
USING AUTOREGRESSIVE DISTRIBUTED LAG (ARDL) MODEL TO MEASURE THE IMPACT OF OIL PRICES ON IRAQ'S INTERNAL DEBT FOR THE PERIOD 2021-2004

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Abstract

The research aims to analyze the changes in oil prices and their effect on Iraq's internal debts for the period (2004-2021) using the Auto Regressive Distributed Lag (ARDL) model. The ARDL model is one of the most prominent models used to analyze the dynamic relations among the economic variables in the short and long terms. The research hypothesis is that there is a direct effect and an inverse relationship between oil prices and internal debt. The research adopts the time series data; applying the stationarity test using the Phillips–Perron test, all the data stabilized after considering the first difference. Consequently, ARDL models were built and estimated for the research variables, as well as conducting determination tests to ensure the models were free of standard problems. The researcher applies the Akaike test to determine the optimal lag length. A set of conclusions was found, and most importantly as follows: An increase in oil prices by one unit leads to a decrease in domestic public debt by a percentage (0.584) at a significant level of (5%).

The research also sets some recommendations, including the necessity of following economic Amending economic policies in order to enhance economic diversification by increasing production rates in sectors other than oil. Moreover, it affirms the commitment to managing financial indebtedness by applying the public debt rule, ensuring that public debt remains less than 60% of GDP. The primary focus must be on directing the majority of debt towards investments, guided by the golden rule of financial oversight. This approach aims to promote economic growth, fuel economic activity, increase employment levels, boost exports, and diversify sources of income.

Introduction

Oil is one of the most important economic resources in the world and an essential financial resource in rentier countries that rely heavily on it to finance their budgets, including Iraq. In light of the correlation of oil prices with global markets, which makes them vulnerable to fluctuations and external shocks, any fluctuations in oil prices will affect the volume of revenues generated from oil exports and thus affect the sources of financing the budget. Since

Iraq suffers from structural imbalances in its economy and weakness in the production system, any decline in oil exports or oil prices will directly affect its economy.

Public debt is one of the tools of financial policy, which reflects the recurring deficits in the government's general budget and is considered a major burden on the economies of debtor countries, including Iraq. Iraq resorted to internal and external debt after 2003 due to the need for development financing sources in addition to internal and external crises. The country went through the mortgage crisis in 2008, the events of ISIS in 2014, then the Corona pandemic, and the accompanying decline in oil prices. This imposed on the Iraqi government the need to increase its debt to finance its expenses, and this in turn led to an increase in the structural imbalances from which the Iraqi economy suffers.

Research problem:

Iraq is considered one of the countries with low productivity as a result of its dependence on oil resources only. Therefore, any decrease in oil prices leads to Iraq resorting to external and internal debt, which raises the level of debt significantly. Most importantly, oil prices are subject to fluctuations as a result of a group of external and internal factors, as well as the dynamics of supply and demand for oil globally. Therefore, raising the level of public debt constitutes a burden on the Iraqi economy. Therefore, the research problem can be formulated as follows: To what extent do oil price fluctuations affect Iraq's internal debt?

Research hypothesis:

The research is based on the hypothesis that there is an impact and an inverse relationship between oil prices and internal debt in Iraq during the research period.

Research importance:

The importance of the research lies in its focus on oil price fluctuations and their repercussions on internal debt, given the extreme importance that oil resources acquire at present and in the future.

Research aims :

1. Analysis of developments in oil prices and internal debt.
2. Measuring the impact of oil price fluctuations on internal debt.

Research Methodology:

The research relied on the method of linking two main approaches, the first descriptive and analytical based on economic theory and previous studies, and the second quantitative standard based on econometric methods to find quantitative results of the impact of oil prices on internal debt.

