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Measuring the Non-linear Response to Economic Shocks in Iraq

Bushra A. Ahmed
Assist. Prof. Dr., College of Management and Economics, Tikrit University, Tikrit, Iraq
bushra.ae33@tu.edu.iq

Abstract

In this Paper, investigate how fluctuations in oil prices impact economic growth in Iraq for the period 2019-2024 and employ the Nonlinear Autoregressive Distributed Lag (NARDL) approach. We analyze whether there is asymmetry in positive and negative changes in oil prices on the GDP growth of Iraq. We consider the linkage between oil prices, GDP growth (real GDP), non-oil GDP, and inflation in this context. This time lag covers many critical economic events, including the global economic upturn post COVID-19 pandemic and recovery of global oil markets. The descriptive analysis shows that in 2020, Iraq's economy experienced a sharp contraction but recovered strongly in 2021 and 2022. The findings highlight the role of oil revenues in national budget formation and overall economic activity. It technically means that positive oil prices help to boost economic growth while negative prices worsen the situation. Moreover, the non-oil sector helps to diversify the economy. Additionally, inflation has also undermined economic stability by impacting the purchasing power and investment. Finally, we use the NARDL tool to analyze asymmetries in the short run and long run.

Keywords: NARDL Model, Oil Price Shocks, Economic Growth, Asymmetric Effects, Iraq, Non-Oil GDP, Inflation.

1. Introduction

Econometric modelling of non-linear macroeconomic dynamics viewed through the prism of economic shocks is a relatively unexplored area in the frame of Iraq. The study embraces the period 2019-2024 and focuses on three essential macroeconomic variables: consumption, investments and public income. The main problem arises from the selection of the appropriate shocks allowing the investigation of non-linear reaction to them [1]. This research describes the shocks chosen and clarifies on their sources such as domestic, external and sectoral factors. The identification approach considers the complexity of the Iraqi economy structure and relies upon the non-linear dynamics theory in order to determine the impact of shocks. Inflation acts as hidden taxation hurting savers in different sectors of the economy. From 2019 to 2024 inflationary pressure emanated from various factors impact both domestic and international environment such as pandemic-induced supply chains', currency depreciation, border closures due to political events, external sanctions, economic policies as well as internal challenges. Consequently, inflation rates have been going up year by year underlining the importance of anticipated rules that dictate economic activities [2].

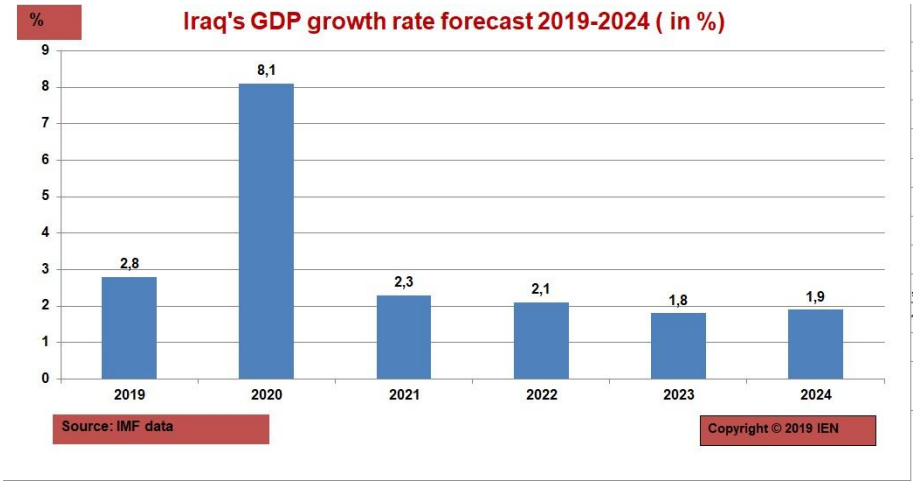


Figure (1): Iraq's GDP Growth Rate (2019–2024)- Source: World Bank, Iraq: Selected Economic and Financial Indicators (2019–2024).

