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Using the (NARDL) model to measure the impact of crude oil price fluctuations on public spending in Iraq for the period (1970-2021)

Dr. Sawsan Ali Mahmood ,
of Nursing, University of Baghdad, Iraq
sawsanali@conursing.uobaghdad.edu.qi

Abstract: The research aims to measure and analyze an effect of oil price fluctuations on public spending in Iraq, using the non-linear autoregressive distributed lag regression (NARDL) model for the period (1970-2021). To describe the phenomenon studied and studying the nature of the impact that each of the positive and negative changes in oil prices has on public spending in Iraq.

The study concluded the existence of a long-term non-linear positive equilibrium relationship between crude oil prices and public spending in Iraq for the studied period, and that there is a positive and moral impact of positive and negative changes in oil prices on public spending in Iraq as, the positive shocks to crude oil prices had a greater impact on public spending in the long term compared to the negative shocks. It was also found that there is an asymmetry between positive and negative shocks to crude oil prices on public spending in the long term.

Keywords: Oil price fluctuations, Iraq, public spending, NARDL model.

1. Introduction

Oil represents the main nerve of the Iraqi economy, being an economy it is not characterized by diversification, and the rest of the sectors only contribute to it in a small percentage, which made it depend in estimating its revenues and implementing public spending (current and investment) on revenues derived from the export of this resource (oil) and since these revenues are subject to fluctuations in oil prices in the global market, which makes public spending is linked to fluctuations in crude oil prices in the Iraqi economy.

Research problem

The research problem can be formulated through the following question:

Relying on a non-linear autoregressive distributed lag (NARDL) model, what is the effect of crude oil price shocks in global markets on public spending in Iraq?

Research Hypothesis

The research stems from the following hypotheses:

- Changes and fluctuations in international crude oil prices have direct effects on public spending in Iraq.
- The existence of a positive, non-linear, long-term equilibrium relationship between crude oil prices and public spending in Iraq

Research importance

The importance of the research comes by showing the importance of the oil sector in the Iraqi economy as it is the main supporter of the components of development and provides the necessary expenditures for economic advancement, improving the standard of living and financing the production and service sectors, which in turn affects the economic growth and stability of the country. Through this study, we will try to assess the role of oil price fluctuations in public spending in Iraq.

Research methodology

The research relied on the inductive and deductive methods in analyzing the relationship between crude oil prices and public spending in Iraq by estimating the (NARDL) model.

2. Theoretical framework for the concept of fluctuations in oil prices and public spending

2.1. Oil price fluctuations and their causes

Oil is a strategic commodity with economic and political dimensions, and it is like any other commodity that must be valued at a price, the price of crude oil is the value of the oil commodity expressed in monetary unit at a specific time and place, also known it the monetary value of a barrel of crude oil in the American scale per barrel. (Al-Dulaimi, T. K. & Al-Dulaimi, A., 2018)

Oil prices are subject to continuous fluctuations due to the nature of the international oil market, which is characterized by dynamic and instability, which is reflected in oil prices and makes them unstable and subject to continuous fluctuations until it became phenomenon a very worrying phenomena, on the global level since the early seventies of the last century and its continuity until now . (Krimley, T., et al., 2016)

The stability of crude oil prices is closely related to the environment producing and consuming it, therefore we find that the fluctuations that occur in oil prices from one period to another are the result of changes that occur in the oil exporting and importing countries , whether these changes are positive or negative, the political and economic conditions, as well as the security conditions of these countries contribute In its impact on the world prices of crude oil, whether up or down, oil is a strategic commodity economically and politically. (Mahdi , 2015)

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2.2. The factors affecting the global oil price

Since the emergence of the oil commodity, the movement of oil prices has been accompanied by a dynamism and permanent instability as a result of the interaction and overlap of a mixture of economic, political and military factors, which made this vital commodity characterized by oscillates the permanent and fluctuations, as political crises, global challenges and the imposition of sieges on some producing countries played a major role in determining the compass of oil prices, until the political scene became dominant over the economic scene in determining oil prices often times. (Lorusso, M., &Pieroni, L. 2018).

The most important factors affecting crude oil prices in global markets can be summarized in the following points:

- Economic factors are considered one of the most important factors affecting the determination of crude oil prices in global markets, as demand and supply remain the main determinants of the price of oil, like any other commodity. (Saleh, 2016)
- Global demand depends on the size of the economic growth and population growth.
- Economic crises, wars and natural disasters.
- The emergence of other sources of energy as an alternative to oil, as happened in the United States, the largest consumer of oil in the world (Volkov, N. I., &Yuhn, K. H. 2016).