Time and Space limits:**1. Spatial Limits: Iraq.****2. Time limits: The period was chosen (2004-2021).****First: The reality and development of oil prices in Iraq:**

Oil prices are one of the important and main indicators of public revenues in Iraq, as the general budget depends on oil revenues at a rate exceeding 90%. Also, most of the productive sectors depend on the oil sector, and therefore any fluctuation in oil prices, especially in the case of a decline, leads to a decrease in revenues of foreign currencies. This leads to a deficit in the general budget, which leads to resorting to public debt, and these debts increase the burden on the budget and negatively affect investment expenditures (Abadi and Lafta, 2020, 138). To understand the picture of oil price fluctuations, see Table (1)

Table (1) Oil prices in Iraq for the period (2004-2021)

Year	Oil Prices (USD \$)	Change Rate
2004	31.39	-
2005	45.67	46
2006	54.21	19
2007	66.37	22
2008	87.94	33
2009	59.41	(32)
2010	75.66	27
2011	105.06	39
2012	106.02	1
2013	102.27	(4)
2014	91.64	(10)
2015	44.74	(51)
2016	36.11	(19)
2017	49.32	37
2018	65.61	33
2019	62.81	(4)
2020	40.68	(35)
2021	63.38	56

Reference: Prepared by researchers based on:**-OPEQ: Annual statistical bulletin(2007,2009,2012,2015,2020,2022)**

Table (1) shows that oil prices during (2004-2021) were fluctuating as a result of their influence by global events as well as market dynamics through supply and demand. The price of a barrel of oil reached \$31.39 in 2004 and continued to rise until it reached \$87.94 in 2008 as a result of the high demand for crude oil. However, as a result of the economic crisis that occurred at the end of 2008 (the mortgage crisis), led to a decline in oil prices to reach \$59.41, with a negative growth rate of (32%) in 2009.

In 2012, oil prices rose to reach their highest level during the research period, as the average price of a barrel of oil reached (106.02) dollars, then oil prices decreased again to reach (36.11) dollars per barrel in 2016. The decline in oil prices in early 2015 was driven by supply factors, including the increase of US oil production, less geopolitical concerns, and changing OPEC policies. However, deteriorating demand prospects also played a role, especially from mid-2015 to early 2016. This partly explains the failure of the oil price collapse to provide a subsequent boost to global economic activity (<https://blogs.worldbank.org/>).

Oil prices rose again in 2018, reaching \$65.7 per barrel, in addition to an increase in oil exports to 4 million barrels, after they were 3.3 million barrels in 2017. This rise contributed to the rise in oil revenues and subsequently an increase in public revenues in the Iraqi economy (Jaber, 2021, 67). Oil prices fell again in 2020 to reach \$40.68 as a result of the Corona pandemic and the international closure policy by countries and international organizations. It was accompanied by a decline in oil exports to (3.5) million barrels, and therefore Iraq does not have the authority to export the quantities it desires as a result of its association with OPEC.

As for the end of the research period, it witnessed an improvement in oil prices when they reached (\$63.38), achieving a positive growth rate of (56%) as a result of the decline of the Coronavirus and the reoperating of factories that were closed as a result of the events accompanying the Coronavirus.

Based on the above-mentioned argument, The volatility in oil prices is influenced by two crucial factors: firstly, the dynamics of the oil market, encompassing shifts in demand and supply; and secondly, the state of the global economy., security, and political events). The Iraqi economy depends on oil exports as the sole source of the dollar and the use of this dollar to stimulate economic activity, which made the Iraqi economy linked to oil prices and external economic fluctuations.

Second. The reality and development of internal debt in Iraq:

Internal debt is one of the financial policy tools that governments resort to in the event of a deficit in their government budget. The problem of internal debt is one of the most important problems that the Iraqi economy suffers from due to financial imbalances, which exacerbate the problem of structural imbalances in the Iraqi economy. In addition, internal debt forces the government to adopt economic programs that negatively affect the economic and social life standards of poor and middle-income groups due to austerity policies, reducing levels of public spending, stopping employment, and reducing government support for many basic commodities demanded by the international financial institutions (Fadil and Mahmoud, 2021, 55-56). The changes that occurred in internal debt during the research period can be explained in Table (2).

