THE IMPACT OF CRUDE OIL PRICE, POPULATION, EXPORTS AND INFLATION ON ECONOMIC GROWTH: EVIDENCE FROM IRAQ

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Abstract: *This study aims to examine the relationship between crude oil prices, population, exports, inflation, and economic growth in Iraq based on annual time series from 1997 to 2022. As it is well known, crude oil is one of the most important resources for energy production, transportation, and various industries. Moreover, this energy source has a critical importance in terms of the international trade. Therefore, the effects of crude oil in Iraq's economy is analyzed in this study. To achieve the degree and magnitude of the parameters used in the models, the Ordinary Least Squares method and the Johansen cointegration test are utilized. According to the empirical results of the study, while crude oil prices, population, and exports have a positive impact on economic growth, inflation has a negative impact. Additionally, a long-term relationship is found between crude oil prices, population, exports, inflation, and economic growth.as a result of cointegration test with the VAR system. Based on these results, it can be said that sustainable oil producing is very crucial in Iraq. Since the government income of Iraq relies heavily on revenue generated from oil exports, the improving and regulation activities should be considered in the oil sector. On the other hand, as the oil is finite resource, the local policymakers need to focus on researching alternative sources for exports and research the ways to boost the country's GDP.*

Key words*:* Economic Growth, Crude Oil Price, OLS Model, Johansen Cointegration Test, Iraq

JEL Classification Codes: E31, O47, Q37, Q48.

1. INTRODUCTION

Crude oil is a major player in the intricate structure of the international trade. It is a crucial component of modern industrialization, serving as the basis for energy production, transportation, and various other industries. However, the relationship between oil and economic growth is a complex issue and extends beyond the borders of countries that produce it. Crude oil is a precious and limited resource in global context. It has been a major factor in determining the economic performance of countries for a long time. Its significance goes beyond just creating energy, as the money obtained from its extraction, processing, and exporting becomes an essential factor in determining the overall economic welfare of a nation. The economic effects of crude oil revenue are complicated and have varying impacts on countries that produce and use oil (Blanchard and Gali, 2007; Hamilton, 2013; Havranek et al., 2016; Herwartz and Plödt, 2016; Van Eyden et al., 2019). The Solow model highlights the hypothesis that increases in capital and productivity are the primary drivers of economic growth in the long run (Solow, 1994). Traditional trade theories suggest that a country's production and exports are influenced by its abundant factors, leading to global efficiency and mitigating geographical imbalances in natural resources, historically benefiting advanced industrialized nations (Bayraç, 2019).

Iraq was the sixth-largest oil-producing country around the world in 2022, with an output of 4,451,516 barrels per day. Its oil exports generated a revenue of $82.3 billion, making it the sixth-largest oil-exporting country in the world. In this context, Iraq's public revenue is heavily dependent on the income generated from oil exports, which is utilized to fund important development projects like infrastructure, social programs, and other initiatives. However, a decline

in oil prices can lead to budget deficits, impact the trade balance negatively, depleting foreign exchange reserves, and hinder economic diversification. High oil prices can stimulate economic growth, attract foreign direct investment, increase social spending, and provide more resources for infrastructure development. Conversely, low oil prices may result in reduced investment, slow down economic growth, and lead to austerity measures that could impact social programs.

The main purpose of this study is to examine the relationship between population, exports, inflation and the price of crude oil on economic growth in Iraq from 1997 to 2022. The following sections firstly, a literature review will be given. Then the methodology and data that used in the models will be outlined. In the fourth section, the empirical findings will be presented. Finally, the study will be concluded with several policy recommendations.

2. LITERATURE REVIEW

According to the literature, various studies yield different results in terms of investigated countries, time periods and methods that used. In this context, some researches use panel data, whereas others utilize time series. That is to say the methods and time periods that used in the analyses might lead to the differences in the results of the studies. Selected literature review in line with the content of this study is given below.

Darrat et al. (1996) analyze quarterly data for the U.S. covering the period from 1960 to 1993. The study reveals that oil price shocks are not a primary cause of U.S. business cycles. Additionally, the findings suggest that both oil prices and real output are significant factors that cause changes in oil consumption. These results support the idea that a systematic conservation policy in the U.S. would not significantly harm real economic activity. Abeysinghe (2001) discusses ASEAN4 (Indonesia, Malaysia, Philippines, Thailand), NIE4 (Hong Kong, South Korea, Singapore, Taiwan), China, Japan, USA, and the rest of OECD as a group (ROECD) data for the period between 1982 and 2000 by applying VAR model. The empirical results show that the pass-through between oil prices and growth is not very important for large economies, but for smaller economies found to be of critical importance.

