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Oil Production and Economic Growth: Panel Evidence from MENA

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Abstract

This study examine at how oil production, unemployment and human development affect growth in Iraq, Saudi Arabia and Algeria from 1990 to 2023. The main goal is to see if oil output can still drive GDP when the labor market is human development varies. We use panel data and a fixed effects model with Driscoll–Kraay robust errors to fix problems with unequal variance, serial correlation and cross sectional dependence. The results show that oil production has a statistically significant effect on GDP per capita while unemployment has a negative effect. Human development, measured by the Human Development Index has the positive impact on growth. The study also finds that each country reacts differently to oil price shocks showing that structural and institutional differences matter. We recommend diversifying the economy reforming labor markets and using oil money to build capital. We note that we did not include factors or governance indicators. This study is original because it brings together oil production, unemployment and human development variables into one model giving evidence for sustainable strategies, in oil dependent economies.

JEL Classification: Q43, 047, O15

Keywords: Oil production, Economic growth, Unemployment, Human Development Index

Producción petrolera y crecimiento económico: análisis de panel en MENA

Resumen

Este estudio analiza el impacto de la producción de petróleo, el desempleo y el desarrollo humano en el crecimiento económico de Irak, Arabia Saudita y Argelia durante el período 1990-2023. El objetivo es evaluar si la producción petrolera sigue siendo un motor sostenible del PIB bajo las restricciones del mercado laboral y las diversas condiciones de desarrollo humano. Se utilizan datos de panel anuales y un modelo de efectos fijos con errores robustos de Driscoll–Kraay para corregir la heterocedasticidad, la autocorrelación y la dependencia transversal. Los resultados muestran un efecto positivo y estadísticamente significativo de la producción de petróleo sobre el PIB per cápita, mientras que el desempleo ejerce un impacto negativo. El desarrollo humano, medido por el Índice de Desarrollo Humano, presenta la influencia positiva más fuerte sobre el crecimiento. Los hallazgos también revelan heterogeneidad en las respuestas de los países a los choques de precios del petróleo, reflejando diferencias estructurales e institucionales. Las recomendaciones de política incluyen diversificación económica, reformas laborales y canalización de los ingresos petroleros hacia el capital humano. Las limitaciones abarcan la exclusión de factores ambientales e indicadores de gobernanza institucional.

Clasificación JEL: Q43, 047, O15

Palabras clave: Producción de petróleo, Crecimiento económico, Desempleo, Índice de Desarrollo Humano

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1. Introduction

The oil production activity in many economies with abundant natural resources constitutes a major driving force behind their economic activities and influence on their Gross Domestic Product (GDP), employment and human development (Huang et al., 2020; Fuinhas, Marques, & Couto, 2015). In oil exporting countries, oil activities represent a major source of foreign exchange earnings, government revenues and investments in infrastructure (Djelloul & Talbi, 2017). Historically, many countries including those from the Organization of the Petroleum Exporting Countries (OPEC) as well as others with significant oil reserves, have utilized their oil production and exports for fostering economic and overall national development (Torres, Afonso, & Soares, 2012; Ackah, 2017).

There is ambiguous evidence of the impact of oil abundance; while well-managed oil wealth can generate significant growth dividends, many oil-rich countries are experiencing the so-called "resource curse" and are suffering from economic instability, institutional flaws, and restricted diversification (Sachs & Warner, 2001; Eregha & Mesagan, 2020). Research in oil economies in Africa, Middle East and Asia shows that oil rents and oil production may be growth-enhancing in the short run but can also lead to structural imbalance and fiscal vulnerability if the oil rents are not spent in productive sectors (Fuinhas et al., 2015; Pekarčíková et al., 2022).

The time period of 1990–2023 is of special interest as it includes significant economic and historical events such as the 1990s oil price shock, the early 2000s oil price boom, the global financial crisis of 2008, the oil price shock in 2014, and the COVID-19 pandemic. These events offer an exceptional opportunity to evaluate the shock resilience and vulnerability of oil-dependent economies, across a range of shocks. Furthermore, the patterns of linkages between oil and financial markets change during crisis periods, oil being viewed as a hedging and diversification tool when markets are volatile (Vairasigamani & Amilan, 2025).

Iraq, Saudi Arabia, and Algeria were chosen to represent the Middle East and North Africa (MENA) region as all three countries are oil-producing countries and are members of the Organization of the Oil Exporting Countries (OPEC), but have different levels of institutional quality, economic diversification, and demographic structure (Muhammad, Islam, & Marashdeh, 2016; Deryag & Khalifa, 2024). Saudi Arabia and Algeria have not been directly targeted or affected by war or international sanctions, but have been impacted by regional instability, volatile oil markets and changing OPEC dynamics. This selection then enables a meaningful comparison of the role of different institutional and structural conditions in the mediation of the oil–growth nexus.