Table (2) Internal debt trends in Iraq for the period (2004-2021) (Million USD)

Year	Internal Debt	Change Rate	Total Public Debt	Internal Debt / Total Internal Debt
2004	4,172	-	132,104	3.2
2005	4,480	7	104,860	4.3
2006	3,849	(14)	68,664	5.6
2007	4,142	8	78,909	5.2
2008	3,735	(10)	68,234	5.5
2009	7,209	93	13,704	52.6
2010	7,847	9	65,653	12.0
2011	6,365	(19)	68,994	9.2
2012	5,616	(12)	70,044	8.0
2013	4,053	(28)	105,262	3.9
2014	8,165	101	68,038	12.0
2015	27,544	237	88,451	31.1
2016	40,070	45	93,338	42.9
2017	40,270	0	102,055	39.5
2018	35,384	(12)	76,522	46.2
2019	32,430	(8)	84,528	38.4
2020	5,436	(83)	132,104	4.1
2021	48,216	787	104,860	46.0

Source: Prepared by the researcher based on:

The Iraqi Ministry of Finance, Directorate of Public Debt, Different Years, (2004-2021)

Table (2) shows the developments in Iraq's internal debt during the period (2004-2021), which took an increasing trend during the research period as a result of the fluctuations in oil prices at the global level. Consequently, it greatly affected the state's public revenues. The reason behind this effect is that public revenues depend heavily on oil revenues, which prompted the Iraqi government to resort to internal debt as one of the sources of financing public expenditures (Kazim and Muhammad, 2023, 627).

Iraq's internal debt reached (4,172) million dollars in 2004, at a rate of (3.2%) of the total public debt, and then it increased until it reached (7,209) million dollars, with a positive growth rate of (93%) in 2009 compared to 2008. This debt constituted (52.6%) of the total public debt as a result of the rise in oil prices from (59.41) to (87.94) dollars per barrel.

After 2010, internal debt tended to decline until it reached (4,053) million dollars in 2013, with a negative growth rate of (28%). The internal debt's percentage of public debt also declined to (4%). The reason for this is due to the rise in oil prices to (102.27) dollars per barrel in 2013. The decline in debt contributed to an increase in public revenues and the

government did not resort to borrowing. During the period (2015-2016), the internal debt rose again to reach (27,544) and (40,070) million dollars, with a rate of change of (23%) and (45%), and a percentage of the public debt (31%) and (43%) respectively. This recent change is due to the ISIS crisis in 2014 and its control of some oil fields. As oil exports declined, public revenues declined in return; in addition to the decline in oil prices, which prompted the Iraqi government to increase internal debt to finance its public spending, especially military ones (Shalal, 2020, 9). Although the internal debt situation recovered after 2016, it rose again to reach (48,216) million dollars for the year 2021, with a positive growth rate of (46%). The reason for this last change is due to the occurrence of two shocks: the Coronavirus and the decline in oil prices, as both affected public revenues of the Iraqi economy. (Kazim and Muhammad, 2023, 627).

Third: The theoretical relationship between oil prices and internal debt

There is a strong co-relationship between oil prices and public debt, which was confirmed by the economic studies concerned in this field, where this co-relationship and impact have several directions. John (2019, 45) confirmed that oil prices affect the revenues of the exporting country. When oil prices rise, revenues increase with it, and this in turn helps the government authorities to pay part of the internal debt. Mary (2018, 75) is of the view that oil prices affect the economic growth of the exporting country, as high oil prices can lead to economic growth. This economic growth can increase tax revenues and be used to pay off debt. Robert (2017, 113) states that oil prices affect internal debt through government spending that increases with increasing oil revenues. The increase in revenues reflects positively on infrastructure and economic development, which positively affects the level of internal debt. As for David (2016, 57), he linked economic turmoil to oil prices, as he considered that oil prices are unstable variables that are affected by global factors such as supply and demand and geopolitical events. Fluctuations in oil prices may lead to economic turmoil in the exporting country, affecting the level of public debt.

Some researchers, including Sarah (2015, 25), have confirmed that this relationship is not fixed and may vary from one country to another based on a set of economic and political variables. There may be other factors that influence the level of internal debt, such as the government's fiscal and economic policies and the structure of the debt.

Fourth: Using the ARDL model to measure the impact of the relationship between oil prices and internal debt

The ARDL model is one of the most prominent models used to measure the relationship between economic variables in the short and long term, which was applied by Pesaran and Shin (1999) and developed by Pesaran et al (2001).

