

The impact of oil shocks on the Algerian economy: An empirical approach using ARDL models

أثر الصدمات النفطية على الاقتصاد الجزائري: نهج تجريبي باستخدام نماذج ARDL

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Abstract:

The Algerian economy relies heavily on hydrocarbons, representing over 93% of exports. Its growth, driven by rising oil prices since the 2000s, is often deemed artificial. This dependence exposes Algeria to risks, as seen with the oil shocks of 1973, 1979, the 1986 price collapse, and the 2014 price decline, further intensified by the 2020 COVID-19 crisis. These events disrupted economic stability, emphasizing the need for analysis. This study examines the impact of oil shocks on Algeria's growth, revealing long-term links between growth and key indicators, underscoring oil price fluctuations' significant role.

Keywords: ARDL; Oil Shocks; Economic Growth; CUSUM Test

Jel Classification Codes : Q13 ; Q43

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Introduction:

For decades, natural resources, particularly hydrocarbons, have been pivotal in shaping global economic activity. Oil, a cornerstone of economic growth, holds a strategic position in both industrialized and developing countries as a critical energy source and industrial input. However, the volatility of oil prices, driven by geopolitical tensions and market dynamics, renders this sector highly unstable, exerting profound impacts on the global economic landscape.

In Algeria, hydrocarbons represent the cornerstone of the national economy. Since the discovery of vast oil and natural gas reserves in the 1950s, the country has emerged as a significant energy player, both regionally and globally. Currently, hydrocarbons account for approximately 30% of gross domestic product, generate over 95% of export revenues, and contribute around 50% to budgetary income. This heavy reliance on hydrocarbons renders the Algerian economy particularly susceptible to fluctuations in oil prices.

The oil shocks of recent decades have profoundly shaped Algeria's economic trajectory. Price increases in 1973 and 1979 facilitated major public investments and infrastructure development. Conversely, price declines in the 1980s and 1990s led to economic crises characterized by debt accumulation, inflationary pressures, and fiscal imbalances. More recently, the sharp price drops in 2014 and 2020, exacerbated by the COVID-19 pandemic, underscored the pressing need for economic diversification. However, persistent structural and policy challenges have hindered significant progress in reducing the economy's reliance on hydrocarbons.

A- Problem of the study:

How do oil shocks influence the Algerian economy, and to what extent do these fluctuations contribute to its economic vulnerability?

B- Research questions:

- What are the mechanisms through which oil shocks affect Algeria's macroeconomic indicators?
- How have different oil shocks been managed by Algeria's economic policies over time?

C- Research hypotheses:

- Oil shocks have a significant impact on Algeria's macroeconomic stability.
- Public policies have not effectively reduced the economy's dependence on hydrocarbons.

D- Study methodology:

This study aims to analyze how oil shocks have influenced the dynamics of economic growth in Algeria, while highlighting the economy's strong vulnerability to fluctuations in oil prices. The study uses the ARDL (Autoregressive Distributed Lag) approach over the period 1980-2023 to model the relationship between oil shocks and key macroeconomic variables. The study is structured into three sections:

- The first section provides a brief overview of Algeria's hydrocarbon sector.
- The second section graphically analyzes the macroeconomic variables used in the modeling.
- Finally, the third section addresses the research problem by presenting the main findings and formulating policy recommendations.

E- Study objective:

The objective of this research is to provide a comprehensive understanding of the effects of oil shocks on Algeria's economy and propose strategies to strengthen the country's economic resilience. The findings could inform policy decisions and contribute to more effective management of oil shocks.

I-The hydrocarbon sector in Algeria:

In Algeria, the hydrocarbon sector plays a dominant role in shaping the level of economic and social development. Its importance is reflected in its significant contribution to various economic indicators, such as gross domestic product (GDP) and overall income, while also exerting considerable influence on the balance of payments. This sector's growing share in the national economy underscores its central role in driving the development and growth dynamics of all other economic and social sectors.

I-1-The role of the hydrocarbon sector in Algeria:

The hydrocarbon sector is a cornerstone of the Algerian economy. It is the primary source of foreign currency and is considered a vital resource for financing economic activities. Hydrocarbons alone account for 95% of Algeria's exports, contribute about 30% to the GDP, and make up more than 50% of the state budget (State, 2024)

This heavy reliance on hydrocarbons shapes the structure and management of the Algerian economy. While it provides the potential for rapid and sustainable economic growth, it also makes the country vulnerable to fluctuations in global commodity prices. Such dependence exposes Algeria's economic development, public finances, and external accounts to significant risks.

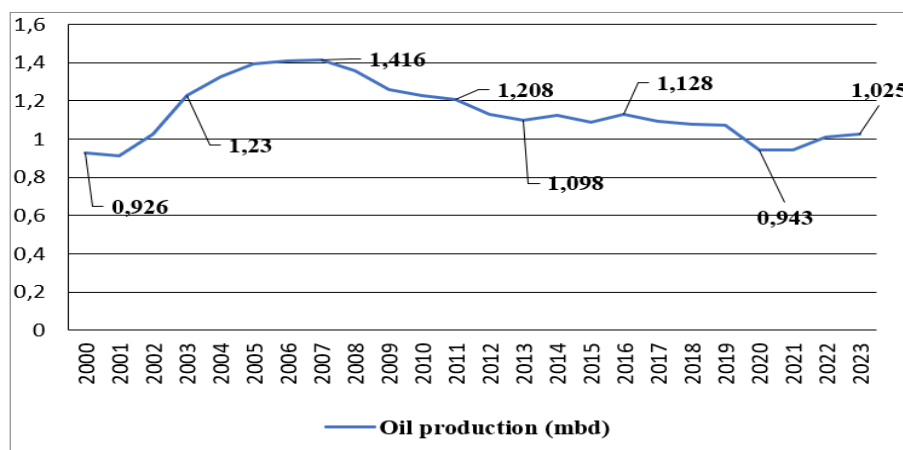
The management of the hydrocarbon sector is overseen by SONATRACH, which plays a pivotal role in the oil industry. SONATRACH's mission is to optimize national resources and generate wealth for the country's economic and social development. Recognized as the leading hydrocarbon company in Africa and the Mediterranean region, SONATRACH continues to be a key player in Algeria's energy sector.

Since joining OPEC in 1969, Algeria has established itself as a major player in global energy markets. Its oil is renowned for its high quality, characterized by its low sulfur content and lightness. Algeria ranks among the top three oil producers in Africa, the 17th-largest oil producer globally, and one of the top 10 to 15 oil-exporting countries in the world. Additionally, it holds the 16th or 17th position globally in terms of proven oil reserves (EIA, 2024).

I-2-Evolution of oil production in Algeria:

The graph below illustrates the evolution of crude oil production in Algeria during the period from 2000 to 2023.

Figure n°1: Evolution of oil Production in Algeria in million barrels per day (2000–2023)



Source: constructed by us based on data from the ministry of energy and mines (MEM)

Between 2000 and 2007, Algeria's oil production experienced steady growth, increasing from 0.926 million barrels per day (mbd) in 2000 to 1.416 mbd in 2007. This growth was driven by rising global energy demand, fueled by economic expansion, particularly in emerging economies such as China and India. Additionally, new investments, the discovery of new oil fields, and advancements in extraction technologies contributed to this rise. During this period, Algeria signed several contracts with foreign oil companies, which helped strengthen its production capacity.

