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EXAMINING THE VOLATILITY OF OIL REVENUE AND ITS IMPACT ON ALGERIA'S MACROECONOMIC STABILITY

Brahim Bouyacoub

University of Oran 2 Mohamed Ben Ahmed, Oran, Algeria
e-mail: brahim.bouyacoub@univ-oran2.dz
ORCID: 0000-0002-0834-9560

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Abstract

Research background: Algeria heavily relies on its oil revenues, being one of the leading crude oil producers in Africa and a key member of OPEC. This dependency exposes its economy to the volatility of oil prices in international markets, which can have significant repercussions on its macroeconomic stability. Understanding these challenges and analyzing their impacts are essential for formulating appropriate public policies.
Purpose: The main objective of this study is to understand the impact of oil revenue volatility on Algeria's macroeconomic stability from 1980 to 2023 and to formulate policy recommendations to mitigate the risks associated with this volatility.
Research methodology: We will examine the long-term implications of an oil revenue volatility analysis on Algeria's macroeconomic stability using the ARDL modeling method. By understanding this correlation, we aim to propose recommendations to promote more stable and sustainable economic management for the country.
Results: The results have revealed significant long-term relationships between various variables, including oil prices, oil revenues, oil production, as well as fiscal and budgetary policies, particularly public expenditures. The findings suggest that higher oil prices have a negative impact on oil revenue volatility, indicating a trend towards revenue stabilization when prices increase. However, an increase in oil production is associated with an increase in revenue volatility. Additionally, stricter fiscal and budgetary policies seem to contribute to stabilizing oil revenues. These conclusions underscore Algeria's strong dependence on oil revenues, with the hydrocarbon sector playing a central role in its economy.
Novelty: This study proposes an innovative approach to thoroughly examine the impact of oil revenue volatility on Algeria's macroeconomic stability over the period 1980-2023, using the empirical ARDL model. These findings can provide valuable insights for policymakers and researchers who are interested in oil-dependent economies.

Keywords: Algeria, Oil revenue volatility, Macroeconomic stability, ARDL modeling method, oil production

JEL classification: C32, E23, E24

Introduction

The hydrocarbon sector plays a crucial role in the Algerian economy, given its dominance in exports and its significant influence on public finances, which are largely dependent on oil revenues. This debate on the importance of hydrocarbons and their economic impact in Algeria has sparked keen political interest, highlighting their crucial role. Therefore, in-depth research on this topic has been undertaken, particularly due to the volatility of oil revenues and its implications for macroeconomic stability. Hydrocarbon revenues are essential for state revenues, primarily through oil taxation, which accounted for 96% of total exports in 2023. Over the past two decades, Algeria has maintained some macroeconomic stability through the implementation of economic recovery programs based on successive public investments, in a Keynesian-like perspective. These plans aim to stimulate economic growth, notably by leveraging the increase in oil barrel prices, resulting in increased exports, mainly composed of hydrocarbons. Additionally, Algeria has benefited from significant expansion in the hydrocarbon sector, promoting its economic and social development. This growth facilitated the repayment of multilateral debt in 2008 and investment in essential infrastructure for economic growth. Social policies have also been implemented to reduce poverty and improve human development indicators, although challenges remain (Bouyacoub, 2018).

From 2010 until December 2023, the production and export of hydrocarbons maintained a central position, representing 21% of the Gross Domestic Product (GDP), 94.50% of merchandise exports, and 40% of budgetary revenues. The sustained increase in oil prices in the global market over the last decade has allowed Algeria to improve its financial and macroeconomic indicators. As a result of the significant oil and gas revenues, Algeria currently displays a trade surplus. Real GDP has increased due to higher oil revenues and increased government spending. Although growth prospects are encouraging and economic indicators are satisfactory, revenues are subject to fluctuations in oil and gas prices.

In 2019, the COVID-19 pandemic was considered a “black swan” event (Nicola et al., 2020). In addition to its devastating health effects, it led to a severe economic recession and social instability on a global scale (Laing, 2020). All productive sectors were affected by the lockdown measures imposed by authorities to contain the spread of the virus, resulting in a drastic drop in demand (Bourghelle, Jawadi, Rozin, 2021). The sudden decline in oil prices, due to the slowdown in global economic activity, significantly disrupted the financial situation and reinforced economic instability in Algeria. The country, heavily reliant on the hydrocarbon sector both economically and financially, faces the challenge of managing the repercussions

of short- and medium-term fluctuations in the global oil market. In the long term, the COVID-19 pandemic accentuates uncertainty regarding the future evolution of the global hydrocarbon market (Sheng et al., 2023).

In 2023, Algeria experienced a notable economic recovery driven by increased hydrocarbon production, following the COVID-19 induced recession. The GDP expanded by 3.55%, rebounding from a 5.1% contraction in 2020. However, growth decelerated in the first nine months of 2022 due to reduced crude oil and natural gas output as a post-COVID rebound. Despite this, non-hydrocarbon GDP growth was bolstered by private consumption and lower imports. Algeria positioned itself as a viable alternative to Russian gas for Europe, meeting 11% of their needs with potential for further growth, as evidenced by a recent gas export agreement with Italy. The Ukraine situation and rising hydrocarbon prices, although detrimental to some, present opportunities for Algeria, a leading gas exporter, offering additional revenue to support its economy. Algerian Energy Minister Mohamed Arkab reported oil production surpassing 942 thousand barrels per day since October 2021, signaling a recovery from previous production constraints. Against this backdrop, the paper aims to analyze the impact of oil revenue volatility on Algeria's macroeconomic stability and assess the influence of oil prices, production, fiscal, and budgetary policies on revenue volatility using the ARDL model as an empirical methodology (Sid Abdellaoui, 2022).

The central issue of our study is thus formulated as follows: How does oil revenue volatility impact Algeria's macroeconomic stability, and what economic and political measures can be envisaged to manage this volatility and ensure sustainable economic growth in the country? To answer this question, we have adopted an empirical approach based on ARDL modeling.

