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A Statistical study of the crude Oil production function and its impact on the Iraqi GDP for the period (2005-2020)

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ABSTRACT

The rentier problem in the Iraqi economy is hidden and still represents a double-edged sword at a time when it provides important financial resources, which can be a reason for achieving economic development and the locomotive of growth in the Iraqi economy. The Iraqi economy affected by the Dutch disease is the duality of the economy, the fragility of the commodity sectors and the dependence to a large extent on the oil sector, as fluctuations in crude oil prices lead to violent shocks in the economy. The research focused on formulating a statistical model to show the effect of independent factors on the gross domestic product, In particular, the variables emanating from the oil sector, and the relationship between the dependent variable and the independent explanatory variables was estimated.

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Introduction

The extractive sector plays a vital and important role in the Iraqi economy, so that fluctuations in global prices of crude oil affect the main financial resource to finance imports of goods and services. Crude oil, and relying on statistical methods to find out the amount of changes that affect the Iraqi economy and thus the gross domestic product, through estimating the relationship between the dependent variable and the explanatory variables. The long-term relationship between crude oil prices and changes in the global economy, so that the researcher believes that crude oil prices are moving in a parallel and interconnected way with changes in global economic activity and its rate of growth, due to its multiple uses as a clean source of energy, requirements for production processes in the hydrocarbon industries, and the presence of large reserves of Crude oil, and its economic cost compared to other energy sources , and that it suits the legislation and laws that want to preserve the environment, and Iraq has large reserves that constitute an important percentage of the global reserves of crude oil.

The problem:

Despite the large reserves of crude oil and the possibility of investing in petrochemical industries with specialized international companies, the industry and production of crude oil in Iraq is still underdeveloped and affected by other variables.

The goal:

The research aims to know the factors affecting the production of crude oil in Iraq to achieve economic diversification and an important factor for the establishment of the petrochemical industry.

Hypothesis: The researcher made the following hypotheses

1-There is a relationship of mutual influence between crude oil prices and reserves.

2-The impact of proven reserves and exports on crude oil production

Model description:

In general, the economic literature related to statistics provides a description of the model to be estimated and the possibility of predicting its variables, which included some variables represented in the production of crude oil (Oil Prod) as an independent variable, crude oil prices (Oil Pri), exports of crude oil (Oil Imp). , and the rate of growth of the gross domestic product in the Iraqi economy is a dependent variable (Gdp Gro), all of the above are independent explanatory variables during the period (2005-2020) The crude oil production function can be expressed by the following formula**.(P. Kennedy: 2015, 436)**

$$\mathbf{Gdp\ Gro}_t = f(\boldsymbol{Oil\ Pro}_t, \mathbf{Oil\ Pri}_t\ , \mathbf{Oil\ Imp}_t\ ,) \dots\dots\dots\dots\dots (1)$$

The study model used takes the following standard form

$$\mathbf{Gdp\ Gro}_t = \boldsymbol{B}_0 + \boldsymbol{B}_1 \boldsymbol{Oil\ Pro}_t + \boldsymbol{B}_2 \mathbf{Oil\ Imp}_t + \mathbf{OI\ Pric}_t + \boldsymbol{\varepsilon}_t \dots\dots (2)$$

In order to obtain a statistical model for the crude oil production function in Iraq, the researcher used a time series of (16) observations, extending from the year (2005) to the year (2020), as in Table (1).

Table (1) shows the gross domestic product, the production of crude oil, and a set of variables in the Iraqi economy.