In 2008, production peaked at 1.360 mbd but dropped to 1.262 mbd in 2009, following the global financial crisis. This decline was directly linked to a sharp reduction in global oil demand, which adversely affected Algeria's output. The downward trend continued through to 2013, with production falling to 1.098 mbd. This period highlighted the challenges posed by aging oil fields and declining investments, despite ongoing efforts to explore new reserves. However, these efforts were insufficient to counterbalance the decline in mature fields.

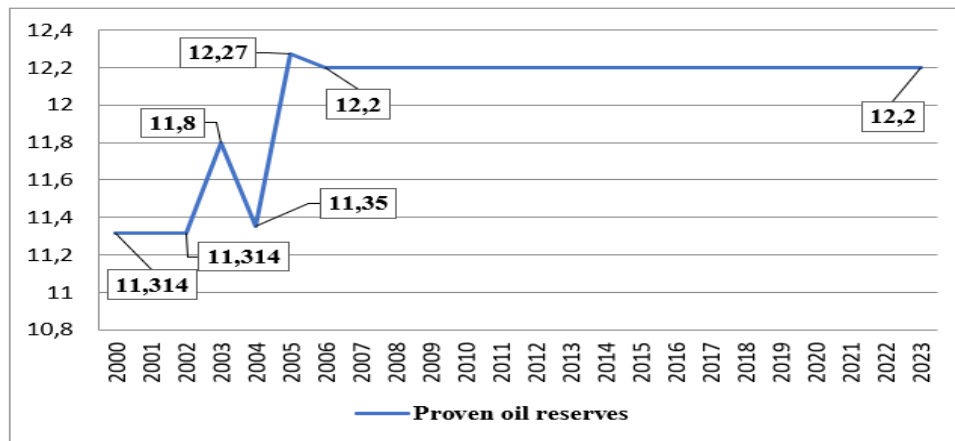
From 2014 to 2019, production stabilized, fluctuating between 1.072 mbd and 1.128 mbd. This stabilization was likely influenced by production regulation policies, such as OPEC agreements, as well as more strategic management of Algeria's oil resources. Despite this, the aging infrastructure and difficulties in discovering new reserves continued to impact production levels.

The period from 2020 to 2023 saw the additional challenge of the COVID-19 pandemic, which exacerbated pre-existing difficulties. The global collapse in oil demand led to a reduction in production in accordance with OPEC agreements. In 2020, production fell to 0.943 mbd and remained low in 2021 at 0.946 mbd. However, a recovery began in 2022, with production reaching 1.013 mbd, and continued to rise in 2023, reaching 1.025 mbd. This recovery was supported by new discoveries, a gradual resumption of investments, and a normalization of global demand. While the recovery suggests a trend toward stabilization, significant structural challenges remain for the future of Algeria's oil sector.

I-3-Proven oil reserves:

Proven oil reserves are determined by both known quantities and the rate of extraction and production. They represent volumes of oil that remain untapped and constitute a future asset, ensuring additional financial resources for the transition to a post-oil economy. Algeria holds proven oil reserves with an average volume estimated at 12.2 billion barrels, accounting for approximately 1% of global reserves. This positions the country as the 17th largest globally and 3rd in Africa, behind Libya, with 48.4 billion barrels, and Nigeria, with 36.9 billion barrels (BP, 2023).

Figure n°2: Evolution of Algeria's proven oil reserves (in billion barrels).



Source: Prepared by us based on data from Statista, 2024.

The analysis of the evolution of Algeria's proven crude oil reserves reveals several key dynamics. Between 2000 and 2004, the reserves remained relatively stable, reaching 11.31 billion barrels by 2002. However, a notable increase occurred in 2003, with reserves rising to 11.8 billion barrels, followed by a slight decline to 11.35 billion barrels in 2004. This fluctuation reflects adjustments in reserves due to ongoing exploration and exploitation activities.

In 2005, reserves peaked at 12.27 billion barrels, signaling a positive phase in resource management. However, this growth was short-lived, as reserves decreased slightly to 12.2 billion barrels in 2006. This decline could be attributed to the depletion of certain oil fields or a slowdown in exploration efforts.

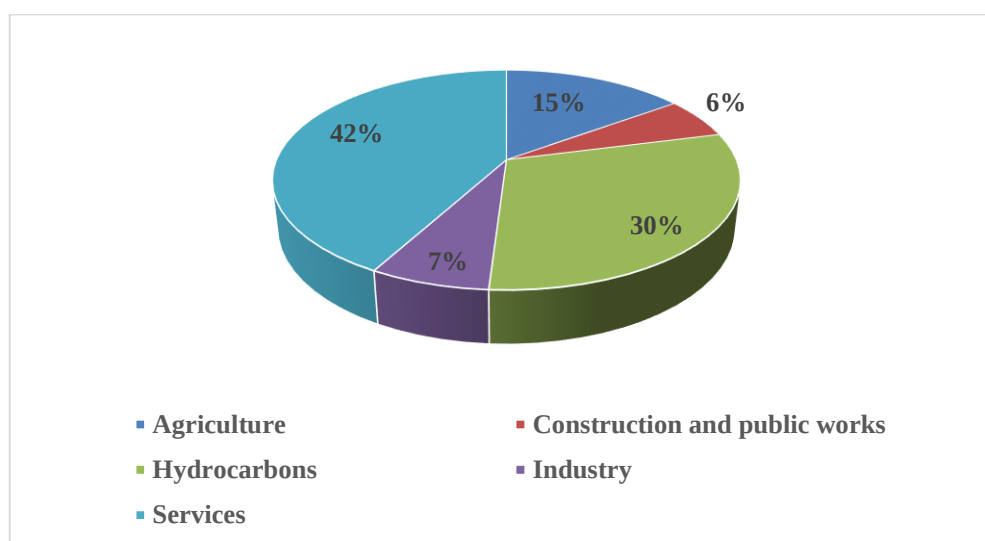
From 2007 to 2023, proven oil reserves remained relatively stable, hovering around 12.2 billion barrels. This prolonged stability suggests that significant new discoveries were absent, and management focused on maintaining existing reserves. Despite this, a gradual decline in reserves was observed, reaching approximately 12.5 billion barrels in 2010, which could indicate the gradual depletion of certain fields and reduced exploration investments.

Between 2010 and 2023, reserves generally stabilized around 11 to 11.5 billion barrels. This stability reflects a balance between extraction and preservation efforts. The slight increase in 2023 may be attributed to new discoveries or revisions of previously estimated reserves. This trend highlights Algeria's economic challenges, marked by its heavy reliance on hydrocarbons and the pressing need for increased investment in exploration and diversification of its economy.

I-4-Contribution of hydrocarbons to GDP:

The Algerian economy is largely dependent on the hydrocarbons sector. Despite ongoing efforts to diversify, oil and gas still account for around a quarter of the GDP. This sector remains a crucial pillar of Algeria's economy, particularly for exports and foreign currency revenues. The income generated from hydrocarbons has financed various investment programs and significantly reduced the country's external debt. As a result, the gross domestic product continues to be heavily influenced by the performance of the hydrocarbons sector, given its substantial contribution to GDP formation.

Figure n°3: Sectoral breakdown of GDP in Algeria for the year 2023



Source: Constructed from data provided by the bank of Algeria, *quarterly statistical bulletin*, No. 66 (First quarter 2024).