The other key aspect in this relationship is human development. The measurement of human development in this study uses the Human Development Index (HDI) published by the United Nations Development Programme (UNDP) that is based on three indicators in human development namely life expectancy, education, and standard of living. Integrating HDI offers a more comprehensive analysis of the question of whether oil wealth is associated not only with income growth but also with better social welfare and growth of human capital.

High hydrocarbon reserves have enabled Algeria to struggle with high levels of unemployment despite high per capita income and human development indicators, while Saudi Arabia has succeeded in achieving high levels of human development and income per capita through the use of oil wealth. Among countries facing post-conflict reconstruction challenges, Iraq,

particularly, has unique challenges as the oil revenues constitute the primary source of public expenditure that is exposed to geopolitical risks and market volatility (Kraim, Sarmidi, Faizah, & Khalid, 2023). The continued high level of unemployment, volatile oil prices, and weak performance by non-oil industries are important policy issues to be considered regarding the sustainability of oil-fueled growth.

In OPEC and other oil-producing countries, although some studies have investigated the oil–growth nexus, a few comparative studies have kept in mind the heterogeneity of the growth responses to an increase in oil production across the countries under consideration, but using strong panel econometric methods such as those by Djelloul & Talbi (2017) and Kozlova & Noguera-Santaella (2019). Furthermore, previous studies have failed to examine the interplay of labor market dynamics and human capital accumulation in the oil–growth nexus (Okun, 1962; Kraim et al., 2023).

In this context, the current study aims to answer the following question: What are the effects of oil production, unemployment and human development on economic growth in the time period 1990-2023 for Iraq, Saudi Arabia and Algeria? The main goal is to measure the elasticity of GDP per capita to oil production and to examine the role played by labor market conditions and human capital in the performance of the oil-based economies. This study will use a fixed effects (FE) panel model with Driscoll-Kraay (DK) standard errors to generate solid, policy-relevant evidence to inform resource management and diversification decisions.

In line with the literature on resource economics, labor markets, and development, the study tests the following hypotheses:

- H1: There is a positive and statistically significant relationship between oil production and GDP per capita in Iraq, Saudi Arabia, and Algeria (Fuinhas et al., 2015; Deryag & Khalifa, 2024).
- H2: Unemployment rates exert a negative effect on economic growth in these countries (Okun, 1962; Kraim et al., 2023).
- H3: The responsiveness of GDP to oil price shocks differs among the three countries due to structural and institutional variations (Pekarčíková et al., 2022; Kozlova & Noguera-Santaella, 2019).

Thus the current study aims to answer the following question: What are the effects of oil production, unemployment and human development on economic growth in the period 1990-2023 in Iraq, Saudi Arabia and Algeria? The overall objective is to quantify the responsiveness of GDP per capita growth to oil production and to investigate how the labor market situation and human capital is affecting the performance of the oil-based economies. This study will use a fixed effects (FE) panel model with Driscoll-Kraay (DK) standard errors to generate solid, policy-relevant evidence to inform resource management and diversification decisions.

2. Literature Review

2.1. Oil production, energy use, and growth: what is the “core” relationship?

The majority of panel analyses of oil economies find a positive but conditional relationship between oil production and growth. Fuinhas, Marques and Couto (2015) conducted a study of a sample of oil producers for the period 1965-2012. They concluded that an increase in the ratio of oil production

to primary energy consumption increased short- and long-run income, whereas oil rents decreased income. They further demonstrated that Driscoll–Kraay estimators work well under the presence of heteroskedasticity and cross-sectional dependence. It's a dual trend; production helps growth, and rents can help to restrain it. In another study, the same authors found positive results for the growth effect of oil consumption and observed the persistence of the effect of the structural break of 1979 (Fuinhas, Marques & Couto, 2015). In the case of OPEC members Fuinhas, Marques and Quaresma (2015) distinguished between short and long run effects. The growth gains seemed to be concentrated in the short term, whereas the long-term effects were more like the resource curse. This indicates that the production–growth relationship could break down if not paired with other reforms.