Our study is structured as follows: The first section will involve an exploration of the existing literature on oil-dependent economies, offering valuable insights into the complex dynamics that characterize them. The second part will provide a detailed exposition of the econometric methodology we have employed to evaluate the impact of oil revenue volatility on the macroeconomic stability of Algeria. We will also analyze various economic and policy strategies that could be implemented to manage this volatility and foster sustainable economic growth. Finally, the third part will focus on presenting the results of our econometric analysis, based on the ARDL model.

1. Literature review

The studies presented here provide valuable insights into the complex dynamics of oil-dependent economies, particularly in regions such as Nigeria, Algeria, and South Asia. In the face of crude oil price fluctuations, these economies encounter numerous challenges, ranging from inflation and economic growth to public spending and institutional quality. By employing various econometric models and analytical techniques, researchers examine the intricate relationships between oil price fluctuations, macroeconomic indicators, government policies, and institutional factors.

In this regard, the study by Joseph Ayoola Omojolaibi (2013), titled The Impact of Oil Price Fluctuations on the Nigerian Economy: A Structural Vector Autoregressive Approach, employs the SVAR (Structural Vector Autoregressive) model to analyze the effects of oil price fluctuations on the Nigerian economy. Nigeria, whose revenues rely heavily on oil exports, is particularly vulnerable to external shocks caused by oil price volatility. The study investigates the dynamic interactions between oil prices, domestic policies, inflation, and economic output (GDP). The findings reveal that positive oil price shocks stimulate economic growth, while negative shocks lead to economic contractions. However, the impact of oil price fluctuations on inflation depends significantly on domestic policies, particularly fiscal and monetary measures. Omojolaibi underscores the importance of well-designed economic policies, such as building fiscal reserves during periods of rising oil prices, to mitigate the adverse effects of oil shocks. He also advocates for economic diversification to reduce oil dependency by developing sectors such as agriculture, manufacturing, and services. Furthermore, the study emphasizes the need to strengthen institutions to improve governance and the management of oil revenues, which is crucial for ensuring long-term economic stability. These findings align with the broader literature on the "resource curse" (Sachs and Warner, 1995) and the macroeconomic effects of oil shocks (Hamilton, 1983), providing valuable insights for policymakers in resource-dependent economies.

Chekouri and Chibi (2016) delve into the dynamics of economic growth in Algeria, highlighting the dual nature of oil abundance as both a blessing and a curse. By examining the correlation between oil revenues, economic growth, and institutional quality, they underscore the need for economic diversification and institutional improvement to maximize the benefits of natural resources.

Okunoye and Hammed focus on Nigeria's policy response to structural shocks in oil prices, revealing significant impacts on monetary and fiscal variables. Their findings underscore

the importance of policy coordination and alignment to stabilize the economy and mitigate the adverse effects of oil price fluctuations (Okunoye, Hammed, 2020).

Studies by Pazouki and Zhu highlight the nexus between democracy, government spending, and oil dependency volatility in oil-exporting countries. Through a Panel Vector Autoregression (PVAR) model, they uncover the differential responses of democratic and non-democratic countries to oil volatility, emphasizing the importance of political institutional quality in shaping government spending patterns (Pazouki, Zhu, 2022). Ahmad et al.'s study explores the relationship between crude oil price volatility and macroeconomic indicators in South Asian countries. It underscores the need for policy reforms aimed at reducing oil energy dependency and promoting sustainable development (Ahmad et al., 2022). Lastly, Chekouri, Benbouziane, and Chibi's exploration of the relationship between natural resource abundance and institutional quality in Algeria highlights the challenges posed by corruption and the potential benefits of strengthening democratic institutions to leverage the positive impact of resource abundance on economic development (Chekouri, Benbouziane, Chibi, 2017).

Collectively, these studies offer valuable insights into the multifaceted challenges and opportunities facing oil-dependent economies, providing crucial implications for policymakers, economists, and stakeholders striving to promote sustainable development and economic resilience (Bouyacoub, 2022). In 2019, the global COVID-19 pandemic triggered an unprecedented economic crisis, particularly in the oil market, characterized by a historic downward shock. Crude oil prices experienced a steep decline, plummeting from an average of around $100 per barrel between 2011 and 2013 to just about $20 in April 2020, before stabilizing around $35 in early 2016. This decline was exacerbated by two major factors: firstly, a supply shock linked to the increasing production of shale oil in the United States, and secondly, a demand shock resulting from the global economic downturn caused by the health crisis (Berg, 2020; Heyer, Hubert, 2020).

A team of researchers and experts, including Eric Heyer and Paul Hubert (2020), Armoum H (2021), Nicolas Berg (2020), Maëlle Tripon and Dorothée Boccanfuso (2020), Gilles Pipien (2018), and Marie Noeline Sinapin (2020), conducted an analysis on the impact of the Covid-19 pandemic-induced decline in oil prices (Lacheheb, Sirag, 2019). Their findings underscore the unprecedented scale of the health crisis's effect on the oil market, underscoring the increasingly crucial need for transitioning to renewable energies as a post-pandemic solution, notably in Algeria, where traditional energy sources have historically been dominant in the economy (Nicola et al., 2020).

The works of Albulescu, C (2020) highlight the impact of Coronavirus (COVID-19) on the global economy by increasing uncertainty and financial market volatility. The reaction of oil prices to the pandemic remained gradual until March 9, 2020, 49 days after the World Health Organization (WHO) released its first monitoring report. On that day, Saudi Arabia flooded the market with oil, causing international prices to drop by more than 20% in a single day. In this context, these studies aim to analyze the effect of COVID-19 cases on crude oil prices while accounting for financial market volatility and economic policy uncertainty in the United States (U.S.). The ARDL estimation reveals that the daily increase in new infections has a slightly negative long-term impact on crude oil prices. However, by exacerbating financial market volatility, COVID-19 also indirectly influences the recent dynamics of crude oil prices.