The analysis of figure n°3 shows that the sectoral breakdown of Algeria's GDP for 2023 highlights the country's economic structure, heavily shaped by the predominance of hydrocarbons, which account for 30%. This sector plays a strategic role as both the main driver of national exports and a critical source of government revenue. However, this heightened dependency on hydrocarbons exposes Algeria's economy to fluctuations in global oil and gas prices, making the country highly vulnerable to oil shocks.

This structural reliance hinders macroeconomic stability and slows efforts toward economic diversification. Oil shocks, whether stemming from price drops or changes in global demand, have historically led to economic slowdowns or even recessions, directly impacting economic growth. Furthermore, such shocks undermine the state's capacity to fund public investments, which are heavily reliant on hydrocarbon revenues.

Additionally, while services dominate the GDP with a 42% share, their development is largely sustained by indirect hydrocarbon revenues, particularly through public spending. This underscores the ripple effects of petroleum dependency across the broader economy. Therefore, to enhance economic resilience and foster more balanced growth, reducing this dependency by

diversifying the economy particularly through investments in industry (7%) and agriculture (15%) is imperative.

After providing a brief overview of the hydrocarbon sector, we will now focus on the evolution of key macroeconomic variables that are essential for understanding Algeria's economic growth. These variables will be used in the context of econometric modeling.

II- Presentation and graphical analysis of the selected macroeconomic variables:

II-1- The choice of variables:

The relationship between oil price fluctuations and economic activity has been extensively studied in both theoretical and empirical literature. The variables selected for this study were inspired by previous research that assessed the impact of oil price variations on economic growth indicators. These studies focus on both oil-importing and oil-exporting countries. Notable examples include:

- **Abderrahmani Fares and Oukaci Kamal (2018):** Their research demonstrated that oil price variations significantly influence Algeria's economic growth in both the short and long term. Using cointegration techniques to account for possible structural breaks, they highlighted Algeria's vulnerability to external shocks, particularly those stemming from oil price fluctuations (Abderrahmani.F & Oukaci.k, 2018).
- **Apere and Ijeoma (2014):** examine the impact of oil price volatility on macroeconomic activity in Nigeria using Exponential Generalized Autoregressive Conditional Heteroskedasticity (EGARCH) models, impulse response functions, and Augmented Lag Vector Autoregression (LA-VAR) models. Their study highlights that oil price shocks have a profound and long-lasting effect on real exchange rates, which, in turn, play a pivotal role in shaping economic growth in Nigeria (Apere & Ijeoma, 2014).
- **Attouchi Manel (2021):** This study applied a non-linear autoregressive distributed lag (NARDL) model to annual data from Algeria covering 1970–2018. The results showed that, in both the short and long term, rising oil prices stimulate economic growth, while falling prices reduce GDP. Additionally, an asymmetry test confirmed that the effects of positive and negative oil price shocks are symmetrical (Attouchi.M, 2021).
- **Bouchaour and Al-Zeaud (2012):** Studied the impact of oil price distortions on the overall economy of Algeria during the period 1980-2011, using a Vector Error Correction Model (VECM). Their results show that, in the short term, oil prices have a minor impact, while in the long term, they have a positive effect on real GDP (Bouchaour et AlZeaud, 2012).
- **Jiménez-Rodríguez and Sanchez (2004):** Using a VAR model, they analyzed the impact of oil price shocks on the real economies of major OECD countries from 1972 to 2001. The variables examined included the real price of oil (Brent in USD), real GDP, inflation, exchange rates, real wages, and short- and long-term interest rates (Jimenez-Rodriguez, 2004).

Most models in these studies identified certain macroeconomic variables as highly influential on economic growth. In our analysis, we selected variables that directly correlate with Algeria's GDP per capita. The selection was based on data availability from sources like the National Office of Statistics (ONS) and the World Bank. We ultimately chose: Oil Prices (PP), Exchange Rate (TCH), Money Supply M2 (as a % of GDP), Imports M (as a % of GDP).

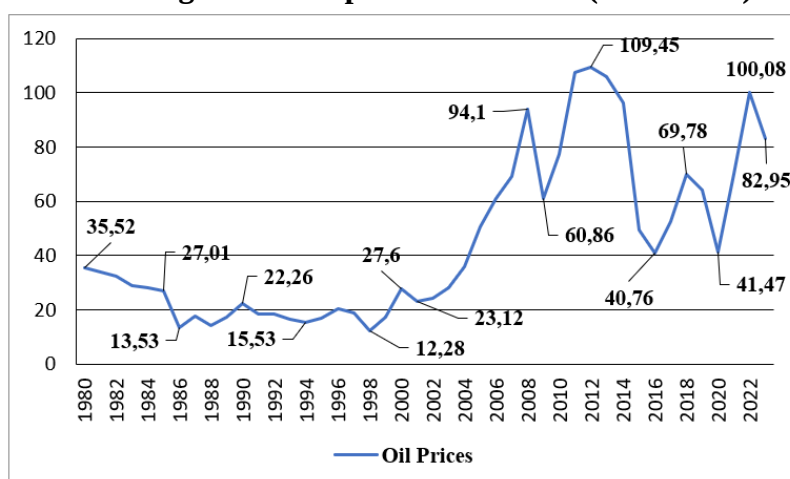
II-2- Graphical analysis of the variables used:

This section highlights the general trends of Algeria's key economic indicators, which will be utilized in econometric modeling.

II-2-1- Evolution of global oil prices:

The graphical analysis of global oil prices between 1980 and 2023 underscores significant fluctuations. These were driven by geopolitical events, economic factors, and shifts in supply and demand.

Figure n° 4: Evolution of average crude oil prices in \$/barrel (1980–2023).



Source: Prepared by us using data from Statista, 2024.

The analysis of Chart n°4 reveals the different phases of the evolution of OPEC's average annual crude oil prices from 2000 to 2023. It also highlights significant price fluctuations over a longer period, from 1980 to 2023, reflecting global economic dynamics, geopolitical tensions, and structural transformations in the oil industry. Between 1980 and 1985, prices remained relatively high, peaking at nearly \$35 in 1980 before gradually declining to \$27,01 in 1985. This trend was largely influenced by the lingering effects of the 1970s oil shocks and sustained demand, although early signs of overproduction began to emerge.

In 1986, a sharp drop to \$13,53 occurred due to an oversupply in the global market and increased competition among oil-producing countries. This shift prompted exporting nations to reassess their economic policies. From 1987 to 1999, prices fluctuated between \$12 and \$22, marking a period of moderate volatility. After a brief recovery to \$17,73 in 1987, prices remained relatively low, particularly in 1998, when they hit a low of \$12.28, largely as a result of the Asian financial crisis, which reduced global energy demand.

The early 2000s marked a significant recovery in oil prices, rising from \$27,6 in 2000 to \$94,1 in 2008. This increase was driven by robust demand from emerging economies, especially China and India, alongside geopolitical tensions in producing regions. However, the global financial crisis in 2008 led to a collapse in demand and a sharp drop in prices to \$60,86 in 2009, highlighting the vulnerability of oil markets to global economic shocks.