One of the characteristics of the ARDL model is that it does not require the time series to be of the same rank – but static at the same degree, either at the first level or the first difference, or both. The ARDL model also requires that the time series are not stable – but static at the second differences. In this model, the researcher used distributed lag periods with autoregression models; as the time series indicate the lag of their values, and the values of the current explanatory variables with a lag of one period or more.

The model requires determining the complementary relationship between the dependent variables and the independent variables in the short and long terms. The ARDL model also gives the result of the error correction model (ECM), and this helps the estimated model return to balance in the event of any shock or defect occurring as a result of any emergency (Al-Rashdi, 2021, 155).

1. Dependent variable (Y) - Internal public debt: It is an amount of money that the government obtains from a group of people residing in its territory, whether they are natural persons or body corporate, regardless of their place of origin, whether they are foreign or local. Internal public debt is also known as the internal public loan and is used to finance the budget deficit, as the government later repays this debt with its interest (Al-Saidi, 2017, 1064).

2. Independent variable (X) - Oil prices: The price of oil is defined as the money value of one barrel of oil, which is measured in dollars. The price of oil is subject to constant price fluctuations, due to the nature of global oil markets, which are dynamic and unstable. This is reflected in the price of oil, making it unstable and subject to permanent and continuous fluctuation. Consequently, the phenomenon of oil price fluctuation has become a cause for concern at global levels since the 1970s until now. According to economic theory, internal debt has an inverse relationship with oil prices.

3. The mathematical formula for the standard model: As a result of the different units of measurement for the study variables, the researcher used the logarithm formula, and therefore the prediction will be percentages and take the following mathematical formula:

$$\text{Log}(Y) = B_0 + B_1 \log(X_1) + U_i$$

4- Charting the time series: After drawing the time series, it turns out that it is not static and fluctuates with the research variables. See Figure (1).

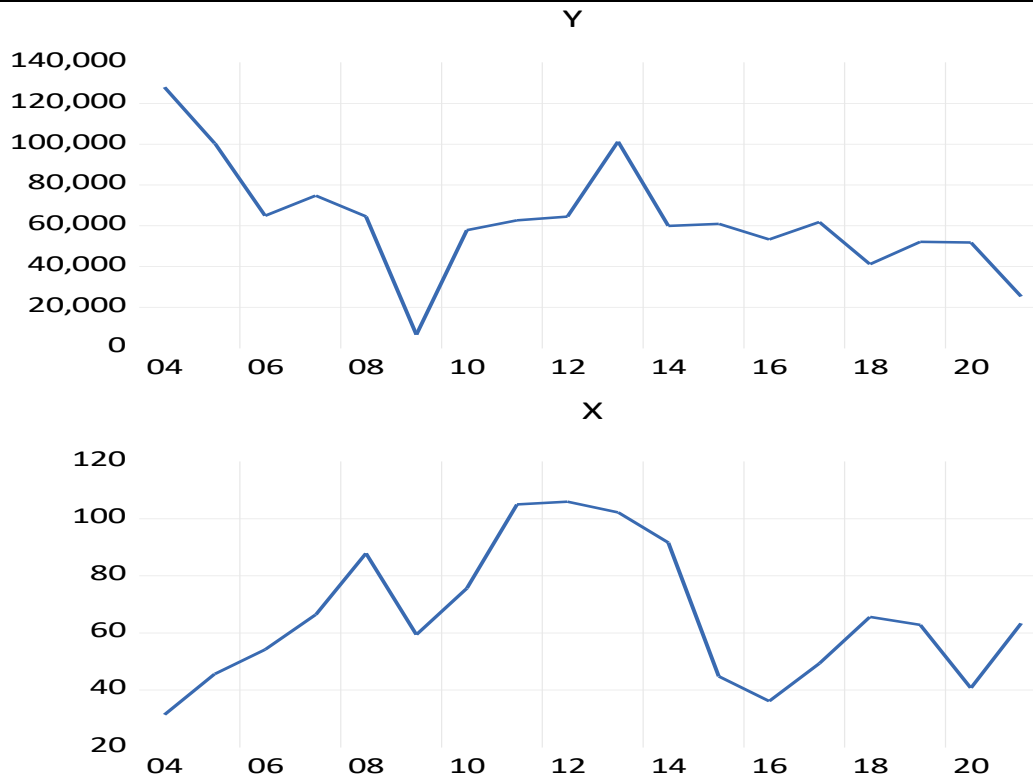


Figure (1) Charting the time series of internal debt and oil prices in Iraq during the period (2004-2021)

Source: using the statistical software (12.EViews).