Year	Oil pri	Oil Imp	Oil pro	GDP gro
2005	50.64	145	1853.2	1.7
2006	61.08	145	1957.2	5.6
2007	69.08	145	2035.2	1.9
2008	94.45	145	2280.5	8.2
2009	61.06	149	2336.2	3.4
2010	77.45	148	2358.1	6.4
2011	107.46	149	2652.6	7.5
2012	109.45	153	2942.4	13.9
2013	105.87	159	2979.6	7.6
2014	96.29	159	3110.5	0.7
2015	49.49	160	3550.4	2.5
2016	40.76	161	3681.3	15.2
2017	52.43	162	3791.6	-2.5
2018	69.78	165	3991.6	-0.6
2019	64.04	165	3921.5	3.5
2020	68.30	165	4382.9	4.2

Sources:

1- Organization of Arab Petroleum Exporting Countries (OAPEC),The Secretary Geenerals Annual Report,(Kuwait,Organization OF arab petroleum exporting countries, Different Issues)

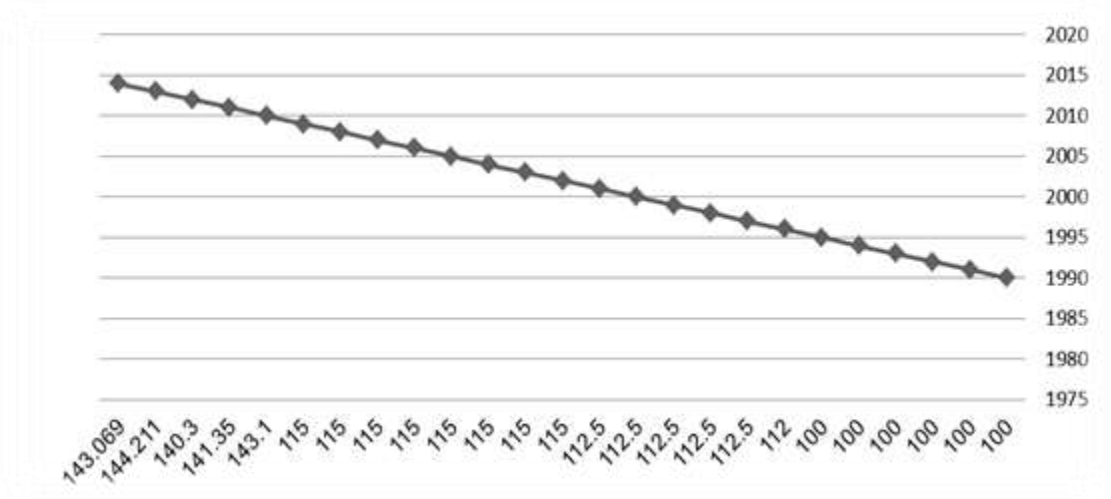
2- Organization of Arab Petroleum Exporting Countries(OPEC) , Annual statistical Bulletin,(vienna, Different ISSUES)

A- Oil reserves

Iraq is one of the countries that have very large oil reserves, and it ranks fourth in the world. When we take the period from (2005-2020) we will find that these reserves witnessed relative stability. During this period, they did not witness significant changes in oil reserves despite the new discoveries. After the rise in crude oil prices, the oil reserves reached during the period (2005-2010) and the oil reserves did not witness increases, but the reserves remained constant at (115) billion barrels of oil until 2011, and after that, when the oil reserves witnessed a significant increase, they were (143) billion Barrels, and that the reason is due to the assistance of international oil companies in (13) oil reservoirs, noting that (73%) of the oil reserves in Iraq were

concentrated in the governorates of southern Iraq, (18%) in northern Iraq, and (9%) in Central governorates, and both the West Qurna field and the Zubair field contributed to raising the reserve percentage (6). It should be noted that the Ministry of Oil had announced the licensing rounds in 2009, the aim of which was to develop oil fields in southern Iraq, while the second round was aimed at To invest and develop seven fields, namely (West field Qurna / Phase II north of Basra, Majnoon field in eastern Basra, Halfaya field in Maysan, Al-Gharraf field in Nasiriyah, Badra field in Wasit, Qayyara field, and Najma field), (7) and Figure (1) shows the oil reserves in Iraq for the period (2005 -2020).**(John Wiley: 2008, 371)**

Figure (1) Oil reserves in Iraq for the period (2005-2020) (billion barrels)