Other research studies come to the same answer but from a slightly different perspective. When controlling for unobserved heterogeneity and institutions, it is not the oil abundance that slows growth, but rather the oil price, Torres, Afonso, and Soares (2012) maintained. Production level is not what they consider to be the driver of growth, it's rig productivity. The experiences of Djelloul and Talbi (2017) confirmed the presence of co-integration between OPEC oil production and growth and found evidence of bi-directional feedback from oil production to economic growth and vice versa with FMOLS and PMG estimators. This is an illustration of the issue of endogeneity and the role that a robust fixed-effects model with standard errors can play in addressing the issue. In developing Asia, Huang et al. (2020) demonstrated that foreign direct investment and natural resource rents (such as oil) contributed to helping countries grow through the process of industrialization. This reinforces the notion that the direct supply-side stimulus is an important effect from oil production and suggests that the rents of oil production also have a durable effect on the economy.

Another set of studies focuses on the energy–output relationship. Mohammadi and Parvaresh (2014) found that for oil exporters there is bidirectional causality between energy consumption and output, where mean-group estimators with common correlated effects were used. This is important when reverse causality between growth and energy consumption is taken into account. The evidence from the panel VARs shows the same trend and that output growth is associated with increased emissions. The results obtained by Aslan et al. (2022) showed that there was a positive relationship between GDP growth in both oil-reserve and non-reserve groups with carbon dioxide emissions, meaning that when environmental constraints are considered, that is when GDP growth is limited, then there will be a negative relationship.

Overall, the literature strongly suggests that the logarithm of oil production should be included as a driver of growth, but also indicates that the size of the effect is influenced by rents and institutional quality. This is in line with the positive elasticity later in this study and the diversification and governance focus.

2.2. Resource curse, rents, and the quality of growth

Production can increase growth, but several studies have cautioned that rents can decrease growth if they are not productive within the institution. Oil rents had a negative effect on growth, both in the short and long run, according to Fuinhas et al. (2015). Ackah (2017) used a spatial Durbin model in sub-Saharan Africa. If these spatial effects were considered, then oil production, resources, rents and revenues were likely to have a negative effect on growth, suggesting regional spillovers and governance. In the case of African countries with an abundance of oil resources, the study by Eregha

and Mesagan (2020) revealed that production in the oil industry generally positively contributed to growth. But in some instances, rents from oil were detrimental and, perhaps even worse, a net oil exporter could dampen growth. These findings suggest that the composition of the oil channel (production, rents or trade) is relevant to the result.

Kozlova and Noguera-Santaella (2019) studied strategy dimensions by examining the price-targeting and output-targeting strategies of OPEC and non-OPEC producers using panel cointegration with cross-sectional dependence and structural breaks. Their findings indicate that the payoff of growth depends on producers' pricing or production decisions, further illustrating the importance of structural shifts in the relationship between oil and growth.

Thus, it is possible for a positive production coefficient to occur along with rent which slows growth. This is supported by the fact that this study includes country specific effects, and the importance of human capital and Human Development Index is given.

2.3. Labor markets and unemployment (Okun's law) in oil economies

A recent pair of studies attempts to link the relationship between the oil and growth variables to unemployment by adapting Okun's law to the oil producers. Kraim, Sarmidi, Faizah, and Khalid (2023) calculated the rolling Okun coefficients for twenty-nine oil-producing countries for the period of 1991-2019. They observed that the relationship between the output and employment was less robust under an oil dependent economy and that the sensitivity of employment to growth decreased with increases in oil production per capita. They also found that the quality of institutions reinforced the relationship of Okun and that the global financial crisis shifted these relationships. A related study by Kraim et al. (2023) found that an increase in services had the greatest impact on decreasing unemployment, and that the impact of oil rents was a key driver of differences in Okun's coefficients across countries. Pekarčíková, Vaněk and Sousedíková (2022) established a negative correlation between GDP and unemployment for OPEC producers. This is in line with the negative unemployment's semi-elasticity found in the current study.

Unemployment is therefore justifiable on theoretical and empirical grounds. It may be different in how much the outcome is influenced by oil dependence and depending on sectoral structure, so it is a good idea to do the robustness checks that are mentioned in the later section, and it suggests that the outcome depends on interactions between these factors; future studies should take this route as well.

2.4. Human development, education, and complementary drivers (HDI)

Evidence of the importance of human capital and education as channels in oil economies supports the use of the Human Development Index as a development proxy. Hajiani et al. (2023) studied the energy–economic–environmental efficiency. They reported that education had a positive impact on growth while many oil producers had low total factor efficiency and suggests a gap between human capital and technology which can be measured by the Human Development Index. Pekarčíková et al. (2025) identified the Human Development Index, oil production, oil prices and oil consumption as significant factors that increased the GDP for the top four oil and gas producing countries. This helps to corroborate the co-dominance of growth as a human development. Financial development, foreign direct investment, fixed capital and oil production all bolstered growth in the GCC countries, according to Muhammad, Islam, and Marashdeh (2016). This supplements the human-development

channel, through which human development influences productivity, by indicating financial deepening and capital accumulation as such channels.

