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Natural gas production in Iraq for the period (2004-2019) a study in econometrics.

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Abstract

Natural gas is a very important source because of its economic and environmental characteristics, and for its multiple uses, as it is used as a clean source of energy and a raw material for the hydrocarbon industries, in addition to its large reserves and low prices compared to other energy sources, in addition to that it fits environmental legislation, Iraq has a large reserve Form an important proportion of the global reserve, as it can be invested to contribute to achieving economic growth, thus highlighting the importance of developing production of natural gas and knowing the extent to which it is affected by a range of variables, including (gas reserves, gas exports, global demand for gas, crude oil prices, growth rate economic) .

Key Words : Natural Gas , Gas Reserve , Gas production Co-Integration

problem

Despite the large reserves of natural gas and the possibility of investing it through partnership with specialized international companies, the gas industry and production in Iraq is still lagging behind, affected by crude oil prices and other variables.

The research aims to know the factors influencing the production of natural gas in Iraq to be a new tributary of economic diversification and an important factor for the establishment of a hydrocarbon industry.

Hypothesis: The researcher relied on the following hypotheses

1-There is a mutual influence relationship between crude oil prices and natural gas production

2-The impact of proven reserves and exports on natural gas production

3-Weak government interest in the natural gas industry

Model Description

In general, the economic literature related to econometrics, provides a description of the model to be measured and prediction of the variables of the study, which included some variables that pertain to the important economic event that is concerned with the production of natural gas, as a dependent variable in the Iraqi economy. As for forecasting the future, gas production is expected to be affected by oil prices. Crude, the volume of gas reserves, global demand for gas, exports of gas, and the growth rate of GDP, all of the above are illustrative independent variables during the period (2004-2019), the natural gas production function can be expressed by the following formula[(1)].

$$\boldsymbol{G\ Pro_t = f(G\ Res_t, G\ Dem_t\ , G\ Imp_t\ , OI\ Pric_t\ , Gdp\ Gro_t)} \dots\dots\dots\dots\dots\dots (\mathbf{1})$$

The study model used the following standard form[(2)].

$$\boldsymbol{G\ Pro_t = B_0 + B_1 G\ Res_t + B_2 G\ Dem_t + + B_3 G\ Imp_t + OI\ Pric_t + Gdp\ Gro_t + \varepsilon_t}. \dots\dots (\mathbf{2})$$

In order to obtain an econometric model for the function of natural gas production in Iraq, the researcher used a time series of (16) observations, extending from the year (2004) to the year (2019), as in Table (1) and below we will analyze the variables to find out the functional relationships between Variables and the amount of influence between the variables.

Table (1) shows the production of natural gas and a set of variables

o pri	GDP gro	G Imp	G res	G dem	G pro	Year
36.05	53.4	193	3170	1000	1000	**2004**
50.64	1.7	293	3170	1450	1450	**2005**
61.08	5.6	412	3170	1450	1450	**2006**

1- Peter Kennedy,A Guide to Econometrics, 3d ,The MIT Press ,Cambridge, Massachusetts, 2015, p413.

2- John Wiley. Rao, Linear Statistical Inference and Its Applications, ,New York, 2008, p413.

69.08	1.9	812	3170	4782	4782	**2007**
94.45	8.2	756	3170	6798	6798	**2008**
61.06	3.4	795	3170	7213	7213	**2009**
77.45	6.4	824	3158	7511	7511	**2010**
107.46	7.5	923	3158	6634	6634	**2011**
109.45	13.9	956	3158	6675	6675	**2012**
105.87	7.6	934	3158	5992	7445	**2013**
96.29	0.7	1000	3158	6839	7927	**2014**
49.49	2.5	1023	3158	6868	7685	**2015**
40.76	15.2	1256	3820	9101	10416	**2016**
52.43	-2.5	1456	3744	9457	10650	**2017**
69.78	-0.6	4100	3729	13025	11130	**2018**
64.04	3.5	6104	3714	17598	11540	**2019**

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)

United Root Tests

Time series are in a stable state if they are devoid of a unit root. The degree of stability of each variable can be tested separately by conducting the test on it. The researcher conducted two very important tests, the first test, the extended Dickey-Fuller test, and the Phillips-Bern test, in the first level and difference As in Tables (2) and (3)**(1)**.

These tests were used for economic variables because they are often considered unstable time series, and the researcher falls into the illusion of morality and an error occurs in predicting the future of the variables under study, so it is necessary to know the degree of their

[1-] Keith Cutibertson, Stephen G.Hell And Mark P.Taylor, Applied Econometric Techniques, The University Of Michigan press, 2009, p130.

integration and stability in order to obtain estimates that are not false, by testing the following hypotheses[(1)].

The null hypothesis: There is a unit root

Alternative Hypothesis: No unit root

The (ADF) test in studying the stability of the $\mathbf{y_t}$ series, for example, depends on estimating the models by the following (OLS) method[(2)]

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

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

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

The above equations differ in that the first equation (3) does not include a constant and a time trend, while the second equation (4) does not contain the time trend only, while the third equation (5) includes the constant and the time trend.