J.P. Entelis (1999) study, titled "Sonatrach: The Political Economy of an Algerian State Institution," explores in detail the role of Sonatrach in Algeria's political economy. It highlights the fact that this state-owned enterprise is not limited to a purely economic function but also serves as a crucial instrument of state power. As the country's primary source of foreign currency and a major contributor to the national budget, Sonatrach holds a strategic position, ensuring the regime's stability by financing public and social policies (Bouyacoub, 2024). In this context, Entelis emphasizes that Sonatrach is a key player in maintaining the balance of power in Algeria, yet it continues to face challenges related to economic reforms and the volatility of energy markets.

In Algeria, hydrocarbons have always been the central pillar of the economy, constituting approximately 30% of the Gross Domestic Product (GDP), generating nearly 60% of budget revenues, and contributing to about 95% of the country's export earnings (Camporeale, Del Ciello, Jorizzo, 2021). This heavy reliance on hydrocarbons is crucial for maintaining Algeria's macroeconomic stability by accumulating foreign currency reserves and limiting external debt, especially during periods of high prices. Thus, hydrocarbons play a predominant role in Algeria's economic landscape, influencing not only its financial stability but also its political and economic directions. From 2000 to 2013, Algeria experienced notable GDP growth, closely tied to the hydrocarbon sector's contribution, surpassing 40% of GDP during 2005 and 2006, peaking in 2005 at 43.31% (Statista, n.d.). However, a decline occurred in 2009 compared to 2008, attributed to a drop in crude oil prices amidst the onset of the global economic crisis. Between 2014 and 2015, a GDP regression was noted, primarily due to a downturn in the hydrocarbon sector, while other sectors maintained stability. From 2016 to 2018, the hydrocarbon sector remained dominant, accounting for 19% of GDP, 93% of merchandise exports, and 38% of the country's budgetary revenues (Laing, 2020). This heavy reliance exposes Algeria's economy

to significant risks associated with global oil and gas price volatility (Lopez-Calix, Touqeer, 2016). The unprecedented crisis triggered by the Covid-19 pandemic in 2019 severely impacted the oil market, leading to a historic downward shock in oil prices. This volatility contrasts sharply with previous years, underscoring the challenges faced by stakeholders in this crucial sector (Chekouri, Chibi, 2016). Hydrocarbon exports experienced a significant decline in 2020 due to the pandemic's impact on oil prices, exacerbating Algeria's economic fragility (Sid Abdellaoui, 2022). This decline underscores the urgent need for economic diversification to ensure stable and sustainable growth (Merghit, 2022). In 2022, Algeria's budgetary revenues and external balance improved, supported by the rise in global hydrocarbon prices (World Bank, 2023). The current account is expected to register a surplus of 5.7% of GDP after a deficit of 2.9% in 2021. Meanwhile, although merchandise imports increased by 7.4% in 2022, the country's international reserves also grew to reach $61.7 billion by the end of 2022, covering approximately 16.3 months of goods and services imports (Pazouki, Zhu, 2022). This improvement in economic indicators offers an opportunity for Algeria to consolidate its financial stability and strengthen its position in the global economic arena (Armoum, 2021). In 2023, the hydrocarbon sector contributed approximately 2.5 trillion Algerian dinars (approximately $18 billion) to Algeria's GDP (Tripon, Boccanfuso, 2020), emphasizing its continued importance while highlighting the necessity for a gradual transition to a more diversified economy to mitigate the risks associated with global oil price volatility (Sheng et al., 2023).

2. Research methodology

The ARDL model is used to study the volatility of oil revenues in Algeria from 1980 to 2023, aiming to understand its impact on macroeconomic stability. This method allows for the consideration of long-term relationships between economic variables, such as oil prices, production, fiscal and budgetary policies, including Algeria's public spending and oil revenues. The analysis aims to identify economic and policy measures to manage this volatility, such as economic diversification, income stabilization mechanisms, fiscal and budgetary reforms, as well as strategies to strengthen the economy's resilience to external shocks (Cadoret, 2004).

2.1. Data Sources and processing method

The data utilized in this study span from 1980 to 2023 and are derived from credible sources like the World Bank and the International Monetary Fund. EViews 12.0software

was selected to conduct the econometric analysis owing to its capacity to execute diverse analyses, encompassing stationarity and cointegration tests, alongside implementing ARDL models. These analytical tools are indispensable for investigating the interrelations among economic variables over time. Through the application of the ARDL model, the study seeks to comprehend the influence of oil revenue volatility on Algeria's macroeconomic stability, encompassing both immediate and prolonged impacts.

2.2. Variables used in the empirical model

This study investigates the relationship between oil revenue volatility and Algeria's macroeconomic stability from 1980 to 2023. As shown in Figure 1, this relationship is central to the analysis. The study also analyzes the key variables integrated into the empirical model.

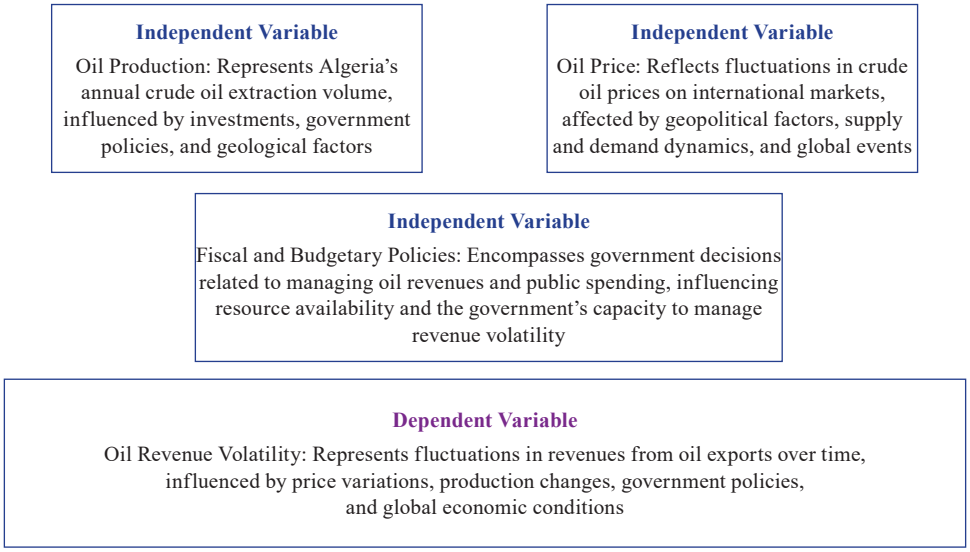

Figure 1. Variables used in the empirical model

Source: own elaboration.