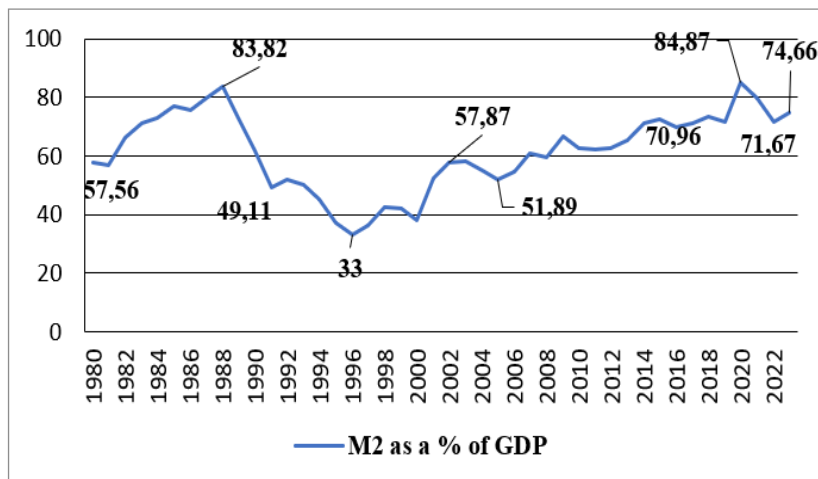
Between 2010 and 2014, prices followed an upward trajectory, reaching historic highs such as \$107,46 in 2011 and \$109,45 in 2012, fueled by global economic recovery and sustained demand. At the same time, the rise of shale oil production in the United States began to shift market dynamics. In 2014, prices fell once again, dropping from \$96,29 to \$40,76 in 2016 due to global overproduction and growing competition from shale oil. This decline significantly impacted the economies of oil-dependent exporting countries.

From 2017 to 2019, prices stabilized between \$50 and \$70, thanks to OPEC and its partners' efforts to balance supply and demand. In 2020, the COVID-19 pandemic triggered a sharp decline in prices to \$41,47, but a rapid recovery was observed in 2021, with prices reaching \$69,89 following the reopening of global economies. In 2022, prices surged to \$100,08 due to the war in Ukraine and sanctions on Russian oil, before falling to \$82,95 in 2023. These fluctuations reflect the complex factors influencing oil markets, from geopolitical developments to structural changes in supply and demand.

II-2-2-The evolution of M2 money supply as a percentage of GDP:

The evolution of the M2 money supply as a percentage of GDP in Algeria from 1980 to 2023 is marked by significant growth, reflecting the country's economic and monetary transformations.

Figure n° 5: Evolution of M2 money supply as a % of GDP (1980-2023).



Source: Constructed by us using data from the bank of Algeria.

The analysis of Chart n°5 highlights the close relationship between Algeria's money supply and key economic events, including fluctuations in oil prices, structural reforms, and global crises, especially the COVID-19 pandemic. The country has experienced several phases of monetary expansion followed by contraction, with oil revenues playing a significant role in these fluctuations.

In the 1980s, the M2 money supply accounted for about 57% of GDP in 1980, peaking at 83,82% in 1988, largely driven by high oil revenues. However, this upward trend was abruptly reversed in 1989 due to falling oil prices and the onset of an economic crisis.

Throughout the 1990s, the money supply steadily declined, reaching a low of 33% of GDP in 1996. This period, marked by political and economic turmoil, led Algeria to implement significant economic reforms under the guidance of the IMF, resulting in a sharp reduction in liquidity.

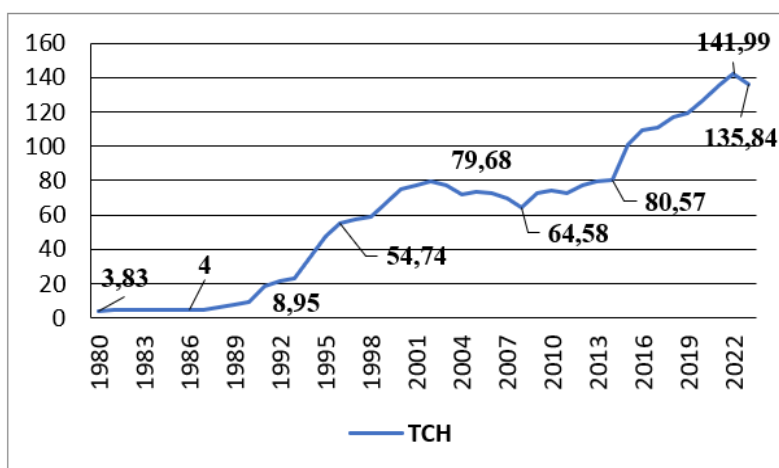
Between 2000 and 2014, the money supply gradually recovered, reaching nearly 71% of GDP in 2014, alongside rising oil prices that boosted foreign exchange reserves and stimulated economic growth. The money supply grew in parallel with the influx of oil revenues.

Since 2015, the money supply has remained relatively stable, fluctuating around 70% of GDP, with notable variations. In 2020, it surged to a record 84,87% due to a substantial injection of liquidity by the government in response to the economic impact of the COVID-19 crisis, combined with a contraction in nominal GDP. Following 2020, the money supply slightly decreased but remains elevated, reflecting ongoing efforts to support liquidity and stimulate economic activity.

II-2-3-The evolution of the exchange rate in Algeria:

The chart below presents the evolution of the Algerian dinar exchange rate against the U.S. dollar from 1980 to 2023.

Figure n°6: Evolution of the Algerian dinar exchange rate in U.S. dollars (1980-2023).



Source: Constructed by us using data from the bank of Algeria.

The evolution of the Algerian dinar exchange rate, illustrated in graph n°6, highlights a strong correlation with Algeria's dependence on oil revenues. Devaluation periods generally correspond to drops in oil prices, while phases of stability or appreciation align with increases in hydrocarbon prices and the accumulation of foreign exchange reserves. These exchange rate adjustments have often served as a tool to restore macroeconomic balance in response to external shocks or economic crises.

Between 1980 and 1989, the chart shows a slight depreciation of the dinar, from 3,83 to 5,02 DZD per 1 USD, in a context of relative economic stability supported by oil revenues. A slight appreciation is visible in 1986 (4,70 DZD per 1 USD), a consequence of the sharp drop in oil prices, which led to exchange rate adjustments aligned with the country's foreign exchange reserves.

In the 1990s, the chart reflects a series of massive devaluations, with the dinar falling from 8,95 DZD per 1 USD in 1990 to 66,57 DZD in 1999. These significant declines occurred in the context of an economic, political, and security crisis, accompanied by drastic economic reforms under the guidance of the IMF. The 1994 devaluation is particularly striking, with the exchange rate going from 23,34 DZD in 1993 to 47,66 DZD in 1995, reflecting efforts to stabilize the balance of payments and reduce the budget deficit.

Between 2000 and 2008, some stabilization is visible on the chart, with the exchange rate fluctuating between 64 and 75 DZD per 1 USD. This period coincided with rising oil prices, which allowed the government to strengthen its foreign exchange reserves and stabilize the currency. The appreciation observed in 2008 (64,58 DZD per 1 USD) reflects prudent management of foreign exchange reserves and a favorable global environment for hydrocarbons.