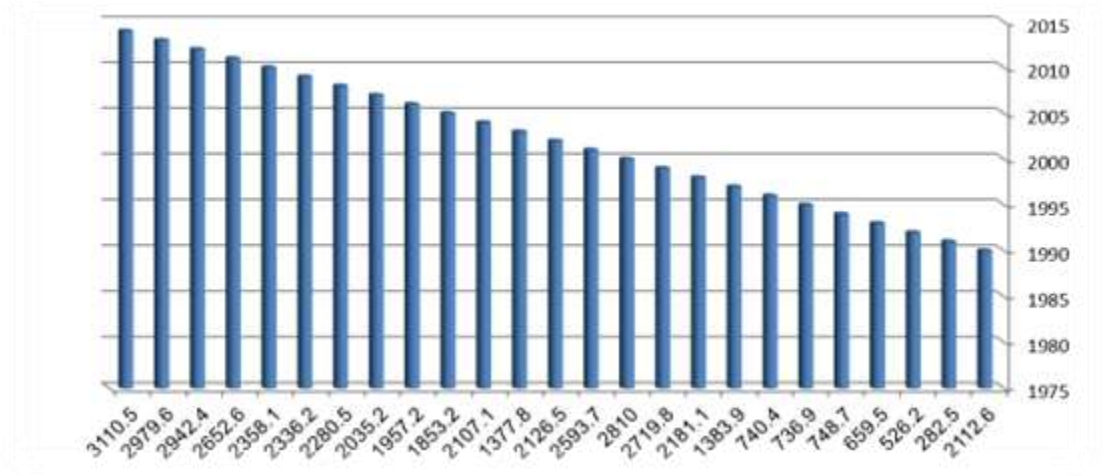


Source: Figure prepared by the researcher based on:
1- OPEC, Annual Statistical Bulletin, Vienna, Austria, 2008,P 18.
2-OPEC, Annual Statistical Bulletin, Vienna, Austria, 2011,P 22.
3-OPEC, Annual Statistical Bulletin, Vienna, Austria, 2015,P 22.

B-Oil production:

Oil production in Iraq in large quantities did not start until after 1934, and since the mid-sixties of the twentieth century, production began to increase, reaching in 1979 when it reached (3.7) million barrels per day, while oil production in 1989 was (3.6) million barrels per day, and because The second Gulf War and the invasion of Kuwait in 1991 decreased oil production to reach (300) thousand barrels per day, as a result of the economic sanctions imposed on Iraq (8), and with the Iraqi desire to increase production and in light of the economic sanctions, this generally led to the deterioration of the efficiency of oil facilities. Oil production increased to reach an average of (3.5) thousand b/d during the period (2005-2020), and production reached its peak in 2020 to reach (4.39) million b/d. Figure (2) shows oil production in Iraq for the period (2005-2020). 2005-2020). From the figure, we find that there are increases in the volume of oil production after 2003, specifically after 2008. Production increased, reaching (3.2) million b/d in 2014, and because of the urgent need for foreign money and expertise. As a result, the government sought to attract foreign oil companies and encourage foreign investment with the aim of Benefiting from expertise and modern technology introduced by investment companies and then increasing production (10), especially since the International Energy Agency indicated in one of its reports that the investment requirements to secure the development of the global oil industry and in all its stages will remain large and in all measures. The period extending from (2001-2030) will require approximately (16) trillion dollars**.(K.Stephen: 2008, 143)**

Figure (2) Oil production in Iraq for the period (2005-2020) (thousand b/d)



Source: Figure prepared by the researcher based on
1 - OPEC, Annual Statistical Bulletin, Vienna, Austria, 2008,P 18.
2 – OPEC, Annual Statistical Bulletin, Vienna, Austria, 2015,P 28.