2.3. The conceptual framework of public spending

2.3.1 The concept of public spending

Financial thought includes many definitions of public spending, but all of these definitions revolve around the same elements that make up the public spending framework. Where some define it as a monetary amount paid by a public person to meet a public need (Al-Wadi, 2010).Or it is a sum of money that comes out of the state treasury with the intention of satisfying public needs (Al-Obaidi, 2011). Others express it as the sums spent by public authorities to achieve a public benefit (Asfour, 2012). There are also those who express public spending with an amount of monetary economic money issued by the state with the intention of achieving a public benefit. (Al-Khatib & Al-Shamiya, 2012) and the concept of public spending has developed in line with the development of the state's role in economic life. (Al-Wadi, 2010)

We can definition public spending as a monetary amount approved by the legislative authority within the framework of the state's general budget, and implemented by the federal government or local and regional governments and the rest of the state's public institutions and bodies with the aim of achieving the public benefits.

Therefore, it can be said that public expenditures are the monetary amounts spent by the central government on several different activities in order to develop different sectors and increase economic development and achieve the welfare of members of society.

2.3.2. The most important elements of public spending

From the previous definitions of public spending, it becomes clear to us that public spending consists of three basic elements or pillars, which are:

2.3.2.1. Monetary form of public expenditure

Everything that the state spends, whether in order to obtain goods and services necessary for the running of public utilities, or to purchase capital goods necessary for production operations, or grants, subsidies and assistance in its various forms, to be considered as public expenditures, it must take the monetary character. (Mahmoud, 2014)

Is considered the monetary form is the most common form of public spending, and even if government spending is done in kind, it is necessary that this spending be capable of monetary evaluation in order for it to be calculated and added to the total public spending. (Andrews, 2014)

2.3.2.2. The public alimony is issued by the state or one of its bodies

Public expenditures are issued through state agencies and institutions even if these institutions and projects are subject in their management to a commercial regulation intended to achieve profit, because this does not remove it being an organ of the state that carries out an important activity in order to achieve some economic goals**.**

2.3.2.3. Public spending achieve public benefit

The goal of public spending must be to satisfy public needs and achieve the general benefit of all members of society, and this is the main justification for public spending. This element is due to the principle of justice among all members of society. If individuals are equal in bearing public burdens such as taxes, they must be equal in benefiting from public spending. As for the spending that do not achieve the public benefit, they are not included in the public spending

3. Methodology nonlinear autoregressive distributed (NARDL)

The(NARDL) model, which was developed by Shin et al. in 2014, is an extension of the (ARDL) model, which takes into account the nonlinear relationship of the asymmetric effect between variables in the short and long run and the(NARDL) method enables us to observe the equilibrium relationship between X_t and Y_t divided into X_t positive and X_t is negative, as it detects short-term and long-term effects in one equation, and the (NARDL) model works under the assumptions of the(ARDL) model and the same conditions. (Shin, Y., Yu, B., and Greenwood-Nimmo, M,2014)

The long-run equation can be written between (Y) as dependent variables and(X) as independent variables, using NARDL as stated in Shin et al (2104).According to the following equation:

$$\ldots\ldots(1) Y_t = a + B_1 X_t^+ + B_2 X_t^- + \varepsilon_t$$

Where (+) and (–) are related long-running parameters.

X_t is just a discrete regression vector.

We can observe the equilibrium relationship between Y_t and X_t the independent variable as it is divided into X_t^+ and X_t^-which is which are about the partial sum of positive and negative values is as follows:(Hobi. Sh.,2016)

$$X_t^+ = \sum_{j=1}^{t} \Delta X_j^+ = \sum_{j=1}^{t} max\left(\Delta x_j, 0\right). X_t^- \sum_{j=1}^{t} \Delta X_j^- = \sum_{j=1}^{t} min\left(\Delta x_j, 0\right) \quad ...(2)$$

4. Formulation and Estimation the Model

4.1. Description the model

The (NARDL) model is based on the idea of dividing the cumulative shocks that occur in crude oil prices (*oilP*) into positive shocks($oilP^+$) (negative shocks (($oilP^-$) and zero shocks ($oilP^0$) (for balance) and the cumulative total of these shocks will be equal to the variable itself and as follows:

$$\ldots\ldots(3) oilP_{t=} oilP^0 + oilP^+ + oilP^-$$

Where :

