THE IMPACT OF GLOBAL OIL PRICE VOLATILITY ON ECONOMIC GROWTH STABILITY IN IRAQ: EVIDENCE FROM THE BATHTUB THEORY, 2003–2024

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Abstract. This study examines the impact of global oil price volatility on the stability of economic growth in Iraq during the period 2003–2024 within the framework of the Bathtub Theory. The study adopts a descriptive-analytical and quantitative econometric approach and applies the nonlinear Autoregressive Distributed Lag (ARDL) model to estimate both short-run and long-run relationships. Oil price volatility and its squared term are included in the model to test for possible nonlinear effects. The analysis is based on annual time-series data obtained from the Central Bank of Iraq, OPEC, and the World Bank. The study variables include economic growth, oil prices, government expenditure, exchange rates, and foreign reserves. The bounds test results confirm the existence of a long-run cointegration relationship among the variables. The findings reveal that the relationship between oil price volatility and economic growth is statistically significant and follows a U-shaped pattern, with a turning point at approximately 28% oil price volatility. This result supports the Bathtub Theory's prediction of nonlinear fiscal dynamics. In the long run, economic growth is positively influenced by oil prices, government expenditure, and foreign reserve.

Keywords: Oil price volatility, economic growth stability, Bathtub Theory, nonlinear ARDL, Iraq.

ВЛИЯНИЕ ВОЛАТИЛЬНОСТИ МИРОВЫХ ЦЕН НА НЕФТЬ НА УСТОЙЧИВОСТЬ ЭКОНОМИЧЕСКОГО РОСТА В ИРАКЕ: ЭМПИРИЧЕСКИЕ ДОКАЗАТЕЛЬСТВА НА ОСНОВЕ «ТЕОРИИ ВАННЫ», 2003–2024 ГГ.

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Аннотация. Данное исследование анализирует влияние волатильности мировых цен на нефть на устойчивость экономического роста в Ираке в период 2003–2024 гг. в рамках «теории ванны» (Bathtub Theory). В работе используется дескриптивно-аналитический и количественный эконометрический подход, а также нелинейная модель авторегрессионного распределённого лага (ARDL) для оценки краткосрочных и долгосрочных зависимостей. Для выявления возможных нелинейных эффектов в модель включены показатель волатильности цен на нефть и его квадратичный член. Анализ основан на годовых временных рядах, полученных из Центрального банка Ирака, ОПЕК и Всемирного банка. В качестве переменных исследования используются экономический рост, цены на нефть, государственные расходы, обменный курс и валютные резервы. Результаты теста на границы подтверждают наличие долгосрочной коинтеграционной связи между переменными. Полученные результаты показывают, что зависимость между волатильностью цен на нефть и экономическим ростом является статистически значимой и имеет U-образную форму с точкой перегиба примерно на уровне 28% волатильности цен на нефть. Данный результат подтверждает положение «теории ванны» о нелинейной фискальной динамике. В долгосрочной перспективе экономический рост положительно зависит от цен на нефть, государственных расходов и валютных резервов, тогда как девальвация обменного курса оказывает отрицательное влияние. Краткосрочный анализ показывает, что шоки волатильности отрицательно влияют на экономический рост, тогда как коэффициент корректировки ошибок указывает на умеренную скорость адаптации около 52% в год. Диагностические тесты подтверждают

корректность и устойчивость оценённой модели. Исследование подчёркивает важность диверсификации экономики, накопления резервов и внедрения контрциклической фискальной политики для снижения воздействия нефтяных шоков и обеспечения устойчивого экономического роста в условиях рентной экономики Ирака.

Ключевые слова: волатильность цен на нефть, устойчивость экономического роста, теория ванны, нелинейная ARDL, Ирак.

Introduction

The Iraqi economy remains heavily dependent on hydrocarbon exports, which account for more than 90% of government revenues and approximately 60% of gross domestic product. Since the institutional and fiscal transformations that followed 2003, Iraq has experienced repeated boom-and-bust cycles closely associated with fluctuations in global oil prices (IMF, 2024). Periods of rising oil prices have often supported post-conflict reconstruction, expansion of the public sector, and infrastructure investment. Conversely, sharp declines in oil prices have rapidly translated into fiscal deficits, currency depreciation, and contractionary pressures on economic activity.

This structural dependence highlights a persistent weakness in the Iraqi economy: economic growth remains highly vulnerable to developments in international energy markets, while institutional mechanisms capable of mitigating external shocks remain limited (Ali & Al-Yasiri, 2021).

