The Asymmetric Impact of Oil Price Shocks on the Budget Deficit: Evidence from a Nonlinear Autoregressive Distributed Lag (NARDL) Model

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Abstract:

Fluctuations in oil prices present a significant challenge to fiscal stability in resource dependent emerging economies, as they directly influence fiscal policy and economic growth, while heightening the vulnerability of public finances—particularly in the face of recurring global shocks. In this context, the present study investigates the asymmetric effects of oil price shocks on Algeria's fiscal deficit, considering the country's status as a rentier state heavily reliant on hydrocarbon revenues. Employing the Nonlinear Autoregressive Distributed Lag (NARDL) model for the period 1990–2023, the analysis reveals that negative oil price shocks have a substantial long-term impact, significantly widening the fiscal deficit, whereas positive shocks exert a relatively weaker effect. In the short term, however, the effects are symmetric and statistically insignificant. These findings highlight the urgent need for structural reforms, revenue diversification, and strengthened fiscal resilience to mitigate the risks associated with global market volatility.

Keywords : Oil prices, budget deficit, asymmetric effects, NARDL.

1. Introduction:

Global oil markets play a pivotal role in shaping the world economy, marked by persistent price fluctuations influenced by shifts in supply and demand, as well as various geopolitical and economic factors. These price dynamics have a pronounced impact on oil-producing countries, exposing them to heightened vulnerability from oil price shocks. Such shocks are particularly evident during periods of extreme price volatility—often triggered by geopolitical tensions, such as the Russia-Ukraine conflict—which result in abrupt and sustained price changes with direct implications for economic growth and public finances in oil-dependent nations.

As a key export commodity, oil represents a primary revenue source for many governments, underpinning their fiscal policy frameworks. However, overreliance on oil revenues increases susceptibility to price and demand volatility in the global market. This dependence gives rise to the phenomenon known as the "resource curse," which describes the paradox whereby countries rich in natural resources, particularly developing ones, tend to experience slower economic growth. (Gelb et al, 2002) argue that oil-exporting countries often perform worse economically than resource-poor nations, a trend attributed to the "paradox of plenty," which hinders the effective utilization of abundant natural wealth.

Within this context, the budget deficit serves as a key indicator of fiscal sustainability, calculated as the gap between public revenues and government expenditures. In oil-exporting economies, oil price volatility directly affects the budget balance, as fiscal revenues are closely linked to oil income. Both positive and negative oil shocks exert significant pressure on the government's ability to align revenues with expenditures, highlighting the fiscal fragility of these states in the face of global market fluctuations.

Oil-dependent economies are particularly sensitive to changes in global oil prices, given oil's central role as an energy source and fiscal revenue stream. According to the International Monetary Fund (IMF, 2022), the primary fiscal balance is a crucial metric reflecting the government's fiscal stance and overall financial health. In this regard, poor resource governance, overdependence on external borrowing, and extreme oil price volatility have been identified as key contributors to persistent fiscal deficits in oil-exporting countries (Borozan & Marina, 2022).

In the long run, oil-reliant fiscal policies face structural challenges related to intergenerational equity and fiscal sustainability. In the short term, they grapple with issues of macroeconomic stability and effective financial planning (Sturm, Gurtner, & González, 2009). These ongoing challenges are underscored by several major global oil shocks that have significantly affected oil-exporting nations. One of the most notable was the dramatic decline in oil prices in 2014, when prices plummeted by over 50% within a short period—driven by factors such as the U.S. shale oil boom and OPEC's decision to maintain output levels despite falling demand.

The sharp decline in oil prices in 2014 had a profound impact on countries heavily dependent on hydrocarbon revenues, such as Algeria. This sudden drop led to a significant reduction in Algeria's oil income, severely constraining the government's ability to finance public expenditures. Given that oil and gas represent the primary sources of state revenue, the price collapse intensified the country's budget deficit, compelling the government to

draw on financial reserves to bridge the gap—thereby raising serious concerns about the long-term sustainability of public finances. This situation also magnified Algeria's broader economic vulnerabilities, as the national economy is structurally imbalanced due to its overwhelming reliance on the hydrocarbon sector, revealing a limited capacity to absorb external shocks from global oil markets.

In this context, the present study aims to examine the asymmetric effects of oil price shocks on Algeria's budget deficit over the period 1990 to 2023, utilizing the Nonlinear Autoregressive Distributed Lag (NARDL) model. This econometric approach is well-suited for capturing asymmetries in both the short- and long-term relationships between oil prices and fiscal outcomes. The objective is to deepen understanding of how fluctuations in oil prices influence Algeria's fiscal position and to explore the implications for fiscal sustainability in a resource-dependent economy.

The significance of this study lies in its focus on the fiscal vulnerabilities of an oil-dependent country, offering insights into the broader consequences of oil market volatility. The anticipated results are expected to support the formulation of more robust fiscal policies and provide practical recommendations aimed at improving public finance management in Algeria.

The study is structured as follows: Section 2 provides a review of the relevant literature. Section 3 analyzes trends in oil price fluctuations and their connection to Algeria's budget deficit. Section 4 outlines the data sources and describes the methodological framework employed in the empirical analysis. Section 5 presents the key findings, and Section 6 concludes with a summary of the results and policy recommendations derived from the study.

2. Literature Review:

The empirical literature examining the relationship between oil prices and fiscal indicators reveals diverse findings. While some studies show that rising oil prices positively influence fiscal balances, others report negative effects. Moreover, limited attention has been given to the asymmetric effects of oil price shocks on budget deficits, indicating the need for further research in this area.

For example, (Kazi et al, 2022) utilized a dynamic ARDL model to assess Russia's fiscal response to fluctuations in oil and gas prices between 2011 and 2021 using monthly data. Their results indicated a positive fiscal balance reaction to rising oil prices, whereas negative price shocks led to deteriorating fiscal outcomes—supporting the view that oil prices significantly shape fiscal performance in oil-exporting nations.

