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Effect Of Oil Shocks on Economic Growth in The Republic of Congo Between 2000 And 2024: An Analysis Using the ARDL Approach

Mack Deny Yila Mabiala, Grâce Paradis MycksonII Mampila, Christ Durhel Yila Moutelet, Marina Eudoxie Yila Ndoulou

Abstract
This article analyzes the impact of oil shocks on economic growth in the Republic of Congo within the framework of resilient energy based on productive investment. The ARDL/ECM model shows that between 2000 and 2024, imbalances were corrected quickly, with an adjustment speed estimated at about one year. A 20 percent increase in oil prices, combined with gross fixed capital formation (GFCF) averaging 37 percent, leads to a 5.7 percent decline in GDP. This confirms the country's energy vulnerability. However, when GFCF reaches 77 percent, the effect of oil shocks becomes positive, thus serving as a buffer. Over the study period, secondary education proves to be nonsignificant in the long term, while institutions, although fragile, remain crucial for sustainable growth.

Keywords: ARDL/ECM, Republic of Congo, economic growth, oil shocks.
JEL codes: E3, E31, E32, O4, O41.

Introduction

Economic growth, defined as the sustained increase in real gross domestic product over a period of time [De La Croix and Baudin, 2015], has long been the central objective of public policy for countries, and is of paramount importance in macroeconomic issues. Many countries around the world, such as the Republic of Congo, have economies closely linked to energy markets, with significant implications for nations with oil resources [AfDB, 2022]. According to the African Development Bank (2023), oil accounts for between 50 percent and 85 percent of export revenues and 30 percent to 70 percent of public revenues in the countries of the Central African Economic and Monetary Community (CEMAC).

For several decades, these countries have seen their growth affected by fluctuations in oil prices [World Bank, 2023; Azerki and Van der Ploeg, 2007; Hamilton, 2003], with major oil shocks. These shocks are defined as sudden and significant disruptions in the global oil market leading to sharp price fluctuations, usually caused by geopolitical, economic, or health events [Hamilton, 2003; IMF, 2021; Linternaute, 2022]. They are a direct result of fluctuations in international prices and have marked contemporary economic history, notably with the OPEC embargo in 1973, the Iranian revolution and the Iran-Iraq war in 1979, the surge in prices with the global financial crisis in 2008, the collapse in prices due to overproduction and shale oil in 2014, and the fall in global demand linked to the COVID-19 pandemic in 2020 [World Bank, 2023; AfDB, 2022] and illustrate the vulnerability of oil economies [Hamilton, 1983; Sachs and Warner, 1995]. Analyses by the International Monetary Fund (2022) and the World Bank (2023) confirm the rule, showing that these shocks mainly result in high volatility in GDP, budget revenues, and investment, reinforcing macroeconomic vulnerability in the absence of productive diversification and effective stabilization mechanisms.

These results justify analyzing the impact of oil shocks on Congolese economic growth, not only to better understand the transmission mechanisms in a context of extreme dependence, But also to provide elements for diversification and macroeconomic stabilization strategies in a context of energy resilience.

The economic literature on this subject is based on Hotelling's rule, which allows analyzing fluctuations in oil prices as the expression of the rent associated with a non-renewable resource. According to Hotelling and Gray (1931), oil is a finite resource whose current extraction causes a loss of future value, the oil rents; thereby ensuring its intertemporal valuation. In this context, oil shocks correspond to adjustments in the economic value of natural resources [Gylfason and Warner, 2016]. They result directly from the characteristics of non-renewable resources, defined as finite natural endowments whose exploitation determines macroeconomic trajectories [Miller, 2018].

Theoretical literature generally distinguishes two major schools of thought. The first suggests that oil shocks can stimulate economic growth by generating favorable effects, such as increased revenues and investment opportunities. The second maintains that these shocks exert a negative influence on economic activity, primarily through rising production costs, inflationary pressures, and macroeconomic imbalances.

Two groups of studies emerge. The first focuses on the positive effects of oil shocks on economic growth. The works of Hamilton (1983), Kilian (2009), Arezki and al. (2007), Gunu and Kilishi (2020), and Ngachili (2021) highlight the positive or conditional effects of oil shocks on growth. They suggest that oil shocks can support economic performance, particularly in oilexporting countries, but under specific conditions related to the nonlinearity of the effects, the time horizon considered, and the quality of governance. The second group examines the negative effects of oil shocks on economic growth. The studies of Mork (1989), Hamilton (1996), Sachs and Warner (1995), Englebert and Ron (2004), Raguindin and Reyes (2015), Rahimli (2020), and Djellouli and Abdelli (2020) emphasize the negative and asymmetric impacts of oil shocks, underscoring the heightened risks of macroeconomic volatility, resource dependence, and structural imbalances.

The main lesson from this literature is that oil shocks have ambivalent effects on economic growth: they can support short-term activity in exporting countries, but increase volatility and structural imbalances. These findings open up avenues for analysis of nonlinear effects and the mediating role of institutions, as well as the influence of productive diversification on the sustainability of long-term growth. This raises the following question: what is the effect of oil shocks on economic growth in the Republic of Congo?

The hypothesis tested is that *oil shocks significantly influence economic growth in the Republic of Congo.*

To test this hypothesis, the methodology employs the Autoregressive Distributed Lag (ARDL) model in the form of an error correction model (ECM), which is useful because it can simultaneously analyze the short- and long-term effects of oil shocks on economic growth, while taking into account the mixed nature of the time series and the specificity of the data available for the Republic of Congo for the period from 2000 to 2024.

The article is structured as follows: first, the conceptual framework followed by a review of the literature; then the methodology, results, and discussions; and finally, the conclusion and economic policy implications.

1. Conceptual framework and literature review

1.1. Conceptual framework

Economic growth is generally defined as a sustained increase in an economy's productive capacity, measured by real GDP at constant prices to neutralize the effect of inflation. The approaches of Kuznets (1971), Piketty (2013), and Passaga and Salin (2021) converge on the idea that growth relies on the accumulation of production factors, technological progress, and institutional transformation. Kuznets' approach is adopted here because it explicitly incorporates sustainability, economic diversification, and the role of institutions.

Oil shocks are understood as sudden variations in prices or revenues resulting from imbalances between supply and demand in global markets. According to the International Energy Agency (IEA, 2014), such shocks negatively affect production, consumption, and investment, thereby undermining macroeconomic stability.

It focuses mainly on the relationship between oil shocks and economic growth. Oil shocks have ambivalent effects on exporting economies: rising prices can temporarily boost growth by increasing revenues, while sudden declines trigger deficits, reduced investment, and instability. Long-term resilience depends on diversification, technological progress, and strong institutions to reduce dependence on oil revenues and stabilize growth.

1. 1. 1. Structural dependence exposes economies to external shocks

The oil embargo declared by OPEC in October 1973, in response to the Yom Kippur War (Egypt-Syria against Israel), caused acute geopolitical tensions. Arab producing countries reduced their supplies, quadrupling the price of a barrel (from USD 3 to 12), which led to global inflation and recession. The Iranian revolution of 1979 overthrew the Shah and paralyzed Iranian oil exports (10 percent of the world supply). Combined with sustained global demand (post-recession) and the Iran-Iraq war (1980), it doubled prices (up to USD 40 per barrel), worsening stagflation [Linternaute, 2022].