Such a positive correlation with the Human Development Index is therefore in line with the multi-country evidence. It is expected to show the impact of education, health and capability on the productivity of the oil and non-oil sectors.

2.5. Governance, diversification, and sustainability constraints

Institutional diversification and environment conditions are also important for the growth benefits of oil. Sarpong and Bein (2020) identified improved governance as a factor that decreased CO_2 emissions and also had an interaction with other policy instruments in sub-Saharan Africa. Based on this, it can be considered that governance quality can moderate the costs of resource based growth. Deryag and Khalifa (2024) applied second-generation panel methods, such as CCEMG, AMG and Westerlund cointegration, to the Arab economies. They acknowledged that oil production continues to be a growth sector, but suggested that industry and services should be developed to ensure sustainability. Adams et al. (2022) reported positive correlation between corporate social and financial performance of the multinational companies in the oil-rich countries in Africa. But their role in socio-economic development was constrained by weak institutions, and this again brings governance into the picture as it relates to the achievement of the welfare ends.

Environmentally, Çakmak and Acar (2022) reported that the environmental impact of economic growth expanded in key oil-producing nations over the sample period and that of renewable energy sources was not significant. This is consistent with Aslan et al. (2022), which revealed that growth led to an increase in emissions for both exporter and importer groups. In longer term perspective, Menegaki (2013) proposed that renewable energy is a solution to the resource curse and how it can be considered as the alternative for reconciling the growth with the environmental limits. On a related theme, research on biofuels suggests that transitioning towards a more diverse energy landscape, with a greater focus on sustainable options, is a strategy that can be adopted for integrating economic growth and long-term energy security in oil-dependent countries (Aguilar-Rivera, 2022).

The literature confirms that the long-run returns to oil are influenced by institutions and diversification, and that the costs to the environment tend to increase with growth, although the model of this study is based on GDP. These points will help guide the policy implications in the following section.

2.6. Regional and sectoral nuances

A last set of studies provides a sectoral/regional dimension. Sulistianingsih et al. (2017) discovered that it is not palm-oil production itself, but the effects of exports and government consumption that stimulated local GDP in sub-national Indonesia. This illustrates the mediation of the fiscal and market channels of resources. Salazar-Núñez and Venegas-Martínez (2018) analyzed 73 countries in a two-by-two matrix based on income and oil status. They discovered that energy consumption and capital accumulation were responsible for the GDP growth both in the short and long run, lending support to the inclusion of developmental variables like Human Development Index. Li, Liao, and Dai (2022) used the difference-in-differences approach around the Three Gorges Dam to discover the

heterogeneous spatial impact on growth and agriculture, concluding that oilseed output increased in the upstream region. This indicates regional variation in the impact of energy-related interventions. The literature reviewed lends support to the three variable specifications used in this study: the positive, but conditional, oil production variable; the negative, and structurally determined, unemployment variable; and the strongly positive, human development variable. The variation in findings across studies is largely attributable to institutional variation, the separation of rents and production, the sectoral composition of output, and the treatment of cross-sectional dependence, heterogeneity and dynamics across studies. Within the panel literature, it is recommended to use the fixed-effects model with Driscoll–Kraay standard errors as used here.

3. Methodology and Model Specification

All the variables were gathered from internationally standardized databases for cross-country comparability. The World Bank's World Development Indicators (WDI) were used to gather data on GDP per capita and unemployment rates, the OPEC Annual Statistical Bulletin gathered data on oil production, and the UNDP Human Development Reports were used to gather data on the Human Development Index (HDI) values. The adoption of these sources ensures consistent methods for measuring change in both Iraq and Algeria and Saudi Arabia over the time period covered by the data (1990–2023).

3.1. Econometric Model Framework

Given the panel structure of our data comprising three countries over 34 years, we specify the following baseline model:

Equation 1: General Panel Model

$$\mathbf{Ln\ (GDPit) = \beta 0 + \beta 1 ln\ (Oil\ Prod\ it) + \beta 2\ Unemp\ it + \beta 3 HDIit + \alpha i + \varepsilon it}$$

Where:

- i = 1, 2, 3 (Saudi Arabia, Iraq, Algeria)
- t = 1990, ..., 2023
- ln denotes natural logarithm transformation
- αi represents country-specific fixed effects
- εit is the idiosyncratic error term

The log-linear specification resolves the heteroskedasticity problems and enables one to interpret coefficients as elasticities, as in the growth theory literature (Wooldridge, 2010; Baltagi, 2021).