For the expanded Dickey-Fuller test (ADF), its estimate is based on the same Phillips-Burn test (PP), but the only difference is that the Dickey-Fuller test takes into account errors of variance that are heterogeneous, and depends on the hypothesis that the variable is affected by the process of autoregression (AR).), while the Phillips-Burn (PP) test depends on more common and general hypotheses in the sense that the variable is affected by the time trend, so it is necessary to trace its path to know its degree of stability dynamic[(3)].

After using the two tests above, it is possible to determine the degree of integration for each variable separately, as it is possible to distinguish between the following cases, the need to

2- Yule,G. U,"Why Do We Sometimes Get Nonsense Correlations Between Time Series? A Study in Sampling and the nature of time series " Journal of the Royal statistical society, vol.302.2012, p176.

3- M.S Bartlett, "On the Theoretical Specification of Sampling Properties of Autocorrelated Time Series "Journal of the royal statistical society, series B, VOL,128,2014, p416.

1- Keith Cutlibertson, Stephen G.Hall And Mark P.Taylor,"Applied Econometric Techniques,The University of Michigan Press, 2007, p256.

ensure that the variables are stable and free from the presence of a unit root, noting the following[(1)].

The null hypothesis: specifically means the presence of unit roots in the values of the variable, that is, the calculated value (t) is less than the tabular value that appears in the program report, and the variable is unstable.

The alternative hypothesis: proves that the variable is devoid of the unit root, that is, the variable is stable, whether in the plane or in the first difference in the case of a constant or a trend or without a constant or a trend.

Tables (2) and (3) show: the variables stability test based on the (ADF) test and the (PP) test, the results were as below.

1- Natural gas production (G Pro): After conducting the test on the variable according to the two tests and in the degree of integration (I(0) and degree (I(1) at the level of significance (5%), it was found that the variable suffers from the presence of a unit root in the level In all its cases and in the two tests, and after taking the first difference, it was found that it was stable without a constant and direction, and gas production in Iraq was considered stable by the first difference.

2- Confirmed Gas Reserve (GRes): The results of the two tests showed that the variable suffers from the presence of a unit root at the I(0) level, so the null hypothesis of the level was accepted, while at the I(1) level, the variable was stable in all cases and at a significant level (5%), That is, the variable is an integral of degree I(1).

3- Gas exports (G Imp): When conducting the test on the variable, results appeared different from its predecessors, as the variable is unstable at the I(0) in all cases and in both tests, and after taking the first difference, the variable was unstable in the constant and the trend at the level of significance) 5%) and showed its stability and devoid of the unit root in the absence of a constant and a trend with a significant level (5%) and accordingly that the variable is an integrated stable of rank I (1), because the test in the absence of a constant and trend is the decisive decision-making.

[2-] C.W. Granger & P.Newbold,"spurous Regressions in Econometrics" Journal of Econometrics, vol.22,2014, p481.

4- Gas Demand (G Dem): The gas demand stability test is similar to the gas exports variable in Iraq, as the variable did not stabilize at the level for both tests at rank I(0) and stabilized at rank I(1) in the absence of a constant and trend.

5- Crude oil prices (O Pri): It was found from the two tests that the variable is stable in the first difference with some specificity, as it was suffering from the unit root in the first difference in the direction only, and it was free from the unit root in the case of constant and without a constant and direction and in both tests, This means that the variable is an integral of order I(1).

6- Growth rate in gross domestic product (GDP Gro): Through the unit root tests (ADF) and the test (PP), it was found that the variable is stable at the level and in its three cases at a significant level (5%), and this shows the uniqueness of this variable With a degree of integration of order I(1), it will be excluded from some of the tests we need to predict the future of variables.

Table (2) Dickey-Fuller test (ADF) for stability test

ADF Test							
Var	**sign**	**)Level Test(**			**)1st difference test(**		
		con	**trend**	**none**	**con**	**trend**	**none**
$GPro_t$	**Test statistic**	**-1.193604**	**-3.832011**	**1.527988**	**-3.336392**	**-3.301591**	-2.596214
	Critical values	**-3.081002**	**-3.875302**	**-1.966270**	**-3.098896**	**-3.791172**	-1.968430
Prob	**5%**	**0.64**	**0.05**	**0.96**	**0.03**	**0.10**	0.01
G Res_t	**Test statistic**	**-0.829918**	**-1.931396**	**0.740126**	**-4.094996**	**-4.113402**	-4.026154
	Critical values	**-3.081002**	**-3.759743**	**-1.966270**	**-3.098896**	**-3.791172**	-1.968430
Prob	**5%**	**0.78**	**0.58**	**0.86**	**0.00**	**0.03**	0.00
G Imp_t	**Test statistic**	**1.600780**	**1.736725**	**3.971679**	**-1.088619**	**1.318731**	-2.754993
	Critical values	**-3.098896**	**-3.759743**	**-1.966270**	**-3.098896**	**-3.828975**	-1.970978
Prob	**5%**	**0.99**	**1.00**	**0.99**	**0.68**	**0.99**	0.00