Similarly, (EL Mahmah & Kandil, 2019) found that oil price fluctuations strongly influence the fiscal balance of the United Arab Emirates (UAE). Rising oil prices contributed to budget surpluses, while declines reduced revenues faster than expenditures, resulting in deficits. An earlier study by the same authors (El Mahmah & Kandil, 2018), employing the GMM method, reinforced these conclusions—demonstrating that oil price increases boost government revenues and primary surpluses in oil-exporting countries. However, in emerging oil-importing nations, higher oil prices were associated with increased import and subsidy spending, ultimately reducing fiscal surpluses.

In contrast, some studies report adverse fiscal impacts from oil price increases. (Bash, 2015), using a VAR model to analyze Jordan's public budget, found that rising oil prices significantly widened the fiscal deficit due to the country's reliance on imported crude oil and petroleum products. Likewise, (Shaheen, 2021), using a TVAR model covering the period 1991–2019, observed that most oil-exporting countries—excluding Canada—experienced exacerbated fiscal deficits during oil price surges, indicating asymmetric fiscal responses to oil market volatility.(Festus Fatai et al, 2017) examined the link between oil rents and fiscal balances in oil-dependent economies from 2000 to 2015 using the GMM method. Their results showed a limited fiscal response to oil rent shocks, particularly in countries with established fiscal rules. Similarly, (Alley, 2016) highlighted that fiscal policies in oil-exporting nations are not strictly cyclical but are instead closely tied to oil price fluctuations, often showing a decline in primary balances in the short term. (Faheem et al, 2022) discussed the negative repercussions of oil price volatility on Saudi Arabia's fiscal and economic stability, emphasizing the urgency of adopting more diversified and sustainable fiscal policies. In the case of Oman, (Ali Ibrahim et al, 2019) used annual data from 1980–2016 and a VAR model to show that falling oil prices slowed revenue growth, while government spending remained high during certain periods.

Studies exploring asymmetric effects provide additional insights. (Adeniyi & Fagbemi, 2019), using the NARDL model, found that in Nigeria, fiscal performance indicators improved more when oil prices declined than when they rose. (Zulfigarov & Neuenkirch, 2020) also identified asymmetric impacts of oil prices on macroeconomic indicators. (Okoro, 2022) further explored these effects across African oil-exporting and oil-importing countries using a Panel ARDL framework.

(Babaji et al, 2023) studied the short-term asymmetric impacts of oil prices on Nigeria's fiscal position using ARDL and NARDL models. Their results showed that positive oil price shocks worsened fiscal balances, while negative shocks encouraged better fiscal performance.

Focusing on Algeria, (Boukhadouni et al, 2020) found that higher oil prices increased public revenues and reduced budget deficits, while falling prices had the opposite effect. (Hansal & Mizouri, 2022) corroborated these findings, emphasizing the direct influence of oil price shocks on Algeria's fiscal health. (Amirouche , Fayçal, & Alsamara, 2023) examined the asymmetric impact of oil price shocks on money demand in Algeria from 1999 to 2020 using the NARDL model. They found that oil price declines significantly reduced money demand in the short term, while long-term effects were predominantly driven by negative shocks. Similarly, (Attouchi, 2021), using the ARDL approach over the period 1970–2018, showed that oil prices positively affected inflation in Algeria and had a dampening effect on GDP in the long run, while their short-term impact was minimal. (sadiq & smail, 2022) analyzed the 2014 oil price shock's impact on Algeria's financial and monetary stability. They observed a reduction in foreign reserves, currency depreciation, and rising inflation, revealing the economy's vulnerability to external shocks. The authors stressed the need to diversify Algeria's revenue sources. This conclusion aligns with (moghrabi & younsi, 2021), who emphasized the structural nature of Algeria's economic crisis and called for urgent diversification and a more favorable investment environment.

In contrast, studies from oil-importing countries offer a different perspective. (Nour , Noura, & Abbas , 2024) identified an asymmetric cointegrating relationship between oil prices and GDP in Lebanon (1988–2021), where oil price declines spurred economic growth, but increases had no significant impact. (Kriskkumar, Mohd Naseem, & Wan Azman-Sa, 2022) reported similar findings for Malaysia, emphasizing the importance of diversifying the economic base. (Babatunde & Yang, 2024) applied a DSGE model with regime switching to assess oil shocks' impacts on Nigeria. Their findings indicated that economic responses to oil shocks vary over time and depend on changes in monetary policy frameworks. Likewise, Agboola, (Agboola, Chowdhury, & Yang, 2024), using nonlinear models, analyzed oil shocks in emerging oil exporters. They found that the impact depends on the type and intensity of the shock as well as the country's institutional context, advocating for counter-cyclical policy measures.

Additional studies confirm the influence of oil prices on fiscal performance. (Sadeghi, 2017) found that rising oil prices increase government spending and contribute to economic stability in oil-rich nations. (Shamon, 2015) highlighted the impact of oil price fluctuations on Saudi Arabia’s fiscal balance relative to GDP, emphasizing revenue diversification as essential for long-term sustainability. (Adedo kun, 2018) concluded that oil price shocks significantly affect both government revenues and expenditures in Nigeria, supporting the fiscal synchronization hypothesis in the short term and the tax-spend hypothesis in the long term.

In summary, while the literature provides substantial evidence on the relationship between oil prices and fiscal outcomes, studies focusing on asymmetric impacts remain limited. Much of the existing research either addresses symmetric relationships or examines broader macroeconomic effects. Despite being one of Africa’s largest oil producers, Algeria has not been sufficiently studied in this context. Given that oil price effects can be either positive or negative, and symmetric or asymmetric, further research is essential. This study aims to fill part of this gap by deepening the understanding of how oil price shocks influence fiscal conditions in Algeria.