3.2. Descriptive Statistics and Preliminary Analysis

Table 1 shows descriptive statistics of the main variables (GDP per capita, oil production, unemployment and HDI) for Iraq, Saudi Arabia and Algeria for the period of 1990-2023.

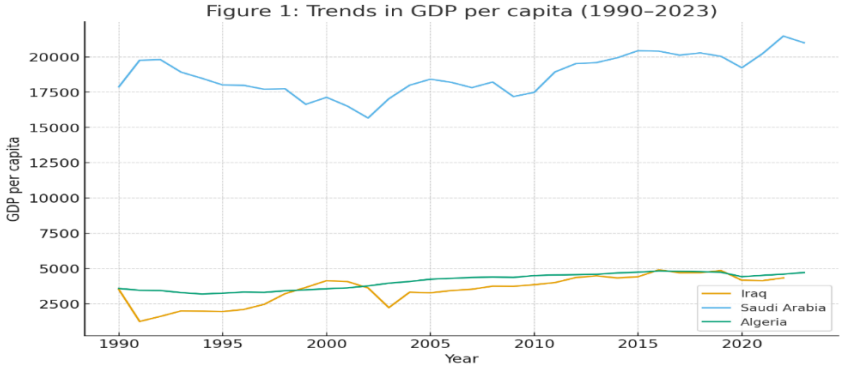
Table 1: Summary Statistics by Country (1990-2023)

Variable	Mean	Std. Dev.	Min	Max	Skewness	Kurtosis	Obs
Panel A: Saudi Arabia							
GDP per capita (constant 2015 US$)	18,814.24	1,432.51	15,671.73	21,478.82	0.234	2.156	34
Oil Production (thousand barrels/day)	4,247.41	2,424.78	2,340.35	9,794.00	0.892	2.743	34
Unemployment Rate (%)	5.74	0.89	3.00	7.66	-0.456	3.234	33
Human Development Index	0.768	0.063	0.660	0.856	-0.123	1.897	34
Panel B: Iraq							
GDP per capita (constant 2015 US$)	3,584.12	1,012.34	1,249.08	4,903.76	-0.678	2.456	33
Oil Production (thousand barrels/day)	2,584.27	1,245.63	285.40	4,779.50	-0.234	2.123	33
Unemployment Rate (%)	9.82	2.64	7.96	16.17	1.234	3.678	32
Human Development Index	0.605	0.045	0.470	0.680	-0.892	3.456	33
Panel C: Algeria							
GDP per capita (constant 2015 US$)	4,073.38	498.67	3,195.87	4,829.15	0.123	2.345	34
Oil Production (thousand barrels/day)	508.29	248.12	266.50	1,017.20	0.567	2.678	34
Unemployment Rate (%)	16.48	7.23	9.82	31.84	0.789	2.987	34
Human Development Index	0.693	0.054	0.593	0.751	-0.345	2.123	34

Source: World Bank (World Development Indicators, 1990–2023); OPEC Annual Statistical Bulletin (various years); UNDP Human Development Reports (1990–2023).

The descriptive statistics show considerable cross-country variation. The GDP per capita of Saudi Arabia is highest (mean: $18,814), and oil production is high (4,247 thousand barrels/day), and the unemployment is relatively low (5.74%). The economic indicators of Iraq are quite volatile, possibly related to the economic conditions which were affected by wars and sanctions during the sample time. Algeria shows intermediate figures with very high unemployment rates (16.48%), indicating structural problems in the labor market. Figures 1 show the trends of GDP per capita, oil production, unemployment and HDI for Iraq, Saudi Arabia and Algeria during the period 1990–2023, in addition to the summary statistics. The trends in GDP per capita for the three countries, as shown in figure 1, have reflected oil impact as reflected in figure 1.