G Dem $_t$	**Test statistic**	**1.083477**	**-1.518085**	**2.930951**	**-1.668363**	**-0.586535**	-1.968430
	Critical values	**-3.081002**	**-3.828975**	**-1.966270**	**-3.098896**	**-3.828975**	-0.998792
Prob	**5%**	**0.99**	**0.76**	**0.99**	**0.42**	**0.45**	0.02
O Pric $_t$	**Test statistic**	**-2.105755**	**-1.961919**	**-0.272449**	**-3.246004**	**-3.245427**	-3.383041
	Critical values	**-3.081002**	**-3.759743**	**-1.966270**	**-3.098896**	**-3.791172**	-1.968430
Prob	**5%**	**0.24**	**0.57**	**0.57**	**0.03**	**0.11**	0.00
GDP Gro$_t$	**Test statistic**	**-10.64333**	**-9.783512**	**-7.575759**			
	Critical values	**-3.081002**	**-3.759743**	**-1.966270**			
Prob	**5%**	**0.00**	**0.00**	**0.00**			

Table (3) Phillips-Burn (P.P) stability test

P.P Test							
Var	**sign**	**)Level Test(**			**)1st difference test(**		
		con	**trend**	**none**	**con**	**trend**	**none**
GPro$_t$	**Test statistic**	**-1.191052**	**-1.930404**	**1.381810**	**-3.335272**	**-3.282687**	**-2.596214**
	Critical values	**-3.081002**	**-3.759743**	**-1.966270**	**-3.098896**	**-3.791172**	**-1.968430**
Prob	**5%**	**0.64**	**0.58**	**0.95**	**0.03**	**0.10**	**0.01**
G Res $_t$	**Test statistic**	**-0.829918**	**-1.919838**	**0.986807**	**-4.128159**	**-4.98575**	**-4.026154**
	Critical values	**-3.081002**	**-3.759743**	**-1.966270**	**-3.098896**	**-3.791172**	**-1.968430**
Prob	**5%**	**0.78**	**0.59**	**0.86**	**0.00**	**0.03**	**0.00**
G Imp $_t$	**Test statistic**	**3.204582**	**1.742895**	**3.709562**	**-1.088619**	**-1.789224**	**-2.740613**

	Critical values	**-3.081002**	**-3.759743**	**-1.966270**	**-3.098896**	**-3.791172**	**-0.718203**
Prob	**5%**	**1.00**	**1.00**	**0.99**	**0.68**	**0.99**	**0.00**
G Dem $_t$	**Test statistic**	**0.522764**	**-0.935434**	**2.246777**	**-1.568100**	**-1.737704**	**-2.740613**
	Critical values	**-3.081002**	**-3.759743**	**-2.728252**	**-3.098896**	**-3.791172**	**-1.968430**
Prob	**5%**	**0.92**	**0.76**	**0.99**	**0.47**	**0.67**	**0.01**
O Pric $_t$	**Test statistic**	**-2.105755**	**-1.962290**	**-0.305421**	**-3.214759**	**-3.295828**	**-3.378422**
	Critical values	**-3.081002**	**-3.759743**	**-1.966270**	**-3.098896**	**-3.791172**	**-1.968430**
Prob	**5%**	**0.14**	**0.57**	**0.55**	**0.04**	**0.10**	**0.00**
GDP Gro$_t$	**Test statistic**	**-11.97882**	**-14.94056**	**-14.94056**			
	Critical values	**-3.081002**	**-3.759743**	**-3.759743**			
Prob	**5%**	**0.00**	**0.00**	**0.00**			

Cointegration Test

The researcher considers the necessity of Cointegration of the study variables after they were all stable in the first difference, in order to observe their time course in order to predict the future of natural gas production in the Iraqi economy, because Cointegration shows the future of the relationship and its nature between the study variables, and can the variables modify their time course as You can achieve equilibrium in the long term, as there is more than one test for co-integration in economic measurement, the purpose of which is to reveal the integrative relationship between the variables of the study, to show that the variables are able to correct their deviant paths through each other, and the researcher adopted the (Johansen) test[(1)].

[1] R.F.Engle&C.W.Granger,"Co-Integration and Error Correction: Representation, Estimation and testing" Econometrica, vol,78,1987, p276.

1- The test is proportional to the nature of the study because the time series allows this, and the absence of co-integration between the dependent variable and the independent variables means that the relationship between the variables remains a matter of doubt and question, even in the case of the significance of all the variables, meaning that the variables do not merge with each other and correct their time paths. deviant by integrating with each other to achieve long-term equilibrium goals, according to the following formula[(1)]

2- The test included two indicators to determine the existence of co-integration from non-existence by index (Trace) and the second index (λ Max) according to the following two formulas.