2. Conceptual Framework

The Iraqi economy the subject of this study is a rentier economy highly susceptible to shocks stemming from oil price fluctuations. Consequently, oil revenues in the general budget are significantly affected by these shocks, given that they account for 90% of total public revenue a fact that has deeply entrenched the rentier nature of the Iraqi economy. Throughout the 2004–2026 period, any negative shock to oil prices led to an increase in domestic public debt. Ultimately, oil price shocks during the study period drove up levels of domestic public debt, reflecting structural imbalances in the general budget that cannot be remedied through short-term fiscal reforms [3]. The non-linear behaviour is responsible for shifts in regimes, the impulses' size, and the adjustments in the economic shocks, resulting in the bifurcation properties. Non-linearities play a role also in terms of the phenomena connected with the threshold and exponentiating impact of shocks. It is worth mentioning that the MENA countries, including Iraq, are subject to various shocks of different sources and magnitudes. These regions are in the state of permanent volatility in terms of the definition given by history [4]. The high variation of the manner and impact is attributed to the external demand stemming from oil price developments. After the foreign shocks have passed through the channels like "trade balance – real exchange rate – inflation rate – output," some governments may experience limited fluctuations in their economic activities. The tendency towards inflation is restored even in the situation of low inflation rate regimes where the pressure of oil revenues is constantly high [5].

Considering the dependency of the Iraqi economy on oil revenue, oil price shock effects will differ depending on whether international oil prices are increased or decreased. In case of falling oil price on the world market government revenues will fall, public finance will be restricted, domestic demand will be limited, and economic growth will be negatively affected. On the contrary to falling oil prices, rising oil prices will contribute to an increase in fiscal revenues, encourage public investment, and

boost the economic activity. However, those processes may not be comparable since state's ability to change public expenditure depends on fiscal restrictions, institutional setting and prevailing economic and political environment. The experience of oil price collapse in 2016 as well as the structural and institutional problems after the year 2003 illustrate that it is important to take those factors into account while analyzing oil price fluctuations in the economy of Iraq. Besides, external oil prices shocks can be affected by geopolitical developments that change situation in the international oil market.

3. Non-linear Dynamics of Economic System

The economic system is governed by the complexities of the interplay between the actions of individuals in a framework of complicated systems. In spite of apparent reliance on linear estimates, the underlying mappings are mostly non-linear and multidimensional in nature. The low-dimensional nature of many mappings draws attention of scientists to non-linear dynamics for the reason of the presence of chaos and bifurcation processes through which non-predictable dynamics may unfold, despite being reproducible at the same time. Non-linear effects would transform minimal changes into grand-scale disturbance due to indirect impact, which may not be intuitively understood as it is interlinked with other actions [4].

4. Shock Identification and Classification

The Iraqi economy saw significant fluctuations during the years from 2019 to early 2024 as a result of volatility in international oil prices. Because of the country's high reliance on oil exports, which is the primary source of government revenue, the fall in oil prices in 2020 resulted in a drop in public income, government expenditures, and economic activity. On the contrary, the increase in oil prices in 2021 brought additional revenue to the government and improved its financial position, thus providing the government with an ability to increase expenditures and accelerate economic recovery. However, the advantages from growth in oil revenues were not necessarily turned into the equivalent increase in economic growth rates because of structural problems, fiscal rigidities, and low level of diversification of the economy. Similarly, oil price variations in the years 2022–2024 resulted in uncertainty for public revenues, maintaining expenditures, and macroeconomic stability. These events show that growth and decline in oil prices can have a different effect on the economy. More specifically, negative oil price fluctuations can impede government spending and economic activity, while positive shocks can bring additional revenue but not necessary increase productive capacity. Therefore, it is necessary to study the effects of fluctuations in oil prices in order to analyze the relationship between oil prices and economic growth of Iraq, while the Nonlinear Autoregressive Distributed Lag (NARDL) model is utilized to study the effect of positive and negative shocks in oil prices on GDP in Iraq.