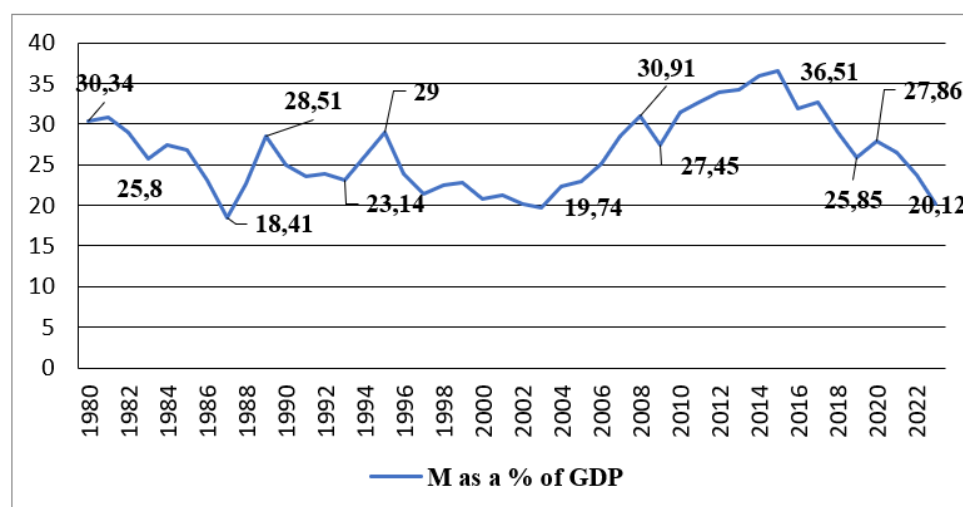
After 2008, a clear trend of gradual depreciation is evident on the chart, with the exchange rate reaching 119,35 DZD per 1 USD in 2019. This period was marked by oil shocks, particularly the 2014 price drop, which significantly reduced state revenues and put increasing pressure on the dinar.

Finally, between 2020 and 2023, the chart illustrates a rapid new devaluation, notably following the COVID-19 crisis and the decline in global oil demand. The dinar reached 126,77 DZD per 1 USD in 2020, peaking at 141,99 DZD in 2022. This devaluation reflects efforts to adjust the exchange rate to economic realities and offset the decline in foreign exchange reserves. A slight improvement in 2023, with an exchange rate of 135,84 DZD per 1 USD, indicates a partial recovery of the global economy and a moderate rise in hydrocarbon prices.

II-2-4- The evolution of Algeria's imports as a percentage of GDP:

The evolution of imports as a percentage of GDP in Algeria reflects complexity tied to various economic and political factors. Graph n°7 illustrates that the evolution of Algeria's imports has experienced several interesting trends over the period 1980–2023:

Figure n°7: Evolution of Algeria's imports as a % of GDP (1980–2023)



Source: Prepared by us based on World Bank data

We observe a general upward trend in imports as a percentage of GDP, especially since the early 2000s. Imports increased significantly from 2000, peaking in 2014 at 36,51% of GDP.

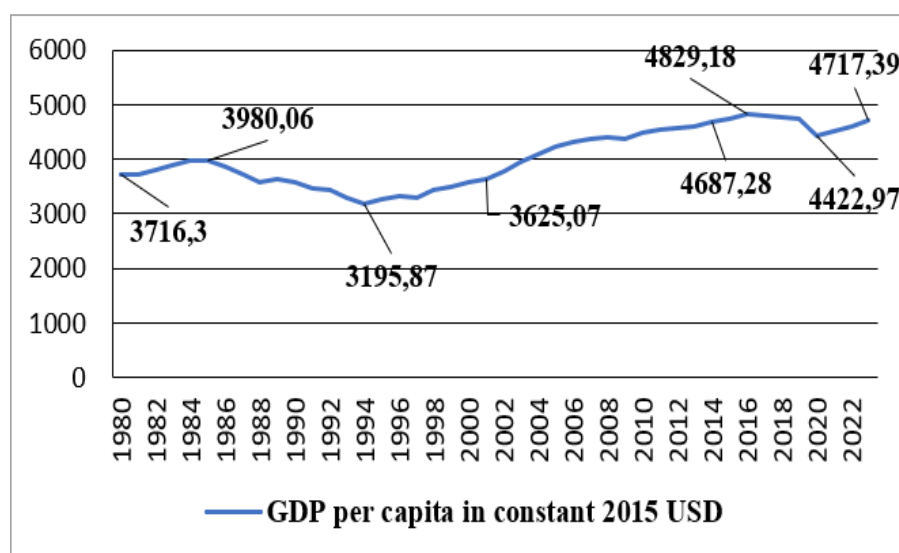
The 2000s, particularly from 2004 onward, show a substantial rise in imports. This period coincides with increased oil revenues, allowing Algeria to import more. After the peak in 2014, imports as a percentage of GDP began to decline, especially after 2016. The decrease continued until 2023, when they fell back to 20,12%. This reduction could reflect efforts to lessen dependency on imports. The observed variations may be influenced by oil prices, domestic economic policies,

and changes in internal demand. Periods of strong economic growth are often associated with increased imports, while times of economic slowdown or crisis may lead to reduced imports.

II-2-5- The evolution of GDP per capita in constant 2015 \$ over the Period 1980–2023:

The graph above illustrates the evolution of Algeria's GDP per capita from 1980 to 2023, highlighting several distinct phases in the country's economic growth.

Figure n°8: Evolution of GDP per capita in constant 2015 dollars



Source: Prepared by us based on world bank data

Between 1980 and 1985, we observe that GDP per capita varied between \$3,700 and \$3,980, indicating relative stability during this period. This corresponds to a time when oil prices were relatively high, supporting national revenues. Algeria benefited from an economy largely based on hydrocarbons, which is reflected in the stability of GDP per capita. After 1985, a gradual decline was observed, with GDP per capita falling from \$3,980 in 1985 to \$3,195 in 1994. The 1986 oil crisis, marked by a sharp drop in oil prices, severely impacted Algeria's economy, which was (and remains) heavily dependent on hydrocarbon exports. This led to a contraction in per capita income during this period, accompanied by economic reforms and structural adjustments in the 1990s.

Starting in 1996, GDP per capita began to recover, reaching \$4,687 in 2014. This period coincided with rising oil prices and political stabilization following the turmoil of the 1990s. Increased revenue from hydrocarbon exports enabled the government to invest in development programs and infrastructure, thereby supporting economic growth. Between 2000 and 2014, this growth was continuous, illustrated by a steady increase in GDP per capita, supported by high oil prices and relatively stable economic management.

After 2014, stagnation occurred, with GDP per capita oscillating around \$4,700–\$4,800. This period coincided with the decline in oil prices from 2014 onwards, which reduced Algeria's foreign currency revenues and slowed economic growth. Despite efforts to diversify the economy, Algeria remains dependent on hydrocarbons, explaining this stagnation in per capita income.

In 2020, due to the COVID-19 pandemic and the global drop in oil demand, GDP per capita fell sharply to \$4,422. The health crisis exacerbated existing economic difficulties, leading to a significant contraction in economic activity. However, from 2021 onwards, a moderate recovery was observed, with GDP per capita reaching \$4,717 in 2023, showing slight improvement partly due to the recovery in hydrocarbon prices and economic measures implemented to stimulate the economy post-pandemic.

III-Methodology and model specification:

Various econometric studies on oil shocks converge on the relationship between economic growth and oil price levels. In what follows, we propose an econometric study aimed at empirically examining the short- and long-term relationship between economic growth and oil price fluctuations in Algeria over the period 1980 to 2023.