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

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

3- The comparison is made between the value of the impact test (Trace) with the critical value (Critical value), and the value of the test of the latent value (Max-Eigen) with the critical value of its (Critical Valu), which always agrees, according to the program report, with the probable value (Prob). If the critical value is greater than the calculated value, we accept the null hypothesis, which means that there is no co-integration between the variables, and we accept the alternative hypothesis in the opposite case[(2)].

Table (4): Results of Johansson's Co-integration Tests:

1- It is noticed that the calculated value of (118.1751), (38.77432), (20.36943) and (7.073687) = λ Trace is greater than the critical value of (Critical Value) at the significance level (0.05), which is equal to (47.85613) and (29.79707) and (15.49471) and (3.841466) respectively for the variables (G Pro: G Imp: G Res: O Pri), which means that there is a co-integration between the dependent variable represented by natural gas production, natural gas reserves, natural gas exports, and finally crude oil prices for the Trace test.

2- The second test represented by the (Maximum Eigenvalue) test after it was performed and the comparison between the calculated values shows that the calculated λ Max = (79.40079)

[2-] LOUIS," A Primer on Cointegration with an Application to Money and Income", Economic Review, Federal Reserve Bank of ,April, 2005,p 158.

[1-] J.D. Sargan and A.S. Bhargave, "Testing Residuals from least-square Regression for being Generaed by the Gaussian Random Walk ", Econometeica, vol ,92,2008, p165.

and (7.073687) is greater than the values (Critical Value) which are (27.58434) and (3.841466), respectively for the two variables (G Pro) and (O Pri), which show a cointegration between them and therefore can affect other variables in order to achieve long-term equilibrium, and therefore the null hypothesis must be rejected and the alternative hypothesis accepted (that is, there are four directions of cointegration between the dependent variable and the independent variables in the Trace test, And two integrations according to the greatest value) and the probability (Prob) reinforces the result reached by the researcher, which agrees with theoretical expectations of the existence of a synchronic relationship between the variables that corrects the imbalances that encounter the impact of the variables during the long term.

3- JOHANSON's test provides an explanation of the integrative relationship between natural gas production in Iraq (the long-term equilibrium) with other variables, and that the study period is sufficient to achieve a long-term balance between the study variables.

Table (4) JOHANSON Cointegration Test

Date: 09/06/21 Time: 21:01				
Sample (adjusted): 2006 2019				
Included observations: 14 after adjustments				
Trend assumption: Linear deterministic trend				
Series: G PRO : G IMP : G RES : O PRI				
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 *	**47.85613**	**118.1751**	**0.996557**	**0.0000**
At most 1 *	**29.79707**	**38.77432**	**0.731428**	**0.0036**
At most 2 *	**15.49471**	**20.36943**	**0.613141**	**0.0085**
At most 3 *	**3.841466**	**7.073687**	**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 *	27.58434	79.40079	0.996557	0.0000
At most 1	21.13162	18.40489	0.731428	0.1154
At most 2	14.26460	13.29575	0.613141	0.0707
At most 3 *	3.841466	7.073687	0.396653	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				

Estimation of the long-term regression equation (ARDL) model

After conducting the stability test and 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 (ARDL) methodology to estimate the regression equation, that the change in the explanatory variables does not directly and immediately affect the dependent variable, but rather it needs a longer period of time You pass until the dependent variable begins to respond to changes in the followed variable[(1)].

For example, the growth rate in the gross domestic product needs a period of time until this growth is reflected in investment in natural gas and the production of natural gas increases, which means that most of the variables of the study have no direct effect on the dependent variable, but rather need a period of time to be achieved balance. The same applies to crude oil prices in the international market, when their prices rise significantly and exaggeratedly. Consumers are looking for alternatives as a source of high-priced energy and switch to a low-cost source, and this needs a long time until production lines adapt to the new source, and then the effect of high prices appears. Crude oil depends on the production of natural gas, so

[1-] T. Kindal and J.B.Ratner,"Regional Forecasting Models with vector Autoregression : The case of New york state", Department of Economics, state University of new york at Aibany, 2000, p234.

it makes sense for the researcher to adopt the long-term analysis, and after estimating the equation, the model's capabilities were as follows**(1)**.

The linear formula was chosen and all the variables were in the first difference except for the growth rate in the GDP as the best formula that represented the function, and the calculated (t) value reflected the insignificance of each of the following variables.

A - the growth rate of GDP Gross.

B - Insignificance of the fixed term in equation (C).

The model indicated that the remaining variables are significant and influential in the model, which are as follows:

1- After testing the optimum lag period, it was found that the level in the ARDL model is the optimal period for the significant delay of independent explanatory variables based on five criteria as in Table (5)[2]. The model, standard (AIC), standard (SCH), standard (H&Q), standard (LR), and final prediction error standard (FPE)

and when applying these standards, a slow period equal to the number (0) was started, all of which were for the significant slowdown period. As in Table (5).