5. Measurement Challenges in Iraq

In measuring economic shocks in Iraq, one has to overcome several obstacles caused by the country's high dependency on oil revenues, political instability, and external shocks. Oil price volatility is one of the key factors driving Iraq's economy up and down. The government faces the changes in the global oil markets and has to adjust their plans for the public spending and GDP growth. In addition,

the repoching of the economy in 2020 due to the COVID-19 crisis led to the huge contraction of the economy. Besides that, low levels of diversification of the economy, inflation, and exchange rate volatility make the measurement of economic shocks a challenging task.

6. Historical Shocks in Iraq

The most significant shock to the Iraqi economy from 2019 to 2024 was the worldwide price of crude oil. The understanding of the crude oil price movements is started from the determination of the days when oil prices changed significantly. Henceforth, four oil price changes were identified by using the trends of the two market cycles – the downward movement of prices on oil and their upward movement later. The above-mentioned methodology allowed for the identification of the two objectives. The first one was to analyze the history of price movements and the transactions that were made by importing and investing using them. The second purpose was to analyze the impact that unexpected movements of oil prices could have on various macroeconomic factors, as the whole process of economic development was going from the stage of gradual improvement to the stage of economic decline caused by Taylor's rule. Therefore, the analysis is based on the annual data of GDP, financing of the economy through government investments in the country, prices of goods in international markets, and trade equations.

7. Empirical Analysis: Non-linear Response Patterns

This analysis also demonstrates the appearance of clearly defined phases of time highlighted by different variables and magnitudes of shocks. The study emphasizes the importance of policy regime changes and formal/informal institutions practices. Four general phases covering the time span from 2019 to 2024 are recognized: the one characterized by large volumes of external aid in humanitarian needs conditions that are taking place due to the intensification of U.S.- led coalition airstrikes directed against the Islamic State; the transitional phase, before any secure situation is restored; the period comprising humanitarian needs that are still high, but the volume of aid has already decreased; and the interval when the new COVID-19 virus variant has just spread around and the restrictions have been introduced. Different forms of changes, characteristic of the later periods of time, show that the consequences of such regime changes affected the nature of non-linearity of economic and financial indicators and the influence of each indicator on the macroeconomic fluctuations.

8. Policy implications and measures for mitigation

The rising significance of sub-national governance in connection with the specific realities in the region creates elementary forms of inter-regional non-linear interactions that can be employed to address various changes at the local level. However, these "Kaldor effects" that take place within Iraq cannot be applied to larger regions. It is believed that to absorb non-linearity, it is necessary to have enough heterogeneity of external economic shocks; otherwise, the transmission speed can only be expressed as an average characteristic of formal and informal links connecting different economies. Non-linearity appears to play an important role in the process of shock absorption observed within

Iraq, with the sequence of non-linear transmission rates being the same. The influence of time phases on non-linear transmission should be viewed as another critical aspect of the investigation.

Both pre- and post-2003 phases have shown significant non-linear behavior of consumption or investment expenditures, while some reactions can demonstrate reversal under the influence of the third-order negative shock. Non-linearity is also present in the process of shock effect on the exchange rate through inflation; specifically, it uses the scheme seen before 2003, where large shocks impact inflation too soon while small shocks influence it only gradually. In terms of public finance, one can identify non-linearity of subsidy reforms, while unemployment instability appears to demonstrate a hysteresis effect. The research of absorptive capacity proves that simple forms of non-linear interaction occur within the sectors of the economy of Iraq and that they are sufficiently powerful to mitigate the effect of shocks that affect the economy.

9. The Methodology

The proposed association between oil price changes and economic development in Iraq has been represented in the figure (2).