1. 1. 2. Oil sector in the Republic of Congo

The Republic of Congo has become one of the main oil producers in sub-Saharan Africa since production began at the Loango oil field in 1972. Its economy remains structurally dependent on hydrocarbons, which account for 85 to 90 percent of exports and 60 to 70 percent of budget revenues [World Bank, 2024]. The oil price trend used in this article (Cycle_Pb) is calculated to approximate oil shocks in the Republic of Congo. This variable results from the application of the Hodrick and Prescott (1997) filter (HP) to decompose the Brent crude oil price series into two components: a trend and a cycle. This process is illustrated in Figures 1 and 2 below.

1998 to 2010 : Growth and volatility.

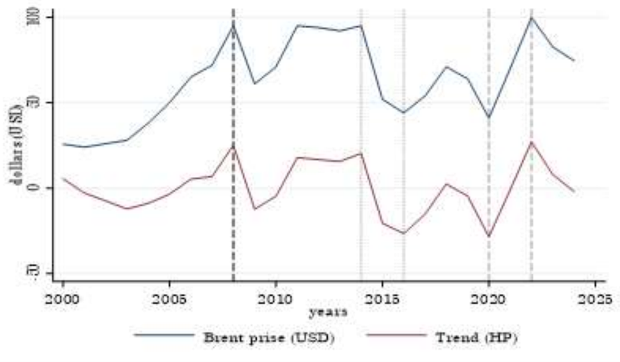
Oil production rose from 53.2 million barrels in 1998 to 81.7 million in 2003, then to 114 million in 2010 thanks to the development of new fields. The sector then accounted for nearly two-thirds of GDP, supporting average annual growth of between 3.5 percent and 10.3 percent.

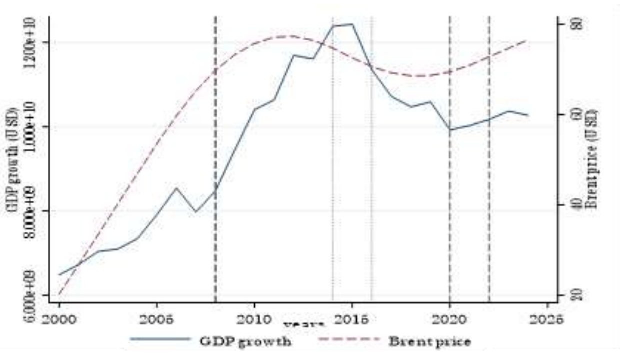
2000 to 2007: First oil boom.

The rise in Brent crude from USD 25 to USD 70 was accompanied by GDP growth from USD 6 billion to USD 9 billion. This favorable phase was based on increased export revenues and public finances, stimulating public investment.

2008: Oil shock and global crisis. Brent crude oil peaked at close to USD 100, generating a record budget surplus of about USD 2.9 billion (equivalent to EUR 2 billion). However, the global financial crisis caused a temporary slowdown in growth, revealing the Congolese economy's high sensitivity to oil price fluctuations. In particular, the 2008 crisis had mixed effects. While the initial surge in prices led to a temporary increase in export revenues, the rapid collapse of prices highlighted the lack of effective macroeconomic stabilization mechanisms [Arezki and Van der Ploeg 2011], and consequently the surge in food products prices [Yila, 2008]. Hence figures 1and 2.

Figure 1 : Oil price trend from 2000 to 2024 Figure **2 :** Growth and oil shocks from 2000 to 2024.





Source: author, using Stata software.

The information in Figures 1 and 2 reveals that between 2000 and 2008, the price of Brent crude oil rose sharply, from around USD 25 to nearly USD 100 per barrel, under the combined effect of strong global growth, particularly in China and India, and relatively rigid supply capacity. This dynamic was reinforced by OPEC quota policies, which limited production increases in order to support prices. The long-term trend derived from the HP filter confirmed this structural uptrend, reflecting a lasting imbalance between supply and demand in the oil market. The international financial crisis of 2008 to 2009, marked by initial restrictive monetary policies followed by massive stimulus plans in the United States and Europe, led to a collapse in the price of Brent crude oil to around USD 40. The trend turned negative, illustrating the effect of a global macroeconomic shock on energy demand. Despite fiscal and monetary support measures, the recovery remained fragile in the short term.

2010 to 2014: Favorable supercycle.

The stabilization of Brent crude oil at around USD 90 to 100 propelled GDP to around USD 12 billion. Oil revenues peaked at USD 7.5 to 8.5 billion in 2015, financing major infrastructure projects and consolidating the dominance of the oil sector [International Monetary Fund and World Bank, 2013].

2014 to 2016: Devastating counter-shock.

The fall in Brent crude to USD 40 to 50 brought GDP back down to USD 10 to 11 billion. The lack of economic diversification amplified the negative impact of this counter-shock, highlighting the country's structural vulnerability, a direct consequence of the boom in shale oil in the United States and OPEC's strategic decision not to reduce production in order to preserve its market share. This can be explained not only by the collapse of the oil cycle, but also by the absence of fiscal stabilization mechanisms.

2017 to 2019: Offshore recovery.

Thanks to the Nene-Banga and Litchendjili fields, average production exceeded 140000 barrels per day in 2017 and peaked at 339000 barrels per day in 2019. The Republic of Congo then positioned itself as the third largest producer in sub-Saharan Africa behind Nigeria and Angola [Chevalier, 2005 ; IMF, 2020]. In 2020, the COVID-19 pandemic and widespread lockdown policies caused a sharp collapse in global demand, causing Brent crude to fall to around USD 35.

The 2021 finance law aims to achieve production of 344000 barrels per day, supported by investments from Total E&P Congo (TotalEnergies EP Congo), Chevron, and Eni in the Moho Nord, Lianzi, and Marine 12 fields. The increase in Brent crude prices to USD 110 to120 in the context of the war in Ukraine led to a revision of the 2022 budget to around USD 2.95 billion, with a 13.4 percent rise in oil revenues representing 52.6 percent of total budgetary resources [IMF, 2022].

The recovery observed in 2021 to 2022, with prices once again exceeding USD 100, is justified by post-pandemic stimulus policies, supply restrictions decided by OPEC+, and geopolitical tensions related to the war in Ukraine. The recent moderation in prices, around USD 75 to 85 in 2023 to 2024, reflects the gradual adjustment of energy policies, the transition to renewable energies, and uncertainties about global growth [PND 2022-2026[1]].

1. 2. Literature review

The theoretical economic literature on the link between growth and oil shocks illustrated in this subsection is divided into two parts: the first is devoted to theoretical examination, while the second focuses on empirical analysis.