To analyze this challenge, the study adopts the “Bathtub Theory” of resource revenue management. This framework views fiscal and economic stability as dependent on balancing inflows (oil export revenues) and outflows (public expenditure, debt obligations, and investment spending), while maintaining an optimal level of financial reserves through countercyclical policies, sovereign wealth accumulation, and adaptive fiscal rules (Eckardt et al., 2012). According to the theory, excessive inflows without sufficient absorptive capacity may generate

inflationary pressures and resource misallocation, whereas inadequate flexibility during periods of declining oil revenues may lead to recession, fiscal stress, and economic instability.

Iraq provides a particularly relevant case for testing this framework because of the procyclical nature of its budgeting system, weak reserve accumulation mechanisms, and limited coordination between fiscal and monetary policy.

This study aims to analyze the relationship between oil price volatility and the stability of economic growth in Iraq during the period 2003–2024. It also seeks to examine the applicability of the Bathtub Theory in explaining the nonlinear relationship between oil price volatility and economic growth stability in the Iraqi economy. In addition, the study investigates the role of government expenditure and foreign reserves in mitigating the negative effects of oil price volatility on macroeconomic performance and stability. Finally, the research provides policy recommendations aimed at promoting sustainable and stable economic growth in the face of continued volatility in global oil markets.

Research Problem

The research problem arises from the Iraqi economy's high sensitivity to fluctuations in global oil prices due to its heavy dependence on oil revenues. Although previous studies have examined the relationship between oil prices and economic growth, insufficient attention has been given to the nonlinear effects of varying levels of oil price volatility on growth stability.

Accordingly, the central research question is as follows:

Does global oil price volatility have a nonlinear effect on the stability of economic growth in Iraq during the period 2003–2024 within the framework of the Bathtub Theory?

The study is based on the hypothesis that global oil price volatility has a nonlinear effect on economic growth stability in Iraq, consistent with the Bathtub Theory. Specifically, the relationship is expected to follow a U-shaped pattern in which the negative effects of volatility increase up to a certain threshold and then

gradually decline. The study also assumes that government expenditure and foreign reserves act as stabilizing factors that reduce the adverse effects of oil price volatility on economic growth.

Literature Review

The literature on economic growth in Iraq has consistently emphasized the central role of the oil sector in shaping macroeconomic performance, fiscal sustainability, and structural development. Most empirical and theoretical studies conclude that the Iraqi economy remains heavily oil-dependent and therefore highly vulnerable to external shocks, particularly fluctuations in global oil prices and the limited diversification of productive sectors.

Hussein and Benhin (2015) provided early empirical evidence on the determinants of economic growth in Iraq during the period 1970–2010 within the framework of the Solow growth model. Their findings indicated that public investment exerted a greater influence on gross domestic product than private investment. The study also showed that excessive dependence on oil revenues contributed to symptoms of the “Dutch disease” and reduced the competitiveness of non-oil sectors, particularly industry and agriculture, thereby limiting their contribution to sustainable economic growth.

Similarly, Jassim (2021) examined the relationship between oil prices, licensing rounds, oil production, and economic development in Iraq between 1981 and 2019. The study identified a strong positive relationship between oil prices and economic growth, confirming that oil revenues remain the primary driver of economic activity in Iraq. However, the findings also demonstrated that this dependence exposes the Iraqi economy to substantial external vulnerability arising from instability in international oil markets.

In the same context, Rasheed (2023) analyzed the impact of oil price shocks on economic growth stability through the public consumption channel during the period 2003–2020. The results indicated that fiscal policy represents the main transmission mechanism through which oil shocks affect the domestic economy.

Increases in oil revenues tend to generate higher current government spending, thereby reducing fiscal space and weakening the government's ability to absorb future shocks.

From a theoretical perspective, Hassan (2020) introduced the "Bathtub Theory" into the Iraqi economic context. The study compared the public budget to a bathtub that fills and drains according to the flow of oil revenues. Positive oil price shocks increase government revenues and rapidly expand public expenditure, whereas negative shocks reduce fiscal capacity. According to the study, this cyclical fiscal behavior undermines economic stability and constrains long-term fiscal sustainability.

Likewise, Ali (2022) emphasized the importance of financial stability for inclusive economic growth in Iraq. The study found that oil price volatility negatively affects inflation and unemployment, ultimately reducing social development indicators such as education, healthcare, and living standards. The author stressed the importance of stronger coordination between fiscal and monetary policy to mitigate the macroeconomic effects of oil shocks.