First: stability test

The time series are in a state of stability, quiescent and unbiased, to ensure that they are free of false regression, the degree of stability was tested for each variable separately, and the researcher relied on the extended Dickie Fuller test (ADF), in the first level and difference as in the two tables (2) The test is used for the variables of time series because it is often considered that the variables are unstable in the level and the researcher falls into the illusion of significance and an error occurs in predicting the future of the variables and their relationship to other variables and the nature of their impact on the dependent variable, so it is necessary to know the degree of integration of each variable, by testing the following hypotheses):**(Yule,G: 2012, 173)**

Null hypothesis: the existence of a unit root
Alternative hypothesis: the absence of a unit root

The (ADF) test depends on the study of the stability of the y_t series, for example, on the estimation of the models using the following (OLS) method**.(M.S Bartlett: 2014, 106)**

$$\boldsymbol{model(0): \Delta yt = \lambda . y_{t-1} - 1 \sum_{j=2}^{p} \phi j\, \Delta yt - j + 1 + \varepsilon t} \dots\dots\dots\dots\dots\dots\dots (3)$$

$$\boldsymbol{model(1): \Delta yt = \lambda . y_{t-1} - 1 \sum_{j=2}^{p} \phi j\, \Delta yt - j + 1 + c + \varepsilon t} \dots\dots\dots\dots\dots\dots (4)$$

$$\boldsymbol{model(2): \Delta yt = \lambda . y_{t-1} - 1 \sum_{j=2}^{p} \phi j\, \Delta yt - j + 1 + c + bt + \varepsilon t} \dots\dots\dots (5)$$

Equation (3) the first does not contain a constant and a trend, and equation (4) does not include the time trend only, while equation (5) contains the constant and the time trend.

After using the above test, it is possible to determine the degree of integration for each variable individually, the need to ensure the stability of the variables and that they are free from the presence of the unit root, depending on the following two hypotheses: **(K. Stephen: 2007, 18)**

a- The null hypothesis: it means the presence of unit roots in the time values of the variable to be tested, that is, the calculated (t) value is smaller than the tabular value, and the variable is in a state of instability.

b-The alternative hypothesis: It is the opposite hypothesis that proves that the variable is devoid of a unit root, meaning that the variable is in a state of stability, whether in the level or in the first difference.

Table (2): Testing the stability of the variables based on the (ADF) test:

1-**Crude Oil production (Oil Pro):** After testing the variable according to (ADF) and in the degree of stability at the level ((I(0)) and integration ((I(1) at a significant level (5%), it was found that the variable is not stable at the level, And stable difference in the first difference.
2-**Crude Oil reserves (Oil Imp):** The results of the two tests showed that the variable suffers from the presence of the unit root at the rank ((I(0) where the null hypothesis of the level was accepted, but at the rank ((I(1)) the variable was stable in all cases and when Significance level (5%), meaning that the variable is integrated of degree I (1).
3-**Crude Oil Prices (O Pri):** It was found from the two tests that the variable is stable in the first difference with some privacy, as it was suffering from the unit root in the first difference in the direction only, and it was devoid of the unit root in the case of constant and without constant and trend and in both tests, Which means that the variable is integral of order (I(1)).
4-Gross Domestic Product Growth Rate (GDP Gro): Through Dickie Fuller's unit root test (ADF), it was found that the variable is unstable at the level and in its three cases at a significant level (5%), and stable in the first difference with the degree of integration of the order (I (1)).

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Table (2) Dickie-Fuller (ADF) test for the stability of the time series for the study variables

ADF Test							
Var	**sign**	**)Level Test(**			)1st difference test(		
		con	**trend**	**none**	**con**	**trend**	none
Oil Pro$_t$	**Test statistic**	**-1.193**	**-3.83**	**1.52**	**-3.33**	**-3.30**	**-2.59**
	Critical values	**-3.08**	**-3.87**	**-1.96**	**-3.09**	**-3.79**	**-1.96**
Prob	**5%**	**0.64**	**0.05**	**0.96**	**0.03**	**0.10**	**0.01**
Oil Imp$_t$	**Test statistic**	**1.60**	**1.73**	**3.97**	**-1.08**	**1.31**	**-2.75**
	Critical values	**-3.09**	**-3.75**	**-1.96**	**-3.09**	**-3.82**	**-1.97**
Prob	**5%**	**0.99**	**1.00**	**0.99**	**0.68**	**0.99**	**0.00**
Oil Pric$_t$	**Test statistic**	**-2.10**	**-1.96**	**-0.27**	**-3.24**	**-3.24**	**-3.38**
	Critical values	**-3.08**	**.75**	**-1.96**	**-3.09**	**-3.79**	**-1.96**
Prob	**5%**	**0.24**	**0.57**	**0.57**	**0.03**	**0.11**	**0.00**
GDP Gro$_t$	**Test statistic**	**-2.64**	**-2.78**	**-1.57**	**-5.35**	**-5.00**	**-3.57**
	Critical values	**-3.08**	**-3.75**	**-1.96**	**-193**	**-2.94**	**-2.03**
Prob	**5%**	**0.86**	**0.829**	**0.472**	**0.00**	**0.00**	**0.00**