1. 2. 1. Theoretical literature on the link between growth and oil shocks

On a theoretical level, the literature generally distinguishes between two major schools of thought. On the one hand,

[1] According to the National Development Plan (2022), production is expected to reach 110.1 million barrels in 2022, 111.7 million in 2023, 124.6 million in 2024, 121.6 million in 2025, and 113 million in 2026. Oil revenues are projected to increase from approximately USD 0.99 billion in 2020 to about USD 1.64 billion in 2022, before declining to roughly USD 1.42 billion in 2026. GDP growth, estimated at 2.5 percent in 2022, is expected to rise to 4.7 percent in 2026, with an intermediate peak of 8.4 percent.

some researchers argue that oil shocks stimulate economic growth by generating a favorable impact. On the other hand, other authors argue that these shocks have a negative influence on economic activity. With regard to the first school of thought, many researchers [Lucas (1988) and Lutz (2018)] highlight the positive role of these effects: the additional revenue generated by price increases or technological innovations in the oil sector can be redirected towards public investment, education, research and development, or infrastructure, triggering a virtuous circle of self-sustaining growth. The second school of thought emphasizes the negative effects: excessive dependence on hydrocarbons exposes economies to price volatility and the "resource curse", while the phenomenon of "Dutch Disease" weakens non-oil sectors [Sachs and Warner, 1995]. Added to this effect is macroeconomic instability.

1. 2. 2. Empirically literature on the link between growth and oil shocks

Empirically, two groups of studies emerge: the first group focuses on the positive effects and the second on the negative effects of oil shocks on economic growth.

Part 1: Positive or conditional effects of oil shocks on growth

Several empirical studies suggest that oil shocks can support economic growth, particularly in oil-exporting countries, but under specific conditions related to the non-linearity of the effects, the time horizon considered, and the quality of governance. Jorgenson (1967), in his study entitled *"Capital Theory and Investment Behavior,"* uses a neoclassical Solow model for the period 1950-1960 for the United States, incorporating gross fixed capital formation (GFCF), total factor productivity, and exogenous oil revenues. His results show that an increase in oil revenues accelerates the accumulation of physical capital, generating 1.2 percent of GDP per 10 percent of GFCF. However, the analysis remains limited by the absence of oil price volatility and failing institutions.

Kydland and Prescott (1982), in their study entitled *"Time to Build and Aggregate Fluctuations,"* use a Real Business Cycle (RBC) model covering the 1970 economic cycles, incorporating temporary oil shocks, intertemporal optimization, and investment duration constraints. Their results conclude that an exogenous oil boom optimizes productive allocation to infrastructure, generating 2.1 percent of potential GDP. However, the analysis remains limited by the optimum hypothesis, which neglects Dutch Disease distortions.

Lucas (1988), in his study entitled *"On the Mechanics of Economic Development,"* uses an endogenous RBC model over the period 1980, incorporating human capital (EDU), learning externalities, and conditional convergence. For this author, oil revenues invested in education generate 0.9 percent of permanent growth. However, the analysis remains limited by the assumption of institutions that promote convergence.

The works of Koutassila (1998), in his dissertation *"The Dutch Disease Syndrome: Theory and Empirical Verification in Congo and Cameroon"*, econometrically tests the Dutch Disease hypothesis over 1970-1995 using Ordinary Least Squares (OLS) regressions on petroleum and non-petroleum sectors. The results reject the classic syndrome in the Republic of Congo (no real appreciation and weak oil–manufacturing transmission) but confirm agricultural crowding-out. Limitations include reliance on aggregated data, lack of endogeneity treatment, and the pre-stabilization context of 1994.

The work of Almutairi (2020), in "*Oil Price Shocks, Economic Growth and Unemployment in Saudi Arabia*," applies a Structural Vector Autoregression (SVAR) model over the period 1980-2018, using real GDP, unemployment, oil prices, and inflation. The results show that the effects of oil shocks differ depending on their nature (supply or demand shocks), with some able to stabilize growth and employment in the short term. However, these conclusions remain sensitive to structural identification assumptions and do not explicitly incorporate institutional dimensions.

For Nigeria, Gunu and Kilishi (2020), in "*Oil Price Shocks and Economic Growth in Nigeria*," estimate a Vector Autoregression (VAR) model for the period 1981-2016, including real GDP, oil prices, unemployment, the consumer price index, and money supply. They confirm a positive impact of oil shocks on growth and highlight a unidirectional causality from oil prices to real GDP. However, their approach does not capture long-term effects or possible asymmetries.

At the regional level, Ngachili (2021), in "*Natural Resource Rents, Governance and Economic Growth in CEMAC Countries*," applies a Vector Error Correction Model (VECM) model over the period 2002-2018, integrating real GDP, natural rents, and governance. He shows that the positive effects of oil shocks on growth are conditioned by institutional quality, although governance is measured in aggregate terms, limiting the analysis of national specificities.

In the same vein, several empirical studies devoted to the Republic of Congo suggest that even if specific conditions are linked to the time horizon, the allocation of oil revenues, and the quality of governance, oil shocks can support economic growth. Kilian (2009), "*Not All Oil Shocks Are Alike*", decomposes supply, demand, and speculative shocks from 1973-2007 using VAR, showing asymmetric negative effects of supply shocks. However, the absence of country-specific indicators limits direct application to the Republic of Congo.

Moussavou (2020), in the *European Journal of Social Law*, examines the impact of inflation on economic growth in CongoBrazzaville over the period 1980-2016 using a VECM. The study incorporates variables such as the inflation rate, money supply, oil prices, gross fixed capital formation, domestic credit to the private sector, and structural adjustment programs. The findings indicate that, in the long run, these lagged variables significantly influence economic growth, while in the short run, inflation and oil shocks exert more volatile effects, partly mitigated by investment and monetary expansion. However, the analysis is limited by its reliance on descriptive macroeconomic data, the absence of more dynamic econometric modeling, and the inability to fully capture the persistence of the observed effects beyond the studied period.

Finally, the World Bank (2019) in "*Congo Economic Update-Oil Dependence*" confirm that the oil booms observed between 2000 and 2018 temporarily supported growth and improved public finances. However, these favorable effects appear to be transitory and highly dependent on the Congolese economy's ability to transform oil revenues into sustainable productive investments, thus supporting the idea that the positive effects of oil shocks in exporting economies are essentially short-term and closely linked to institutional quality.

Part 2: Negative effects of oil shocks on economic growth

The second strand of literature highlights the negative and asymmetric effects of oil shocks on economic growth, emphasizing the increased risks of macroeconomic volatility, resource dependence, and structural imbalances. Sachs and Warner (1995), in their seminal study entitled *"Natural Resource Abundance and Economic Growth,"* analyze the period 1970-1990 for 95 resource-rich countries using a cross-sectional regression model (OLS), incorporating the resource exports/GDP ratio, institutional indicators, trade openness, and human capital. Their results reveal a systematic inverse correlation (-0.62 percent annual growth per +10 points in the resource/GDP ratio) between resource abundance and economic growth, laying the foundations for the "resource curse" via four channels: Dutch Disease, income volatility, corruption, and elite myopia.

In the same sense, the studies of Englebert and Ron (2004), in *"Raw Materials and War: The Ambivalent Curse of Resources in Congo-Brazzaville,"* analyze the role of oil in the conflicts of the 1990s. They show that natural resources can both fuel violence (armed factions, authoritarian regimes) and support stabilization (compromise, reconstruction). The study highlights the ambivalence of the "resource curse", shaped by elite strategies and institutional context. The study remains on political and military dynamics, without exploring in depth the economic mechanisms through which oil rents are transmitted.