5- Static Time Series Test: Figure (1) shows instability in the time series. To ensure that there is no spurious regression in the estimation results, we conduct the unit root test by (Phelps Perron). The test results showed that the dependent and independent variables are not static at the same level. However, after considering the first difference, the time series stabilized, whether with a fixed limit and trend; or without a fixed term and trend, at a significance level of (1%), see Table (3).

Table(3) Unit root test (Phillips-Perron) - Iraq

At Level		Y	X
With Constant	t-Statistic	-1.483	-2.575
	Prob.	0.517	0.117
		n0	n0
With Constant & Trend	t-Statistic	-2.955	-2.529
	Prob.	0.171	0.311
		n0	n0
Without Constant & Trend	t-Statistic	1.216	0.382
	Prob.	0.935	0.783
		n0	n0
At First Difference			
With Constant	t-Statistic	d(Y2)	d(X)
	Prob.	-4.373	-3.436

		0.004	0.025
With Constant & Trend	t-Statistic	***	**
	Prob.	-4.074	-3.003
		0.028	0.161
Without Constant & Trend	t-Statistic	**	n0
	Prob.	-4.413	-3.603
		0.002	0.001
		***	***

Source: using the statistical software (12.EViews).

Given of staticity and stability of the data in the first difference, an autoregressive distributed lag (ARDL) model will be used by dividing the data and converting it to quarterly data using the statistical program (12.EViews).

6- Determining the Lag Degree: According to the statistical program, the automatically determined lag degree was used, which is (4) degrees. The model was chosen according to the (Akaike) criterion shows that there are (20) models and that the best lag degree is (4) degrees for the dependent variable and (1) degree for the independent variable. **See Figure (2).**

Akaike Information Criteria

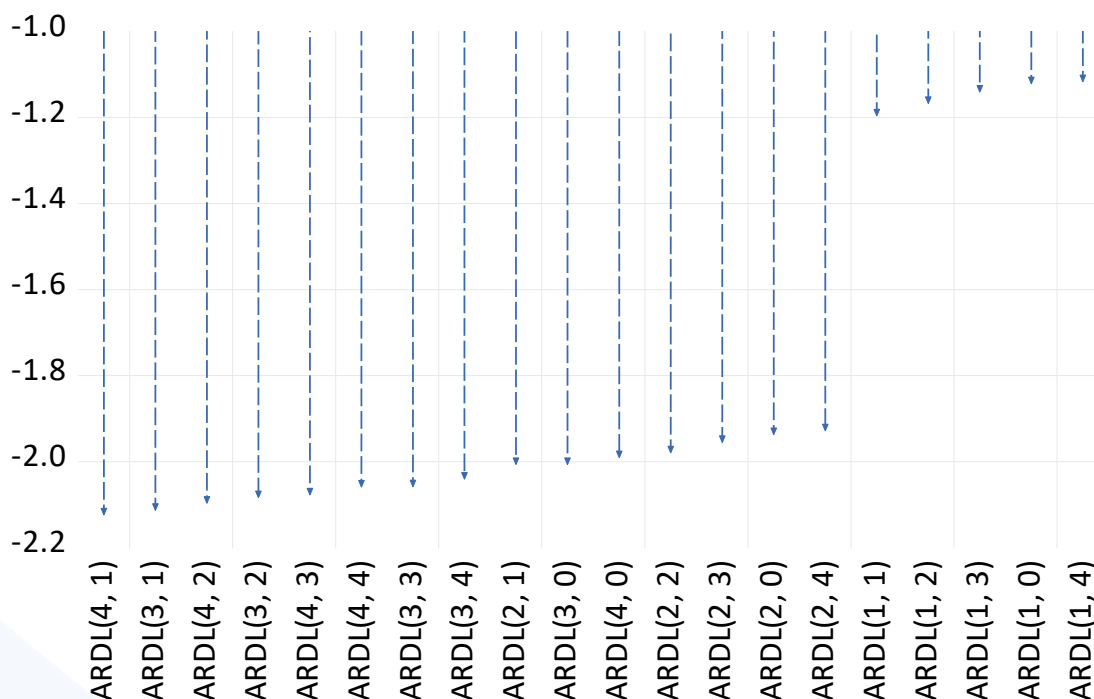


Figure (2)