2-The significance of the global demand for Iraqi natural gas in the first difference D(G Dem(-1)) meaning that the change in global demand for the previous year by one time, will affect the production of natural gas in the current year and directly by (1.11) by double, representing the demand The ability of the Iraqi economy to market natural gas through partnership contracts with international companies, as the State of Qatar did with partnership contracts, linking to the young and active global markets and searching for promising markets in India or China, through modern transport networks, whether pipelines or tankers , The ability to market is an important factor for the production of natural gas, as many countries

[2]- S. McNees, "Forecasting Accuracy of Alternative Techinquison : A Comparison of u.s Macroeconomic Forecasts,"Journal of Business and Economic Statistics, vol.43,2008, p749.

[3]- L.M.Koyck,"Distributed Lags and investment analysis, North Holland publishint company Amsterdam,2001, p28.

possess global reserves, but their experiences in the gas industry are still limited, as is the case in Nigeria[(1)].

3-The impact of exports of natural gas in the first difference is positive and moral by the amount of the impact factor of (1.63), this effect, which is doubled one and a half times, is very logical, because production depends on the availability of international markets for Iraqi exports, which are either through tankers, or need pipelines to transport gas Which represent complementary projects for the natural gas industry because there are competitors in the region who own production lines and transport them to global markets with high efficiency, so that natural gas transportation pipelines connect the world's continents to make it a single production market, as the State of Qatar did.

4-The regression analysis shows the sentiment of crude oil prices on the production of natural gas in the first difference for the long term (D(O Pri(-1)), and this agrees with the economic logic based on scarcity and abundance and its impact on costs and production, as the high crude oil prices and the extreme fluctuations in them call for To concern from consumers and major international companies, and a sufficient reason to search for an alternative that is stable in prices and less expensive, as natural gas represents a very strong competitor to crude oil, so the change in crude oil prices by one time affects the production of natural gas in the long term By an impact factor of (0.62%) in subsequent years, and this calls for attention to natural gas and the development of an appropriate scenario with the global outlook for natural gas in the future.

5- The proven reserves of natural gas (G Res(-1)) by the first difference are significant and affected by the dependent variable by the amount of the effect coefficient of (3.0), meaning that changes in the reserves of natural gas affect the production share in the Organization of Energy Producing Countries (OPEC), in addition to that A country in which a large amount of reserves is available will be an attractive factor for investment in natural gas, especially from large international companies, because the depletion ceiling is very far, which allows for long-term partnership contracts, so it is logical that reserves are an influential factor in the production of natural gas in Iraq.

6-The value of (R^2) was estimated at about (0.95), which is the ratio of what was explained by the explanatory variables in the dependent variable, while the other variables that were not

[1-] OPECM Annual Statistical Bulletin, Vienna, Austria2007, t9-3,p52.

included in the model affected by (0.05) and it was found from the calculated (F) that it was significant for the function in general, while the value of (D.W) which is (1.9) in the acceptance region and the autocorrelation problem did not appear.

Table (5) Optimum lag time test

VAR Lag Order Selection Criteria						
Endogenous variables: G PRO G DEM G RES G IMP						
Exogenous variables: C						
Date: 09/08/21 Time: 13:11						
Sample: 2004 2019						
Included observations: 14						
Lag	**SC**	**AIC**	**FPE**	**LR**	**LogL**	**HQ**
0	59.51824*	57.87495*	4.19e+20*	30.87202*	-369.1246	57.72283*
1	62.67658	61.76364	8.93e+21	43.95776	-412.3455	61.67913
2	64.54471	64.36212	1.05e+23	NA	-446.5348	64.34522
*** 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						

Table (6) Regression Equation Estimation Using (ARDL(

Dependent Variable: d(G Pro (-1))				
Method: ARDL				
Date: 09/06/21 Time: 14:50				
Sample: 2004 2019				
Included observations: 16				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
D(G Dem (-1))	**1.111965**	**0.129219**	**8.605292**	**0.0000**

D(G IMP (-1))	**1.637381**	**0.284238**	**5.760596**	**0.0002**
D(O PRI (-1))	**0.620246**	**0.241002**	**2.578205**	**0.0317**
GDP Gro	**-12.34967**	**16.01257**	**-0.771249**	**0.4584**
D(G RES (-1))	**3.005228**	**1.311304**	**2.291786**	**0.0449**
C	**156.1112**	**134.9186**	**1.157078**	**0.2806**
@TREND	**59.77680**	**18.23007**	**3.279021**	**0.0112**

R-squared	**0.969796**	**Mean dependent var**	**6894.125**
Adjusted R-squared	**0.954694**	**S.D. dependent var**	**3337.850**
S.E. of regression	**710.4676**	**Akaike info criterion**	**16.24972**
Sum squared resid	**5047642.**	**Schwarz criterion**	**16.53944**
Log likelihood	**-123.9978**	**Hannan-Quinn criter.**	**16.26456**
F-statistic	**64.21654**	**Durbin-Watson stat**	**1.981556**
Prob(F-statistic)	**0.000000**		

Test Impulse Response Functions(IRF)

The test of the pulse response functions shows the amount of response in the variable dependent on the shock to which it is exposed from the explanatory variables in the current and future values. (Andrew Harvey:2014:248) as this test is very suitable for predicting the future of natural gas in Iraq by predicting the impact of independent variables in the long term and their effective role in influencing the variable affiliate.