By analyzing these variables, the study aims to understand how oil revenue volatility affects Algeria's macroeconomic stability and how economic policies can mitigate its negative impacts, promoting sustainable growth. This research helps identify effective strategies for managing oil revenues and enhancing the resilience of the Algerian economy against external shocks.

2.3. Model specification

The ARDL model allows for the analysis of both long and short-term relationships between variables.

For this model, we will formulate it using the levels of variables rather than their changes (i.e., log levels) to avoid stationarity problems. Here is the correct specification:

$$Y_t = \alpha + \beta_1 x_{1t} + \beta_2 x_{2t} + \beta_3 x_{3t} + \varepsilon_t$$

where:

Y_t – oil revenue volatility (annual percentage change) at time t,

x_{1t} – oil price (USD per barrel) at time t,

x_{2t} – oil production (million barrels per day) at time t,

x_{3t} – public expenditure level (percent of GDP) at time t,

t, α – the intercept term,

β_1, β_2, and β_3 – the coefficients associated with each independent variable, measuring the effect of these variables on oil revenue volatility,

ε_t – the error term at time t.

This model will allow us to analyze how the levels of oil prices, oil production, and fiscal and budgetary policies influence oil revenue volatility in Algeria over the studied period. The coefficients β_1, β_2, and β_3 will provide us with the magnitude and direction of these effects, while statistical tests can be used to assess their significance.

3. Results

Before proceeding with the ARDL approach, we conducted stationarity tests on the different series to ensure that none of them were integrated of order two, I(2), or higher. Stationarity is a crucial prerequisite for several econometric models, as it ensures that the statistical properties of the data remain constant over time. To assess stationarity, we employed the Augmented Dickey-Fuller (ADF) test (Dickey, Fuller, 1981). This test helps determine whether the variables exhibit unit roots, ensuring that they are either stationary at level I(0) or at first difference I(1), which is necessary for applying the ARDL methodology.

3.1. The Augmented Dickey-Fuller (ADF)

Unit root tests, such as the Augmented Dickey-Fuller test, are commonly used to assess the stationarity of time series data. In both the ADF and PP tests, the null hypothesis (H0) states that the series has a unit root, meaning it is non-stationary, while the alternative hypothesis (H1) states that the series is stationary. If these tests reject the null hypothesis, it indicates that the series is stationary, which is crucial for many econometric analyses.

As shown in Table 1, After applying the ADF test, we found that all four examined series were stationary, indicating the absence of systematic trends or significant temporal structures. These results provide a solid foundation for utilizing the ARDL approach in our analysis.

Table 1. ADF stationarity test results (at level)

At level		OIL_REVENUE	OIL_PRODUCTION	OIL_PRICE	FISCAL_AND_ BUDGETARY_POLICIES
With Constant	t-Statistic	–4.1765	–1.9420	–1.9842	–1.3921
	prob.	0.0020 ***	0.3106 n0	0.2925 n0	0.5773 n0
With Constant & Trend	t-Statistic	–4.2086	–2.0051	–2.0801	–1.9928
	prob.	0.0094	0.5820 n0	0.5418 n0	0.5886 n0
Without Constant & Trend	t-Statistic	–1.3003	–1.5834	–0.3940	–0.6374
	prob.	0.1757 n0	0.1057 n0	0.5361 n0	0.4353 n0

*** – this symbol is generally used to indicate a level of statistical significance. n0 – this symbol means "not significant" or "non-stationary."

Source: Personal design through EViews 12.0.

The results from the table provide information on the stationarity properties of the different series, evaluated using the Augmented Dickey-Fuller (ADF) test (Table 1). Here is a more detailed explanation: Stationary series at the level:

OIL_REVENUE: This series is considered stationary at the level, implying that it does not exhibit systematic trends and that its statistical properties remain constant over time. In other words, oil revenue volatility does not show long-term drift behavior, making it suitable for econometric analysis. In contrast, the other variables are non-stationary, meaning they exhibit persistent trends or fluctuations over time.

OIL_PRODUCTION follows a trend, indicating that shocks to oil production may have long-lasting rather than temporary effects.

OIL_PRICE is also non-stationary, reflecting the instability and volatility of the oil market, where prices are influenced by economic and geopolitical factors without quickly returning to a stable mean.

Similarly, FISCAL_AND_BUDGETARY_POLICIES evolve without a stable trend, suggesting frequent adjustments in response to economic conditions, making their behavior unpredictable without appropriate statistical transformation.

Table 2. ADF stationarity test results (at first difference)

At first difference		OIL_REVENUE	OIL_PRODUCTION	OIL_PRICE	FISCAL_AND_ BUDGETARY_POLICIES
With Constant	t-Statistic	–10.5307	–5.9341	–5.8629	–6.3363
	prob.	0.0000	0.0000 ***	0.0000	0.0000
With Constant & Trend	t-Statistic	–10.4635	–5.8743	–5.7670	–6.2668
	prob.	0.0000	0.0001 ***	0.0001 ***	0.0000 ***
Without Constant & Trend	t-Statistic	–10.6421	–5.9704	–5.9270	–6.4160
	prob.	0.0000 ***	0.0000 ***	0.0000 ***	0.0000 ***

*** – this symbol is generally used to indicate a level of statistical significance.

Source: Personal design through EViews 12.0.