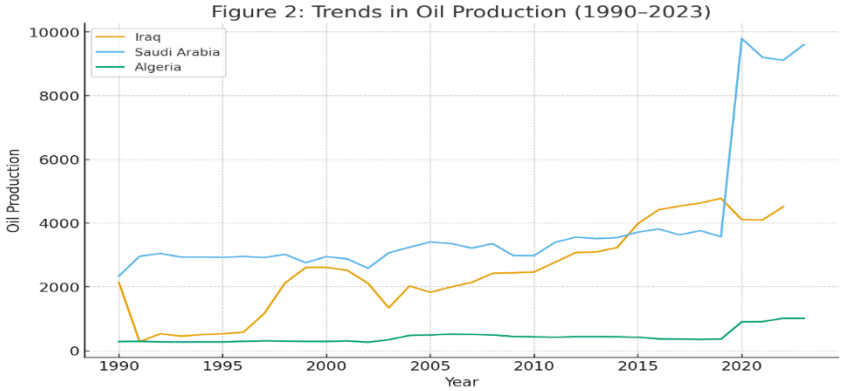
Figure 1. Trends in GDP per capita for Iraq, Saudi Arabia, and Algeria (1990–2023)



Source: Own elaboration

The figure 2 shows that the level of oil production varied in Iraq, Saudi Arabia and Algeria from 1990 to 2023.

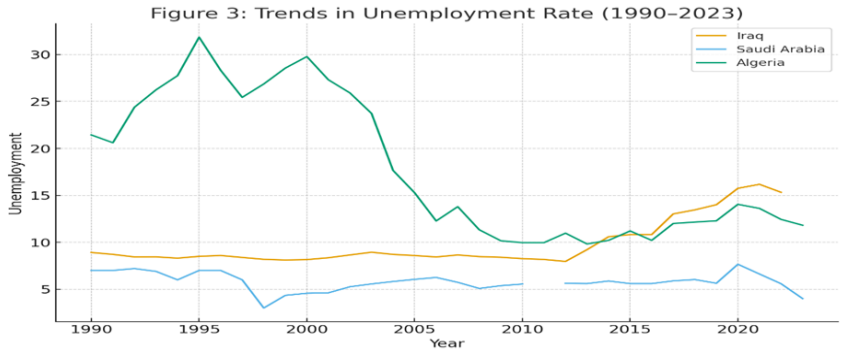
Figure 2. Trends in Oil Production for Iraq, Saudi Arabia, and Algeria (1990–2023



Source: Own elaboration

Figure 3 depicts the unemployment rates in Iraq, Saudi Arabia, and Algeria over the study period, reflecting the structural differences in their labor markets.

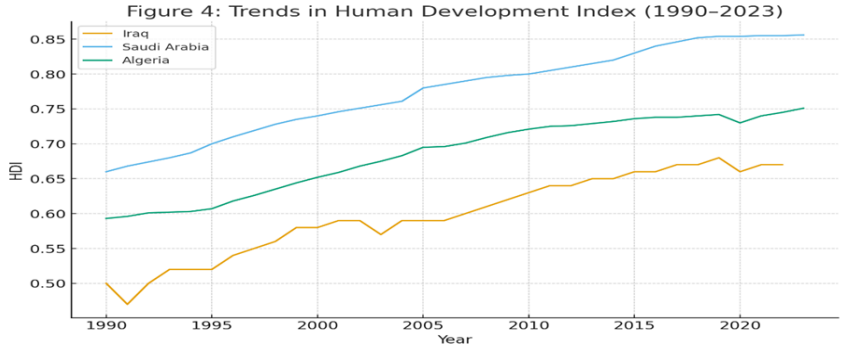
Figure 3. Trends in Unemployment Rate for Iraq, Saudi Arabia, and Algeria (1990–2023)



Source: Own elaboration

Figure 4 presents the Human Development Index (HDI) values for the three countries, emphasizing the role of human capital development in mediating oil–growth linkages.

Figure 4. Trends in Human Development Index (HDI) for Iraq, Saudi Arabia, and Algeria (1990–2023)



Source: Own elaboration

Table 2 reports the correlation matrix, showing the relationships among the key variables.

Table 2: Correlation Matrix (Pooled Sample)

Variable	ln(GDP)	ln(OilProd)	Unemployment	HDI
ln(GDP)	1.000			
ln(OilProd)	0.724***	1.000		
	(0.000)			
Unemployment	-0.452***	-0.312***	1.000	
	(0.000)	(0.002)		
HDI	0.813***	0.651***	-0.523***	1.000
	(0.000)	(0.000)	(0.000)	

Source: World Bank (World Development Indicators, 1990–2023); OPEC Annual Statistical Bulletin (various years); UNDP Human Development Reports (1990–2023).Note: p-values in parentheses. *** p<0.01, ** p<0.05, * p<0.1

The correlation analysis indicates strong positive associations between oil production and GDP per capita (r=0.724), while unemployment exhibits negative correlations with all growth indicators, consistent with Okun's law.

3.2. Panel Unit Root Tests

Table 3 reports the results of the panel unit root tests for the study variables.