Where the impact of the shock was measured by one unit, as in Table (7) and graph (1), the response of natural gas production (G Pro) to a sudden shock of one unit in the same variable and explanatory variables, as we note the response in the production of natural gas in Iraq begins to be positive in the year The first gradually decreases until it is negative by (0.96) in the fourth year, then begins to gradually rise to be in the fifth year (3722.2), the sixth (6903.03) and the ninth year (17492.8), when it doubled until it reached (32457.04) in the tenth year.

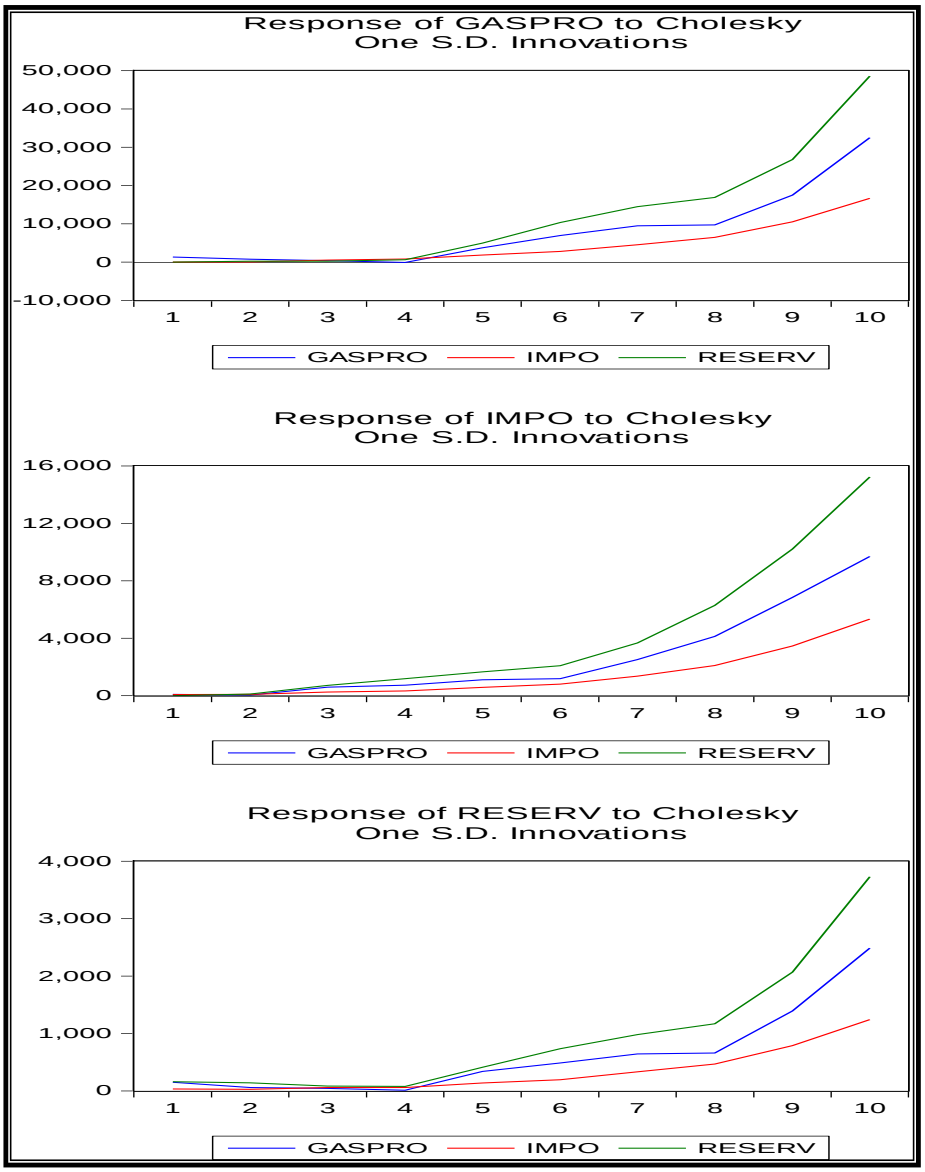
The response of natural gas (G Pro) to a sudden shock of one unit in the proven reserves of natural gas (G Res), has no effect in the first year, and its effect appears after the second year in a positive way by (101.6), gradually increasing upward so that It will be in the fourth year (1179) and in the sixth (2078.9) and in the eighth year (6277.03) and in the tenth year

(15226.3) the continuous upward trend is clear in Figure (1), which shows an indisputable fact that the long term, or the future will be for gas Natural and increasing its position in the global energy market and may be the first source of energy in the world after ten years.