Stationary series after first differencing

Oil price, Oil production, and Fiscal and budgetary policies: Initially, these series are not stationary at the level, indicating the presence of trends or temporal structures in the data. However, after being differenced once (i.e., taking the difference between successive values), they become stationary (as shown in Table 2). Differencing eliminates trends and makes the time series more statistically stable. The fact that these series become stationary after the first differencing suggests that they are integrated of order one (I(1)), meaning they are likely to converge to a long-term equilibrium after a shock or disturbance.

In summary, the stationarity of time series data is crucial in econometric analysis as it ensures statistically valid estimates. It also helps to better understand the relationships between variables and formulate more reliable forecasts in economics.

3.2. Optimal offset and ARDL model estimation

It is imperative to stress that selecting the optimal ARDL model entails balancing fit quality and model simplicity, prioritizing models that effectively explain the data with minimal parameters to prevent overfitting. The estimation results of the optimal ARDL model are pivotal for comprehending the relationships among the studied economic variables.

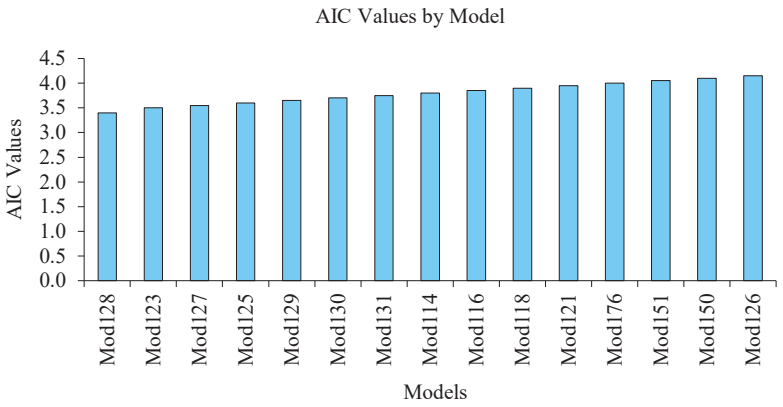

Figure 2. SIC graphic values

Source: Personal design through EViews 12.0.

The analysis evaluated 20 ARDL models, identifying model (4, 4, 4, 2) as the most optimal based on its lowest SIC value. Diagnostic tests confirmed the model's robustness, showing no autocorrelation or heteroscedasticity in the errors, and validating the normality of errors. Furthermore, as illustrated in Figure 2, the model was deemed well-specified, accurately capturing the relationships between the included variables. Overall, the selected ARDL model (4, 4, 4, 2) provides the best balance of accuracy and simplicity, making it suitable for a further analysis of the economic relationships.

3.3. Cointegration Test at Terminal Level

As part of the automated procedure in Eviews 12, the cointegration test by Pesaran et al. (2001) requires prior estimation of the ARDL model. This approach involves first estimating the ARDL model with relevant variables, and then using the residuals from this estimation to conduct the cointegration test.

Once the ARDL model has been specified and estimated, the obtained residuals represent the differences between the observed values and the values predicted by the model. These

residuals are then utilized in the Pesaran et al (2001) cointegration test to assess whether a cointegration relationship exists among the variables included in the model.

Table 3. ARDL Bounds test

F-Bounds Test		Null Hypothesis: levels relationship		
Test Statistic	Value	Level of significance (%)	I(0)	I(1)
Asymptotic: n = 1000				
F-statistic	14.45911	10.0	2.37	3.20
k	3	5.0	2.79	3.67
		2.5	3.15	4.08
		1.0	3.65	4.66
Actual Sample Size 40 Finite Sample: n = 40				
		10.0	2.592	3.454
		5.0	3.100	4.088
		1.0	4.310	5.544

Note: The variable k represents the number of explanatory (independent) variables in the ARDL model, that is, the number of variables used to explain the dependent variable in the regression equation. Here, k = 3, which means that the ARDL model under study includes three explanatory variables in addition to the dependent variable.

Source: Personal design through EViews 12.0.

These results indicate that the Fisher statistic (F = 14.45911) exceeds the upper bound for various significance thresholds (10% and 5%), meaning that the probability of observing such a statistic under the null hypothesis is less than these thresholds. In Table 3, the null hypothesis is labeled as "levels relationship", which in this context means the absence of a long-term relationship (no cointegration) between the variables. Since the F-statistic exceeds the upper bound (I(1)) for the given significance levels, we reject this null hypothesis and conclude that there is a long-term relationship between the variables. In other words, the results confirm that the variables are cointegrated, implying that they move together over time despite short-term fluctuations. This strengthens the validity of the econometric models used and provides valuable insights into underlying economic dynamics.

3.4. Long-Term Coefficients and Short-Term Dynamics Analysis

We are now commencing the estimation of the final ARDL model, which will allow us to analyze both the long-term relationships and short-term dynamics among the variables. The presence of a cointegration relationship leads us to examine the long-term coefficients, which represent the relationships established over an extended period, as well as

the short-term dynamics, which reflect adjustments in response to shocks or disturbances in the economic system. This approach will enable us to gain a comprehensive understanding of the economic mechanisms at play and formulate relevant forecasts for the variables under study.

Long-Term Coefficients Analysis

In this stage, we explore the long-term coefficients, which are essential for understanding the dynamics of the underlying variables. These coefficients provide valuable insights into the long-term relationships between variables and allow us to assess the lasting impact of factors on oil revenues. As shown in Table 4, the detailed results of this estimation are presented, where each coefficient is accompanied by its standard error and p-values to evaluate its statistical significance. This information is crucial for determining the importance of each explanatory variable in shaping long-term oil revenues and guiding future policy and economic decisions.

Table 4. Long-term coefficients estimation results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
OIL_PRODUCTION	0.1297	0.0320	4.0435	0.0002
OIL_PRICE	–0.0111	0.0470	–2.8199	0.0076
FISCAL_AND_BUDGETARY_POLICIES	0.0076	0.2019	0.0379	0.0000
C	4.5746	1.7488	2.6158	0.0127

Source: Personal design through EViews 12.0.