Likewise, Djellouli and Abdelli (2020), in their study entitled "Testing The Resource Curse Hypothesis: Evidence *From Republic Of The Congo Over The Period Of 1974-2015 By Using ARDL Approach*," incorporating real GDP, natural resource abundance (percent GDP), financial development, and total exports. Their results confirm the resource curse with a significant negative effect of resources on economic growth, negative short-term financial development, and significant positive exports (1 percent) in the long/short term. However, the analysis remains limited due to its symmetrical nature (absence of NARDL asymmetries), macroeconomic aggregation (without micro-sectoral analysis), and the absence of institutional moderators. For exporting economies, Rahimli (2020) in his article *"Impact of oil prices on the Azerbaijani economy: relationship between oil prices, real effective exchange rates, and real GDP",* based on quarterly data from the first quarter of 2001 to the first quarter of 2020, using a VAR model. The results indicate the existence of Granger causality between oil prices and GDP. Furthermore, by demonstrating that an oil price shock explains 72 percent of the variations in real effective exchange rate fluctuations, it confirmed that the Azerbaijani economy can be considered to be suffering from Dutch disease. Although the results illustrate the positive impact of an oil price shock on GDP in the short term, this impact proves to be negative in the long term.

Similarly, the study by Alouache et al. (2022), in *"Is oil income a lever for economic growth in Algeria?"*, examine the impact of oil price fluctuations on Algeria's economic growth between 1983 and 2020. After testing the stationarity of the series (real GDP and Saharan Brent crude oil price) and applying the Granger causality test, the results show no significant causal relationship between oil price variations and Algeria's economic growth. This conclusion highlights the structural dependence of the Algerian economy on hydrocarbons, while also underscoring the complexity of transmission mechanisms, thereby confirming the need for diversification and stronger governance.

With regard to Congolese growth, there is a high level of macroeconomic vulnerability linked to oil dependence. The World Bank (2019), in *"Congo Economic Update-Oil Dependence,"* emphasizes that negative oil shocks are more lasting and costly than positive shocks, revealing a strong asymmetry in effects. This dynamic confirms that oil dependence, combined with limited institutional capacities, increases the macroeconomic vulnerability of the Congolese economy.

Finally, Ayessa and Hakizimana (2021), in *"Effects of Political Instability on Economic Growth in the Republic of Congo"*, apply the ARDL model to the period 1986–2017, focusing on political instability (conflicts/elections), real GDP, and oil shocks (Δprice). They demonstrate that instability, exacerbated by oil price declines, significantly hampers growth through social tensions. However, the absence of an explicit instability–shock interaction constrains causal analysis, underestimates the endogeneity of oil price declines, and thereby contributes to the generation of instability.

The main lesson from this empirical literature is that these studies show, in the first part, that oil shocks can support growth, especially in exporting countries, but under certain conditions (non-linearity, short term, governance). In the second part, they highlight the risks of volatility, dependence, and structural imbalances linked to oil shocks. This literature does not adequately address the case of the Republic of Congo, due to approaches that are often linear and insensitive to the differentiated effects of oil shocks and the role of governance.

This study adopts an ARDL model to identify the short- and long-term effects of oil shocks on Congolese growth and to assess the country's ability to transform oil revenues into sustainable growth.

2. Methodology, analysis and interpretation of results

This section details the scientific approach adopted to analyze the effect of oil shocks on economic growth in the Republic of Congo. It is structured around two fundamental axes. First, the choice of methodological approach and the nature of the data used. Second, the results and discussions.

2. 1. Modeling

The choice of model in our study is based directly on tests, a diagnostic approach used to determine the appropriate estimator.

2. 1. 1. Theoretical and empirical model

Theoretical model

To test the basic hypothesis of this study, our methodological approach draws on a robust theoretical framework to explain long-term growth influenced by oil prices and the mechanisms through which these shocks can affect the growth trajectory of the Congolese economy. This framework has been specifically adapted to analyze the impact of oil shocks. In this regard, our approach is also enriched by the work of Berument and Ceylan (2010). Their study examined the impact of oil shocks on the economic growth of certain countries in the MENA region, using a similar approach and basing their own analysis on Solow's (1956) neoclassical growth model.

Theories of exogenous growth versus endogenous growth
The literature on endogenous growth emphasizes the role of physical capital, human capital, and energy as key factors in growth, particularly in economies rich in natural resources. In the Republic of Congo, oil revenues directly influence growth through public investment and imports, which justifies the empirical analysis of the effect of oil price fluctuations on economic growth over the period 2000-2024 based on World Bank data [WDI, 2024].
Mankiw-Romer-Weil (1992) model
Referring to Solow's (1956) neoclassical growth model, Mankiw-Romer-Weil (1992) model or MRV model [Mankiw and al., 1992] proposes an extension that incorporates human capital labor (via a neoclassical production function such as Cobb-Douglas [Cobb and Douglas, 1928]), allowing the economy to reach a stable steady state. Hence the production function:

$$Y_t = AK_t^{\alpha}L_t^{\beta} \quad (1)$$

In line with the work of Stiglitz (1974) and Heal (1979), who recognize energy as a key productive factor in economic growth and the main lever for financing public spending and imports, as highlighted by Gylfason (1995), and Aljarallah and Angus (2020). The aggregate production function, based on the Mankiw-Romer-Weil (1992) model and extended to include energy, is specified as follows :

$$Y_t = AK_t^{\alpha}H_t^{\theta}L_t^{\beta}E_t^{\delta} \quad (2)$$

where, H_t : human capital, E_t : energy , α, θ, β and δ : partial elasticities.
Under the assumption of constant returns to scale $\alpha + \theta + \beta + \delta = 1$. Hence, what reduces the model that takes the form by switching to terms per worker :

$$\frac{dY_t}{dL} = \frac{d(AK_t^{\alpha}}{dL}\frac{H_t^{\theta}}{dL}\frac{L_t^{\beta}}{dL}\frac{E_t^{\delta})}{dL} \quad (3)$$

The model becomes:

$$y_t = Ak_t^{\alpha}h_t^{\theta}e_t^{\delta} \quad (4)$$

The log-linearized version used for empirical estimates is often:

$$lny_t = lnA + \alpha ln(k_t) + \theta ln(h_t) + \delta ln(e_t) \quad (5)$$

If technology evolves according to : $A_t = A_0e^{gt}$. In log-linear form, by associating a time dimension with most variables, the equation becomes:

$$lny_t = lnA + \alpha ln(k_t) + \theta ln(h_t) + \delta ln(e_t) + g_t + \varepsilon_t \quad (6)$$