: They represent positive changes in the level of oil prices and is calculated $oilP^+$ according to the following formula:

$$\ldots\ldots (4) oilP_t^+ = \sum max(\Delta oilP) oilP_t^+ = \sum_{n+1} \Delta oilP_n^+$$

$oilP^-$*:* They represent negative changes in the level of oil prices and are calculated according to the following formula:

$$\ldots\ldots (5) oilP_t^- = \sum max(\Delta oilP) oilP_t^- = \sum_{n+1} \Delta oilP_n^-$$

And the NARDL model will be as follows:

$$Y_t = \sum_{j=1}^{p} \partial Y_{t-j} + \sum_{j=0}^{q} (\emptyset_{j=0}^{+} oilP_{t-j}^{+} + \emptyset_j^{-} oilP_{t-j}^{-}) + \sum_{j=1}^{z} \eta X_{1t-j} + \mu_t$$

…(6)

Where:

$\boldsymbol{Y_t}$: public spending , $\boldsymbol{oilP_t^+}$: crude oil price hike , $\boldsymbol{oilP_t^-}$: crude oil prices drop, X_t : exchange rate , ,random error limit $\boldsymbol{\mu_t}$:

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The above equation represents the short-term formula for (NARDL) model description, whose parameters should be stable and not suffer of econometrics problems.

$$\Delta Y_t = p\varepsilon_{t-1} + \sum_{j=1}^{p-1} Y_J \Delta Y_{t-j} + \sum_{j=0}^{q-1}(v_j^+ \Delta oilP_{t-j}^+ + v_j^- \Delta oilP_{t-j}^-) + \sum_{j=0}^{\varpi} X_j \Delta X_{t-j} \quad .(7)$$

Where:

$\boldsymbol{\varepsilon_{t-1}}$: error correction limit , **ρ** : error correction speed

The error correction limit must be negative and significant; in addition to the error correction must be between, (1) and (0).

And we can formulate the long-run equation for the NARDL model as follows:

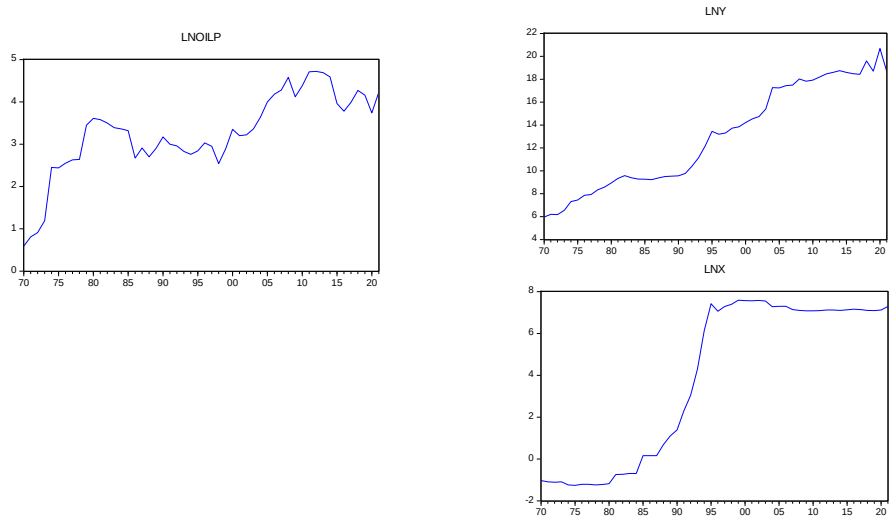
$$Y_t = pY_{t-1} + \emptyset^+ oilP_{t-1}^+ + \emptyset^- oilP_{t-1}^- + \lambda X_{t-1} + \sum_{i=1}^{p-1}\gamma_i \Delta Y_{t-1} + \sum_{i=0}^{q-1}\tau_i \Delta oilP_{t-i} + \sum_{i=0}^{z-1}\eta_i \Delta X_{t-i}$$

… (8)

4.2. Model data

Public spending data (Y) was used based on the annual statistical bulletins of the Central Bank of Iraq in the Iraqi dinar and from the same source, the exchange rate data (X) was obtained. As for the prices of crude oil in the global market (oilP), it was obtained from the unified Arab economic report and the Arab Monetary Fund, in the US dollar and at current prices, and by the use of a time series of annual data to Iraq that covered the time period (1970-2021), by taking natural logarithm, the data will appear according to the figure (1).