Beyond oil dependence and fiscal instability, several studies have examined broader structural and policy-related determinants of growth in Iraq. Faraj (2025) investigated the relationship between national income, unemployment, inflation, and economic growth during the period 1990–2023. The study confirmed the existence of a long-run relationship among these variables and argued that weak policy management and excessive state intervention contributed to slow economic growth and persistent structural unemployment. The findings also indicated that institutional inefficiency and limited private sector participation remain major obstacles to sustainable development in Iraq.

Trade policy has also been identified as an important determinant of economic development. Al-Taie et al. (2022) examined the impact of foreign trade policy on Iraq's economic growth during the period 1986–2020. The study found a positive relationship between trade policy and economic growth but emphasized

that uncontrolled trade liberalization may expose domestic industries to unfair foreign competition. The authors therefore recommended balanced trade policies aimed at protecting local industries and supporting economic diversification.

Environmental sustainability has recently emerged as another important dimension of economic development in Iraq. Shukr and Hameed (2021) examined the relationship between economic growth and environmental degradation within the framework of the Environmental Kuznets Curve (EKC). Their findings suggested that economic growth initially increases emissions and environmental degradation, but in the long run growth may improve environmental quality if accompanied by effective environmental regulation and a gradual transition toward renewable energy sources.

Overall, the reviewed literature highlights several recurring themes within the Iraqi economy. First, oil remains the primary driver of economic growth, fiscal policy, and public expenditure. Second, excessive dependence on oil exports has created structural vulnerabilities, including exposure to external shocks, weak productive diversification, and fiscal instability. Third, policy effectiveness, industrial competitiveness, and coordination between fiscal and monetary authorities continue to represent major challenges for achieving sustainable and inclusive economic growth. Finally, recent studies increasingly emphasize the importance of trade reform, institutional efficiency, and environmental sustainability in strengthening Iraq's long-term economic resilience and diversification.

Research Gap

Although previous studies have examined the relationship between oil prices, public expenditure, and economic growth in Iraq, most of them have approached this relationship within a linear framework. Limited attention has been given to how the effects of oil price volatility may differ across varying levels of volatility, whether low, moderate, or high. In addition, previous research has not sufficiently integrated the Bathtub Theory with nonlinear econometric modeling to

explain how fluctuations in oil revenue inflows and outflows affect economic growth stability.

Accordingly, the present study seeks to fill this gap by examining the nonlinear effects of global oil price volatility on the stability of economic growth in Iraq during the period 2003–2024. The study also analyzes the role of government expenditure and foreign reserves in mitigating the impact of oil price volatility on economic stability.

Research Methodology

This study adopts both descriptive-analytical and quantitative econometric approaches. The descriptive approach is used to explain the structural characteristics of the Iraqi economy and its dependence on oil revenues, while the econometric approach is employed to estimate the impact of oil price volatility on the stability of economic growth.

The study applies the Autoregressive Distributed Lag (ARDL) model because it is suitable for relatively small sample sizes and can be used with variables integrated at different orders, specifically I(0) and I(1), provided that none of the variables are integrated at the second order I(2). In addition, the ARDL model allows for the estimation of both short-run and long-run relationships.

To capture the nonlinear effect proposed by the Bathtub Theory, the model incorporates both oil price volatility and its squared term.

Data Description

The study is based on annual time-series data for the Iraqi economy covering the period 2003–2024. This period was selected because it reflects major structural and economic transformations in Iraq, including political transition, oil price shocks, fiscal pressures, and the economic consequences of the COVID-19 pandemic.

The data were collected from official and international sources, including the Central Bank of Iraq, the Organization of the Petroleum Exporting Countries (OPEC), and the World Bank. The study variables include economic growth,

global oil prices, oil price volatility, government expenditure, exchange rate, and foreign reserves.

The use of annual data is consistent with the nature of macroeconomic variables and the availability of reliable statistical data for Iraq during the study period. These variables are appropriate for empirically analyzing the relationship between oil price volatility and economic growth stability within the framework of the Bathtub Theory.

Empirical Framework of the Study

The empirical analysis in this section examines the impact of global oil price volatility on the stability of economic growth in Iraq during the period 2003–2024. The analysis is based on the Bathtub Theory, which suggests that the effects of oil price volatility may vary depending on the degree of volatility.

In line with this framework, the study employs the ARDL model to estimate both the long-run and short-run effects of oil price volatility, government expenditure, exchange rate, and foreign reserves on economic growth stability.

Designing the Econometric Model for Hypothesis Testing

The study adopts two econometric models to examine the effects of global oil price volatility on the stability of economic growth in Iraq. The first is a linear benchmark model used for comparison purposes, while the second is a nonlinear model that incorporates the squared term of oil price volatility.