The model chosen for the internal public debt variable

Source: using the statistical software (12.EViews).

7. Testing the quality of the standard model: The standard model estimated through a statistic test (F) was significant at the (1%) level. Accordingly, the explanatory power of the

corrected coefficient of the determination reached (0.967), meaning that changes in the independent variable (oil prices) explain changes in the dependent variable (internal public debt) by (97%) in Iraq and by (3%) in other variables out of the standard model, see Table (4).

Table(4) Results of the initial estimation of the (ARDL) model - Internal Public Debt In Iraq

Sample (adjusted): 2005Q1 2021Q4				
Variable	Coefficient	Std. Error	t-Statistic	Prob.*
Y2(-1)	1.385	0.125	11.006	0.000
X	0.5736	0.219	2.613	0.011
X(-1)	-0.714	0.219	-3.252	0.001
C	1.055	0.258	4.090	0.001
R-squared	0.970	Mean dependent var		4.021
Adjusted R-squared	0.967	S.D. dependent var		0.437
F-statistic	281.549	Durbin-Watson stat		1.975
Prob(F-statistic)	0.000			

Source: using the statistical software (12.EViews).

8- Cointegration test: Testing the existence of a long-run equilibrium in the relationship between. (oil prices) as an independent variable and the Explanatory variable (Internal public debt), the test is conducted by using a statistical test (F-Bounds Test), and the results are shown as in Table (5) as follows:

Table (5) Testing the cointegration relationship of internal public debt

F- Bounds Test		Null Hypothesis : No levels of relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	12.316	10%	5.59	6.26
k	1	5%	6.56	7.3
		2.5%	7.46	8.27
		1%	8.74	9.63
Actual Sample Size	68		Finite Sample: n=70	

Source: using the statistical software (12.EViews).

Based on the test results, it can be noted that the test value according to the (F) value is (12.3), which is greater than the highest and lowest value at a significance level (5%), and thus there is a long-term cointegration relationship between oil prices and internal public debt.

9 .Short and long-term relationship:

Short-term relationship: The results showed that the sign is positive, meaning that the relationship is direct between oil prices and internal public debt and that increasing. A one-unit change in oil prices results in an increase in internal debt by (0.573) at a significant level (5%). After the second year in the short term, the sign is negative, meaning the relationship is inverse, and the rise in oil prices in the second year by one unit leads to a reduction in internal public debt by (0.140%) at a significant level (10%). This is consistent with the reality of the Iraqi economy, which depends almost entirely on oil revenues.

The results showed that the value of the error correction parameter $ECM = (-0.240)$ is negative and significant at level (5%). This result fulfills the necessary and sufficient condition for the long-term relationship between the variables, and that the short-term imbalance in the previous year ($t-1$) is corrected at (24%) of the current year (t)

- **Long-term relationship:** The results showed that the sign is negative, meaning that the relationship is inverse between oil prices and internal public debt, and that increasing oil prices by one unit leads to a decrease in internal public debt by (0.584) at a significant level (5%), and this result is compatible with the reality of the Iraqi economy. See Table (6).

Table(6) Short and long term results

Conditional Error Correction Regression				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.055	0.258	4.090	0.001
Y2(-1)*	-0.240	0.048	-4.955	0.000
X(-1)	-0.140	0.074	-1.88	0.063
D(X)	0.573	0.219	2.613	0.011
* p-value incompatible with t-Bounds distribution.				
Levels Equation				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
X	-0.584	0.279	-2.088	0.041
$EC = Y - (-0.584 * X)$				

Source: using the statistical software (12.EViews).