Figure (1): The evolution of public spending (Y), oil prices crude (oilP) and exchange rates (X) in Iraq, for the period (1970-2021)



Source: Prepared by the researcher using E. Views program

First of all, the behavior and quality of each of the variables included in the model must be verified, and the examination of the data and study of its evolution over time and the distribution of values across the normal distribution curve will be done through table (1) which describes the feature of the data, validity it and outliers.

We note from table (1) that the variables (public spending, oil prices, and the exchange rate) are not subject to a normal distribution, as the (Jarque-Bera) test statistic for the variables was (8.36, 7.73, 7.66) respectively, this is confirmed, by the probabilistic value (Prob.J-B) corresponding to the statistic (Jarque - Bera)

Table (1)
Statistical characteristics of the study variables during the period (1970-2021)

Variables	***LnY***	**LnoilP**	***LnX***
Mean	12.9954	3.2638	3.8356
Median	13.255	3.335	7.07
Maximum	20.68	4.72	7.59
Minimum	5.96	0.59	-1.26
Std. Dev.	4.53764	0.96077	3.82594
Skewness	-0.37705	- 0.83685	-0.31140
Kurtosis	1.50994	3.87676	1.22562
Jarque-Bera	8.36204	7.73499	7.66199
Prob.J-B	0.03287	0.02091	0.02169
Sum	675.76	169.72	199.4500
Sum Sq.Dev.	1050.101	47.07723	746.5295
Observations	52	52	52

Source: Prepared by the researcher using E. Views program

which were (0.033, 0.021, 0.022,) respectively as less than 5%, thus we reject the null hypothesis and accept the alternative hypothesis that the distribution of the time series is abnormal.

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4.3. The unit root test

There are several tests to find out if the time series are stationarity or un stationarity, The time-series stationarity properties of the variables were examined, using the extended Dickey-Fuller test application and Phillips-Perron (ADF, PP) respectively, as in table (2) below:

Table (2): Test (ADF, PP) of public spending time series, crude oil prices and exchange rates

	(Level) * In level				first difference			
Tests / **Variables**	**ADF**		**PP**		**ADF**		***PP***	
	T-Statistic	**Prob**	**T-Statistic**	**Prob**	**T-Statistic**	**Prob**	***T-Statistic***	***Prob***
LnY	-0.842	0.798	-0.939	0.768	-3.848	0.004	-9.054	0.000
LnoilP	-2.810	0.064	-2.838	0.060	-6.545	0.000	-6.546	0.000
LnX_1	-1.048	0.689	-0.968	0.758	-3.511	0.011	-3.489	0.012

*The model includes at level the intersection limit,(Intercept) as well as the first difference

Source: Prepared by the researcher using E. Views program

It is clear from the above table that the time series of public spending (LnY), crude oil prices (LnoilP) and exchange rates (LnX) are stationarity at the first difference [I (1)], where the statistical value to (T) in both tests (ADF, PP) is greater than the tabulation , and (the probability value) is less than (5%), which means rejecting the null hypothesis that time series are not stationarity and accepting the alternative hypothesis that time series stationarity.

5. Estimation Model (NARDL)

Table (3) shows the results of estimating the NARDL model, as we note that all the variables are in the term short is statistically significant because the value of (P-Value) is less than (5%), which means rejecting the null hypothesis and accepting the alternative hypothesis. The results of the analysis also showed that all variables are significant in the long run, where was the statistical value of (T) is greater than its tabular value in addition to the value of (Value - P), which was less than (5%), which means rejecting the null hypothesis and accepting the alternative hypothesis, and confirms the (F-Bounds) test, which is (9.71) and (P-value) was (0.000) is less than (5%), which means rejecting the null hypothesis and accepting the alternative hypothesis with having a long-term equilibrium relationship, when the oil price increases by (1%), it will lead to an increase in

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public spending by (0.67%), and if the oil price decreases by (1%), it will lead to a decrease in public spending about (0.30%), and if the exchange rates are changed by (1%) it will lead to a change in public spending by (0.50%)assuming stable crude oil prices , and if is any disruption in the short term about long-term equilibrium, the error correction model restores equilibrium a speed of (-0.448930) annually. Which means that (44.89%) from the disequilibrium in the shock of the last year is correcting in the current year.