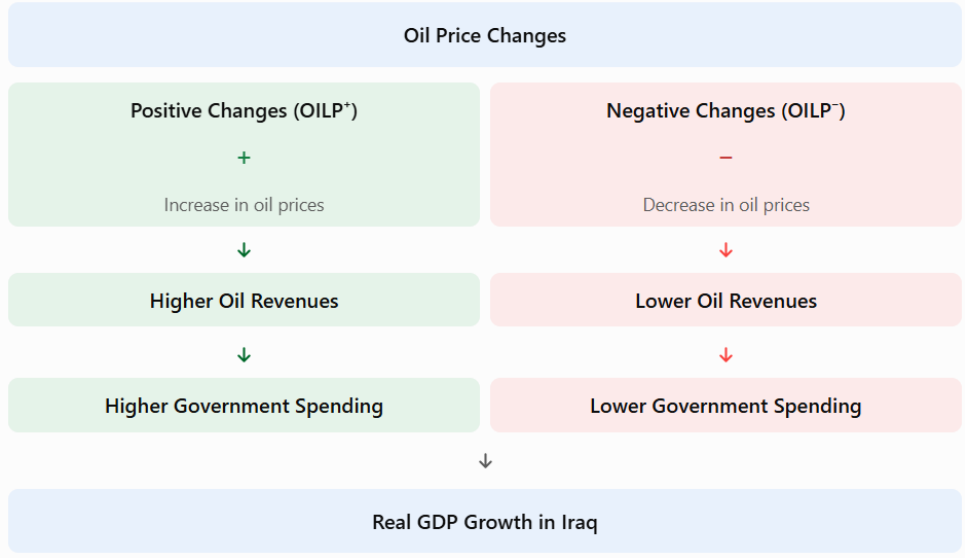


Figure (2). Conceptual Framework and Hypothesized Relationships Among the Variables in the NARDL Model

The figure (2), presented is that rises in oil prices increase oil income and public spending, which in turn may enhance economic performance. On the other hand, falls in oil prices may lead to lower revenues and government spending, which may hinder economic growth. In addition, it is hypothesized that there will be a positive correlation between non-oil GDP and economic performance, while inflation is expected to have a negative correlation. The framework demonstrates anticipated connections between the variables as it indicates that positive and negative shocks in oil prices may have unequal implications on economic growth.

9.1 Data Sources and Variables:

The present research investigates the way in which the economy of Iraq reacts to economic shocks of both positive and negative nature from 2019 to 2026. The aim is to assess whether any economic shocks lead to asymmetric or symmetric effects on economic growth, inflation rate, exchange rate and revenues of the government. One of the reasons to choose Iraq as the focus of the case study is the fact that the country is heavily reliant on oil exports. As a result, the fluctuations in global oil prices impact the government's revenues, public spending, economic activity and financial stability.

Table (1). The period includes several important economic events:

Period	Economic shock or event	Potential economic impact
2018–2019	Recovery and fluctuations in oil-market	Shift in government income
2020	Oil price crash during the Covid-19 pandemic	Serious fiscal and economic issues
2021–2022	Recovery in oil price on global stage	Increased oil income and better fiscal position
2023–2024	Fluctuations in oil markets and exchange rate problems	Fiscal and monetary difficulties

In this research paper, the variables that are taken into consideration in order to analyze the influence that fluctuations in oil prices and macroeconomic variables have on economics development in Iraq. The dependent variable refers to real GDP growth (GDPG) which is calculated using the annual percentage of changes in the form of GDP index. Apart from that, explanatory variables are such as oil prices (OIL) expressed in USD dollars per barrel in order to examine how changes in oil prices on international level have impacted economic development in Iraq. Inflation (INF), measured as an annual percentage is another explanatory variable demonstrating changes in the prices that may have influence on economic development of the country. Moreover, exchange rate (EXR) is added to the analysis in order to determine how currency fluctuations affect economic performance in Iraq. The next variable taken into account is oil revenues (OREV) that describes the degree of participation of the oil sector in the economy of the country expressed as a percentage of GDP. In addition to that, government expenditure (GOV) measured as a percentage of GDP is included in the research. Lastly, non-oil GDP growth (NOGDP) which is calculated as an annual rate of non-oil sectors' contribution to growth and diversification of economy in the country is also included into the analysis.

Table (2). Description and Measurement of Study Variables

Variable	Symbol	Measurement
Real GDP growth	GDPG	Annual percentage
Oil price	OIL	US dollars per barrel
Inflation	INF	Annual percentage
Exchange rate	EXR	Iraqi dinars per US dollar
Oil revenues	OREV	Percentage of GDP
Government expenditure	GOV	Percentage of GDP
Non-oil GDP growth	NOGDP	Annual percentage

The following table presents a foundational dataset derived from World Bank and International Monetary Fund statistics.