Narayan et al. (2008) use Fiji Islands data for the period 1971-2003 with the VAR method in their study, observed that increases in oil prices had a positive effect on GDP. Berument et al. (2010) analyze MENA Countries (The Middle East and North Africa) data for the period of 1952-2005 by using the VAR method in their study. They found that the increase in oil prices in most of the oil exporting countries made a positive and significant contribution to economic growth. Ftiti et al. (2016) investigate the level of correlation between oil prices and economic growth in four major countries (United Arab Emirates, Kuwait, Saudi Arabia, and Venezuela) that are members of the Organization of the Petroleum Exporting Countries (OPEC) during the period from September 3, 2000, to December 3, 2010. The result of the study revealed that oil price fluctuations have both short- and medium-term impacts on economic growth.

On the other hand, Yılancı (2017) deduced that there is no long-term relationship between oil prices and growth. As a result of the empirical analyses, the cointegration relationship was not found between oil prices and growth in Türkiye for the period of 1990-2016. Additionally, Kavaz (2020) incorporated the variables such as imported crude oil, the real price of crude oil, real GDP and utilized annual time series data from 1970 to 2018 for Türkiye. According to the Harvey's Structural Time Series Modelling Method, with the underlying energy demand trend, the estimated income and price elasticities for imported crude oil suggest inelastic demand.

Sweidan and Bargathi (2023) examines and compares the influence of oil prices, international geopolitical risks, and government expenditures on Saudi Arabia's economic diversification during 1970–2020. Oil prices and geopolitical risks negatively impact Saudi Arabia's diversification process in the short run. In this sense, the negative impact of oil prices persists in the long-term, while geopolitical risks have a short-term effect. On the other hand,

government spending plays a crucial role in promoting diversification both in the short and long term. These findings show that Saudi Arabia's government has the ability to encourage economic diversification, which is a positive indication of the impact of the state capitalism doctrine.

In parallel to the main context of this study, the connection between Iraq's economic development and the price of crude oil has been the subject of several studies. Researchers have examined other factors, such as inflation, export and oil revenue alongside of crude oil price and economic growth parameters to increase the accuracy of the studies.

Most of these research has concluded that there is a long-term correlation between crude oil prices and economic growth. In this context, the crude oil prices have a significant effect on Iraq's GDP. As the country opened up its economy to the international markets and boosted oil production following the overthrow of Saddam Hussein's dictatorship, the number of studies analyzed the relationship between oil revenue and economic growth have increased. The most significant studies are listed below and will be given priority.

According to the Fezzani and Nartova (2011), Odhiambo (2020), Drebee and Razak (2022) and Al Taie et al. (2022) the oil prices have a significant impact on economic growth in Iraq. Despite the fact that all these studies use different time periods and models, they support that the oil price is important driving force for the GDP growth in Iraq. Consequently, the rise in oil revenue increases the country's GDP.

Al-Zanganee (2017) analyses the impact of volatility in crude oil prices on the economic activity levels of Iraq from 2003 to 2015.The multivariate autoregressive regression (VAR) model was used to determine that the volatility in crude oil prices had a highly significant impact on the GDP level of Iraq. In parallel to Al-Zanganee (2017), Aktuğ et al. (2019) stated that Iraq relies heavily on crude oil exports (90% of the government's budget) as its primary source of national income. In this study, authors found a strong positive correlation between oil prices and GDP from 1995 to 2017 and highlighted the importance of the oil industry to Iraq's economy.

Recently, Rasheed (2023) explained the nature and characteristics of the global oil market, as well as the association between oil, public expenditure, and the economy in Iraq from 2003 to 2020. The research indicated that adhering to budgets and establishing transparent and adaptable principles are vital for actual economic growth in Iraq economy. In addition, the findings revealed that efficient management of oil revenues and public spending is important for sustainable economic development in Iraq.

Iraq ranks among the world's top producers and exporters of oil. The public budget of the government is mostly dependent on the oil industry since the price of oil directly affects the GDP of the country. For this reason, the studies discussed the relationship between oil prices/revenues and economic performance of Iraq have gradually increased in the recent period.

3. METHODOLOGY AND DATA

One of the most significant data in econometric analysis is time series. Because of the fact that these data sets include trend, when they are added into the regression without any conversion, the regression results may be spurious. In other words, conducting econometric studies using this data usually provides results that do not reflect reality. Therefore, the variables used in these models should be stationary. In a case where time series data are stationary, studies using such data can be valid. The stationarity test of time series data is usually done using unit root tests. After determining the stationarity of a series, cointegration tests can be implemented.