The table was prepared by the researcher based on the program (Eviews 10)

Secondly: Cointegration test

The researcher believes that it is necessary to test the co-integration of the variables of the study after all of them did not suffer from false regression and were stable in the first difference, in order to know the time course for the purpose of predicting the future of economic growth in Iraq, because the co-integration shows the nature of the relationship between the research variables, and whether the variables can correct their time course The balance was achieved in the long term, to clarify their deviant paths through some of them, and the researcher adopted the (Johansen) test. The test included two indicators to know the existence of cointegration or not by the indicator (Trace) and the second indicator (λ Max) according to the following two formulas. **(R.F.Engle: 2003, 274)**

$$\propto \boldsymbol{Trace} = -\boldsymbol{n} \sum_{\boldsymbol{i=t+1}}^{\boldsymbol{x}} \mathbf{log}(\mathbf{1}-\propto \boldsymbol{i}) \dots\dots\dots\dots\dots\dots (\mathbf{6})$$

$$\propto \boldsymbol{Max} = -\boldsymbol{nlog}(\mathbf{1} - \boldsymbol{xr} + \boldsymbol{i}) \dots\dots\dots\dots\dots\dots\dots (\mathbf{7})$$

A comparison is made between the trace value test with the tabular value (critical value), the latent value test (Max-Eigen) with the tabular value of the (critical value) of the variables, which agrees with the probability

value (Prob), if the tabular value is greater From the calculated value, we accept the null hypothesis, which means that there is no co-integration between the dependent variable and the independent variables, and the alternative hypothesis is accepted.**(C. Granger: 2014, 275)**

Table (4): Results of cointegration tests for (Johanson)

1-Noting that the calculated value of (118.1), (38.7), (20.3), and (7.07) = λ Trace is greater than the critical value of (Critical Value) at a significant level (0.05), which is equal to (47.8), (29.7), and (15.4) and (3.8), respectively, for the variables (Oil Pro: Oil Imp: Oil Pri: GDP), which means that there is a co-integration between the dependent variable, which is the growth rate of gross domestic product, reserves of crude oil, exports of crude oil, and crude oil prices for the test. Effect.

2-As for the (Maximum Eigenvalue) test, after conducting the test and comparing between the calculated and tabular values, it was found that the calculated λ Max = (79.4) and (7.07) are greater than the (Critical Value) and amount to (27.5) and (3.8) respectively for the two variables (Oil Pro) and (Oil Pri) which show the presence of a joint complementarity between them and thus can affect other variables in order to achieve long-term equilibrium, and accordingly we reject the null hypothesis and the alternative hypothesis is accepted, so the probability (Prob) enhances the result reached by the researcher, which agrees with the theoretical expectations of the existence of a simultaneous relationship Among the variables that correct imbalances in the variables during the long run.

3-A test of (Johanson) provides an explanation for the complementary relationship between the gross domestic product in Iraq (equilibrium in the long run) with other explanatory variables, and that the duration of the study is sufficient to achieve long-term equilibrium.