Table (7) Impulse response test for natural gas in Iraq

Response of G PRO:			
Period	**RESERV**	**G PRO**	**G IMP**
1	**0.000000**	**1293.947**	**0.000000**
2	**197.3477**	**753.2265**	**21.06180**
3	**205.5106**	**366.1596**	**516.0302**
4	**596.8263**	**-96.39934**	**795.4755**
5	**4926.794**	**3722.205**	**1794.241**
6	**10285.16**	**6903.037**	**2747.925**
7	**14472.81**	**9474.439**	**4519.312**
8	**16873.88**	**9680.326**	**6456.551**
9	**26789.28**	**17492.87**	**10482.89**
10	**48540.08**	**32457.04**	**16637.60**

Figure (1) Impulse response natural gas in Iraq



Analyze the results of the variance test

The analysis of variance is one of the important structural tests for detecting interdependent bilateral relations or in one direction and for the long term. It measures the impact of the explanatory variable crude oil prices (OPri) on the production of natural gas in Iraq (GPRO) as a dependent variable, by calculating the averages of the independent variable for each year and comparing them With the average for each time series of the dependent variable, if the

differences between the averages for each year are large, it indicates the significance of the independent variable and its impact on the dependent variable[(1)].

This model enables the researcher to segment the variations of errors and the possibility of predicting the production of natural gas in Iraq in the future, and helps the researcher in formulating scenarios for the future of the natural gas industry, and the components of the variance can be obtained from the equations below[(2)].

$$Xt = \mu + \sum_{i=0}^{\infty} A_i \, Ct - 1 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (8)$$

Since (Ai) is the matrix of coefficients of the model variables (n×n), (C) represents the random error limit vector (n×1). And the error for the prediction is obtained in duration (h) using equation (9) below.

$$Xt + h \; - Et(Xt + h) = \sum_{1=0}^{h-1} Ai \; Ct + h - 1 \ldots\ldots\ldots\ldots\ldots (9)$$

By splitting the prediction error for (Xt), equation (10) is.(G.P.E. Box:2002:416)

$$\boldsymbol{Xj, t + h \; - E_1(Xj, t + h)} = \sum_{\boldsymbol{I=0}}^{\boldsymbol{h-1}} (\boldsymbol{Aj1, i\,v1, t + h - 1 + \; Aj2, i\,v2, t + h - 1 + \ldots\ldots + aja, i\,va, t + h - 1}) \ldots\ldots (\boldsymbol{10})$$

Gas production variance test (G Pro) as a dependent change and oil prices (O Pri) as an independent variable.

Table (8) results of the variance analysis for gas production (GPro) affected by fluctuations in crude oil prices (OPri) in the global market. 1- Column (2) represents the standard error (S.E)

2- Column (3) The variable (GPro) shows the variance of (100%) for natural gas production in the first period, when a pulse is directed by one standard deviation in the same variable, and it declines to an average of (2.5) after (5) years and this large discrepancy after The

[1-] Robert Halvorsen and Raymond Palmquist,"The Interpretation of Dummy Variables in Semilogarithmic Equations,"American Economic Review,vol.89,2016, p315.
[2-] Aipha C.Chiang, Fundamental Methods of Mathematical Economics,3d 2015, chap2, p362.

passage of five years shows the intrinsic nature of natural gas production, as it is affected by crude oil prices (OPri) and natural gas exports (Gimp).

3- The variation of natural gas in relation to exports is substantial and effective, as it was in the first year (0%) and in the second year (3.6), while in the third year the discrepancy was very large by (90), and then decreased to (75) in the fifth year to reflect the essential Exports and their impact on natural gas production, after (10) years, the difference in the average standard deviation continues and its amount is (21) This confirms the significance of the variable dependent on the average standard deviation of exports during the long term.