3. Oil Price Fluctuations and Budget Deficits in Algeria

The graph illustrates the strong correlation between oil prices and Algeria’s fiscal balance (expressed as a percentage of GDP) over the period from 1990 to 2023. It clearly demonstrates Algeria’s heavy dependence on oil revenues, as fluctuations in the fiscal balance closely mirror changes in global oil prices.

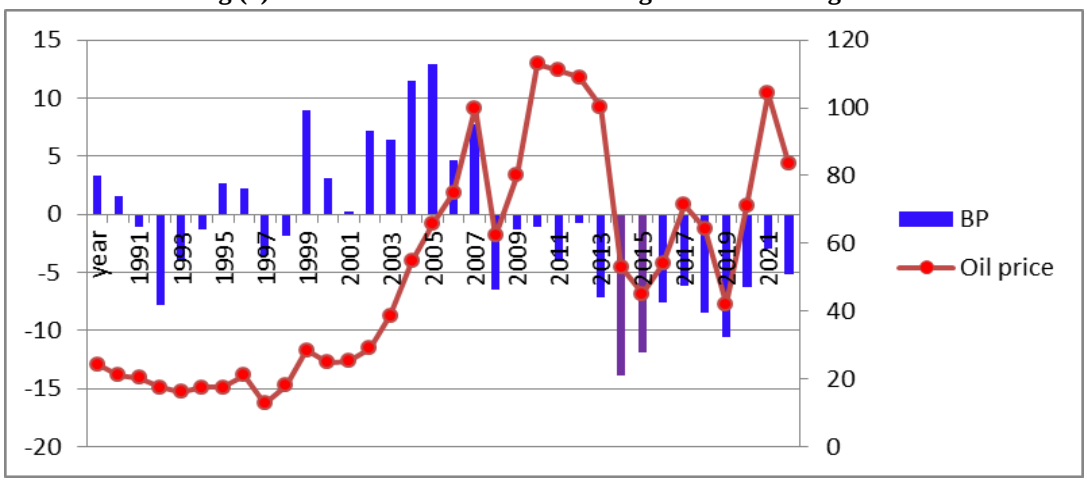
During the 1990s, oil prices experienced a prolonged decline, resulting in a persistent and substantial budget deficit. This was primarily due to reduced oil revenues, which represent the main source of government financing. The lack of alternative revenue streams further exacerbated fiscal imbalances during this period.

In contrast, between 2000 and 2008, oil prices rose sharply, driven by increasing global demand. This surge in prices led to significant improvements in Algeria’s fiscal balance, with the country recording notable budget surpluses. This period highlights the direct link between oil price trends and fiscal outcomes, underlining the limited diversification of government income sources.

However, beginning in 2014, oil prices fell dramatically due to rising global supply and conomic slowdowns in major consuming countries. This downturn triggered a sharp fiscal deterioration in Algeria, pushing the budget balance back into a substantial deficit.

This pattern underscores the Algerian economy's acute vulnerability to external shocks stemming from oil market volatility. The continued reliance on hydrocarbon revenues, combined with a lack of economic diversification, has made public finances highly susceptible to global price fluctuations. These developments highlight the urgent need for structural reforms aimed at building a more resilient and diversified economy. To enhance fiscal stability and reduce reliance on oil, it is essential for Algeria to implement more flexible and diversified fiscal policies and to invest in the development of non-oil sectors such as industry and agriculture.

Fig (1): Oil Price Fluctuations and Budget Deficits in Algeria.



Source: Prepared by the researcher

4. Data and Methodology

4.1. Data

The primary objective of this study is to investigate the asymmetric impact of oil price shocks on Algeria's budget deficit over the period 1990–2023. To achieve this, annual data were collected on key macroeconomic indicators. The dependent variable is the budget balance as a percentage of GDP (BP), which serves as a proxy for the fiscal deficit. The study also includes the exchange rate (EX), inflation rate (INF), and oil prices (Oil) in U.S. dollars as explanatory variables.

Data on the budget balance, exchange rates, and inflation rates were obtained from the World Bank database, while oil price data were sourced from OPEC. Table 1 provides a summary of the variables included in the analysis, along with their abbreviations and data sources.

Tab (1): Description of data

Indicator	Abbreviation	Description	Source
Government Budget deficit	BP	Government Budget Deficit as a percentage of GDP	WDI
Exchange Rate	EX	Real Exchange Rate	WDI
Inflation	INF	Inflation Rate	WDI
Oil Price	OIL	Oil Prices in US Dollars	OPEC

Source: Prepared by the researcher

4.2. Methodology

This study employs the Nonlinear Autoregressive Distributed Lag (NARDL) model, developed by (Shin et al, 2014), to examine the hypothesis of a nonlinear relationship between oil prices and Algeria's budget deficit in both the short and long run.

The NARDL model is an extension of the traditional Autoregressive Distributed Lag (ARDL) approach proposed by (Pesaran et al, 2001). Unlike the linear ARDL model, the NARDL framework allows for the detection of asymmetric effects, meaning it can differentiate between the impacts of increases and decreases in the independent variable—here, oil prices—on the dependent variable, the budget deficit. This feature is particularly useful when analyzing economic relationships that may not respond symmetrically to positive and negative shocks.

One of the key strengths of the NARDL model is its ability to estimate both short-run and long-run dynamics within a single unified framework, offering greater flexibility compared to other nonlinear cointegration techniques. Additionally, the model is well-suited for small sample sizes and can be applied when the underlying variables are either stationary at level (I(0)), first-difference stationary (I(1)), or a combination of both, provided none is integrated of order two or higher (Kashif et al, 2023).