Firstly, the Augmented Dickey-Fuller (ADF) and the Philips-Perron (PP) Unit Root Tests are introduced in this section. Then the Ordinary Least Squares (OLS) approach is presented. Finally, the Johansen Cointegration Test within the Vector Autoregressive (VAR) system is briefly explained, which is used in the analysis to determine the long-term relationship of the parameters

discussed in the study. Furthermore, the diagnostic tests are utilized to adjust the model and present current outcomes. It is crucial to state that the methods used in the study are commonly used in the literature.

3.1. Unit Root Tests

Unit root tests are a set of statistical tests that assist in determining whether a time series dataset is stationary or not. Stationarity of data is an essential assumption in many statistical models, and it is often necessary to perform specific time series analyses such as regression, forecasting, and hypothesis testing. In the empirical analyses part, the Augmented Dickey-Fuller and Phillips Perron tests are used for testing the stationarity of the data sets.

Dickey and Fuller have developed the hypotheses for the Generalized Augmented Dickey-Fuller test (Dickey and Fuller, 1981). The ADF test is used to determine whether a time series data sets are stationary or not.

Dickey and Fuller (1979) state that using the Monte Carlo simulation method. The model and test procedure used for the Augmented Dickey-Fuller unit root test are as follows:

$$Y_t = pY_{t-1} + \sum_{i=1}^{p} B_i \Delta Y_{t-i} + u_t \qquad \Delta Y_t = SY_{t-1} + \sum_{i=1}^{p} B_i \Delta Y_{t-i} + u_t \qquad (1)$$

Here Y_t is the original series with a random walk which means the subsequent year's value equals the current year's value plus a stochastic error term. Equations is used for series that do not contain constants. Afterwards, the hypotheses shown above are tested to test whether the series are stationary or not. In each of these cases, the null hypothesis is $\delta = 0$, which means there is a unit root (non-stationary). On the other hand, the alternative hypothesis is $\delta < 0$, and this means Yt is stationary (Gujarati, 2022: 815).

In the study, the Phillips and Perron (1988) PP unit root test was also used to address the limitations of the ADF test and provide an alternative. The ADF unit root test assumes that the error terms are independently distributed and have a constant variance. However, if these assumptions are not valid, it can lead to problems with the reliability of the test. To solve this issue, Phillips and Perron (1988) introduced heteroskedasticity and autocorrelation between error terms and developed the PP test. This test has similar hypotheses to the ADF test and is expressed by the following equations:

$$Y_t = \lambda_1 Y_{t-1} + \delta_0 + \varepsilon_t \qquad (2)$$

The stationarity test of the time series that used in the analyses are done by using ADF and PP unit root test.

3.2. Ordinary Least Square Model

The OLS model is a statistical technique that is commonly used to estimate the parameters of a linear regression model. This method is widely used in a variety of fields, including econometrics, to analyze the relationship between one or more independent variables and a dependent variable.

The OLS model equation shows how a dependent variable (Y) is related to one or more independent variables (X) (Gujarati, 2022, p 850-854).

$$Y_t = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_n X_n + \varepsilon_t \qquad (3)$$

After determining the stationarity of a series, the OLS model can be implemented to examine the impacts independent variables on dependent variable. This study follows the OLS model procedure and applies the following empirical model:

$$GDP_t = \beta_0 + \beta_1 COP_t + \beta_2 P_t + \beta_3 EX_t + \beta_4 INF_t + \varepsilon_t \quad (4)$$

In equation (4), where ε refers to the random variable, β to the regression parameters. COP, P, EX, and INF are the independent variables, and the GDP is the dependent variable. After conducting another round of analysis, we will examine the model's structural stability and diagnostic tests, which confirm its reliability. Further checks were performed to identify fitting model results and reject autocorrelation issues (Hussein and Mohammud, 2022).

3.3. Cointegration Analysis

Johansen's (1992) approach was used is this study to test for the cointegration. In this context, a maximum likelihood method is employed on cointegration vectors. Johansen's method adopts all variables as endogenous, and thus the problem of normalising the cointegrating vector on one of the variables cannot appear. The Johansen cointegration test can determine the presence of a long-term linear relationship between variables. To determine the cointegration relationship among the variables the following equation is used.

$$Y_{it} = \alpha_i + \delta_{it} + \beta_{1i} X_{1it} + \cdots + \beta_{ki} X_{ki,t} + \varepsilon_{it} \quad (5)$$

In parallel to the cointegration process, the Johansen test within the VAR system was adopted to investigate a long-run relationship among the variables.