The nonlinear specification is intended to test whether the impact of oil price volatility on economic growth changes across different levels of volatility, as suggested by the Bathtub Theory.

Definition of Study Variables

- **GDP:** Economic growth rate (dependent variable)
- **OILP:** Global oil price
- **OILV:** Oil price volatility
- **OILV²:** Squared oil price volatility
- **GOVEXP:** Government expenditure

- **EXCH:** Exchange rate
- **RESERVES:** Foreign reserves

1. Mathematical Specification of the Models

The linear model is specified as a benchmark model to capture the direct effect of oil price volatility on economic growth. The nonlinear model, however, includes the squared volatility term in order to test for the possible existence of a U-shaped relationship between oil price volatility and economic growth stability.

1. Linear Model

$GDPt = \alpha0 + \alpha1OILPt + \alpha2OILVt + \alpha3GOVEXPt + \alpha4EXCHt + \alpha5RESERVESt + \varepsilon t$

Or

GDP at time t = α0 + α1(Oil Price at time t) + α2(Oil Volatility at time t) + α3(Government Expenditure at time t) + α4(Exchange Rate at time t) + α5(Foreign Exchange Reserves at time t) + Error term

2. Nonlinear Bathtub Theory Model

$GDPt = \beta0 + \beta1OILPt + \beta2OILVt + \beta3OILVt^2 + \beta4GOVEXPt + \beta5EXCHt + \beta6RESERVESt + \varepsilon t$

Or

GDP at time t = β0 + β1(Oil Price at time t) + β2(Oil Volatility at time t) + β3(Oil Volatility squared at time t) + β4(Government Expenditure at time t) + β5(Exchange Rate at time t) + β6(Foreign Exchange Reserves at time t) + Error term

2. Results and Statistical Analysis

Presentation of Raw Data

Table 1 presents the annual data for the study variables covering the period 2003–2024. The low growth rate recorded in 2003 reflects the impact of the war and the sharp decline in economic activity. In contrast, the high growth rate observed in 2004 can largely be attributed to the low base effect and the beginning of post-war reconstruction efforts.

The period 2014–2016 illustrates the economic consequences of the decline in global oil prices, while the sharp contraction in 2020 reflects the combined effects of the COVID-19 pandemic and the collapse in global oil demand. Oil price volatility reached its highest levels during periods of major global and domestic shocks, particularly in 2009, 2015, and 2020.

The data also indicate a strong relationship between oil prices, government expenditure, and foreign reserves, highlighting the continued rentier nature of the Iraqi economy.

Table (1): Annual Data for the Study Variables, 2003–2024

Year	Economic Growth (%)	Oil Price (USD/Barrel)	Oil Price Volatility (Coefficient of Variation)	Government Expenditure (Billion USD)	Exchange Rate (Dinar/USD)	Foreign Reserves (Billion USD)
2003	-21.4	28.4	15.2	15.2	1,950	6.5
2004	46.7	38.3	22.1	22.1	1,840	8.2
2005	3.7	54.5	18.5	28.5	1,470	12.4
2006	6.2	65.1	12.3	35.2	1,460	18.6
2007	1.5	72.7	9.8	42.8	1,230	27.3
2008	9.5	99.0	25.4	58.4	1,170	38.5
2009	5.8	61.8	31.2	48.6	1,170	42.1
2010	6.4	79.6	18.7	52.3	1,170	45.8
2011	7.6	111.3	22.4	68.5	1,170	52.3
2012	13.9	111.7	8.9	75.2	1,166	58.6
2013	7.6	108.6	6.2	78.4	1,166	62.4
2014	0.5	98.9	11.3	72.8	1,166	59.8
2015	2.5	52.4	38.5	58.6	1,182	53.2
2016	13.1	43.3	18.2	52.4	1,182	45.6
2017	-1.6	54.2	15.6	58.2	1,182	48.3
2018	0.6	71.3	14.2	68.5	1,190	52.8
2019	4.4	64.2	12.8	72.3	1,190	56.4
2020	-15.7	41.7	42.5	58.6	1,450	48.2
2021	7.7	70.9	28.3	65.8	1,480	52.6
2022	7.0	100.9	22.6	85.4	1,458	58.4
2023	-2.9	82.6	18.4	78.6	1,320	62.8
2024	1.2	80.5	12.5	82.3	1,310	65.2