To capture asymmetric effects, (Shin et al, 2014) proposed decomposing the independent variable—in this case, oil prices—into two partial sum components that separately account for positive and negative changes. In this study, oil price movements are modeled using the following decomposition:

$$OIL_t = OIL_0 + OIL_t^+ + OIL_t^-$$

Where OIL_t^+ and OIL_t^- represent the partial sums that reflect the increases and decreases in oil prices, and are expressed as follows:

$$OIL_t^+ = \sum_{i=1}^{t} \Delta OIL_i^+ = \sum_{i=1}^{t} \max(\Delta OIL_i' 0)$$

$$OIL_t^- = \sum_{i=1}^{t} \Delta OIL_i^- = \sum_{i=1}^{t} \min(\Delta OIL_i' 0)$$

Where $\Delta OIL_i = OIL_t + OIL_{t-1}$, we reconstruct the NARDL model according to the following equation:

$$\Delta BP_t = \alpha + \sum_{i=1}^{n1} \emptyset_{1i} \Delta BP_{t-i} + \sum_{i=0}^{n2} \emptyset_{2i} \Delta EX_{t-i} + \sum_{i=0}^{n3} \emptyset_{3i} \Delta INF_{t-i} + \sum_{i=0}^{n4} \emptyset_{4i}^{+} \Delta OIL_{t-i}^{+} + \sum_{i=0}^{n4} \emptyset_{4i}^{-} \Delta OIL_{t-i}^{-} + \theta_1 BP_{t-1} + \theta_2 EX_{t-1} + \theta_3 INF_{t-1} + \theta_4^{+} OIL_{t-1}^{+} + \theta_4^{-} OIL_{t-1}^{-} + \varepsilon_t$$

Long-term and short-term asymmetry can be tested using the Wald test. For the long term, the null hypothesis is $\theta_4^- = \theta_4^+$. A significant difference between these two values indicates the presence of an asymmetric relationship in the long term. Similarly, $\emptyset_4^- = \emptyset_4^+$ implies the absence of asymmetry in the short term. Furthermore, the existence of cointegration can be assessed using the bounds test, where the null hypothesis ($\theta_1 = \theta_2 = \theta_3 = \theta_4^- = \theta_4^+$) suggests the absence of cointegration.

The scatterplot matrix of relationships between the variables (Figure. 2) shows that BP is negatively correlated with EX (-0.3924), INF (-0.42127), and OIL (-0.10482), with statistically significant relationships at the 1% level for EX and INF. However, the relationship between BP and OIL, though negative, is not statistically significant. These distributional characteristics, along with skewness and kurtosis values deviating from the normal value of 3, suggest the potential presence of asymmetry and nonlinearity in the data. Therefore, the NARDL model is deemed appropriate for capturing the asymmetric effects of oil price changes on the budget balance.

5. Results and Discussion

5.1. Descriptive Statistics of Study Variables

The descriptive statistics offer a comprehensive overview of the distributional properties of the key variables analyzed in this study: budget balance as a percentage of GDP (BP), exchange rate (EX), inflation rate (INF), and oil prices (OIL).

The BP variable exhibits a mean value of -1.206, indicating an overall budget deficit during the sample period. Its standard deviation of 6.587 reflects moderate variability around this average. The skewness of BP is 0.2561, suggesting a slight positive skewness, while the kurtosis value of 2.4654, being less than the normal distribution benchmark of 3, indicates a platykurtic distribution—characterized by a flatter peak and lighter tails.

The EX-variable, representing the exchange rate, has a mean of 76.7264 and displays the greatest dispersion among the variables, with a standard deviation of 33.8944. The skewness is close to zero (0.0696), implying an approximately symmetric distribution. The kurtosis of 2.6242, slightly below 3, indicates that the distribution is nearly normal but marginally flatter in its peak.

For INF, the inflation rate, the mean is 8.6026 with a standard deviation of 8.8985, revealing considerable variation over the period. The skewness is notably positive at 1.5368, indicating a pronounced right tail, which is likely attributable to episodes of elevated inflation. The kurtosis of 4.0079 exceeds 3, pointing to a leptokurtic distribution, which is marked by heavier tails and a sharper peak compared to the normal distribution.

Regarding OIL, the oil price variable, the mean is 52.7026 with a standard deviation of 32.7508, suggesting moderate variability. Its skewness of 0.4756 indicates a mild positive skewness, while the kurtosis of 2.4756, less than 3, suggests a platykurtic distribution similar to that observed for the budget balance variable.

Tab (2): Descriptive Statistics

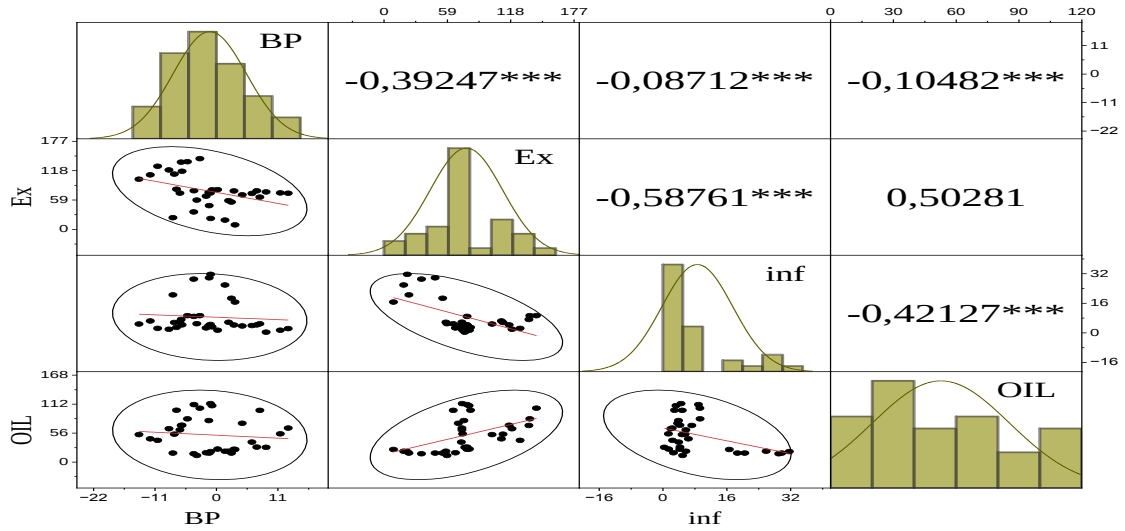
	BP	EX	INF	OIL
Mean	-1.206	76.7264	8.6026	52.7026
Maximum	12.869	141.9949	31.6696	112.94
Minimum	-13.879	8.9575	0.3391	12.85
Std. Dev.	6.58719	33.8944	8.8985	32.7508
Skewness	0.2561	0.0696	1.5368	0.4756
Kurtosis	2.4654	2.6242	4.0079	0.4756
Observations	34	34	34	34