where, y, real GDP per capita in steady state ; k_t, savings/physical capital investment rate representing investment (GFCF); h_t , human capital investment rate, measured by secondary education expenditure (EDU); e_t , captures energy, proxied by the price of a barrel of Brent crude oil (Pb), A_0 : initial level of technology, g : rate of technical progress; t indicates the study period (2000-2024) and ε , random variable that measures the error term that takes into account the temporary dimension. It captures variables not explained in the model, such as production costs, transaction costs, etc. It should be noted that the real GDP was also used instead of real GDP per capita, which is used in the reference model.
Based on the above, the ad hoc model, adapted to analyze the effects of oil shocks in the Republic of Congo economic growth between 2000 and 2024, takes into account the key explanatory variable, which is the commodity cycle (Cycle_Pb), as well as the heterogeneity of the coefficients and other control variables. The following equation remains valid for modeling the interactions between the price cycle (Cycle_Pb) and investments. Moreover, oil shocks create macroeconomic volatility, but their lasting impact is shaped by institutions. Weak governance amplifies instability, while stronger institutions can transform resource revenues into sustainable growth. This makes the shift from analyzing oil shocks to analyzing institutions crucial for understanding the development path of the Republic of Congo.
2. 1. 2. Empirical model
This work considers a 25 years time series from 2000 to 2024 for analysis. The corresponding data sources of the selected variables come from the World Bank (WDI 2024) and are presented in the table below.
All other things being equal, the addition is associative, the expanded from becomes:

$$lnPIB_{it-1} = \alpha_i + \lambda_i lnCycle\_Pb_{it-1} + \beta_1 GFCF_{it} + \beta_1 EDU_{it} + \beta_4 INSP_{it} + \varepsilon_{it} \quad (7)$$

Table 1 : Variable and sign.

Variable	Sign	Measure	Definition
Dependent variable			
Real GDP	+ (lagged)	Gross domestic product (constant 2015 USD).	Economic growth: total income earned through the production of goods and services in an economic territory during an accounting period.
Explanatory variables			
Variable of interest			
Price per barrel of oil	+/-	Crude oil value on international markets (constant 2015 USD)	Affects production costs, terms of trade, inflation [Kilian, 2009], indicator of price cycles, exogenous shocks calculated by the authors.
Control variables			
Education spending (EDU)	+	School enrollment, secondary (percent gross)	Human capital: affects productivity and long-term growth [Barro, 1990], percent of population in the 5-year age group immediately following primary education.
Gross fixed capital formation (GFCF)	+	Investment in durable goods such as buildings and equipment (percent of GDP)	Indicates accumulation of productive capital; driven of structural growth, represents the total income earned through the production of goods and services within an economic territory during an accounting period [World Bank, 2024]

Institutional quality (INSP)	+	Political Stability and Absence of Violence/Terrorism index): country score on aggregate indicator, standard normal units (approx. -2.5 to +2.5)	Measures perceptions of the likelihood of political instability and/or politically-motivated violence, including terrorism [Kaufmann et al., 2011].

Source: authors, using database of World Bank (2024).

2. 2. Descriptive analysis and discussion of results
This involves descriptive data analysis and stationarity tests due to the time series nature of the data. In the presence of non-stationary variables, an error correction model is used and, subject to a long-term relationship, the normality of the series is also verified.

Table 2 : Descriptive statistics.

Variable	Obs	Mean	Std. Dev.	Min	Max
lnGDP	25	22.968	.197	22.592	23.244
lncycle Pb	25	4.099	.358	3.008	4.348
GFCF	25	36.952	16.417	20.97	76.78
EDU	25	45.504	4.366	38.01	53.11
INSP	25	-.596	.428	-1.587	-.017

Source: authors, using Stata software.

Descriptive statistics confirm that real GDP (lnGDP) is relatively stable (mean 22.968; standard deviation 0.197), reflecting steady growth despite oil cycles (lncycle_Pb) marked by high volatility (mean 4.099 ≈ USD 60 per barrel; standard deviation 0.358), reflecting the country's structural exposure to international markets. GFCF represents on average 36.95 percent of GDP, but shows high dispersion (standard deviation 16.42), illustrating contrasting investment phases. EDU is slowly increasing to reach 45.5 percent (standard deviation 4.37), reflecting human capital that is still modest and marginal in the economic dynamic. Finally, the quality of institutions (INSP) remains structurally weak (average of -0.596; standard deviation of 0.428), confirming fragile governance and episodes of political instability.

Table 3 : Multicollinearity analysis.

Variables	lnGDP	lncycle_Pb	GFCF	EDU	INSP
lnGDP	1.000				
lncycle_Pb	0.850	1.000			
GFCF	0.219	0.378	1.000		
EDU	0.469	0.184	-0.243	1.000	
INSP	0.786	0.761	0.087	0.469	1.000

Source: authors, using Stata software.

Taking into account the results in this table, all values except those on the main diagonal are less than 1. No correlation reaches the critical threshold of ±0.90, so there is nothing that needs to be removed. Therefore, there is no multicollinearity between the variables.

Table 4 : Multicollinearity test.

Variable	VIF	1/VIF
ISNP	3.360	0.297
lncycle_Pb	3.190	0.314
EDU	1.480	0.676
GFCF	1.370	0.728
Mean	2.350	

Source: authors, using Stata software.

All variables have VIF below 5 (below 10), with an average of 2.35, indicating the absence of multicollinearity.
2. 2. 1. Tests of stationarity of the variables
There are several stationarity tests, but in this study, the choice is made only for the augmented Dickey-Fuller (ADF) test and the Phillips-Perron (PP) test, used to test the presence of a unit root in our variables, and all three options will be checked (Trend and intercept, Intercept, None).
Augmented Dickey-Fuller test
ADF tests [Dickey and Fuller, 1979] take into account the hypothesis of error autocorrelation and are therefore under the alternative hypothesis absolute value $\theta_1 < 1$, on the OLS estimation of the following models. The ADF test is based on the following three equations:

- Model (A) : $$\Delta Y_t = \lambda Y_{t-1} - \sum_{i=2}^{k} \theta_i \Delta Y_{t-i+1} + \varepsilon_t \quad (8)$$
- Model (B) : $$\Delta Y_t = \lambda Y_{t-1} - \sum_{i=2}^{k} \theta_i \Delta Y_{t-i+1} + c + \varepsilon_t \quad (9)$$
- Model (C): $$\Delta Y_t = \lambda Y_{t-1} - \sum_{i=2}^{k} \theta_i \Delta Y_{t-i+1} + + c + b_t + \varepsilon_t \quad (10)$$

We begin by studying model (C). We examine whether b_t is significantly different from 0 or not. If b_t is significantly not different from 0, we move on to studying model (B) and try to determine whether it is significantly different from 0 or not. If it is significantly not different from 0, we study model (A). Under the true H0, the Student's t-statistics for the constant and trend are compared with the value in the Dickey-Fuller table at the 5 percent threshold. The decision rules are as follows: if $|t| > 0.05$, we accept H0: the series is non-stationary; if $|t| < 0.05$, reject H0: the series is stationary.
Phillips-Perron test
The Phillips-Perron test (PP) [Phillips and Perron, 1988] allows both autocorrelation and heteroscedasticity of errors

to be taken into account. It is based on the same models as the Dickey- Fuller test but proposes a non-parametric correction of the t-statistic. This test is a non-parametric adaptation of the Dickey-Fuller test. As with the Dickey-Fuller test, the null hypothesis of the test is the presence of a unit root. The PP test is carried out in four stages, which are:

- Estimation of the three Dickey-Fuller test models using the ordinary least squares method and calculation of the associated statistics.
- Determination of the so-called short-term variance: $\sigma^2 = \frac{1}{n}\sum_{t=1}^{n} e_t^2$
- Estimate the corrective factor known as long-term variance:

$$S_t^2 = \frac{1}{n}\sum_{t=1}^{n} e_t^2 + 2\sum_{i=1}^{\ell}\left(1 - \frac{i}{\ell+1}\right)\left(\frac{1}{n}\sum_{t=1}^{n} e_t e_{t-i}\right) \quad (11)$$

where: e_t is the residual of the estimated model; n is the sample size; ℓ is the number of lags (lag truncation parameter) ; $\left(1-\frac{i}{\ell+1}\right)$ is Bartlett's weight ; $\left(\frac{1}{n}\sum_{t=1}^{n} e_t e_{t-i}\right)$ is the empirical autocovariance of order i. The optimal truncation parameter is often chosen according to the empirical rule: $\ell \approx 4\left(\frac{n}{100}\right)^{\frac{2}{9}}$ where ℓ is the number of lags expressed as a function of the number of observations.