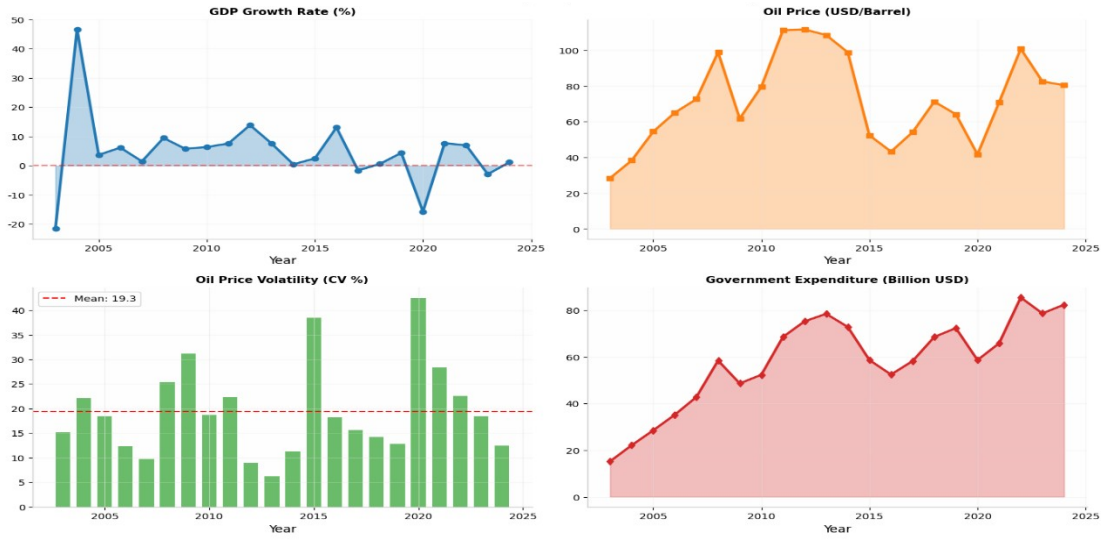
Source: Prepared by the researcher based on data from the Central Bank of Iraq, OPEC, and the World Bank.

The GDP growth rate, presented in the upper-left panel of Figure 1, appears highly volatile and does not follow a stable upward trend. A sharp contraction is observed in 2003, reflecting the effects of war and the disruption of economic

activity. This was followed by a strong recovery in 2004, largely driven by post-conflict reconstruction efforts and the low base effect.

Another significant decline occurred in 2020, coinciding with the COVID-19 pandemic and the sharp fall in global oil demand. This highlights the vulnerability of Iraq's economic growth to external shocks, particularly those related to the oil market. Overall, the data indicate that Iraq has struggled to achieve stable and sustained economic growth, with periods of expansion frequently interrupted by economic contractions.

Figure (1): Trends of the Main Study Variables, 2003–2024



Source: Prepared by the researcher using EViews 24 software.

The upper-right panel presents global oil prices (USD per barrel), which display a pronounced cyclical pattern with a strong influence on Iraq's domestic economic performance. Oil prices increased steadily until the 2008 global financial crisis, recovered and peaked during the period 2011–2014, and then declined sharply in 2015 and again in 2020.

The lower-left panel illustrates oil price volatility, measured using the coefficient of variation. The figure shows that periods of oil price collapse, particularly in 2009, 2015, and 2020, were accompanied by substantial increases in volatility, often exceeding the average level of 19.3%. This pattern provides visual support for examining the nonlinear effects of external oil shocks on economic growth in Iraq.

The lower-right panel presents government expenditure in billion USD. The trend indicates a strong positive relationship between government spending and oil revenue cycles, reflecting the rentier nature of the Iraqi economy. Between 2003 and 2013, public expenditure increased rapidly alongside rising oil prices. Although the collapse in oil prices led to a noticeable decline in spending during 2015–2016, expenditure levels later recovered and exceeded previous levels by 2022.

This pattern of fiscal "stickiness," where public expenditure expands quickly during periods of high oil revenues but adjusts slowly during downturns, clearly reflects the fiscal dynamics described by the Bathtub Theory and highlights the structural dependence of the Iraqi budget on volatile oil revenues.

Descriptive Statistics

Table 2 shows that economic growth exhibits the highest level of dispersion, as indicated by its relatively large standard deviation. This reflects the instability of economic growth in Iraq during the study period. Oil price volatility also demonstrates considerable variation, highlighting the economy's vulnerability to external shocks originating from global oil markets.