Source: Prepared by the researcher using Eviews 13

The scatterplot matrix illustrating the relationships among the variables (Figure 2) reveals that the budget balance (BP) is negatively correlated with the exchange rate (EX) at -0.3924, inflation rate (INF) at -0.42127, and oil prices (OIL) at -0.10482. The correlations between BP and both EX and INF are statistically significant at the 1% level, whereas the negative correlation between BP and OIL is not statistically significant.

These observed distributional features, combined with skewness and kurtosis values that diverge from the normal benchmark of 3, indicate the likely presence of asymmetry and nonlinear relationships within the dataset. Consequently, the application of the NARDL model is well justified, as it effectively captures the asymmetric impacts of oil price fluctuations on Algeria's budget balance.

Fig (2): Scatter plot and data distribution visualizations



Source: Prepared by the researcher using Origin

5.2. Nonlinearity Test

The results of the BDS test proposed by (Brock et al, 1996), as illustrated in Table 3, indicate that for all the studied variables and across various dimensions, the null hypothesis of the BDS test is rejected. This confirms the presence of nonlinearity in the time series. The rejection of linear dependence suggests that the relationship is nonlinear, thereby

supporting the use of nonlinear models. Consequently, this result provides strong evidence of nonlinearity in the relationship between the study variables.

Tab (3): Nonlinearity BDS test results

Variables	***Dimensions***				
	M = 2	***M = 3***	***M = 4***	***M = 5***	***M = 6***
BP	0.065370***	0.089520***	0.093104***	0.073554***	0.042945**
EX	0.165113***	0.253885***	0.291611***	0.329435***	0.372451***
INF	0.167954***	0.313367***	0.408510***	0.463596***	0.497262***
OIL	0.083932***	0.115921***	0.155326***	0.198449***	0.225054***

*Notes: ***, **, and * represent statistical significance at the 1%, 5%, and 10% levels, respectively. These significant levels are determined by rejecting the null hypothesis of linearity at the corresponding levels*.

Source: Prepared by the researcher using Eviews 13

5.3. Unit Root Tests

Testing the stationarity of time series is a necessary condition for cointegration. To correctly apply the (NARDL) model, all study variables must be integrated of order I(0) or I(1), meaning there should be no variables integrated of higher orders.

Table (4): Results of the unit root testing using PP and ADF

Variables	***PP Test***		***ADF Test***	
	Level	***First Difference***	***Level***	***First Difference***
BP	*-2.1891***	*-7.5374****	*-2.2838***	*-6.9510****
EX	*2.2704*	*-3.1882****	*2.9632*	*-3.2658****
INF	*-1.4268*	*-5.7529****	*-1.4133*	*-5.7529****
OIL	*-0.1217*	*-5.4044****	*-0.2863*	*-5.3823****

Note: (*) Significant at the 10%; (**) Significant at the 5%; (***) Significant at the 1%.

Source: Prepared by the researcher using Eviews 13

Structural breaks caused by adverse events can profoundly impact the stability of economic indicators and variables, making it essential to account for them to ensure the robustness and accuracy of empirical analyses. To this end, unit root tests such as the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests were conducted, alongside structural break tests following the methodology of (Zivot & Andrews, 2002). While conventional unit root tests assess the overall stationarity of the variables, structural break tests specifically identify the timing of any breaks that may correspond to long-lasting or permanent economic shocks.

The results summarized in Table 4, together with those of the Zivot and Andrews test in Table 5, confirm that none of the examined time series are integrated of order two, I(2). This finding validates the suitability of employing cointegration tests to explore the existence of long-term equilibrium relationships among the variables.

Tab (5): Structural break unit root test

Variables	***Level***		***First Difference***	
	T-statistics	***Break-point***	***T-statistics***	***Break-point***
BP	*-4.9991****	*2009*	*-7.6530***	*2007*
EX	*-2.6564***	*2003*	*-5.0306****	*2015*
INF	*-4.5140*	*2000*	*-6.0073***	*2009*
OIL	*-4.3022****	*2015*	*-7.7865****	*2014*