Calculation of the Phillips-Perron statistic

$$t_{\phi 1}^{*} \frac{\sqrt{K}(\widehat{\phi 1}-1)}{\varphi 1} + \frac{n(K+1)\sigma_{\phi 1}}{\sqrt{K}} \quad \text{with } K = \frac{\sigma^2}{S_t^2}. \quad (12)$$

where: $\widehat{\phi 1}$: autoregressive coefficient estimator; $\sigma_{\phi 1}$: standard error of $\widehat{\phi 1}$, σ^2 : short-term variance ; S_t^2 : long-term variance (HAC variance), K : correction factor linked to the variance ratio. Phillips and Perron (1988) show that this non-parametric correction to t does not alter the asymmetric distribution of the statistic, which remains identical to that observed in the Dickey-Fuller test.

2. 2. 2. Bounds test or cointegration test by Pesaran et al (2001)

There are two steps to follow to apply the Bounds Test of cointegration or Pesaran et al. (2001) test of: first, determine the optimal lag (AIC); then, use the Fisher test to test for cointegration between series.

Optimal lag

The optimal Autoregressive Distributed Lag (ARDL) model to be selected and shows that the optimal number of lags for the model variables is 1 4 1 2 1, respectively. With the addition of the interaction variable, the optimal model is ARDL(1 4 1 2 1 1).

Table 5 : Stationarity test of variables.

Variable		ADF		PP		Integration order
		At the level	Difference	At the level	Difference	
lnGDP	TL	-0.992	-3.003	-0.828	-3.981**	I(1))
	L	-1.951	-2.496	-2.053	-3.463**	I(1)
	NCL	1.049	-2.383**	1.523	-3.272***	I(1)
lncycle_Pb	TL	-10.172***	-	-5.809***	-	I(0)
	L	-16.021***	-	-8.567***	-	I(0)
	NCL	2.679	-11.152***	1.341	-6.208***	I(1)
GFCF	TL	-2.021	-3.247 *	-1.921	-5.003***	I(1)
	L	-1.869	-3.089**	-1.867	-4.900 ***	I(1)
	NCL	-0.636	-3.169***	-0.727	-5.016***	I(1)
EDU	TL	-2.899	-4.405***	-4.720***	-	I(1)
	L	-1.228	-4.649***	-3.043**	-	I(1)
	NCL	0.540	-4.535***	-0.085	-8.242***	I(1)
INSP	TL	-2.082	-5.578***	-2.705	-5.646***	I(1)
	L	-1.326	-5.433***	-0.841	-5.779***	I(1)
	NCL	-2.052**	-	-1.254	-5.287***	I(1)

Note: The optimal lag structure for the test was determined based on the Schwarz information criterion (AIC). ADF: Augmented Dickey-Fuller, PP: Phillips- Perron, TL: Trend lag, L: Lag,
*NCL: No constant and lag. Legend: * p<0.10; **p<0.05; *** p<0.01; **** p<0.001.*

Source: authors, using Stata software.

The results of the unit root tests show that the variables lnGDP, GFCF, EDU, and INSP are integrated of order 1 (I(1)), while the variable lncycle_Pb is stationary in level (I(0)). This confirms the relevance of the ARDL approach.

Bounds cointegration test

The test statistic calculated F will be compared to the critical values as follows:

- do not reject H0 if either F or t are closer to zero than critical values for I(0) variables (if either probability (p-value) > desired level for I(0) variables) ;
- reject H0 if both F and t are more extreme than critical values for I(1) variables (if both probabilities < desired level for I(1) variables) ;
- decision: no rejection (.a), inconclusive (.), or rejection (.r) at levels.

Table 6 : Pesaran, Shin, and Smith (2001) bounds test.

	Global Stat.	10 percent		5 percent		1 percent		p-value	
		I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
F	11.667	2.744	4.092	3.403	4.983	5.098	7.269	0.007	0.034

t	-5.615	-2.561	-3.850	-2.959	-4.346	-3.807	-5.409	0.001	0.024
decision		.r		.r		.			

Source: authors, using Stata software.

The value F = 11.667 greatly exceeds the critical bound I(1) and t = -5.615 is more negative than the critical bound, respectively, at significance thresholds of 1 percent ; 5 percent and 10 percent).The probabilities are well below 5 percent , reinforcing statistical significance. There exist of a long-term cointegration relationship between the variables in the model.

3. Presentation of the distributed lag autoregressive model (ARDL)

Autoregressive Distributed Lag (ARDL) models are dynamic models that improve forecasting and policy effectiveness, unlike the simple model, where only a part of the variation of the variable can be explained.

3. 1. Presentation, interpretation and discussion of results

As a reminder of the hypotheses, the variable of interest (Cycle_Pb) was combined with that of investments (GFCF) to identify the multiplier effect of oil shocks on investments on the one hand, and on growth on the other, in order to improve the viability of the model. The error correction model (ECM) is:

$$\Delta lnGDP_t = \lambda[lnGDP_{t-1} + \beta_1 lnCycle - Pb_{t-1} + \beta_2 GFCF_{t-1} + \beta_3 EDU_{t-1} + \beta_4(lnCycle\_Pb * GFCF_{t-1}) + \beta_5 INSP_{t-1}] + \varepsilon_t \quad (13)$$

The estimated model with its various parameters is as follows:

$$\Delta lnGDP_t = -0.4227[lnGDP_{t-1} + 0.5574 * lnCycle\_Pb_{t-1} + 0.2470 * GFCF_{t-1} - 0.0065 * EDU_{t-1} - 0.0578 * (lnCycle\_Pb \times GFCF)_{t-1} + 0.2075 * INSP_{t-1} - 10.607] + \varepsilon_t \quad (12)$$

3. 1. 1. Presentation of results

The results of the model estimation are as follows: the results relating to the coefficient of determination, the results relating to the estimation of short-term dynamics, the results of the long-term model estimation, and finally the results of the speed of adjustment towards the long-term target (restoring force).

Table 7 : Model estimation results.