The direct estimations of cointegrating vectors are provided by the Johansen test. In addition, this method can enable to test for the rank (r) of cointegration. In the procedure of determining the cointegration rank, the Johansen test uses two test statistics known as the trace and maximal eigenvalue tests.

In addition, choosing an optimal lag length is very important in terms of the performance of cointegration tests ((Hatemi-J and Irandoust, 2000). There are many methods that can be used to select the lag length. In this study, Akaike's Information Criterion (AIC) is used to select the number of lags required in the cointegration test.

3.4. Data

The main aim of this study is to examine the correlation between crude oil prices, population, exports, inflation, and economic growth (GDP). In the empirical examination, annual time series data from 1997 to 2022 is utilized. Additionally, the study comprises natural logarithm of the annual time series data.

Table 1 displays economic growth as a dependent variable and crude oil prices, population, exports, and inflation as independent variables.

Table 1. Variables Used in the Models

Types of Variables	Variables	Source	Measure
Dependent	Economic Growth (GDP)	WB Data (2023)	Million Dollar
Independent (1)	Crude Oil Prices (COP)	Macrotrends Data (2023)	Pbd Dollar

Independent (2)	Population (P)	WB Data (2023)	Number of Individual
Independent (3)	Exports (EX)	WB Data (2023)	Export of Goods and Services Million Dollar
Independent (4)	Inflation (INF)	WB Data (2023)	Inflation Prices (annual %)

4. EMPIRICAL RESULTS

In this section, the results of various tests are presented, including unit root tests, OLS model, Johansen cointegration test with VAR model, and diagnostic tests.

4.1. Unit Root Tests

In Table 2, the results of the unit root tests performed using the ADF and PP techniques for GDP, COP, P, EX, and INF are shown. At the level, all variables were found to be neither significant nor stable. However, when tested at the first difference, all variables showed significant and stable results.

Table 2. Unit Root Test Results of ADF and PP Tests

Order of Integration	Variables	PP	ADF
		Prob.	Prob.
Level	GDP	0.4065	0.1662
1st Difference	GDP	0.0036*	0.0019*
Level	COP	0.7286	0.6988
1st Difference	COP	0.0003*	0.0003*
Level	EX	0.3035	0.3035
1st Difference	EX	0.0000*	0.0000*
Level	P	0.3382	0.1975
1st Difference	P	0.0461*	0.0322*
Level	INF	0.0511	0.2407
1st Difference	INF	0.0000*	0.0018*

(*) indicates that the result a significant at 5% MacKinnon (1991) critical value.

4.2. Estimation of the Model

The information about the empirical results are given in Table1. The population (P) is 0.0000, the export (EX) is 0.0117, and the price of crude oil (COP) is 0.0000. These independent variables have a favorable effect on economic growth as their probability findings are significant and their coefficient values are positive. Despite being significant at 0.0005, the inflation rate (INF) had a negative effect on Iraq's economic growth from 1997 to 2022, as indicated by the negative coefficients.

Table 3. Estimation of the Model

Ordinary Least Squares Model				
Variables		**Coefficient**	**t-Statistic**	**Prob.**
COP		0.526519	6.421275	0.0000
EX		0.209452	2.762444	0.0117
P		1.916727	8.511892	0.0000

INF		-0.011974	-4.108593	0.0005
C		-4.797122	-7.195866	0.0000
R-squared		Durbin-Watson stat	F-statistic	Prob (F-statistic)
0.971507		1.772511	179.0084	0.00000
Diagnostics Tests				
Test		**Statistical value**	**p-value**	
Histogram – Normality test		3.747861	0.153519	
Heteroskedasticity Test: White		1.678452	0.1925	
Breusch-Godfrey Serial Correlation LM		0.176753	0.8393	

R-squared value of 0.97 indicates that the independent variables (COP, P, EX, and INF) have a strong ability to explain the variations in the dependent variable (economic growth). It means that almost 97% of the fluctuations in economic growth can be accounted for by the selected independent variables. The F-statistic value for the model 179.01 which is statistically significant. Durbin-Watson statistic, on the other hand, is estimated as 1.77 which is almost near 2. These results suggest that the model has a good explanatory power. Based on the Ordinary Least Squares model, several tests such as the Histogram – Normality, Heteroskedasticity White, and Breusch-Godfrey Serial Correlation LM tests are performed. The results of these tests can be seen from Table 3. The Histogram – Normality, Heteroskedasticity Test, White, and Breusch-Godfrey Serial Correlation LM test results are indicating that the model does not have any autocorrelation problem and there is a good fit in the model. In other words, the model is reliable and unbiased.