The results obtained from the ARDL model applied to the period 1980–2023 in Algeria, as part of the analysis of oil revenue volatility and its implications for macroeconomic stability, highlight several important conclusions. It is observed that oil production (measured in million barrels per day) and public expenditure level (measured as a percentage of GDP) have positive and significant effects on oil revenue volatility (measured as the annual percentage change in oil revenues) in the long term. This means that when oil production increases by one million barrels per day, oil revenue volatility increases on average by 0.12 percentage points, and similarly, an increase of one percentage point in public expenditure as a share of GDP leads to an average increase of 0.007 percentage points in oil revenue volatility. This positive relationship suggests that policies favorable to the oil industry and higher public spending can contribute to increased fluctuations in oil revenues over time. However, contrary to expectations, the oil price (measured in USD per barrel) has a negative and statistically significant impact on oil revenue volatility, indicating an inverse long-term relationship between these two variables. One

possible explanation is that higher oil prices may not always translate into stable revenue growth, as Algeria's economy remains highly dependent on external market conditions, and the inability to quickly adjust production levels or implement diversification policies may lead to unpredictable revenue variations despite rising oil prices. These findings emphasize the importance of diversified economic policies and prudent management of oil revenues to ensure Algeria's macroeconomic stability, highlighting the need for strategic planning to mitigate the effects of oil revenue volatility and diversify the economy, reducing the country's dependence on global oil price fluctuations.

Short-term coefficients (ST)

The estimation of the short-term relationship highlights the system's ability to return to equilibrium, ensuring stabilization. The coefficient CointEq(-1), representing the adjustment speed (–0.1611), is both statistically significant and negative. Since its absolute value lies between zero and one, it confirms the presence of an effective error correction mechanism. This implies that 16.11% of the previous year's imbalances are corrected within the current period, indicating a relatively fast convergence towards the long-term equilibrium, as presented in Table 5.

Table 5. The ARDL cointegration test and the long-term form

Variable	Coefficient	Std. Error	t-Statistic	Prob.
1	2	3	4	5
D(OIL_REVENUE(-1))	–1.1814	0.1627	–7.2581	0.0000
D(OIL_REVENUE (-2))	–0.4844	0.2207	–2.1939	0.0391
D(OIL_REVENUE (-3))	0.2270	0.1435	1.5810	0.0128
D(OIL_PRODUCTION)	0.0879	0.0732	1.1999	0.0243
D(OIL_PRODUCTION(-1))	0.1088	0.0764	1.4244	0.0168
D(OIL_PRODUCTION(-2))	0.0970	0.0391	2.4780	0.0214
D(OIL_PRODUCTION(-3))	0.2970	0.0396	7.4876	0.0000
D(OIL_PRICE)	–0.1621	0.0383	–4.2300	0.0003
D(OIL_PRICE(-1))	–0.1587	0.0369	–4.3012	0.0003
D(OIL_PRICE(-2))	–0.2106	0.0410	–5.1352	0.0000
D(OIL_PRICE(-3))	–0.1505	0.0466	–3.2251	0.0039
D(FISCAL_AND_BUDG	0.0334	0.0291	1.1477	0.0034
D(FISCAL_AND_BUDG	0.0960	0.0300	3.1953	0.0042
CointEq(-1)*	–0.1611	0.0174	–9.2434	0.0000
R-squared	0.8694	Mean dependent var	0.1125	

1	2	3	4	5
Adjusted R-squared	0.8041	S.D. dependent var	2.4471	
S.E. of regression	1.0829	Akaike info criterion	3.2664	
Sum squared resid	30.4900	Schwarz criterion	3.8575	
Log likelihood	–51.3280	Hannan-Quinn criter.	3.4801	
Durbin-Watson stat	3.8432			

* Significant at the 5% level.

Source: Personal design through EViews 12.0.

Additionally, according to the results obtained from EViews 12.0, we note that:

1. The coefficients are significant.
2. The coefficient of CointEq(-1) (–0.1611, t-stat = 9.2433) has the correct sign (negative), indicating an error correction mechanism.

Our in-depth analyses have shed light on complex and significant long-term relationships among various key variables, thus providing a deeper understanding of Algeria's economic dynamics. Among these variables, oil price, oil revenue, oil production, and fiscal and budgetary policies have been identified as crucial factors.

Firstly, our study reveals that higher oil prices have a negative impact on oil revenue volatility. This observation suggests a tendency for revenue stabilization when oil prices increase, which can be attributed to improved revenue predictability in a context of higher prices.

However, an intriguing finding emerges from our analysis: an increase in oil production is correlated with an increase in oil revenue volatility. This observation can be explained by fluctuations in global oil demand, as well as how production increases affect prices in the global market.

Moreover, our study highlights the crucial role of fiscal and budgetary policies in oil revenue stability. The results show that stricter policies in these areas seem to promote oil revenue stabilization, underscoring the importance of careful and effective resource management in the context of dependence on oil revenues.

These findings emphasize the need for the Algerian government to adopt prudent economic policies focused on diversifying the economy to reduce dependence on oil price fluctuations. Promoting non-hydrocarbon sectors and investing in diversified infrastructure and industries can help mitigate risks associated with volatility in global oil markets.

In conclusion, our analysis provides essential insights for the formulation of sustainable economic policies in Algeria, highlighting the challenges and opportunities associated with its

dependence on oil revenues and offering pathways for more stable and diversified economic growth.

4. Stability test of the model using CUSUM statistics

After meticulously establishing the long-term dynamics between a set of explanatory variables and oil revenue volatility, a crucial step is to evaluate the stability of the developed model. To do this, we opted for the CUSUM test, widely recognized for its ability to detect anomalies in the context of a dynamic model, such as one based on ARDL estimation. This test was introduced by Brown, Durbin, and Evans (1975) as a method for assessing the constancy of regression relationships over time.