Table (3). Iraqi Economic and Financial Indicators, 2019–2024

Economic and Financial Indicators	2019	2020	2021	2022	2023	2024
Economic Growth and Prices						
Real GDP Growth (%)	5.5	-11.3	2.8	8.7	4.0	2.9
Non-oil Real GDP Growth (%)	7.9	-9.4	7.8	5.0	3.5	2.0
GDP per Capita (US$)	5,943	3,768	5,048	6,646	6,582	6,249
GDP (IQD trillion)	276.2	219.8	301.4	406.3	412.0	400.3
Non-oil GDP (IQD trillion)	161.8	156.4	163.8	181.8	196.6	206.5
GDP (US$ billion)	233.6	151.6	207.9	280.2	N.A.	N.A.
Oil Production (million barrels per day)	4.74	4.00	3.97	4.43	4.62	4.78
Oil Exports (million barrels per day)	3.54	2.99	3.02	3.3	3.4	3.6
Iraqi Oil Export Prices (US$ per barrel)	61.1	38.4	68.4	100.0	92.0	80.0
Consumer Price Inflation (%)	-0.2	0.6	6.0	5.7	4.5	3.0

9.2 Econometric Methods for Non-linear Responses:

Its application is considered to analyze the asymmetric effects of per positive and negative changes in oil price, oil revenues, or oil production on the economic growth of Iraq in the context of the NARDL model. A model distinguishes between positive and negative shocks to assess the differential effect that increases and decreases in oil-related variables have on economic performance, both in the short run and the long run.

9.3 Model Specification:

In order to study the influence of oil prices on the economic growth of Iraq, the model of NARDL can be formulated as:

$$GDP_t = f(OP_t)]$$

Where:

- $(GDP_{t)}$ represent to real GDP growth in Iraq.
- (OP_t) represent to oil prices.
- (t) represent to time period.

9.4 Decomposition of Positive and Negative Shocks:

Through the nonlinear autoregressive distributed lag (NARDL) methodology, the oil price series is divided into positive and negative partial sums, which is beneficial in understanding the possible unequal effect of oil price rises and falls on the mentioned variable.

$$OP_t^+ = \sum_{j=1}^{t} max(\Delta OP_j, 0)$$

$$[\ OP_t^- = \sum_{j=1}^{t} min(\Delta OP_j, 0)$$

This in turn enables the model to differentiate between the impact of increasing or decreasing oil prices.

9.5 NARDL Model Equation:

The general NARDL model can be written as:

$$\Delta GDP_t = \alpha + \rho GDP_{t-1} + \theta^+ P_{t-j}^- + \varepsilon_t + \theta^- OP_{t-1}^- + \sum_{i=1}^{p-1} \gamma_t \Delta GDP_{t-1} + \sum_{j=1}^{q-1} \pi_j^+ \Delta OP_{t-j}^+ + \pi_j^- \Delta OP_{t-j}^{\pm}$$

10. Results and Discussion

The outcomes of this paper can be found in Table (2), which shows what might description of variables of (NARDL) model's application to the Iraqi economy. This table demonstrates the possible asymmetric effects of variations in oil prices and real GDP growth as well as inflation on the real GDP growth in Iraq during the period between 2019 and 2024.

Table (4). Preliminary Expected SIGNS OF NARDL

Variables	Expected Sign	Economic Interpretation
Positive oil price changes ($OILP^+$)	+	Which contribute to economic growth
Negative oil price changes ($OILP^-$)	−	Which do not contribute to economic growth
Non-oil GDP growth (NONOIL)	+	Which act in support of economic growth
Inflation (INF)	−	May negatively affect economic growth
Error Correction Term (ECT)	−	Expected adjustment toward long-run equilibrium