Table (3) : Results of NARDL Model Estimation

Dependent Variable: LnY				
Short - run estimates				
Variable	***Coefficient***	***Std Error.***	***t-Statistic***	***Prob***
LnY(-1)	**0.4970**3	**0.0697**5	**7.1261 2**	**0.000 0**
LnoilP_POS	**0.**63714	0.07439	8.5645 9	**0.000 0**
LnoilP_POS(-1)	**-0.**29538	**0.**09942	**- 2.9711 0**	**0.002** 5
LnoilP_NEG	**0.20499**	**0.03743**	**5.4766 2**	**0.000 0**
D(LnX)	**-0.31851**	**0.13054**	**- 2.4399 4**	**0.039 3**
C	**3.72637**	**0.67563**	**5.5153 9**	**0.000 0**
CointEq(-1)	**-0.44893**	**0.08079**	**- 5.5562 7**	**0.000 0**
		Long-run estimates		
LnoilP_POS	**0.67317**	**0.25851**	**2.6040 4**	**0.021 0**
LnoilP_NEG	**0.29987**	**0.11720**	**2.5586 2**	**0.025 9**
D(LnX₁)	**-0.50398**	**0.17953**	**-**	**0.003**

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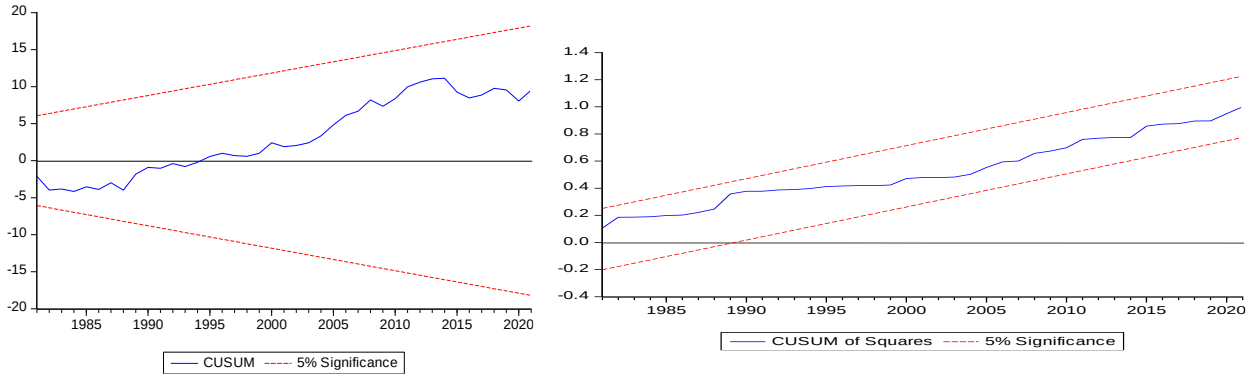
			2.8072 1	**7**
C	**7.15628**	**0.97873**	**7.3118 0**	**0.000 0**
		Model diagnostics		
R – squared	**0.4675**			
Adjusted R – squared	**0.4456**			
F – statistic	**17.571**	0.00**0**		
F-Bounds Test	**9.713**	0.00**0**		
Breusch – Godfrey	**1.6931**	**0.**353		
Breusch – Pagan – Godfrey	**7.8161**	**0.1**29		
Jarque – Bera	**16.3715**	0.000		
Ramsey RESET	**0.13125**	**0.**845		

Source: Prepared by the researcher using E. Views program

The independent variables (crude oil prices, exchange rates) interpret, about (47%) of the changes in public spending, as shown by test value (R^2), the model is considered statistically acceptable as statistical value of (F) is (17.571) and (Value - P) to it (0.000), which is less than (5%), which means rejecting the null hypothesis and accepting the alternative hypothesis and significance the model in a whole . Also, the residuals of the model does not suffer from the problem of autocorrelation, as proved by(Godfrey-Breusch) test, where (P-Value) of (Obs*R-Squared) is equal to(%35.3) which is greater than (5%) , which means accepting the null hypothesis and rejecting the alternative hypothesis, as well as that residuals of the model does not suffer from the heteroscedasticity

Figure (2): Structural stability test for NARDL model parameters



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Source: Prepared by the researcher based on the outputs E. Views program