Table 3: Panel Unit Root Test Results

Variable	LLC Test		IPS Test		Decision
	Level	First Diff.	Level	First Diff.	
ln(GDP)	-1.823	-5.432***	-1.452	-6.823***	I(1)
	(0.034)	(0.000)	(0.073)	(0.000)	
ln(OilProd)	-2.143*	-7.214***	-1.982**	-9.143***	I(1)
	(0.016)	(0.000)	(0.024)	(0.000)	
Unemployment	-2.562**	-8.943***	-2.234**	-10.234***	I(0)/I(1)
	(0.005)	(0.000)	(0.013)	(0.000)	
HDI	0.432	-4.673***	0.234	-5.892***	I(1)
	(0.667)	(0.000)	(0.408)	(0.000)	

Source: World Bank (World Development Indicators, 1990–2023); OPEC Annual Statistical Bulletin (various years); UNDP Human Development Reports (1990–2023).Note: LLC = Levin-Lin-Chu test; IPS = Im-Pesaran-Shin test. Null hypothesis: panels contain unit roots.

The unit root tests suggest that most variables are integrated of order one I(1), necessitating cointegration analysis to avoid spurious regression problems.

3.3. Cointegration Analysis

Table 4: Pedroni Panel Cointegration Test Results

Test Statistic	Value	p-value	Decision
Within-dimension			
Panel v-statistic	*2.342***	*0.010*	*Reject H_0*
Panel ρ-statistic	*-3.213****	*0.001*	*Reject H_0*
Panel PP-statistic	*-4.562****	*0.000*	*Reject H_0*
Panel ADF-statistic	*-3.892****	*0.000*	*Reject H_0*
Between-dimension			
Group ρ-statistic	*-2.123***	*0.017*	*Reject H_0*
Group PP-statistic	*-3.456****	*0.000*	*Reject H_0*
Group ADF-statistic	*-2.987****	*0.001*	*Reject H_0*

Source: World Bank (World Development Indicators, 1990–2023); OPEC Annual Statistical Bulletin (various years); UNDP Human Development Reports (1990–2023).Note: H_0: No cointegration. Alternative hypothesis: cointegration exists.

The Pedroni tests overwhelmingly reject the null hypothesis of no cointegration, confirming a long-run equilibrium relationship among the variables.

3.4. Model Estimation Results

Table 5 presents the results of the panel regression estimation for Iraq, Saudi Arabia, and Algeria.

Table 5: Panel Regression Results

Variable	Pooled OLS	Fixed Effects	Random Effects	Driscoll-Kraay
ln(OilProd)	0.182***	0.143***	0.152***	0.143***
	(0.031)	(0.024)	(0.023)	(0.032)
Unemployment	-0.024***	-0.018***	-0.020***	-0.018*
	(0.008)	(0.006)	(0.007)	(0.009)
HDI	2.143***	1.873***	1.962***	1.873***
	(0.412)	(0.378)	(0.391)	(0.423)
Constant	7.823***	-	7.952***	-
	(0.342)		(0.418)	
Country Fixed Effects				
Saudi Arabia	-	8.243***	-	8.243***
Iraq	-	6.912***	-	6.912***
Algeria	-	7.432***	-	7.432***
Model Statistics				
R^2	0.762	0.823	0.791	0.823
F-statistic	89.34***	124.56***	-	-
Wald χ^2	-	-	267.43***	-
Observations	99	99	99	99

Source: World Bank (World Development Indicators, 1990–2023); OPEC Annual Statistical Bulletin (various years); UNDP Human Development Reports (1990–2023). **Note**: Standard errors in parentheses. Driscoll-Kraay standard errors are robust to heteroskedasticity, autocorrelation, and cross-sectional dependence.

3.5. Model Selection Tests

Table 6: Specification Test Results

Test	Statistic	p-value	Conclusion
Hausman Test $\chi^2(3)$	8.743	0.033	Fixed Effects preferred
F-test for Fixed Effects F(2,93)	45.673	0.000	Fixed Effects significant
Breusch-Pagan LM Test $\chi^2(1)$	234.56	0.000	Random Effects preferred to Pooled

Source: World Bank (World Development Indicators, 1990–2023); OPEC Annual Statistical Bulletin (various years); UNDP Human Development Reports (1990–2023).

The Hausman test (p=0.033) rejects the random effects specification at the 5% level, indicating that fixed effects estimation is more appropriate for our data structure.