The expected positive coefficient of positive oil price changes (OILP+) suggests that increases in oil prices will meet with higher oil revenues, and so generate economic growth through increased government spending. In contrast, since a decline in oil prices might mean that the government collects less revenue, the negative and statistically significant coefficient of negative oil price changes (OILP−) may mean that a decline in oil prices discourages economic activity. Non-oil GDP growth (NONOIL) should be expected to support economic growth as it signifies the significance of industrial, agricultural, and service activities in this economic diversification. Inflation (INF) is assumed to be

detrimental to economic growth since increased prices lead to lower purchasing power and increased production costs. While the Error Correction Term (ECT) is expected to be negatively signed, indicating that any deviation from the long-run equilibrium gradually corrects itself over periods. Distinguishing actual estimated coefficients from illustrative computations descriptive oil-price changes and cumulative positive/negative changes, table (5) delineates the changes in oil price inputs causing changes into different letterings of real GDP output inputs.

Table (5): Numerical Analysis of Oil Price Changes and Economic Growth in Iraq (2019–2024)

Year	Real GDP Growth (%)	Oil Export Price (US$/barrel)	Change in Oil Price (%)	Direction
2019	5.5	61.1	–	–
2020	-11.3	38.4	-37.15	Negative
2021	2.8	68.4	+78.13	Positive
2022	8.7	100.0	+46.20	Positive
2023	4.0	92.0	-8.00	Negative
2024	2.9	80.0	-13.04	Negative

The derived figures show that all positive changes amounted to US$61.60 per barrel while total negative changes amounted to US$42.70 per barrel. The highest level of positive change in oil price was in year 2021, 78.13%, whereas the highest value of negative change was in year 2020, at 37.15%. The numbers show how important it is to distinguish between positive and negative oil price shocks when assessing their impacts on the economy of Iraq shown in table (6).

Table (6). The result of applied NARDL to Cumulative Positive and Negative Oil Price Changes in Iraq (2019–2024)

Year	Oil Price	Positive Changes ($OILP^{+}$)	Negative Changes ($OILP^{-}$)
2019	61.1	0.00	0.00
2020	38.4	0.00	-22.70
2021	68.4	30.00	-22.70
2022	100.0	61.60	-22.70
2023	92.0	61.60	-30.70
2024	80.0	61.60	-42.70

11. Conclusion

In conclusion, one could confirm the fact that oil prices are significant factors for the economic development and stability of Iraq. Undoubtedly, the stability of the Iraqi economy is closely connected to oil revenue and oil-related government revenue. The analysis presented indicates that positive changes in oil prices will contribute to the economic development and increase the government's income. With the high level of oil revenue, the government will be able to attract money for more public spending and investments. At the same time, negative oil shocks will reduce the government's income and will create problems in terms of fiscal budget. The findings show that both positive and negative changes in oil prices can lead to asymmetric effects on economic performance. That's why the use of NARDL methodology is beneficial for understanding the non-linear relations in the Iraqi case. Furthermore, this study shows the significance of non-oil GDP for the economic growth and diversification. The development of non-oil industries will allow reducing dependence on fluctuations

in international oil prices. Another important factor is inflation, which may negatively affect the economic growth. At the same, economic shocks may affect different regions and sectors of the economy in Iraq. The COVID-19 period has shown how vulnerable Iraq has been to significant shocks in the economy and oil market. The results indicate the necessity of good fiscal and economic policies in the process of managing these shocks. Improvement of economic diversity will allow improving the sustainability of Iraq's economic growth. To sum up, reducing dependence on oil revenues and enhancing non-oil economic activities are extremely important for long-term economic stability.

12. Recommendations

Given the high dependence of the Iraqi economy on oil-related revenues, the government should strengthen economic diversification. Economic diversification means that more investments will be directed to agriculture, industry, manufacture, tourism, and services. Consequently, the Iraqi economy will have to strengthen the development of the non-oil sector, which will increase its chances to possess stable sources of economic growth. Therefore, oil revenues can be directed to productive investments and infrastructure development. The efficiency of fiscal policies needs to be increased to prepare the economy for the declining oil prices. It is recommended to create reserves that will be able to minimize the effects of oil shocks. Public expenditures should be focused rather on the productive projects that contribute to the economic development. One has to pay attention to inflation, which can worsen the economic position of the country.

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