To this end, the Autoregressive Distributed Lag (ARDL) model, developed by Pesaran et al. (2001), was selected due to its relevance in testing the existence of a long-term relationship. The economic literature was consulted to identify the key variables to include in the model, which takes the following form:

$$PIBH = f(PP, M2, MBS, TCH)$$

To smooth out measurement discrepancies among the different series, the logarithm was applied to the base model, resulting in the following final form:

$$\text{Log PIBH} = \alpha + \beta_1 \text{Log PP} + \beta_2 \text{Log M2} + \beta_3 \text{Log MBS} + \beta_4 \text{Log TCH} + \varepsilon$$

Where:

- **PIBH**: GDP per capita
- **PP**: Average oil price
- **M2**: Money supply as a percentage of GDP
- **MBS**: Imports of goods and services as a percentage of GDP
- **TCH**: Exchange rate

III-1-Univariate analysis of the series:

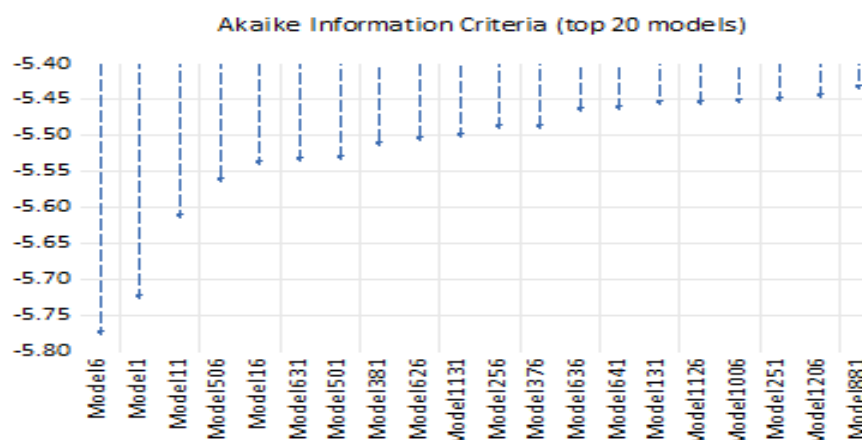
For proper interpretation of the results and to avoid spurious regressions, it is essential to first verify the stationarity of the time series in our model. To assess the stationarity of the series, the Augmented Dickey-Fuller (ADF) test is applied. The results of the stationarity analysis (see Table n°1 in Appendix n°1) indicate that the LMBS series is stationary at level (i.e., integrated of order zero), while the four variables LPIBH, LM2, LPP, and LTCH are stationary at first difference (i.e., integrated of order one). It is worth noting that none of the series is integrated of order 2, which satisfies the conditions for implementing the ARDL cointegration model and allows testing for long-term relationships between variables with different integration orders.

III-2- Multivariate analysis of the series:

In this section, we estimate the ARDL model related to the impact of oil price fluctuations on economic growth in Algeria and apply the "Bounds Test" for cointegration. To do this, it is necessary to determine the lag structure in the ARDL model to avoid misspecification of the model's dimensions. Econometricians recommend using Akaike Information Criterion (AIC) or Schwarz Criterion (SC), which test a set of twenty lag combinations and select the one that minimizes the result.

The estimation results of the optimal ARDL model selected using Eviews 12 from the top 20 models are: ARDL (4,4,4,3,4), which corresponds to the lowest AIC value.

Figure n° 9: Akaike information criterion



Source: Prepared by us based on the results from Eviews 12

III-2-1- The autoregressive distributed lag model (ARDL):

After determining the optimal number of lags for the ARDL model, the next step is to estimate the model, which will later serve as the basis for conducting the Bounds test. This test will confirm or refute the presence of a cointegration or long-term relationship. The estimation results of the ARDL model are presented in Table 2 (see Appendix n°2).

The estimation results of the ARDL model indicate that the student's t-statistics values associated with the calculated coefficients of the exogenous variables are almost all greater than the critical value from the student's table (1,96). In the short term, it is observed that GDP positively depends on the variation of its own lagged values, the variation in oil prices, the one-period lagged variation in the money supply (M2), and the lagged variations in the exchange rate. The goodness of fit, measured by the R² statistic (99,69%), shows that almost the entire variability of GDP per capita is explained by the variables in our model. Additionally, the Fisher statistic, which exceeds its critical value at the 5% threshold, indicates a high level of precision in the model's fit.

III-2-2-The results of the cointegration test (Bounds Test):

After estimating the model, the next step is to determine whether the variables share a long-term relationship. To do so, we test for the presence of a long-term relationship using the ARDL Bounds test.

Table n°1: Results of Pesaran's cointegration test

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
Asymptotic: n=1000				
F-statistic	9.084232	10%	2.2	3.09
k	4	5%	2.56	3.49
		2.5%	2.88	3.87
		1%	3.29	4.37

Source: Prepared by us based on the results from Eviews 12

III-2-3-The short-term relationship:

In our case, the results of the "Bounds test" procedure show that the Fisher statistic ($F = 9.08$) exceeds the upper bound of the critical values interval at the 5% threshold (Table n°1), confirming the existence of a long-term relationship between GDP per capita (PIBH) and its determinants considered in this study.

To examine the short-term relationship between the variables in our model, the Error Correction Model (ECM) test was conducted, with the results presented in Table n°3 (see Appendix 3).

The short-term results reveal a positive dependence of the growth rate on its past values. As in many resource-dependent economies, this phenomenon may be influenced by several factors related to economic structure and historical dynamics. In Algeria, economic growth is strongly tied to its past performance due to structural dependence on hydrocarbon revenues, capital accumulation, and an economic dynamic where past successes create opportunities and resources for future growth.

The variations in oil prices have a positive short-term impact on economic growth, mainly due to the significant role of the hydrocarbon sector in national income, public revenue, and the government's ability to stimulate domestic demand through increased investment and spending during periods of high prices.

The negative and significant coefficients in the short-term relationship between the money supply and economic growth in Algeria may be explained by inflationary effects. A rapid increase in the money supply can lead to price hikes, especially in an import-dependent economy like Algeria's. Inflation erodes household purchasing power, reducing consumption and overall demand, which negatively impacts short-term economic growth. Other factors, such as imbalances between liquidity and productivity or poor resource allocation, may also contribute. These elements can neutralize or even reverse the expected effect of an increased money supply on economic growth, at least in the short term.

The negative impact of the exchange rate and imports on Algeria's economic growth can be attributed to import dependence, trade imbalances, imported inflation, and pressure on the exchange rate. An increase in imports leads to higher demand for foreign currencies, depreciating the national currency and making imports more expensive. This intensifies domestic inflation, reduces household purchasing power, increases business costs, and hampers investment, thus contributing to lower economic growth.

Moreover, the term $\text{cointEq}(-1)$ corresponds to the lagged residual from the long-term equilibrium equation. Its estimated coefficient is negative (-1,12) and highly significant ($p\text{-value} = 0,00$), ensuring an error correction mechanism and thus the existence of a long-term relationship (cointegration) among variables. This coefficient, which reflects the speed at which economic growth returns to the long-term target, is estimated at -1,129 in our ARDL model. This means that once the model deviates from equilibrium, it adjusts by 112,9% within the same period. The overall quality of the model is good, as evidenced by $R^2 = 91,5\%$.

III-2-3-The long-term relationship:

The results in Table n°4 (see Appendix 4) provide insights into the elasticities of the endogenous variable relative to the other exogenous variables.

An analysis of Table 5 shows that a 1% increase in oil prices leads to a 0,04% rise in GDP per capita, highlighting Algeria's heavy dependence on hydrocarbons. This relationship can be explained by several factors: increased export revenue improves the trade balance and stimulates

economic growth; higher investment, facilitated by increased oil revenues, boosts domestic demand and consumption. Additionally, oil revenues have spillover effects on other sectors such as construction, services, and transportation, contributing to GDP growth. While the impact is not entirely proportional, it underscores the critical importance of the oil sector for Algeria's economy.