Table (3) cointegration test (Johanson)

Date: 09/06/23 Time: 21:01				
Sample (adjusted): 2005 2020				
Included observations: 14 after adjustments				
Trend assumption: Linear deterministic trend				
Series: OIL PRO : OIL IMP : OIL PRI : GDP				
Lags interval (in first differences): 1 to 1				
Unrestricted Cointegration Rank Test (Trace)				
Hypothesized	**0.05**	**Trace**		
No. of CE(s)	**Critical Value**	**Statistic**	**Eigenvalue**	**Prob.****
None *	**47.8**	**118.1**	**0.996557**	**0.0000**
At most 1 *	**29.7**	**38.7**	**0.731428**	**0.0036**
At most 2 *	**15.4**	**20.3**	**0.613141**	**0.0085**
At most 3 *	**3.8**	**7.07**	**0.396653**	**0.0078**
Trace test indicates 4 cointegrating eqn(s) at the 0.05 level				
*** denotes rejection of the hypothesis at the 0.05 level**				
****MacKinnon-Haug-Michelis (1999) p-values**				
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized	**0.05**	**Max-Eigen**		
No. of CE(s)	**Critical Value**	**Statistic**	**Eigenvalue**	**Prob.****
None *	**27.5**	**79.4**	**0.99**	**0.0000**
At most 1	**21.1**	**18.4**	**0.7**	**0.1154**
At most 2	**14.2**	**13.2**	**0.6**	**0.0707**
At most 3 *	**3.8**	**7.07**	**0.3**	**0.0078**
Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level				
*** denotes rejection of the hypothesis at the 0.05 level**				
****MacKinnon-Haug-Michelis (1999) p-values**				

The table was prepared by the researcher based on the program (Eviews 10)

Third: Estimating the long-term regression equation

After conducting the stability test, it was found that all the variables are stable in the first difference except for one variable that is stable at the level, so the researcher adopted the (OLS) methodology to estimate the regression equation, that the change in the independent variables does not directly affect the dependent variable, but rather it needs a certain time for the variable to start function in response to explanatory variables. For example, the rate of growth in the gross domestic product needs a period of time in order for this growth to be reflected in the investment in the reserves of crude oil and the production of crude oil increases, which means that most of the study variables have an impact that is not directly reflected in the gross domestic product, but it needs a period even time to achieve equilibrium. The same is the case with crude oil prices in the global market, when prices rise dramatically, consumers are looking for alternatives, and then the impact of the rise in crude oil prices appears on crude oil reserves and growth in economic activity, so it is logical for the researcher to rely on the long-term analysis After estimating the equation, the model estimates were as follows**.(LOUIS: 2005, 280)**

The semi-linear formula was chosen from the side of the dependent variable, and all the variables were in the first difference, and the calculated (t) value reflected the significance of each of the variables. The model shows that the variables are significant and influential as shown below**.(Sargan & Bhargave: 2008, 375)**

a- After testing the duration of slowdown, it was found that the level in the model is the optimal period of slowdown of the significance of the independent explanatory variables based on five criteria as in Table (4), for the purpose of determining this period in the model over the long term. The criterion (AIC), the criterion (SCH), the criterion (H&Q), the criterion (LR), and the criterion Final Prediction Error (FPE) (), and when applying these criteria, a delay period equal to (0) was started, so they were all significant for the delay period as in the table (4). **(J.B.Ratner: 2000, 95)**

b- Significance of crude oil prices in the first difference D (Oil Pri(-1)) meaning that the change in crude oil prices by one time will affect crude oil production and exponentially by (1.1), i.e. double the GDP, representing the global demand for Crude oil through partnership contracts for licensing rounds with international companies, linking up with the young and active global markets in the Middle East, and searching for promising markets in Asia such as India or China.

c-The impact of oil exports in the first difference is positive and significant by the amount of the impact coefficient of (1.6) on the gross domestic product, this effect which is twice and a half times, because exports depend on the availability of global markets for Iraqi exports that are through tankers. **(S. McNees: 2008, 386)**

d-The proven reserve of crude oil (Oil Res(-1)) in the first difference is significant and influencing the dependent variable by the effect coefficient of (3.0) in the gross domestic product, meaning that changes in the reserves of crude oil affect the production share in the Organization of Energy Producing Countries (OPEC).), and thus affect economic activity, in addition to the fact that the country that has a large amount of reserves is an attractive factor for investment in crude oil.