At the same time, the descriptive statistics reveal a strong relationship between oil revenue cycles and government expenditure, while foreign reserves and exchange rate movements reflect the effects of monetary and exchange rate adjustments. Overall, the descriptive results provide preliminary evidence of macroeconomic instability and support the use of econometric analysis to further examine the relationships among the study variables.

Table (2): Descriptive Statistics of the Study Variables

Variable	Mean	Standard Deviation	Minimum	Maximum	Observations
GDP	4.85	13.42	-21.40	46.70	22
OILP	72.45	25.31	28.40	111.70	22
OILV	18.63	9.87	6.20	42.50	22

Variable	Mean	Standard Deviation	Minimum	Maximum	Observations
GOVEXP	56.18	20.15	15.20	85.40	22
EXCH	1,362.27	254.60	1,166.00	1,950.00	22
RESERVES	43.85	18.92	6.50	65.20	22

Source: Prepared by the researcher using Stata 18 software.

Unit Root Tests

Before estimating the ARDL model, the stationarity properties of the variables were examined using the Augmented Dickey–Fuller (ADF) test. This test is necessary to determine the order of integration of each variable and to ensure that none of the variables is integrated of order two, I(2), which is a key requirement for applying the ARDL bounds testing approach (Table 3).

The ADF results indicate that oil price volatility (OILV) is stationary at level, I(0). In contrast, economic growth (GDP), oil price (OILP), government expenditure (GOVEXP), exchange rate (EXCH), and foreign reserves (RESERVES) become stationary after first differencing, I(1).

Since none of the variables is integrated at I(2), the conditions for the ARDL approach are satisfied. Accordingly, based on Pesaran et al. (2001), the ARDL framework is appropriate for estimating both the short-run and long-run relationships among the variables.

Table (3): Augmented Dickey–Fuller (ADF) Unit Root Test Results

Variable	At Level	Critical Value (5%)	Decision	At First Difference (1st Diff)	Critical Value (5%)	Decision	Order of Integration
GDP	-2.145	-3.020	Non-Stationary	-5.672**	-3.040	Stationary	I(1)
OILP	-1.890	-3.020	Non-Stationary	-4.921**	-3.040	Stationary	I(1)
OILV	-3.410**	-3.020	Stationary	---	---	---	I(0)
GOVEXP	-2.330	-3.020	Non-Stationary	-5.110**	-3.040	Stationary	I(1)
EXCH	-1.780	-3.020	Non-Stationary	-4.550**	-3.040	Stationary	I(1)

RESERVES	-2.980	-3.020	Non-Stationary	-6.200**	-3.040	Stationary	I(1)

Source: Prepared by the researcher using EViews 24 software.

Note: ** indicates significance at the 5% level.

The Bounds Test for Cointegration

The Schwarz–Bayesian Information Criterion (SBIC) was used to determine the optimal lag length for the ARDL model, with a maximum lag of two lags, given the limited number of annual observations. After identifying the optimal lag structure, the ARDL bounds testing approach was applied to examine the existence of a long-run equilibrium relationship among the study variables.

As shown in Table 4, the calculated F-statistic (7.45) exceeds the upper bound critical value (4.22) at the 5% significance level. Therefore, the null hypothesis of no cointegration is rejected.

These results confirm the existence of a stable long-run equilibrium relationship between economic growth and its determinants, namely oil price volatility, government expenditure, exchange rate, and foreign reserves.

Table (4): ARDL Bounds Test Results for Cointegration

Calculated F-Statistic	Significance Level	Lower Bound I(0)	Upper Bound I(1)	Decision
7.45	5%	2.86	4.22	Long-run cointegration exists

Source: Prepared by the researcher using EViews 24 software.

Estimation of Long-Run Coefficients and Testing the Bathtub Theory

All explanatory variables are statistically significant in the long-run estimation results. Oil price volatility (OILV) has a negative and significant coefficient, while the squared term of oil price volatility ($OILV^2$) is positive and statistically significant. This combination confirms the existence of a U-shaped nonlinear relationship between oil price volatility and economic growth, consistent with the Bathtub Theory (Table 5).

The results indicate that the adverse impact of oil price volatility is stronger at lower levels of volatility and gradually diminishes as volatility increases.

In addition, oil prices, government expenditure, and foreign reserves have a positive long-run effect on economic growth, whereas the exchange rate has a negative long-run effect.