The impact of an oil shock on Algeria's economy depends on the nature of the shock positive or negative. A rise in oil prices can increase public revenue and stimulate economic growth, whereas a decline can reduce income, increase budget deficits, cause currency depreciation, and trigger inflation. In all cases, prudent management and appropriate economic policies are crucial to mitigating negative effects and maximizing potential benefits.

We observe that a 1% increase in the money supply (M2) leads to a 0,30% rise in GDP per capita. This phenomenon can be attributed to the stimulating effect of increased liquidity in the economy. Such an increase facilitates consumer and business spending. With more money in circulation, households can boost consumption, while businesses benefit from lower interest rates, making borrowing cheaper. This encourages investment in new projects, equipment purchases, and hiring, increasing the economy's productive capacity and raising GDP per capita. Overall, an increase in the money supply stimulates aggregate demand, investment, and consumption, fostering GDP per capita growth.

In the long term, the exchange rate and imports of goods and services have a positive impact on Algeria's GDP. This can be explained by several factors: a favorable exchange rate policy improves export competitiveness and optimizes the trade balance; access to technologies and capital goods diversifies the economy and supports various industrial sectors; and infrastructure and service development strengthen a more diversified economic structure. These combined elements contribute to sustainable economic growth and reinforce Algeria's economy.

III-2-4- Model validation tests:

To validate the results of our model estimation, it is necessary to subject them to a series of validation tests, including tests for autocorrelation, heteroscedasticity, normality, and coefficient stability.

Table n°2: Residuals test results

	The Test	Value	P-value
Heteroscedasticity	Breusch-Pagan-Godfrey	0,65	0,82
Heteroscedasticity	ARCH	0,65	0,42
Autocorrelation	Breusch-Godfrey	0,002	0,99
Normality	Jarque-Berra	5,11	0,07
Stability	Ramsey (Fisher)	0,26	0,79

Source :Prepared by us based on the results from Eviews 12.

To conclude our analysis, we will test the econometric robustness of our ARDL model. These statistical tests aim to assess the quality of residuals, including homoscedasticity, autocorrelation, and error normality. Additionally, we test the stability of the model coefficients to determine whether the model remains fully significant.

Based on the results of the various tests conducted, we reject the hypothesis of heteroscedasticity [ARCH (0,42 > 0,05), Breusch-Pagan-Godfrey (0,82 > 0,05)], and accept the hypothesis of serial independence [Breusch-Godfrey (0,99 > 0,05)]. Similarly, for the normality test

[Jarque-Bera ($0,07 > 0,05$)] and stability test [Ramsey-Fisher ($0,79 > 0,05$)], the results exceed the 5% threshold, leading us to accept the null hypothesis for each test.

Moreover, according to the results of the CUSUM and CUSUM of Squares tests (see appendix n°05), we also observe that the recursive residuals consistently remain within the confidence interval at the 5% threshold. Therefore, the coefficients are stable over time, and we accept the hypothesis of structural stability throughout the duration of our study.

Results:

The results of our econometric study highlight several key dynamics for the Algerian economy. In the short term, economic growth is positively influenced by its past performance, a phenomenon linked to the country's heavy reliance on oil revenues. An increase in oil prices stimulates the economy through higher state revenues, which boosts investment and consumption. However, a rapid increase in the money supply may have a negative short-term impact, primarily due to inflationary pressures. Moreover, the exchange rate and imports have a detrimental effect on growth, due to the reliance on imports and trade imbalances.

In the long term, the impact of oil prices remains significant, illustrating Algeria's ongoing dependence on hydrocarbons. Negative shocks to the oil market can, however, slow down economic growth. The increase in the money supply, on the other hand, supports long-term growth by encouraging consumption and investment. Finally, appropriate management of the exchange rate and imports could offer long-term economic benefits by diversifying the economy and strengthening competitiveness.

Conclusion:

The aim of this research was to examine the impact of oil shocks on economic growth in Algeria using the ARDL model for the period 1980–2023.

The analysis confirmed the existence of a long-term relationship among the variables studied. Oil shocks, whether positive or negative, have a complex impact on economic growth in Algeria. The findings indicate that increases in oil prices can stimulate economic growth both in the short and long term by increasing revenues available for public spending, investment, and consumption. However, an excessive dependence on oil revenues exposes the Algerian economy to market volatility and hinders economic diversification.

Conversely, declines in oil prices pose economic challenges, affecting public finances, reducing investments, and straining the state budget. The resilience of Algeria's economy to these shocks depends on its ability to diversify its revenue sources and implement appropriate economic policies.

It is crucial to note that oil shocks are only one of many factors influencing economic growth. Other elements, such as government policies, structural reforms, political stability, global economic conditions, and exchange rate fluctuations, also play significant roles.

To fully understand the impact of oil shocks, it is recommended to conduct in-depth analyses using different econometric approaches while considering Algeria's specific economic and political context. Economic diversification and the adoption of sustainable policies are essential to strengthen the country's economic resilience.

The findings of this study highlight Algeria's significant dependence on oil prices, emphasizing the need for the Algerian government to encourage private investment, diversify the economy, and promote alternative energy sources. Achieving this transformation will require structural reforms, a long-term vision, and political commitment to foster sustainable and inclusive growth.

Finally, it is important to note that the results of this study are not exhaustive due to the limited number of variables. Future studies could include additional variables such as public spending, investments, and exports.

Suggestions :

- Algeria should invest in non-hydrocarbon sectors such as manufacturing, agriculture, tourism, and information technology to reduce its dependence on oil revenues and ensure greater economic diversification.
- Private sector investments must be encouraged through tax reforms, administrative simplifications, and streamlined procedures to attract both domestic and foreign investors.
- The development of renewable energy sources, such as solar and wind power, should be prioritized to diversify Algeria's energy mix and generate alternative revenue streams.
- Structural and institutional reforms are essential to improve economic governance, strengthen public institutions, and implement stable and predictable economic policies.
- Establishing a sovereign wealth fund to manage budget surpluses during periods of high oil prices could help finance strategic investments and ensure financial stability during economic downturns.

- Promote innovation and scientific research by allocating resources to universities and research centers, with a focus on strategic sectors such as renewable energy, sustainable agriculture, and new technologies.
- Develop an efficient logistical infrastructure (ports, roads, industrial zones) to facilitate trade and encourage the export of non-hydrocarbon products.
- Strengthen vocational training and education to align workers' skills with the needs of emerging and diversified sectors of the economy.
- Encourage public-private partnerships in key sectors such as infrastructure, renewable energy, and agriculture to mobilize additional resources and share risks.