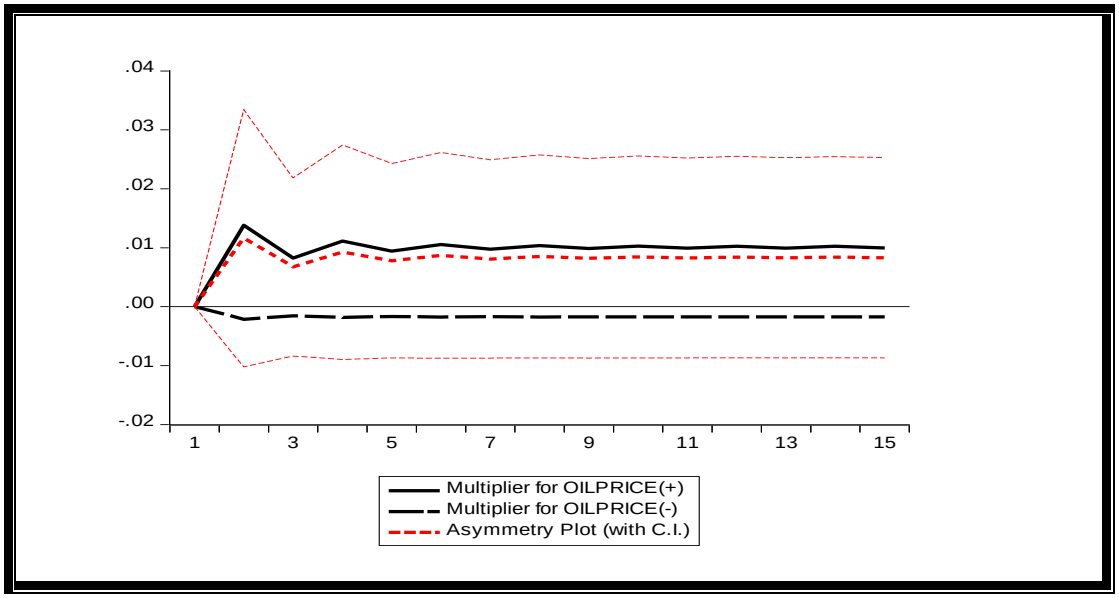
problem as shown by the(Godfrey – Pagan – Breusch) test where the (P-Value) of (Obs*R-Squared) is equal to(%12.9) which is greater than (5%) than it means accepting the null hypothesis and rejecting the alternative hypothesis, while the residuals of the model is distributed evenly abnormal as it is confirmed by the (Jarque-Bera) test where it has a value of (16.3715) and (P- value) was (0.000), which means rejecting the null hypothesis and accepting the alternative hypothesis, the model is also well-described, as indicated by the (Ramsey RESET)test (Ramsey Error Specification Equation Regression) , where was statistical value (F) to it is (0.13125) and the (P- value) (0.845) which is greater than (5%) which means rejecting the null hypothesis and accepting the alternative hypothesis that the model does not suffer from the characterization error problem. We note from figure (2) that the statistics CUSUM and CUSUM of Squares are located within the critical limits at a significant level of 5%, and this indicates that there is stability and harmony in the model between the results of the short and long term.

6. **Estimation the dynamic Multipliers**

It is clear from the figure (3) that the rise in crude oil prices has a positive impact on the increase in public spending (government) by a much greater degree than the impact of the decline in crude oil prices on government spending. It was also found that there is an asymmetry between positive and negative shocks to crude oil prices on public spending in the long term.

Figure (3)

The dynamic multipliers of crude oil prices and public spending in Iraq



Source: Prepared by the researcher based on the outputs E. Views program

Note. The horizontal axis shows years and the vertical axis shows the magnitude of both kinds of shocks.

Conclusions and Recommendations

Conclusions

1. The existence of a long-term non-linear positive equilibrium relationship between crude oil prices and public spending in Iraq during the considered period.

2. There is significant positive effect of the positive and negative changes in oil price on public spending in Iraq.

3. The positive shocks to crude oil prices had a greater impact on public spending in the long term compared to the negative shocks.

4. Existence of asymmetry for positive shock and the negative of crude oil prices on public spending in the long run.

Recommendations

1. Decision makers should take the issue of fluctuations in oil prices and their risks into consideration when preparing budgets and future plans by setting special policies for hedging that would address the imbalances and damages that may occur due to the drop in oil prices in the global market, such as adopting future formulas In selling crude oil or establishing investment funds that act as financial buffers during crises.

2. Increasing the competitiveness of Iraq in the face of external shocks, by rearranging priorities and using the financial surpluses of oil in periods of high crude oil prices and investing them in a way that enhances the structural transformation to contribute to the high rates of growth and economic development in the country.

3. Reducing dependence on oil resources and restructuring government spending, especially with regard to the components of operating and consumer spending that can be compressed and rationalized according to a financial and economic reform program that aims to provide more financial resources to support investments, reform the reality of economic sectors, enhance the process of economic an social development and diversify economic.

4. We also recommend the use of the (NARDL) model in economic studies because of its importance in analyzing economic problems and helping decision makers to develop future plans.

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