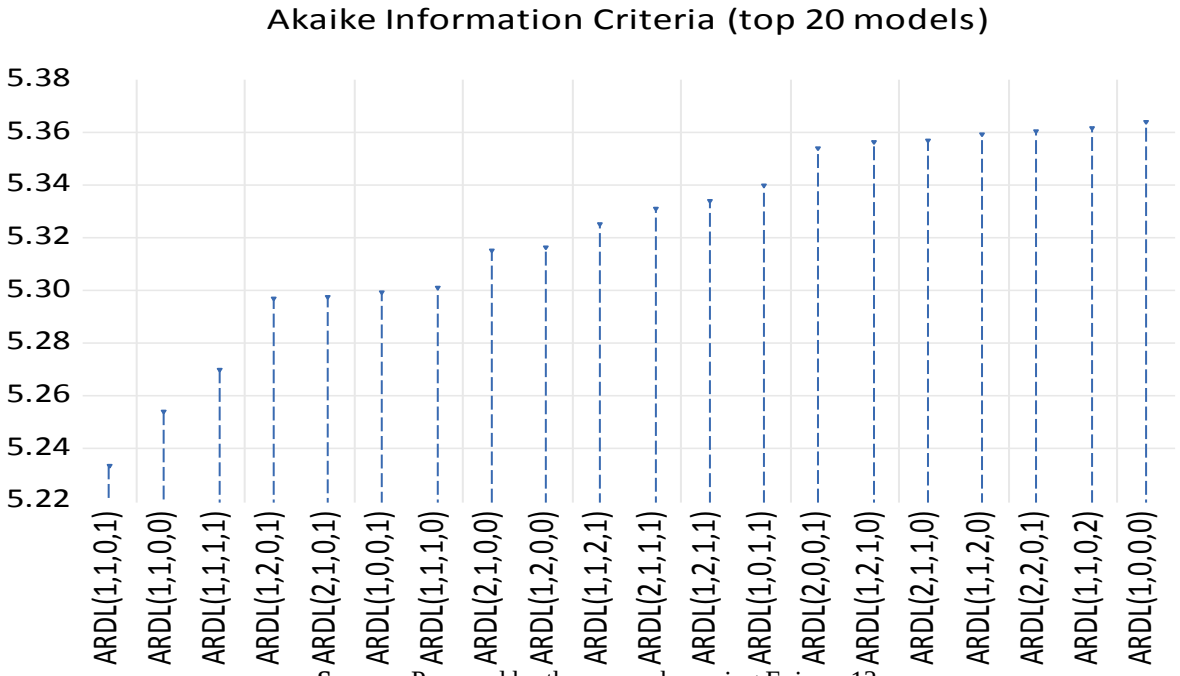
Note: (*) Significant at the 10%; (**) Significant at the 5%; (***) Significant at the 1%.

Source: Prepared by the researcher using Eviews 13

5.4. Cointegration Test

To test the cointegration relationship among the study variables, it is necessary to estimate the (NARDL) model. The (AIC) criterion was used to determine the optimal lag lengths, where the appropriate model is the one that yields the lowest value for this criterion. The selected model in this study, as shown in Figure (03), is of the form NARDL(1,1,0,1).

Fig (3): Lag length selection



Source: Prepared by the researcher using Eviews 13

From Table (02), which presents the results of the Bounds Test, it is evident that the calculated F-statistic value is 5.3910, which exceeds the upper critical value at the 1%, 5%, and 10% significance levels. Consequently, the alternative hypothesis indicating the existence of a long-term equilibrium relationship among the study variables will be accepted.

Tab (6): Bounds tests for asymmetric cointegration.

Test Statistic	***Value***	***Significant Level***	***I(0)***	***I(1)***
F-statistic	*5.3910****	*10%*	*2.450*	*3.520*
K	*4*	*5%*	*2.860*	*4.010*
		1%	*3.740*	*5.060*

Note: *** indicates the 1% significance level.

Source: Prepared by the researcher using Eviews 13

5.5. Wald Test

The null hypothesis in this approach states that the effect of negative values of the independent variable is symmetric to the effect of its positive values, meaning that the mechanism of the independent variable's impact on the dependent variable when it increases is similar to its impact when it decreases. Conversely, the alternative hypothesis suggests that the impact mechanism differs when the behavior of the independent variables changes over time. The table below presents the results of the asymmetry test.

Tab (7): Results of asymmetry tests.

Null hypothesis: Coefficient is symmetric			
Variable	*Statistic*	*Value*	*Probability*
Long-run			
OIL	*F-statistic*	*14.7812*	*(0.0008)****
	Chi-square	*14.7812*	*(0.0001)****
Short-run			
OIL	*F-statistic*	*0.41481*	*(0.5259)*
	Chi-square	*0.41481*	*(0.5195)*
Joint (Long-Run and Short-Run)			
OIL	*F-statistic*	*7.9944*	*(0.0023)****
	Chi-square	*15.9889*	*(0.0003)****

Note: (*) Significant at the 10%; (**) Significant at the 5%; (***) Significant at the 1%.
Source: Prepared by the researcher using Eviews 13

The findings reveal that oil prices influence Algeria's budget deficit differently over the short and long term. Specifically, the long-term effect of oil prices is asymmetric and highly significant, as evidenced by an F-statistic of 14.7812 ($p < 0.01$), indicating a pronounced and uneven impact. Conversely, in the short term, the effect appears symmetric and statistically insignificant, with an F-statistic of 0.41481 ($p > 0.05$). When considering the combined short- and long-term effects, the results remain statistically significant (F-statistic = 7.9944, $p < 0.01$), underscoring the distinct overall influence of oil price fluctuations on the budget. Given these outcomes, the analysis will primarily concentrate on the long-term effects of oil prices, due to their statistical significance and critical role in explaining Algeria's fiscal performance.

5.6. Diagnostics test results

After estimating the model, it is essential to conduct a set of diagnostic tests to verify the presence of any standard issues that may affect the strength and validity of the estimated model. The following table presents the results of the diagnostic tests:

Tab (8): Results of diagnostics tests of the estimated model

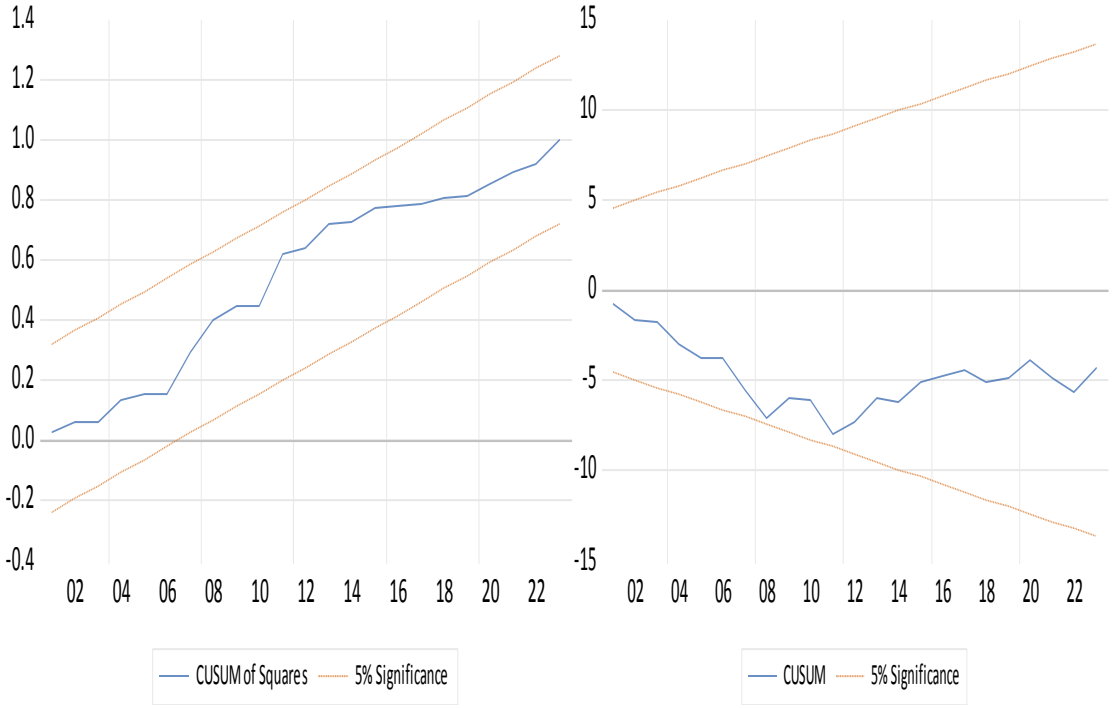
Test description	***Test Statistics***	***Prob-value***	***Decision***
Serial Correlation (LM test)	*1.9242*	*0.1709*	*Absence of autocorrelation.*
Heteroskedasticity (Breusch-Pagan-Godfrey)	*1.4926*	*0.2140*	*Absence of Heteroscedasticity.*
Normality (Jarque-Bera)	*2.2400*	*0.3262*	*Normality of the data distribution*
Ramsey RESET Test	*0.1582*	*0.6946*	*The specification is consistent.*
CUSUM	-		*Stability Verified (see Fig. 4)*
CUSUM sq	-		

Source: Prepared by the researcher using Eviews 13

The results of the diagnostic tests demonstrate that the estimated model possesses robust statistical properties. The LM test yielded a p-value of 0.1709, exceeding the 0.05 threshold, thereby supporting the null hypothesis of no autocorrelation in the residuals. Likewise, the Breusch-Pagan-Godfrey test reported a p-value of 0.2140, also above 0.05, indicating the absence of heteroscedasticity. The Jarque-Bera test confirmed that the

residuals are normally distributed at the 5% significance level, accepting the null hypothesis. Additionally, the Ramsey RESET test validated the functional form of the model, with a p-value of 0.6946, suggesting no specification errors. Structural stability tests, including CUSUM and CUSUMSQ, showed that the model remains within the critical bounds at the 5% significance level, reflecting its stability over time. Overall, these findings confirm that the model is structurally stable and statistically sound, which strengthens its reliability.

Fig (4): Result for model stability test



Source: Prepared by the researcher using Eviews 13

5.7. Short-run results of NARDL model

The short-term relationship is represented by estimating the error correction model. Table (9) presents the results of the short-term estimation of the study model.

Tab (9): Short-run results of NARDL model (dependent variable: BP)

Variable	Coefficient	Std. Error	T Statistic	Prob.
COINTEQ*	-0.8953***	0.1591	-5.6252	0.0000
D(EX)	0.0408	0.1072	0.3809	0.7062
@DCUMDP(OIL)	0.1501***	0.0509	2.9482	0.0065
@DCUMDN(OIL)	0.2278***	0.0516	4.4104	0.0001
C	-16.1708***	2.8508	-5.6722	0.0000

Note: (*) Significant at the 10%; (**) Significant at the 5%; (***) Significant at the 1%.
Source: Prepared by the researcher using Eviews 13

The table reveals that the error correction term, CointEq(-1), carries a negative and statistically significant coefficient of -0.8953, confirming the presence of a long-term equilibrium relationship among the variables studied. This coefficient suggests that about 89% of any short-term deviation in the budget deficit from the previous period is adjusted

in the current period, moving the system back toward long-term equilibrium following shocks or changes in the explanatory variables.

Regarding the independent variables, positive shocks in oil prices (@DCUMDP(OIL)) have a positive and statistically significant effect on the budget deficit, with a coefficient of 0.1501 at the 1% significance level. Conversely, negative shocks (@DCUMDN(OIL)) exert a larger influence, with a coefficient of 0.2278, also significant at the 1% level. These findings indicate that the budget deficit is more sensitive to decreases in oil prices than to increases. In contrast, the exchange rate (EX) does not exhibit a statistically significant short-term effect on the budget deficit, as indicated by a p-value of 0.7062. Therefore, it is evident that oil prices are a key determinant of the short-term budget deficit, whereas the exchange rate's short-term impact appears negligible.

5.8. Long-run results of NARDL model

The previous results confirmed the existence of cointegration among the study variables. The following table presents the results of estimating the long-term equilibrium relationship for the NARDL(1,1,0,1) model.