Appendices:

Appendix n°1:

Table n°1: Results of the stationarity tests (ADF Test)

Variables	ADF Test in Level						ADF Test in Difference	
	T-statistic	Model 3		Model 2		Model 1	Model 1 or Model 2	Order ofDS
		TADF	Ttrend	TADF	Tconst	TADF	TADF	
LPIBH	Calculated T	-2.71	2.80	-0.61	0.63	0.95	-3.86	I(1)
	Tabulated T	-3.52	2.81	-2.93	2.56	-1.94	-1.94	
LPP	Calculated T	-2.34	2.18	1.10	1.16	0.27	-6.62	I (1)
	Tabulated T	-3.52	2.81	-2.93	2.56	-1.94	-1.94	
LM2	Calculated T	-1.40	0.73	-1.28	1.30	0.30	-5.30	I(1)
	Tabulated T	-3.52	2.81	-2.93	2.56	-1.94	-1.94	
LMBS	Calculated T	-1.86	0.34	-1.87	1.84	-2.68	-	I(0)
	Tabulated T	-3.52	2.81	-2.93	2.56	-1.94	-	
LTCH	Calculated T	-1.06	0.38	-1.68	2.29	1.31	-2.50	I(1)
	Tabulated T	-3.52	2.81	-2.93	2.56	-1.94	-1.94	

Source: Prepared by us based on Eviews 12 results.

Appendix n°2:

Table n°2. Estimation Results of the ARDL Model

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LPIBH(-1)	0.688425	0.173874	3.959340	0.0011
LPIBH(-2)	0.078099	0.219151	0.356372	0.7262
LPIBH(-3)	-0.558218	0.207976	-2.684056	0.0163
LPIBH(-4)	-0.337551	0.145403	-2.321487	0.0338
LPP	0.029971	0.010192	2.940733	0.0096
LPP(-1)	0.007990	0.012887	0.619974	0.5440
LPP(-2)	-0.003638	0.013150	-0.276655	0.7856
LPP(-3)	-0.018125	0.013754	-1.317782	0.2061
LPP(-4)	0.035002	0.013067	2.678637	0.0165
LM2	0.044948	0.040669	1.105209	0.2854
LM2(-1)	0.200279	0.041711	4.801575	0.0002
LM2(-2)	0.014861	0.047433	0.313296	0.7581
LM2(-3)	-0.042109	0.040317	-1.044432	0.3118
LM2(-4)	0.128308	0.037603	3.412177	0.0036
LMBS	0.017971	0.028912	0.621572	0.5430
LMBS(-1)	0.057380	0.031116	1.844082	0.0838
LMBS(-2)	0.035396	0.039381	0.898812	0.3821
LMBS(-3)	0.063064	0.032375	1.947917	0.0692
LTCH	-0.035331	0.024888	-1.419578	0.1749
LTCH(-1)	0.080635	0.033124	2.434338	0.0270
LTCH(-2)	-0.081814	0.036306	-2.253478	0.0386
LTCH(-3)	-0.011627	0.036197	-0.321221	0.7522
LTCH(-4)	0.099264	0.027123	3.659715	0.0021
C	7.025788	1.131617	6.208629	0.0000
R-squared	0.996902	Mean dependent var		8.299467
Adjusted R-squared	0.992448	S.D. dependent var		0.134657
S.E. of regression	0.011702	Akaike info criterion		-5.774375
Sum squared resid	0.002191	Schwarz criterion		-4.761047
Log likelihood	139.4875	Hannan-Quinn criter.		-5.407988
F-statistic	223.8282	Durbin-Watson stat		1.932147
Prob(F-statistic)	0.000000			

Source: Prepared by the authors based on the results from Eviews 12

Appendix n°3:

Table n°3. Estimation of the Error Correction Model (ECM)

ECM Regression Case 2: Restricted Constant and No Trend				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LPIBH(-1))	0.817670	0.114571	7.136823	0.0000
D(LPIBH(-2))	0.895770	0.135968	6.588097	0.0000
D(LPIBH(-3))	0.337551	0.117286	2.878006	0.0109
D(LPP)	0.029971	0.007272	4.121255	0.0008
D(LPP(-1))	-0.013239	0.008345	-1.586536	0.1322
D(LPP(-2))	-0.016877	0.008948	-1.886229	0.0776
D(LPP(-3))	-0.035002	0.009171	-3.816627	0.0015
D(LM2)	0.044948	0.029256	1.536347	0.1440
D(LM2(-1))	-0.101060	0.035466	-2.849539	0.0116
D(LM2(-2))	-0.086200	0.026148	-3.296550	0.0046
D(LM2(-3))	-0.128308	0.026593	-4.824961	0.0002
D(LMBS)	0.017971	0.018378	0.977862	0.3427
D(LMBS(-1))	-0.098460	0.023639	-4.165200	0.0007
D(LMBS(-2))	-0.063064	0.023344	-2.701539	0.0157
D(LTCH)	-0.035331	0.017728	-1.992881	0.0636
D(LTCH(-1))	-0.005823	0.021195	-0.274739	0.7870
D(LTCH(-2))	-0.087637	0.018787	-4.664665	0.0003
D(LTCH(-3))	-0.099264	0.021528	-4.610989	0.0003
CointEq(-1)*	-1.129245	0.133512	-8.458033	0.0000

Source: Prepared by the authors based on the results from Eviews 12

Appendix n°4:

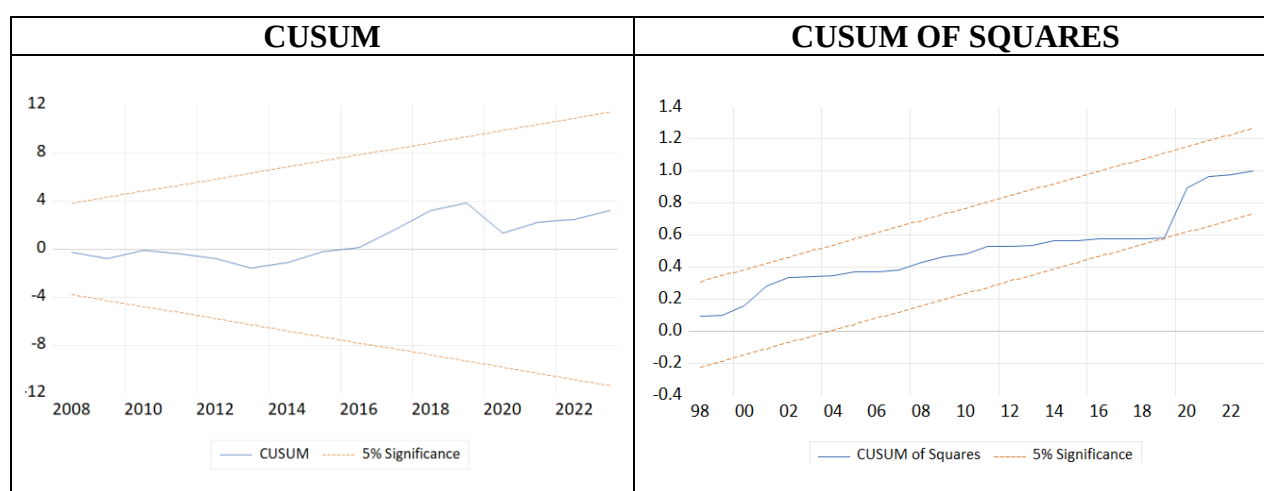
Table n°4. Estimation of the Long-Term Relationship

Levels Equation Case 2: Restricted Constant and No Trend				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LPP	0.045340	0.015155	2.991773	0.0086
LM2	0.306654	0.020107	15.25102	0.0000
LMBS	0.153917	0.041681	3.692747	0.0020
LTCH	0.045276	0.003211	14.09904	0.0000
C	6.221668	0.136170	45.69041	0.0000

Source: Prepared by the authors based on the results from Eviews 12

Appendix n°5:

Figure n°1: Results of the CUSUM and CUSUM of Squares Test for Stability



Source :Prepared by us based on the results from Eviews 12.

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