D.lnGDP	Coefficient	t	Standard errors
ADJ			
lnGDP			
L1.	-0.42273492****	-4.840	0.087
	Long term		
lncycle_Pb	-0.55749506*	-1.770	0.314
GFCF	-0.24706942****	-4.020	0.061
EDU	0.00650397	1.230	0.005
lncycle_Pb_GFCF	0.0577816****	4.020	0.014
INSP	-0.20748832*	-1.810	0.115
	short term		
_cons	10.607****	5.190	2.045
Number of obs	24	df	7
R-squared	0.6605	Adj R-squared	0.5407
Log likelihood	49.364024	Root MSE	0.0368
Akaike crit. (AIC)	-84.72805	Bayesian crit. (BIC)	-76.48167

Legend: Akaike's information criterion (AIC) and Bayesian information criterion (BIC);
** p<0.10; **p<0.05; *** p<0.01; **** p<0.001*

Source: authors, using Stata software.

3. 2. 2. Interpretation and discussion of results

Using the command maxlags (1) ec, the ARDL(1,0,0,0,0,0) model for the period 2000-2024 shows a satisfactory fit with an R^2 of 0.6605 and an adjusted R^2 of 0.5407, indicating that 54 percent of the variance in total real GDP is explained by the predictors after controlling for degrees of freedom. The results (AIC = –84.73; BIC = –76.48) suggest that the model provides a satisfactory fit to the data while maintaining parsimony. The error correction adjustment coefficient (ECM L1.lnGDP = -0.423 with a probability of 0.000) reveals that the speed of adjustment calculated by estimating the time needed to absorb 95 percent of an exogenous shock on lncycle_Pb from the formula, $(1 - \beta_0) = 1 - |\alpha_1|)^t$. Replacing the values $\beta_0 = 0{,}95$ and $\alpha_1 = -0.423$ becomes $(0.5 = -0.5493)^t$. The logarithm gives $t = \frac{\ln(0.5)}{\ln(1-0.423)} \approx t = \frac{-0.6931}{-0.5493} \approx t = 1.26$ year a rapid convergence towards long-term equilibrium, with a half-life of approximately 1.3 years ; this means that a shock is reduced by half in at least one year. This result confirms the validity of the cointegration approach of Pesaran et al. (2001). This demonstrates the Congolese economy's tendency to revert to equilibrium post-shock, essential for macroeconomic resilience.

Confirmed energy vulnerability

In the long term, the oil price cycle (lncycle_Pb) exhibits a marginally significant negative effect on real GDP growth (-0.557 with a probability of 0.094), meaning a 1 percent oil shock increase reduces real GDP by 0.56 percent in steady state equilibrium, corroborating the energy vulnerability of developing economies. This aligns with Hamilton (2003), showing supply-driven oil price hikes generate recessionary effects [Hamilton, 1983; Burbidge and Harrison, 1984]. In the Congolese context, this reflects excessive dependence on poorly redistributed oil rents. Djellouli and Abdelli (2020) confirm oil shocks negatively impact long-term growth in undiversified economies.

Structural Inefficiency

The effect of gross fixed capital formation (GFCF) is surprising: negative and highly significant (-0.247 with a probability of 0.001), indicating a possible fiscal crowding-out effect [Barro, 1990], a 1 percent investment increase reduces real GDP by 0.25 percent. This matches Ndikumana and Boyce (2011) findings that poor budget governance and resource allocation opacity diminish expected investment-growth impacts or unproductive overinvestment at the exceptional level observed (37 percent of GDP on average).

Strategic resilience through investment

The main contribution of the model lies in the highly significant dynamic strategic interaction [Kripfganz and Schneider, 2023], captured by lncycle_Pb_GFCF (0.058 with a probability of 0.001). A 1 percent oil shock, combined with an increase in investment, leads to a 0.058 percent rise in real GDP, suggesting that welldirected investment mitigates the adverse effects of oil shocks. The net marginal effect of the oil shock is given by -0.557 + 0.058 × GFCF. At the minimum level of investment (21 percent of GFCF), oil shocks retain a coefficient of -0.42, corresponding to an 8.3 percent GDP loss for a 20 percent oil price increase. At the mean level (37 percent), the attenuation reaches 49 percent, with the effect reduced to -0.285, equivalent to a 5.7 percent GDP loss. At a high level of investment (77 percent of GDP), the marginal effect becomes positive (+0.007), indicating that oil chocks no loger cause losses, but rather stimulate growth. A 20 percent increase in oil price even generates a slight gain (see Table 8). This quantifies the "double dividend" of productive investment: simultaneously enhancing growth and ensuring energy resilience. Higher levels of gross fixed capital formation substantially reduce exposure to oil shocks.

Table 8 : Marginal effect of GFCF level.

GFCF Level	Marginal Effect	+1 percent Oil Shock	+10 percent Oil Shock	+20 percent Oil Shock	Attenuation
Min 21 percent	-0.415	-0.42 percent GDP	-4.2 percent GDP	-8.3 percent GDP	25 percent
Mean 37 percent	-0.285	-0.29 percent GDP	-2.9 percent GDP	-5.7 percent GDP	49 percent
Max 77 percent	+0.007	+0.01 percent GDP	+0.07 percent GDP	+0.1 percent GDP	101 percent

Source: authors, using Stata software.Underutilized Human Capital.

The gross secondary school enrollment rate have expected but insignificant effects (EDU = 0.0065; p = 0.236) does not reach the threshold of effectiveness (average 45.5 percent). Though positive, statistical insignificance aligns with endogenous growth models of Barro (1991) and Mankiw, Romer and Weil (1992). Hanushek and Woessmann (2020) emphasize learning quality over enrollment rates determines economic impact. The lack of significance of human capital in the growth model used by the Republic of Congo can be attributed to several external factors. The country's limited technological development reduces the productivity gains that education and skills could generate. The mismatch between training and labor market needs further weakens the impact of education [Deaton, 2019, Dasgupta and Heal, 1979]. A strong dependence on oil revenues overshadows other growth drivers, while underemployment and brain drain prevent the full use of available skills [Gylfason, 1999]. Finally, weak institutions and governance limit the effective integration of human capital into the economy, thus reducing its long-term contribution to growth.

Institutional Constraint

Investment remains counterproductive, probably due to net capital imports. The coefficient is -0.2075 (p = 0.088), where 1 percent instability increase reduces real GDP by 0.21 percent. Englebert and Ron (2004) demonstrate Central African conflicts, and weak institutions hinder economic performance. Political instability erodes investor confidence, disrupts public policy, and reduces spending efficiency. Acemoglu and Robinson (2012) stress inclusive institutions enable sustainable growth.

3. 2. Diagnostic tests

Diagnostic tests are essential to ensure the validity and robustness of the estimated results.

Table 9 : Diagnostic test of estimated ARDL model.

Test hypothesis	Test		Value	P-value
Autocorrelation	Durbin–Watson errors	d-statistic (7, 24)	2.289017	
Autocorrelation	Breusch–Godfrey LM	chi2	0.866	0.3521
Heteroscedasticity	Breusch–Pagan/Cook–Weisberg	Chi2	1.30	0.2548
Conditional heteroscedasticity	ARCH	Chi2	0.012	0.9112
Normality	Jarque-Bera probability	JB	1.740	0.419
Specification	Ramsey RESET	F(3,14)	0.43	0.7345

Source: authors, using Stata software.