Table (5): Long-Run Coefficients of the Nonlinear ARDL Model

Variable	Coefficient	Standard Error	t-Statistic	Probability Value	Expected Relationship
C	-5.210	2.150	-2.423*	0.035	---
OILP	0.125	0.042	2.976**	0.012	Positive
OILV	-0.840	0.310	-2.709*	0.021	Negative
$OILV^2$	0.015	0.005	3.000**	0.015	Positive
GOVEXP	0.250	0.080	3.125**	0.010	Positive
EXCH	-0.005	0.002	-2.500*	0.030	Negative
RESERVES	0.180	0.060	3.000**	0.015	Positive

Source: Prepared by the researcher using EViews 24 software.

Note: *p < 0.05, **p < 0.01.

Turning Point of the Nonlinear Relationship

Based on the estimated coefficients of OILV and $OILV^2$, the turning point of the nonlinear relationship is calculated as follows:

$$\textbf{Turning Point} = -\beta_2 / 2\beta_3 = -(-0.840) / 2(0.015) = 0.840 / 0.030 = 28$$

The results indicate that the effect of oil price volatility on economic growth reaches its critical point at approximately 28%. Beyond this level, the marginal effect of volatility becomes less negative, which may reflect the activation of fiscal and monetary stabilization mechanisms during periods of high volatility.

Estimation of Short-Run Coefficients and the Error Correction Model (ECM)

The Error Correction Model (ECM) within the ARDL framework was estimated to capture short-run dynamics and the speed of adjustment toward long-run equilibrium. The ECM reflects the immediate impact of changes in the explanatory variables on economic growth, while the error correction term measures the speed at which deviations from long-run equilibrium are corrected.

The short-run results show that changes in oil prices, government expenditure, and foreign reserves have a statistically significant positive effect on

economic growth, while changes in oil price volatility have a statistically significant negative effect.

The error correction term ECM(-1) is negative and statistically significant, confirming the validity of the error correction mechanism (Table 6). Its coefficient is −0.520, indicating that approximately 52% of short-run disequilibrium is corrected within one year. This suggests a moderate speed of adjustment toward long-run equilibrium.

Table (6): Error Correction Model and Short-Run Coefficients

Variable	Coefficient	Standard Error	t-Statistic	Probability Value
ΔOILP	0.090***	0.030	3.000	0.012
ΔOILV	-0.650**	0.220	-2.954	0.018
ΔGOVEXP	0.180***	0.060	3.000	0.015
ΔRESERVES	0.120**	0.045	2.666	0.025
ECM(-1)	-0.520***	0.110	-4.727	0.001

Source: Prepared by the researcher using EViews 24 software.

Note: **p < 0.05, ***p < 0.01.

Model Diagnostic Tests and Economic Interpretation of the Results

The diagnostic test results indicate that the estimated model satisfies the main econometric assumptions. The Breusch–Godfrey LM test shows no evidence of serial correlation, while the Breusch–Pagan–Godfrey test confirms the absence of heteroscedasticity in the residuals.

In addition, the Jarque–Bera test suggests that the residuals are normally distributed (Table 7). The CUSUM stability test further indicates that the estimated coefficients remain within the critical boundaries, confirming the stability of the model over time.

Overall, the diagnostic results demonstrate that the ARDL model is statistically reliable and econometrically valid.

Table (7): Diagnostic Tests and Model Validity

Test Type	Statistics	Critical Value	Probability Value	Decision
Autocorrelation Test (Breusch–Godfrey LM)	1.850	3.84	0.39	No autocorrelation
Heteroscedasticity Test	2.320	3.84	0.32	No

(Breusch–Pagan–Godfrey)				heteroscedasticity
Normality Test (Jarque–Bera)	1.120	5.99	0.57	Residuals are normally distributed
Model Stability Test (CUSUM)	—	—	—	Stable coefficients

Discussion

This study provides strong empirical evidence of a nonlinear relationship between global oil price volatility and economic growth stability in Iraq over the period 2003–2024. The results confirm the existence of a long-run equilibrium relationship between oil price volatility, government expenditure, exchange rate, foreign reserves, and economic growth, thereby supporting the Bathtub Theory in the context of a rentier economy. Several important theoretical, empirical, and policy implications emerge from the analysis.

A key finding is the presence of a nonlinear relationship between oil price volatility and economic growth. The coefficients of oil price volatility (OILV: −0.840) and its squared term ($OILV^2$: 0.015) are statistically significant and carry opposite signs, confirming a U-shaped relationship. This suggests that the negative impact of volatility increases at lower to moderate levels but gradually weakens beyond a certain threshold. The estimated turning point at approximately 28% volatility indicates that the Iraqi economy is most vulnerable at this level of uncertainty, while the marginal adverse effect declines thereafter.