The decision rule of the CUSUM test is based on the graphical analysis of the CUSUM and CUSUM of Squares statistics. A model is considered structurally stable when these statistics remain within the critical bounds, with a 5% error threshold. Any exceedance of these critical bounds signals model instability.

The CUSUM statistic tracks cumulative sums of recursive residuals, helping detect gradual structural changes in the model over time. The CUSUM of Squares statistic, on the other hand, is based on squared residuals and is more sensitive to sudden shifts or large deviations in the relationship between variables.

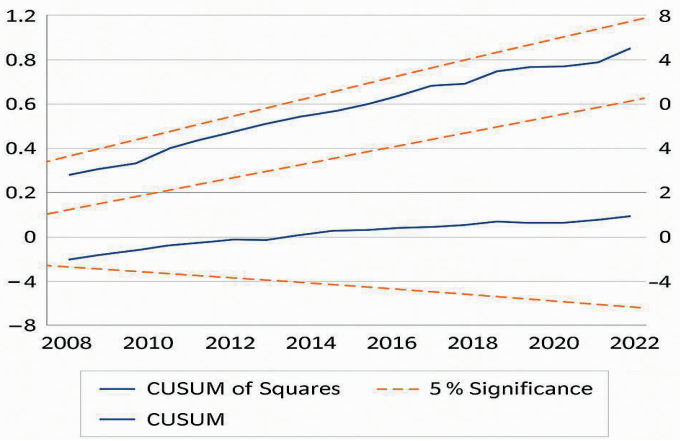

Figure 3. CUSUM and CUSUM of squares tests for the stability of variables

Source: Personal design through EViews 12.0.

Figure 3 presents both statistics along with their respective critical bounds. The time interval 2008–2023 is highlighted because it corresponds to key economic events that may have influenced oil revenue volatility, such as the 2008 global financial crisis, fluctuations in oil prices, and recent economic shocks.

Additionally, an unnumbered table appears below the third paragraph without a title or interpretation. It should either be properly labeled and explained or removed if it does not add significant value to the analysis.

The results indicate that the model meets the criteria for the structural stability of the coefficients estimated by the ARDL model for the study period 1980–2023. This reinforces the reliability and robustness of the model in capturing the relationship between explanatory variables and oil revenue volatility, further supporting its relevance for future analyses.

Conclusions

The comprehensive analyses conducted in both the short and long term offer valuable insights into the intricate economic dynamics of Algeria, shedding light on the interconnectedness of various key variables.

To begin with, the impact of oil prices on oil revenues underscores Algeria's heavy reliance on oil and gas exports. While higher oil prices can bolster the country's oil revenues, excessive volatility poses challenges in budget planning and necessitates significant economic adjustments during price downturns.

Furthermore, the relationship between oil production and revenue volatility highlights the complexities of managing oil resources. While increasing production may lead to short-term revenue gains, it also introduces volatility as the global market reacts to the additional supply. Effective management of production levels, exploration investments, and international partnerships are crucial in navigating these complexities.

Additionally, fiscal and budgetary policies play a pivotal role in stabilizing oil revenues amidst price fluctuations. However, stringent measures may encounter resistance due to social and political considerations, underscoring the need for careful balance in policy implementation.

Moreover, overreliance on oil revenues can exacerbate economic vulnerabilities, necessitating diversification efforts to mitigate risks. Strategic diversification into sectors such as agriculture, tourism, services, and manufacturing can reduce dependency on oil and enhance the economy's resilience to external shocks.

In conclusion, the findings underscore the importance of adopting prudent and diversified economic policies to mitigate the risks associated with oil revenue dependence and foster sustainable and balanced economic growth in Algeria. In light of these findings, several key recommendations emerge:

1. Strengthening economic diversification: The government should prioritize investments in non-hydrocarbon sectors, particularly agriculture, renewable energy, and technology, to create a more balanced and resilient economy.
2. Enhancing institutional quality: Improving governance, regulatory frameworks, and transparency in resource management can help optimize the benefits of oil revenues and attract foreign direct investment.
3. Developing a sovereign wealth fund: Establishing a well-managed sovereign wealth fund could help stabilize the economy by accumulating surplus revenues during periods of high oil prices and mitigating the impact of future price fluctuations.
4. Implementing counter-cyclical fiscal policies: The adoption of flexible fiscal policies that adjust spending based on oil price cycles can reduce economic volatility and ensure long-term financial sustainability.
5. Investing in human capital: Prioritizing education, vocational training, and research can equip the workforce with the necessary skills to support industrialization and innovation in non-oil sectors.

Future research could further explore the impact of global energy transitions on Algeria's economy, assessing how the shift towards renewable energy and decarbonization efforts might affect its oil-dependent economic model. Additionally, studies on the effectiveness of various diversification strategies in similar resource-rich economies could provide valuable comparative insights for policy formulation.

References

Ahmad, I., Iqbal, S., Khan, S., Han, H., Vega-Muñoz, A., Ariza-Montes, A. (2022). Macro-economic effects of crude oil shocks: Evidence from South Asian countries. *Frontiers in Psychology*, *13*, 967643. DOI: 10.3389/fpsyg.2022.967643.

Albulescu, C. (2020). *Coronavirus and oil price crash*. Retrieved from https://hal.science/hal-02507184v2.

Armoum, H. (2021). Les effets de la pandémie COVID-19 sur l'économie. *Revue internationale des sciences de gestion*, *4*(1).

Banque mondiale (2023). *Accueil*. Retrieved from https://www.banquemondiale.org.

Berg, N. (2020). La grande peur de l'an 2020: le bug du coronavirus et le grand confinement. *Futuribles*, *4*, 43–52.

Bourghelle, D., Jawadi, F., Rozin, P. (2021). Oil price volatility in the context of COVID-19. *International Economics*, *167*, 39–49. DOI: 10.1016/j.inteco.2021.05.001.