4.3. Results of Johansen Cointegration Test

After conducting a thorough analysis of the data, it can be seen that the independent variables in the OLS model had a significant positive and/or negative impact on the dependent variable. To investigate the relationship between the variables, the Johansen cointegration test within the VAR system is conducted in this study. First of all, the optimum lag length should be determined. According to the results are given in Table 4, the optimum lag length is chosen as 3 for all criteria. After this procedure, the maximum eigen value and trace tests are applied to analyze the cointegration relation.

Table 4. VAR Lag Order Selection Criteria

lag	LogL	LR	FPE	AIC	SC	HQ
0	-96.69835	NA	0.004768	8.843334	9.09018	8.905416
1	7.812803	154.4947	5.04e-06	1.929322	3.410401	2.301809
2	48.37514	42.32591	1.87e-06	0.576075	3.291387	1.258968
3	132.0822	50.95213*	3.80e-08*	-4.52888*	-0.57934*	-3.53558*

**Indicates lag order selected by the criterion.*
**LR: sequential modified LR test statistic; FPE: Final prediction error; AIC: Akaike information criterion; SC: Schwarz information criterion; HQ: Hannan-Quinn information criterion.*

Table 5. Results of Johansen Cointegration Test

Trace				
Hypothesized No. of CE(s)	**Eigenvalue**	**Trace Statistic**	**0.05 Critical Value**	**Prob.****
None*	0.990489	202.8018	69.81889	0.0000
At most 1*	0.890720	95.72880	47.85613	0.0000

At most 2*	0.693668	44.81036	29.79707	0.0005
At most 3*	0.534533	17.59942	15.49471	0.0238
At most 4	0.000478	0.010990	3.841466	0.9163
Maximum				
Hypothesized No. of CE(s)	**Eigenvalue**	**Max-Eigen Statistic**	**0.05 Critical Value**	**Prob.**
None*	0.990489	107.0730	33.87687	0.0000
At most 1*	0.890720	50.91844	27.58434	0.0000
At most 2*	0.693668	27.21094	21.13162	0.0062
At most 3*	0.534533	17.58843	14.26460	0.0144
At most 4	0.000478	0.010990	3.841466	0.9163

Depending on the statistics given in Table 5, there are at most 3 cointegrating vectors among the variables. These results show that there is a strong and long-run relationship between economic growth, crude oil price, population, exports, and inflation in Iraq from 1997 to 2022.

5. CONCLUSION AND POLICY RECOMMENDATIONS

This research provides a detailed analyses of the impact of several independent variables - such as crude oil prices, population, exports, and inflation on Iraq's economic growth from 1997 to 2022. The series that used in this study is collected from reliable data sources like the World Bank and Macrotrends.

According to the OLS model the study finds that a rise in crude oil prices by 1% results in an increase in economic growth by 0.52%. Similarly, an increase in exports of goods and services by 1% leads to a boost in economic growth by 0.20%. If the population increases by 1%, it results in a significant rise in economic growth. This research produced the same findings as those in the literature review (Fezzani and Nartova, 2011; Aktuğ et al., 2019; Odhiambo, 2020; Drebee and Razak, 2022; Al Taie et al., 2022; Rasheed, 2023). On the other hand, if inflation increases by 1%, it leads to an approximate decrease in economic growth by 0.02%. Peculiarly, population has the largest impact on GDP in Iraq. This is because, the population increased from 22 million to 44 million in the period between 1997 and 2022. Furthermore, most of the population in Iraq consists of young people. The proportion of Iraq's young population of the total is almost 60% in 2022.

The presence of the long-term relationship among the variables used in the analyses are examined by Johansen cointegration test with the use of VAR system. Due to Iraq's heavy reliance on oil exports, fluctuations in crude oil prices significantly impact the country's economic stability. Furthermore, population growth is another significant factor that affects economic growth as it increases the demand for goods and services. Along with that, exports also contribute substantially to economic growth as the international trade generate income and stimulate economic activity.

The study's results can be used to develop effective policies that can improve Iraq's economic growth and stability. In order to prepare for any emergencies in the oil sector, protecting and sustaining the oil production for future generations is very crucial. Since the oil is a limited resource, Iraqi policymakers need to focus on researching alternative sources for exports and research the ways to boost the country's GDP. Also, Iraqi policymakers need to work on improving human capital and non-oil sectors, such as agriculture, manufacturing, services, and tourism to promote the economic performance of the country and to spread of income to the baseline.

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