Tab (10): Long-run results of NARDL model (dependent variable: BP)

	Long Run Coefficients			
Variable	***Coefficient***	***Std. Error***	***t-Statistic***	***Prob.***
EX	0.3625***	0.0837	4.3317	0.0002
INF	0.2468	0.1266	1.9488	0.0614
@CUMDP(OIL)	0.0187	0.0271	0.6916	0.4948
@CUMDN(OIL)	0.2766***	0.0591	4.6808	0.0001

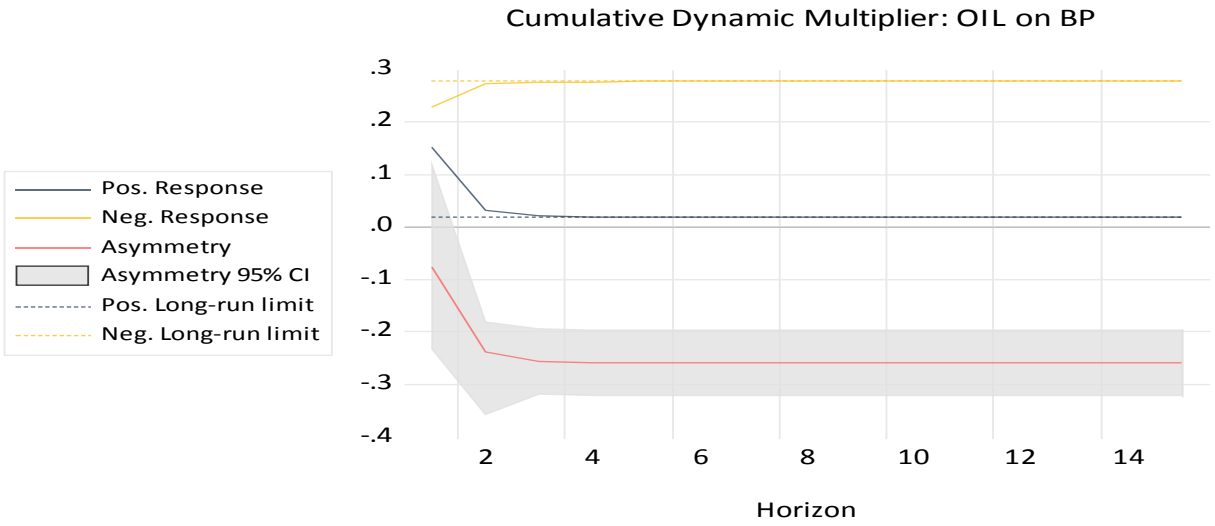
Note: (**) Significant at the 5%; (***) Significant at the 1%.
Source: Prepared by the researcher using Eviews 13

The estimation results presented in Table (10) reveal that the exchange rate (EX) has a positive and statistically significant long-term effect on the budget deficit, indicating its strong influence over time. The inflation rate (INF) also positively impacts the budget deficit, though its effect is only statistically significant at the 10% level, suggesting a modest but noticeable influence. In contrast, positive oil price shocks do not show a statistically significant impact on the budget deficit, as indicated by an insignificant p-value, implying these shocks do not substantially affect fiscal outcomes. However, negative shocks in oil prices have a pronounced and statistically significant negative effect on the budget, with decreases in oil prices worsening the budget deficit by 0.2766%. These findings highlight that declines in oil prices critically affect Algeria's budget deficit, whereas positive oil price changes and inflation have limited or no significant effects. Consequently, it is advisable for Algeria to diversify its government revenue streams to lessen dependency on oil and to improve the management of oil revenues during price upswings to ensure sustainable fiscal health in the long run.

5.9. Analysis of Cumulative Effects of Positive and Negative Oil Shocks on the Budget Deficit

The graph demonstrates that oil price shocks have an asymmetric impact on the budget deficit. Negative shocks, or declines in oil prices, cause a significant and swift deterioration in the fiscal balance, which then stabilizes at a low level over the long term. Conversely, positive shocks, or increases in oil prices, produce a weak and unsustainable effect, with the budget response leveling off close to zero. This pattern reflects the rigidity of fiscal policy in effectively utilizing surpluses from rising oil prices, underscoring the urgent need to enhance oil revenue management and diversify government income sources to improve fiscal sustainability.

Fig (5): The cumulative effects of positive and negative oil shocks on BP



Source: Prepared by the researcher using Eviews 13

6. Conclusion:

This study analyzed the asymmetric impact of oil price shocks on Algeria's fiscal balance deficit over the period 1990–2023, using the Nonlinear Autoregressive Distributed Lag (NARDL) model developed by Shin et al. (2014). The findings reveal a significant difference in the relationship between oil prices and the fiscal deficit over the short and long term. In the long run, the relationship is asymmetric and statistically significant, with oil price declines having a stronger and more lasting effect on the fiscal deficit than price increases. Conversely, in the short term, the relationship is symmetric and statistically insignificant, indicating relative stability in immediate fiscal responses.

The results show that negative oil price shocks impose a greater and more persistent burden on the fiscal balance, causing rapid deterioration that stabilizes at low levels over time, while positive price changes exert limited and unsustainable effects. These outcomes underscore Algeria's limited fiscal policy flexibility to efficiently manage oil revenue surpluses and highlight the urgent need to improve revenue management and diversify income sources to support fiscal sustainability.

Accordingly, the study recommends enhancing the effective use of surplus revenues during periods of high oil prices by adopting prudent and sustainable fiscal policies. It also emphasizes reducing excessive dependence on oil revenues by fostering the development of non-oil sectors and increasing their contribution to GDP. Moreover, establishing sovereign wealth funds managed with transparency is crucial for investing surpluses to maintain fiscal stability and cushion against oil price volatility.

Finally, improving fiscal policy flexibility through adaptable public expenditure frameworks and sound public debt management is vital for responding swiftly to oil shocks. These measures will help mitigate adverse impacts on the fiscal deficit and strengthen macroeconomic stability. Overall, the recommendations stress the importance of balanced and diversified fiscal policies to promote economic growth and financial resilience amid global market fluctuations.

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