Bouyacoub, B. (2018). *La politique monétaire et la croissance économique (cas de l'Algérie)* [Thèse de doctorat, Université d'Oran 2 Mohamed Ben Ahmed]. Retrieved from https://ds.univ-oran2.dz:8443/jspui/handle/123456789/1929.

Bouyacoub, B. (2022). Inflation targeting and economic growth in the Middle East and North Africa (MENA): Empirical modeling using ARDL approach. *Financial Markets, Institutions and Risks*, *6*(1), 5–12. DOI: 10.21272/fmir.6(1).5-12.2022.

Bouyacoub, B. (2024). Empirical exploration of economic policy in the Middle East and North Africa (MENA) region: An ARDL approach. *Financial Markets, Institutions and Risks*, *8*(1). DOI: 10.61093/fmir.8(1).158-172.2024.

Brown, R.L., Durbin, J., Evans, J.M. (1975). Techniques for testing the constancy of regression relationships over time. *Journal of the Royal Statistical Society: Series B (Methodological)*, *37*(2), 149–192.

Cadoret, I. (2004). *Économétrie appliquée: Méthodes, applications, corrigés*. De Boeck Supérieur.

Camporeale, C., Del Ciello, R., Jorizzo, M. (2021). *Beyond the hydrocarbon economy: The case of Algeria*. IntechOpen. DOI: 10.5772/intechopen.91033.

Chekouri, S.M., Chibi, A. (2016). *Algeria and the natural resource curse: Oil abundance and economic growth*. Working Papers 990, Economic Research Forum. Retrieved from https://www.erf.org.eg/publications/algeria-and-the-natural-resource-curse-oil-abundance-and-economic-growth.

Chekouri, S.M., Benbouziane, M., Chibi, A. (2017). Oil rents and institutional quality: Empirical evidence from Algeria. *Topics in Middle Eastern and African Economies*, *19*(2), 1.

Dickey, D.A., Fuller, W.A. (1981). Likelihood ratio statistics for autoregressive time series with a unit root. *Econometrica*, *49*(4), 1057–1072.

Entelis, J.P. (1999). Sonatrach: The political economy of an Algerian state institution. *Middle East Journal*, *53*(1), 9–27. http://www.jstor.org/stable/4329281.

Hamilton, J.D. (1983). Oil and the macroeconomy since World War II. *Journal of Political Economy*, *91*(2), 228–248.

Heyer, E., Hubert, P. (2020). Impact de la baisse du prix du pétrole liée à la crise de la Covid-19 sur les entreprises et ménages français. *Revue de l'OFCE*, *168*, 139.

Laing, T. (2020). The economic impact of coronavirus (COVID-19): Implication of the mining industry. *The Extractive Industry and Society.* Retrieved from https://www.elsevier.com/locate/exis.

Lacheheb, M., Sirag, A. (2019). Oil price and inflation in Algeria: A nonlinear ARDL approach. *The Quarterly Review of Economics and Finance*, *73*, 217–222. DOI: 10.1016/j.qref.2018.12.003.

Lopez-Calix, J.R., Touqeer, I. (2016). Algeria: Comparing the last two oil shocks and policy responses. *Topics in Middle Eastern and African Economies*, *18*(2), 117.

Merghit, A. (2022). What constrains growth in Algeria? A diagnostic approach. *Les Cahiers du CREAD*, *38*(4). DOI: 10.4314/cread.v38i4.8.

Nicola, M., Alsafi, Z., Sohrabi, C., Kerwan, A., Al-Jabir, A., Iosifidis, C., Agha, M., Agha, R. (2020). The socio-economic implications of the coronavirus and COVID-19 pandemic: A review. *International Journal of Surgery*, *78*, 185–193. DOI: 10.1016/j.ijsu.2020.04.018.

Okunoye, I., Hammed, S. (2020). Oil price shock and fiscal-monetary policy variables in Nigeria: A structural VAR approach. *MPRA Paper No. 104145*. Retrieved from https://mpra.ub.uni-muenchen.de/104145.

Omojolaibi, J.A. (2013). Does volatility in crude oil price precipitate macroeconomic performance in Nigeria? *International Journal of Energy Economics and Policy*, *3*(2), 143–152. Retrieved from www.econjournals.com.

Pazouki, A., Zhu, X. (2022). The dynamic impact among oil dependence volatility, the quality of political institutions, and government spending. *Energy Economics*, *115*, 106383. DOI: 10.1016/j.eneco.2022.106383.

Pesaran, M.H., Shin, Y., Smith, R.J. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics*, *16*(3), 289–326. DOI: 10.1002/jae.616.

Pipien, G. (2018). Changement climatique, perte de biodiversité et santé. *Year Book – Santé et Environnement*.

Sachs, J.D., Warner, A.M. (1995). *Natural resource abundance and economic growth* (NBER Working Paper No. 5398).

Sid Abdellaoui (2022). The Algerian economy between oil dependence and the inevitability of economic diversification. *International Journal of Economic Performance*, *5*(2).

Sinapin, M.N. (2020). Les conséquences de la pandémie de COVID-19 sur la sphère socio-économique et environnementale: Quelle place à l'utilité commune, socle de l'agilité future? *HAL Archives ouvertes*.

Sachs, J.D., Warner, A.M. (1995). *Natural resource abundance and economic growth* (NBER Working Paper No. 5398).

Sheng, X., Kim, W.J., Gupta, R., Ji, Q. (2023). The impacts of oil price volatility on financial stress: Is the COVID-19 period different? *International Review of Economics & Finance.* DOI: 10.1016/j.iref.2023.02.006.

Stock, J.H., Watson, M.W. (2019). *Introduction to econometrics* (4th ed.). Pearson.

Statista (2023). GDP contribution of hydrocarbons in Algeria. Retrieved from https://www.statista.com/statistics/1184162/gdp-contribution-of-hydrocarbons-in-algeria/#statisticContainer.

Tripon, M., Boccanfuso, D. (2020). Agriculture urbaine, pratiques agricoles et impacts environnementaux et de santé publique. *GREDI*, *Cahier de Recherche*, *13.*

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