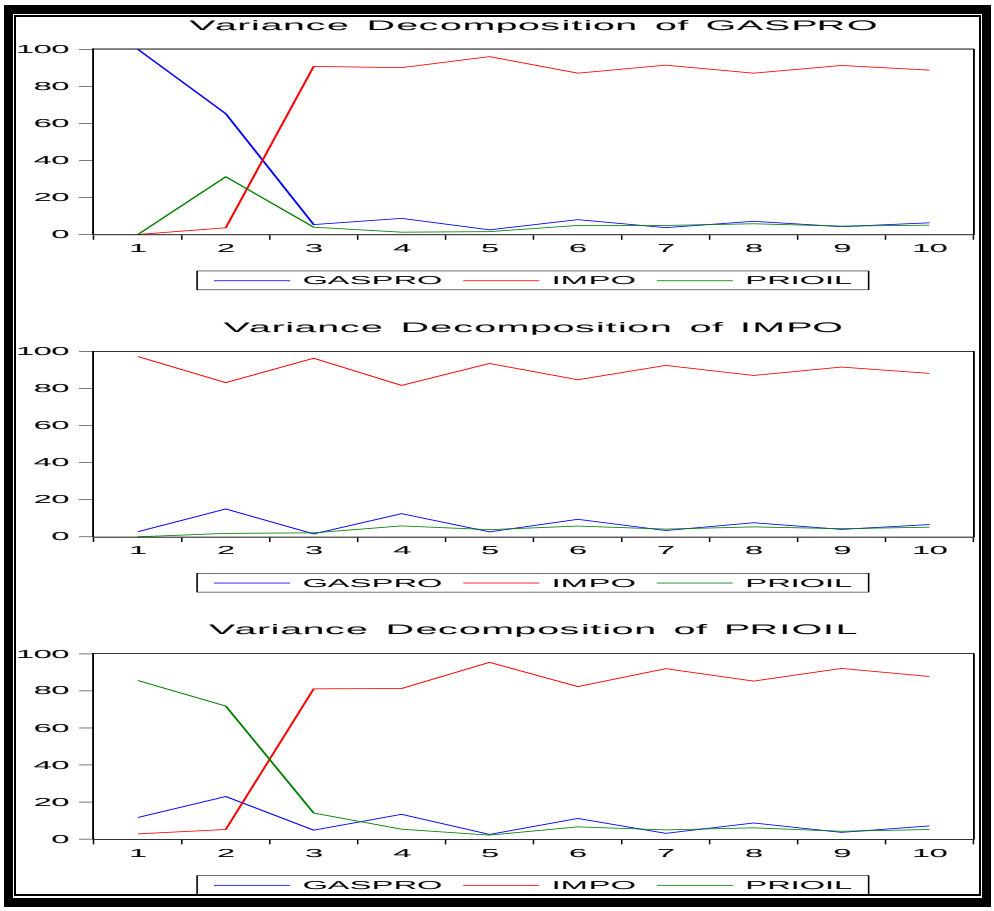
4- Oil prices do not differ from exports in terms of the moral impact on the production of natural gas, and this is clearly shown by the averages that started in the second year (31) and decreased to (3) in the third year, and continued to rise gradually until they reached (65) in the tenth year.

5-The researcher concludes that the large differences between the averages force us to accept the alternative hypothesis, which means that the production of natural gas in Iraq in the future is affected by crude oil prices and natural gas exports and is integrated with them. Figure (2) reinforces the conclusion reached from the above.

Table (8) Test variation of natural gas production (G Pro) in Iraq

Variance Decomposition of GASPRO:				
Period	**S.E.**	**GASPRO**	**IMPO**	**PRIOIL**
1	**999.6235**	**100.0000**	**0.000000**	**0.000000**
2	**1243.367**	**65.18645**	**3.633860**	**31.17969**
3	**4361.277**	**5.305429**	**90.76202**	**3.932546**
4	**9122.686**	**8.641604**	**90.09445**	**10.26949**
5	**25506.26**	**2.522262**	**75.98002**	**1.497715**
6	**48689.79**	**8.012053**	**70.07512**	**4.912828**
7	**127556.9**	**3.712530**	**51.40640**	**14.88072**
8	**274410.8**	**7.143801**	**47.10889**	**50.74304**
9	**710553.3**	**4.213889**	**21.26754**	**54.51567**
10	**1586922.**	**6.302784**	**88.68227**	**65.01941**

Figure (2) Natural gas variance test in Iraq



Conclusions and Recommendations:

Conclusions:

1-There is global interest in the natural gas industry and international laws and legislations indicate an increase in the contribution of natural gas production and industry to the global economy and it is likely that it is the primary source of energy, industry and other use.

2-There is a co-integration between the dependent variable natural gas production and the explanatory variables, meaning that the model variables are able to correct the deviations and imbalances that occur in the short term.

3- Crude oil prices affect the production of natural gas in Iraq, and their effect appears in the long term to be an important factor for the development of natural gas production in Iraq.

4-Through the reserves of natural gas, exports of natural gas and global demand, the volume of production of natural gas can rise, as shown by the results of standard tests.

5- The shocks that the natural gas industry is exposed to are reflected in the production of natural gas and can be an important resource for diversifying revenues from the extractive sector and an important factor for the development of the industrial sector and electricity generation in Iraq.

6-The increase in production of natural gas provides a suitable environment for investment in the hydrocarbon industries.

Recommendations:

1- Develop a clear strategy for the gas industry in Iraq and have plans and programs under implementation in order to advance the reality of the industry.

2-Using the latest technological methods in the gas industry to reduce combustion rates and benefit from associated gas.

3-The Iraqi government's interest in the natural gas industry at a level commensurate with the interest in the crude oil industry.

4- Benefiting from successful experiences in countries similar to the conditions of the Iraqi economy, providing an appropriate investment environment, and creating conditions that allow the establishment of the hydrocarbon industry.

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