10. Diagnostic tests: To ensure the accuracy of the results that emerged from the previous tests, we perform diagnostic tests to prove the validity of the results, which are as follows:

- **The problem of autocorrelation:** To ensure that the model is free of the problem Autocorrelation between error term values, and through the data of the test of the autocorrelation problem (LM Test) in Table (7), we notice that the value of the F-statistic has a probability level of (Prob=0.489) which is not significant at the (5%) level, which means that there is no problem of autocorrelation in the model between the random variables.

2. The problem of heterogeneity of variance: The results of the (ARCH) test in Table (7), which are related to identifying the problem of heterogeneity, showed that the value of (F-

statistic) with a probability level of (Prob=0.402) is not significant at the level of (5%), which means there is no problem of heterogeneity of variance among the random residuals.

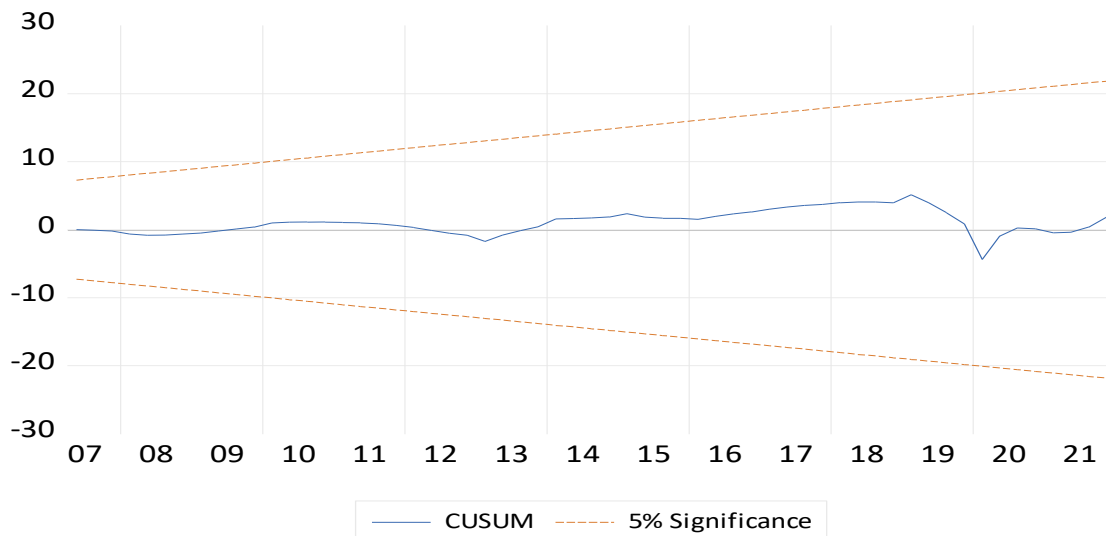
Table (7)

Diagnostic tests of the internal public debt model

Breusch-Godfrey Serial Correlation LMTest:			
Null hypothesis: No serial correlation at up to 2 lags			
F-statistic	0.722586	Prob. F(2,58)	0.4898
Obs*R-squared	1.653149	Prob. Chi-Square(2)	0.4375
Heteroskedasticity Test: ARCH			
F-statistic	0.709670	Prob. F(1,65)	0.4026
Obs*R-squared	0.723605	Prob. Chi-Square(1)	0.3950

Source: using the statistical software (12.EViews).

To ensure that the data used in this study are free of structural changes, and to determine the extent of consistency of the long-term coefficients with the estimates of the short-term parameters, the researcher used the following two tests:



Figure(3)
CUSUM - Y-hat test

Source: using the statistical software (12.EViews).