This result is consistent with the work of Hassan (2020) and Rasheed (2023), who emphasize the cyclical nature of fiscal behavior in rentier economies. The U-shaped pattern implies that uncertainty is highest in the intermediate range of volatility, where investment and consumption decisions are delayed, leading to weaker growth performance. At higher levels of volatility (above 28%), however, the Iraqi authorities appear to activate stronger fiscal and monetary stabilization measures, partially offsetting negative shocks. This “crisis response effect” is also discussed by Ali & Al-Yasiri (2021), where extreme shocks trigger institutional reactions that are not present under moderate fluctuations.

The findings also contribute to the broader literature on commodity-dependent economies by showing that the relationship between oil price volatility and growth is not linear, but conditional on the level of volatility. This contrasts with earlier linear specifications in the literature (Hussein & Benhin, 2015; Abid et al., 2023) and highlights the importance of nonlinear modeling in analyzing resource-dependent economies.

Government expenditure plays a central role in the transmission mechanism. The results reflect the "voracious appetite effect" described by Hassan (2020), where increases in oil revenues are largely translated into current expenditure rather than productive investment. This is consistent with Dutch disease effects, where resource booms reduce the competitiveness of non-oil sectors and increase import dependence (Hussein & Benhin, 2015). The persistence of this pattern limits structural transformation and reinforces the phenomenon of "jobless growth," as discussed in Ali & Al-Yasiri (2021).

Foreign reserves (coefficient: 0.180) have a positive effect on economic growth, highlighting their role as a macroeconomic buffer. From a stabilization perspective, reserves support exchange rate stability, enhance investor confidence, and reduce vulnerability to external shocks (Hassan, 2020; Ali, 2022). However, the results also indicate that reserves themselves are pro-cyclical, increasing during oil booms and declining during downturns, which limits their effectiveness as an independent stabilization tool.

The error correction term (ECM(-1): −0.520) indicates that approximately 52% of short-run disequilibrium is corrected within one year. This reflects a moderate speed of adjustment toward long-run equilibrium. In practical terms, the Iraqi economy does return to equilibrium after oil shocks, but the adjustment process is gradual. This inertia is largely driven by institutional rigidities, particularly in fiscal adjustment and limited diversification of revenue sources (IMF, 2024).

From a policy perspective, the results highlight the need for proactive rather than reactive fiscal management. The evidence suggests that stabilization mechanisms become more effective only at high levels of volatility, which implies delayed policy responses. Strengthening fiscal rules, improving stabilization funds, and reducing dependence on oil revenues are therefore essential. In addition, improving governance quality, expanding productive investment, and supporting diversification strategies are critical for long-term stability (Ali & Al-Yasiri, 2021; Ali, 2022). Transitioning toward renewable energy and sustainable development strategies also represents an important policy direction (Shukr & Hameed, 2021).

The study has several limitations. First, the use of annual data may mask short-term dynamics and intra-year adjustments. Second, the relatively small sample size (n = 22) limits statistical power, although the ARDL approach is suitable for small samples. Third, the analysis is conducted at the aggregate level and does not capture sectoral heterogeneity, which may differ significantly across oil and non-oil sectors. Future research could address these limitations by using higher-frequency data, sectoral disaggregation, and additional institutional variables such as governance quality, political stability, and investment climate indicators.

Conclusions and Future Recommendations

The empirical results confirm the applicability of the Bathtub Theory in explaining the relationship between oil price volatility and economic growth stability in Iraq during 2003–2024. The nonlinear ARDL estimates show a clear U-shaped relationship between volatility and growth, with a turning point at approximately 28%. The results indicate that the Iraqi economy remains structurally dependent on oil revenues and highly exposed to external shocks.

Government expenditure and foreign reserves are found to play a stabilizing role in both the short and long run, while exchange rate instability negatively

affects growth stability. The error correction mechanism indicates a moderate adjustment speed of approximately 52% per year, reflecting partial but not immediate recovery from shocks.

Policy recommendations include strengthening fiscal discipline, improving stabilization funds, enhancing reserve management, introducing early warning systems for oil price volatility, expanding productive public investment, and accelerating economic diversification away from oil dependence.

Future research should incorporate additional macroeconomic and institutional variables such as governance quality, political stability, foreign direct investment, inflation dynamics, and financial development. Comparative studies with other oil-dependent economies could provide further insights. In addition, more advanced econometric techniques such as threshold models, nonlinear panel approaches, and structural VAR models may better capture asymmetric responses. Sectoral-level analysis is also recommended to better understand the heterogeneous impact of oil shocks across different segments of the Iraqi economy.

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