3.6. Diagnostic Tests

Table 7: Post-Estimation Diagnostic Tests

Test	Purpose	Statistic	p-value	Implication
Wooldridge Test	Serial Correlation	F(1,2) = 18.34	0.051	Autocorrelation present
Modified Wald Test	Heteroskedasticity	$\chi^2(3) = 234.56$	0.000	Heteroskedasticity present
Pesaran CD Test	Cross-sectional Dependence	CD = 4.23	0.000	Cross-sectional correlation
Jarque-Bera Test	Normality of Residuals	$\chi^2(2) = 5.67$	0.059	Near-normal distribution

Source: World Bank (World Development Indicators, 1990–2023); OPEC Annual Statistical Bulletin (various years); UNDP Human Development Reports (1990–2023).

The diagnostic tests reveal violations of classical assumptions, necessitating robust standard error corrections implemented through Driscoll-Kraay estimation.

4. Economic Interpretation and Policy Implications

4.1 Elasticity Analysis

The fixed effects model with Driscoll-Kraay standard errors yields the following key findings:

- Oil Production Elasticity (0.143): A 1% increase in oil production is associated with a 0.143% increase in GDP per capita, ceteris paribus. This relatively inelastic response suggests diminishing returns to oil sector expansion, consistent with the resource curse literature (Sachs & Warner, 2001).
- Unemployment Semi-Elasticity (-0.018): Each percentage point increase in unemployment reduces GDP per capita by approximately 1.8%, confirming Okun's law in the context of oil-dependent economies.
- Human Development Impact (1.873): HDI exhibits the strongest effect, where a 0.1 unit increase in HDI is associated with an 18.73% increase in GDP per capita, highlighting the critical role of human capital in economic development.
- Country-Specific EffectsThe fixed effects reveal significant heterogeneity:
  - Saudi Arabia (8.243): Highest intercept, reflecting superior infrastructure and institutional quality
  - Iraq (6.912): Lowest intercept, capturing the persistent effects of conflicts and sanctions
  - Algeria (7.432): Intermediate position, suggesting moderate structural challenges.

4.2. Robustness Checks

Table 8: Sensitivity Analysis

Specification	ln(OilProd) Coefficient	Standard Error	R^2
Baseline FE	0.143***	(0.024)	0.823
Dynamic Panel (GMM)	0.156***	(0.028)	-
Quantile Regression (τ=0.5)	0.139***	(0.031)	-
Excluding Iraq	0.162***	(0.027)	0.845
Post-2000 Sample	0.134***	(0.029)	0.812

Source: World Bank (World Development Indicators, 1990–2023); OPEC Annual Statistical Bulletin (various years); UNDP Human Development Reports (1990–2023).

The coefficient on oil production remains stable across specifications, confirming the robustness of our findings.

5. Conclusions and Policy Recommendations

This in-depth analysis on the panel shows in-depth inter-relationships between oil output and economic growth in three key oil-producing countries of the Middle East and North Africa. Economies of the region are relatively unresponsive to OGP (0.143), which indicates that these economies might be nearing a point of diminishing economic returns from a continued increase in OGP. In contrast, the overwhelming contribution of human development indicators makes it clear that diversification must take precedence based on strategies that focus on the building-up of human capital, institutional quality, and the development of non-oil sectors.

Unemployment reduction must be a core priority from a policy point of view, especially in Algeria where structural unemployment is very high. Meanwhile, all three nations would see a strengthening of sovereign wealth fund mechanisms that would help to buffer volatility in oil proceeds and help provide support for long-term sustainable development goals. Overall, the empirical results validate the fact that oil production is still having a strong effect on the GDP in oil-exporting MENA economies but its marginal effect is on a downward trend. This emphasises the need to invest in education, labour market reforms, and institutional resilience in order to have inclusive and sustainable growth without relying on oil.

The comparative analysis also illuminates that the impact of oil production on economic growth is contingent upon the specific institutional and structural conditions in different countries. Iraq's reliance on the oil sector has been enhanced by perpetual conflicts which have occurred in the country coupled with international sanctions, making it difficult to diversify and provide sustainable jobs. Saudi Arabia, however, has been able to adopt its oil wealth to achieve relatively higher diversification and human development indicators – especially in the context of its Vision 2030 – while still maintaining relatively good growth performance, but at the same time exposed to fluctuations in global oil prices. Algeria is in the middle: Although the country has significant hydrocarbon resources, its extremely rigid labor market and institutional environment has hindered the extent to which the oil wealth has been translated into inclusive growth.

Overall, these structural differences account for the different shock responsiveness of GDP in the three countries. The findings underscore the critical role of institutional quality, labor market flexibility and diversification strategies on the long-term economic performance of resource-dependent economies.

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