariance estimates (Bartlett kernel, Newey-West fixed bandwidth)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
OP	95.45870	14.89288	6.409689	0.0000
TFC	0.006456	0.001897	3.402728	0.0009
WF	820.8649	231.9950	3.538287	0.0005
TOP	1970.583	2278.116	0.865005	0.0085

R-squared	0.976340	Mean dependent var	24786.66
Adjusted R-squared	0.974685	S.D. dependent var	20062.22
S.E. of regression	3192.021	Sum squared resid	1.46E+09
Long-run variance	19020412		

Source: Prepared by the researchers based on the outputs of Eviews 12.

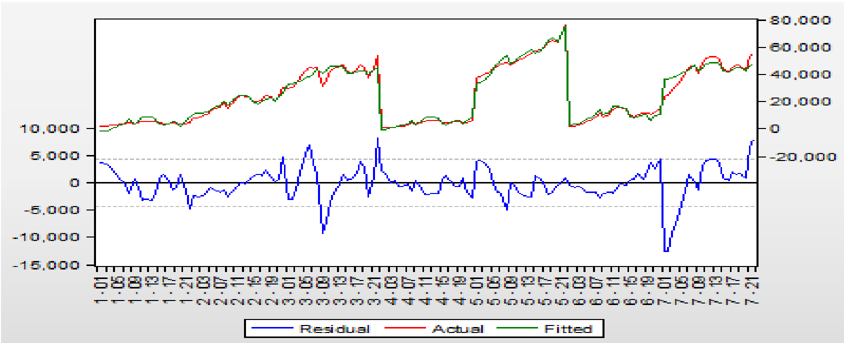
We observe from Table 17 that the value of the coefficient of determination indicates $R^2 = 0.98$ that 98% of the changes in economic growth are explained within this model in the long term. Regarding the coefficient of the oil prices variable (OP), it is statistically significant at the 1% significance level, and its sign is economically acceptable, indicating a positive impact on per capita GDP in the long term. Specifically, an increase in oil prices by one unit leads to an increase in per capita GDP by approximately $95,458.70 for all countries in the sample. Thus, it can be considered a determining factor for increasing economic growth in the long term. As for the other control variables (TFC, WF, TOP), they are also statistically significant at the 1% significance level, with economically acceptable signs, indicating their influence on per capita GDP in the long term.

4.3. Diagnostic Tests:

Through diagnostic tests, we aim to assess the quality of the selected model according to the following tests:

1. Goodness-of-Fit Test:

Figure 1: Result of the Goodness-of-Fit Test



Source: Prepared by the researchers based on the outputs of Eviews 12.

We observe from Figure 1 that there is a nearly perfect fit between the original series (Actual) and the fitted series (Fitted). This gives us an idea of how well the estimated model expresses the data of the studied series.

2.4.3. Ljung-Box Test for Residuals:

Figure 2: Results of Ljung-Box Test Statistics for Residuals

Date: 03/31/24 Time: 11:24
Sample: 2000 2022
Included observations: 154

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
		1	0.009	0.009	0.0063	0.937
		2	-0.091	-0.091	0.7283	0.695
		3	0.013	0.014	0.7425	0.863
		4	0.121	0.114	2.0653	0.724
		5	0.062	0.064	2.4182	0.789
		6	-0.041	-0.023	2.5749	0.860
		7	-0.142	-0.139	4.4759	0.724
		8	-0.065	-0.089	4.8785	0.770
		9	0.005	-0.032	4.8808	0.845
		10	-0.116	-0.124	6.1977	0.798
		11	0.030	0.071	6.2860	0.854
		12	0.248	0.287	12.478	0.408

*Probabilities may not be valid for this equation specification.

Figure 3: Results of Ljung-Box Test Statistics for Squared Residuals

Correlogram of Residuals

Date: 03/31/24 Time: 11:12
Sample: 2000 2022
Included observations: 154

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
		1	0.146	0.146	1.8458	0.174
		2	0.010	-0.011	1.8548	0.396
		3	0.048	0.049	2.0570	0.561
		4	-0.181	-0.200	5.0250	0.285
		5	-0.225	-0.178	9.6450	0.086
		6	-0.086	-0.039	10.325	0.112
		7	0.055	0.101	10.608	0.157
		8	0.045	0.024	10.799	0.213
		9	0.013	-0.064	10.815	0.289
		10	0.009	-0.067	10.823	0.372
		11	0.112	0.129	12.073	0.358
		12	0.051	0.080	12.336	0.419

*Probabilities may not be valid for this equation specification.

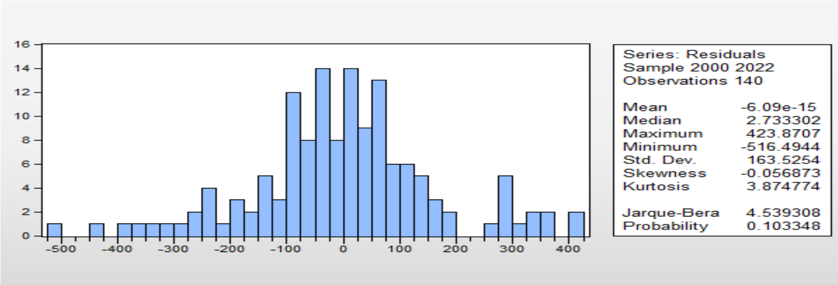
Source: Prepared by the researchers based on the outputs of Eviews 12.

From Figure 2, we observe that the Ljung-Box test statistic for residuals is greater than the 5% significance level, leading us to accept the null hypothesis, which states that there is no autocorrelation among the residuals. Furthermore, the Ljung-Box test statistic for squared residuals in Figure 3 indicates the homoscedasticity of the residuals, which signifies the quality and efficiency of the model's estimates.

3.4.3. Normality Test for Residuals:

We conduct the Jarque-Bera test to determine whether the residuals follow a normal distribution. The null hypothesis states that the residuals are normally distributed, and the results are recorded in Figure 4:

Figure 4: Results of the Normality Test for Residuals



Source: Prepared by the researchers based on the outputs of Eviews 12.

Figure 4 shows that the p-value associated with the Jarque-Bera test is 0.10, which is greater than 0.05. Therefore, we accept the null hypothesis that the residuals are normally distributed.

Conclusion

This empirical study on the impact of oil prices on economic growth in several oil-exporting countries during the period (2000-2020) reveals that the proposed model for the study sample is a fixed effects model (MEF) based on the Hausman test. This indicates that oil price fluctuations significantly influence the model's intercept. According to this model, rising oil prices positively affect economic growth.

However, the results of the autocorrelation tests indicated that the model suffers from residual autocorrelation. In this case, the estimates of the parameters are unbiased and consistent, but they lose the property of being the best linear unbiased estimators (BLUE), which implies that the model is not acceptable in the traditional sense and better estimations should be sought. To enhance the results of the study and the explanatory power of the model, we examined the long-term effects of oil prices on economic growth, and the findings indicate the following:

- The Pedroni cointegration test confirmed a long-term equilibrium relationship between economic growth and oil prices, along with other control variables.
- The results from estimating the error correction model (VECM) using FMOLS indicated that higher oil prices (OP) have a positive impact on economic growth, measured by per capita GDP, in the long term.
- As for the other control variables (TFC, WF, TOP), they are statistically significant at the 1% level, and their signs are economically valid, positively influencing per capita GDP in the long term.

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