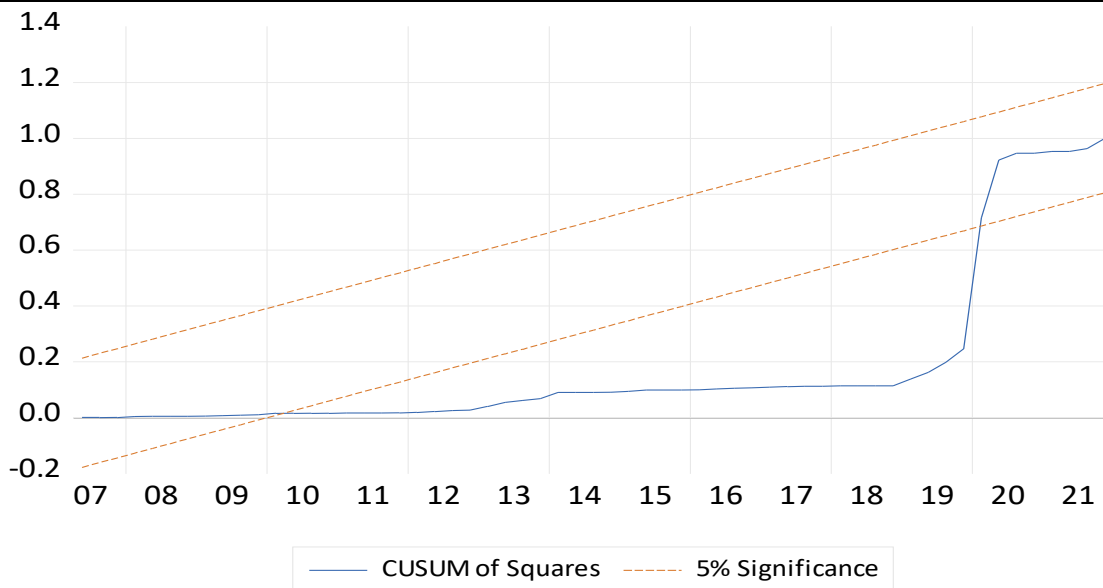


Figure (4)
Test of Squares CUSUM – Y`

Source: using the statistical software (12.EViews).

It is observed from the graph of the (CUSUM) tests that they are within the critical limits (the upper and lower limits) at a significance level (5%), meaning that the results are characterized by stability, while the (CUSUM of squares) test is outside the critical limits (the upper and lower limits) during the period (2010-2020). That is, there is no consistency and stability between the short-term and long-term results at a significance level (5%).

Conclusions

1. Oil prices witnessed fluctuations during the research period, and these fluctuations were linked to global crises such as the mortgage crisis and the Coronavirus pandemic, which affected the global demand and supply of oil, which in turn was reflected in oil prices.
2. Iraqi internal debt has witnessed an increasing trend in general, which indicates the importance of internal debt in addressing the budget deficit that arises as a result of the decline in oil prices.
3. The results of (ARDL) proved in the short term that there is an inverse relationship between oil prices and internal debt and that increasing oil prices in the second year by one unit leads to a reduction in internal public debt by (0.140%) at a significant level (10%). This is consistent with the research hypothesis and the reality of the Iraqi economy, which depends almost entirely on oil revenues.
4. The results of (ARDL) proved in the long term that there is an inverse relationship between oil prices and internal debt and that A one-unit increase in oil prices results in a reduction in internal debt. (0.584) at a significant level (5%), and this result was also consistent with the reality The Iraqi economy and the research hypothesis.
5. The return to the equilibrium situation between the short and long terms will be corrected during (24%) of the current year (t) according to the value of the error correction parameter $ECM = (-0.240)$, which is negative and significant at a significance level (5%), and this result

fulfills the necessary condition. It is sufficient for the long-term relationship between variables.

Suggestions:

1. Working to achieve stability in oil prices through coordination with international organizations concerned with oil, such as OPEC and OAPEC, which control the oil supply in a way that ensures stability in oil prices.
2. The Iraqi government authorities must diversify sources of income by encouraging other economic sectors, such as industry, agriculture, and services, in a way that contributes to increasing public revenues, and thus the government avoids internal debt when oil prices decline.
3. The Iraqi government authorities must benefit from oil revenues in the years when oil prices rise by establishing sovereign wealth funds to benefit from them in times of declining oil revenues and avoid public debt.
4. It is necessary to follow a policy of financial control of indebtedness (the public debt rule) by the Iraqi government authorities in a way that contributes to the percentage of Ensure that public debt remains less than 60% of GDP, with the majority of the debt allocated to investments, while adhering to the “golden rule” of financial control to promote economic growth.

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