e-The value of (R^2) was estimated at about (0.90), which is the ratio of what the independent variables explain in the dependent variable, while other variables that were not in the model affect the ratio (0.10) (Henri: 2010: 238). Significant for the function in general, while the value of (D.W) of (2.01) in the acceptance region did not show the problem of autocorrelation**.(Halvorsen & Raymond: 2016, 142)**

Table (5) Optimum deceleration duration test

VAR Lag Order Selection Criteria						
Endogenous variables: OIL PRO OIL PRI OIL RES GDP						
Exogenous variables: C						
Date: 26/03/23 Time: 13:11						
Sample: 2005 2020						
Included observations: 14						
Lag	**SC**	**AIC**	**FPE**	**LR**	**LogL**	**HQ**
0	59.5824*	57.8495*	4.1+20*	30.8202*	-369.146	57.7283*
1	62.6658	61.7364	8.93+21	43.9776	-412.355	61.6913

2	64.5471	64.3212	1.05+23	NA	-446.548	64.3522
*** indicates lag order selected by the criterion**						
LR: sequential modified LR test statistic (each test at 5% level)						
FPE: Final prediction error						
AIC: Akaike information criterion						
SC: Schwarz information criterion						
HQ: Hannan-Quinn information criterion						

The table was prepared by the researcher based on the program (Eviews 10)

Table (5) estimation of the regression equation by (OLS)

Dependent Variable: d(GDP (-1))				
Method: OLS				
Date: 26/03/23 Time: 14:50				
Sample: 2005 2020				
Included observations: 16				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
D(OIL IMP (-1))	**1.6**	**0.28**	**5.7**	**0.0002**
D(OIL RES (-1))	**3.0**	**0.24**	**2.5**	**0.0317**
D(OIL PRI (-1))	**1.1**	**1.31**	**2.2**	**0.0449**
C	**156.1**	**134.9**	**1.1**	**0.2806**
@TREND	**59.7**	**18.2**	**3.2**	**0.0112**

R-squared	**0.90**	**Mean dependent var**	**6894.1**
Adjusted R-squared	**0.90**	**S.D. dependent var**	**3337.8**
S.E. of regression	**710.4**	**Akaike info criterion**	**16.2**
Sum squared resid	**5047642.**	**Schwarz criterion**	**16.5**
Log likelihood	**-123.9**	**Hannan-Quinn criter.**	**16.2**
F-statistic	**62.2**	**Durbin-Watson stat**	**2.08**
Prob(F-statistic)	**0.000000**		

The table was prepared by the researcher based on the (Eviews 10) program

Fourth: Conclusions and Recommendations

1-Conclusions

a-The existence of global interest in crude oil production, international laws and legislation, and contracts concluded through licensing rounds that contributed to increasing production.

b-The existence of a joint integration between the dependent variable, the production of growth in the economic activity represented by the Gross Domestic Product, and the explanatory variables, meaning that the model variables are able to correct the imbalances and problems that occur during the short term.

c-Crude oil prices affect economic growth in Iraq and their impact appears in the long term to be an important factor for diversifying the Iraqi economy.

d-Through crude oil reserves, oil exports and global demand, the rate of economic growth can rise, as shown by the results of statistical tests.

e-The shocks that the crude oil industry is exposed to are reflected in exports and reserves, and it can be an important resource for diversifying revenues from the extractive sector and an important factor for developing the industrial sector, generating electricity and other energy sources in Iraq.

2-Recommendations:

a- Developing a clear strategy for the industry and production of crude oil and the development of industries related to the extractive sector in Iraq, which must have plans and programs under implementation in order to advance the reality of the Iraqi economy and get rid of rentierism.

b-Use the latest technological methods in the crude oil industry and try to reduce combustion rates and benefit from the gas associated with crude oil.
c-The interest of the Iraqi government in the petrochemical industry at a level commensurate with the interest in the manufacture and production of crude oil.
d-Benefit from successful experiences in countries that have conditions similar to those of the Iraqi economy, try to provide an appropriate investment environment, and create conditions that allow the establishment of the petrochemical and hydrocarbon industry.

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