The test results indicate that the residuals have all the desired properties: absence of autocorrelation, heteroscedasticity and normality, thus confirming the absence of specification errors. The ARDL model used is econometrically robust, and the estimates can be interpreted reliably without bias related to conditional volatility.

3. 2. 1. Error autocorrelation test

The error autocorrelation test presented in Table 9 checks whether the residuals are independent or display serial correlation. The results in the table below confirm this statement.

Table 10 : Descriptive Statistics of resid.

Variables	Obs	Mean	Std. Dev.	Min	Max	p1	p50	p99	Skew.	Kurt.
resid	24	0	0.018	-0.033	0.031	-0.033	-0.0019	0.031	0.064	2.021

Source: authors, using Stata software.

The residual distribution shows that the errors are centered around zero, nearly symmetric, and moderately dispersed, with skewness close to zero and kurtosis slightly below 3, indicating an overall normal and wellbehaved pattern, as shown illustrated in the figures below.

Figure 3 : Normality of errors

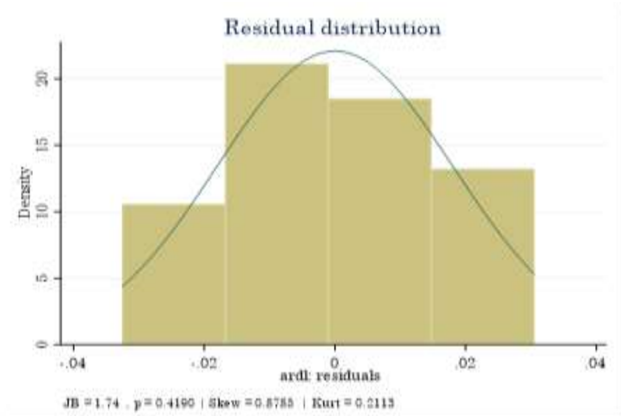
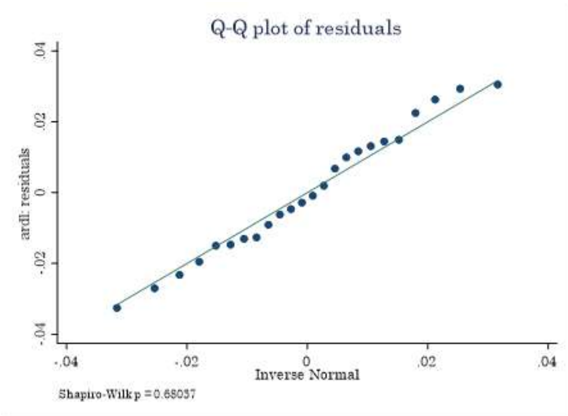


Figure 4 : Quantile-Quantile plot.



Source: authors, using Stata software.

3. 2. 2. Stability Test of Coefficients

The stability of the model's coefficients is assessed using the CUSUM and CUSUMSQ tests. The results indicate that the cumulative sum of recursive residuals remains within the 5% confidence bounds, confirming parameter stability and the absence of significant structural breaks.

Figure 5 : Cusum

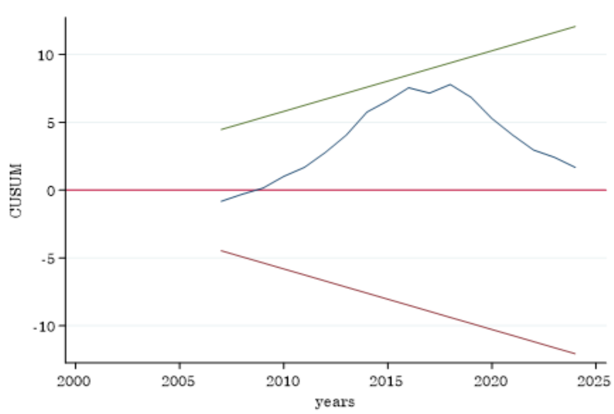
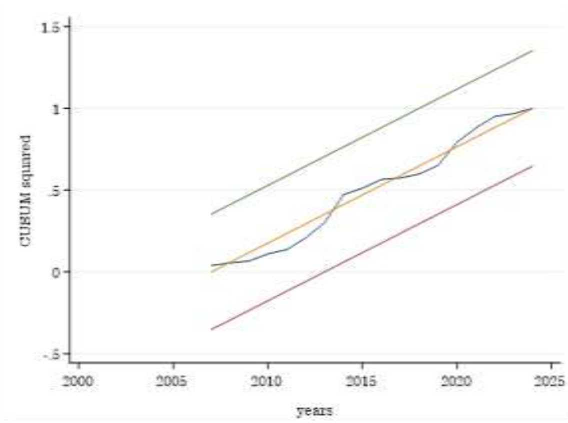


Figure 6 : Cusum squared.



Source: authors, using Stata software.

The Quantile-Quantile plot visually confirms that the distribution of residuals follows the normal distribution. Similary, the CUSUM test in the figure 5 and 6 above confirms the stability of the model at a significance level of 5 percent. This justifies the validation of the ARDL model. The interaction between GFCF and oil cycle (p=0.001) remains the major contribution.

Conclusion and economic policy implications

Between 2000 and 2024, the Congolese economy exhibited a strong dependence on fluctuations in the oil market. The Autoregressive Distributed Lag (ARDL) model estimated over this period confirms the existence of a robust long-term relationship between real GDP and its structural determinants, with a significant adjustment dynamic lasting at least one year. The results show that investment plays a central role, even at relatively low levels such as the observed average of 37%. In this context, investment partially mitigates the impact of oil shocks, reducing GDP contraction by about one third (a mitigation effect of 49%). Oil shocks themselves generate substantial contractions: a 10% increase in oil prices leads to an almost 4% decline in GDP, while a 20% increase can cause a drop of more than 8% when investment remains minimal. At 77% of GDP investment, oil shocks shift from losses to growth, showing the "double dividend" of productive investment, simultaneously enhancing growth and ensuring energy resilience. The study confirms that Congolese growth remains highly vulnerable to oil price cycles, reflecting excessive dependence on poorly redistributed oil rents and structural fragility. At the same time, the results highlight a strategic resilience potential through investment, which, when well directed, mitigates the adverse effects of oil shocks and can even transform them into opportunities for growth. The insignificance of secondary education shows the inefficiency in capital allocation. This could be explained, among other things, by external factors, notably technological delays, the gap between education and employment, dependence on oil, underemployment, brain drain, and institutional weakness. In summary, the Congolese economy faces a double reality: a persistent energy vulnerability on the one hand, and on the other hand, the possibility of resilience and transformation, conditioned by the quality of investment, governance, and diversification.

To achieve this, the Republic of Congo should implement and rigorously follow simplified policy measures, such as:

Improving the efficient of public investment ; creating a special fund for acquiring energy-efficient equipment, with a clear target of allocating 77% of investment to the economy each year.

Optimize the use of public funds ; dedicating one-fifth of investment resources to research and modern technologies, with simplified annual monitoring.

Train more young people ; establishing a scholarship system for secondary school students by 2030.

Promote local manufacturing ; setting up incubators in every region to stimulate economic diversification, which remains in its early stages

The outlook favors three extensions: multi-country panel, asymmetric Non-linear Autoregressive Distributed Lag (NARDL), and non-linearities with GFCF.

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