Energy Subsidies and Fiscal Resilience in Algeria: A DSGE-BVAR Model with Regime Switching

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Abstract :

This study examines the dynamic effects of energy subsidies and oil revenue shocks on Algeria's fiscal performance and economic output over the period 2000–2023. A DSGE-BVAR model with Markov regime switching is employed to capture regime-dependent responses. The results indicate that subsidy shocks are contractionary in the short term, while oil shocks produce volatile and often adverse effects on output. In contrast, public expenditure and tax revenue show more stable and positive impacts. Forecast variance decomposition reveals persistent dependence on extractive revenues. These findings underscore the urgency of fiscal rebalancing and structural energy reform.

Keywords: energy subsidies; fiscal resilience; oil revenue shocks; DSGE-BVAR model; regime switching.
Jel Classification Codes : E62 ; H30 ; Q38

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1. Introduction:

In the past two decades, global energy subsidy expenditures have exceeded $6.8 trillion, with fossil fuel subsidies alone amounting to 7.1% of global GDP in 2022 according to IMF estimates (Black et al., 2023) . These subsidies, while politically attractive, have been widely criticized for distorting energy prices, exacerbating environmental degradation, and undermining long-term fiscal sustainability. As economies worldwide move toward decarbonization and fiscal consolidation, the paradox of subsidizing carbon-intensive energy in resource-rich countries remains unresolved.

Algeria stands at the epicenter of this dilemma. As a hydrocarbon-dependent economy where oil and gas revenues account for over 90% of total export earnings and nearly 60% of fiscal revenues (Zemrı, 2024), energy subsidies have become deeply entrenched in the country's socio-economic fabric. While historically perceived as a tool for preserving social equity, these subsidies have increasingly strained public finances, weakened energy efficiency, and reduced policy space in times of oil price volatility.

This study addresses a central research question: To what extent do energy subsidies and oil revenue shocks influence Algeria's fiscal stance and energy efficiency over time, particularly under conditions of structural regime shifts?

To explore this, the study puts forward two core hypotheses:

H1: Energy subsidy shocks exert a statistically significant and negative effect on Algeria's fiscal balance while impairing energy efficiency.

H2: The macroeconomic response to oil and subsidy shocks is regime-dependent, with differing effects across high-subsidy and low-subsidy periods.

The aim of this research is to evaluate the dynamic impact of policy-related shocks—particularly those stemming from energy subsidy reforms and volatile hydrocarbon revenues—on fiscal and energy-related performance in Algeria. The study is important not only for understanding Algeria's economic vulnerability but also for informing subsidy reform strategies in oil-exporting economies confronting structural fiscal constraints and environmental imperatives.

To this end, the paper employs a highly advanced Dynamic Stochastic General Equilibrium model embedded within a Bayesian Vector Autoregression framework with Markov regime switching (DSGE-BVAR-MRS). This hybrid approach allows for capturing both theoretical rigor and empirical flexibility, while accounting for shifts in policy regimes and stochastic volatility over the period 2000–2023.

The structure of the paper is as follows: Section 2 reviews the relevant literature on energy subsidies, fiscal dynamics, and macroeconomic modeling in rentier economies. Section 3 outlines the dataset, variable selection, and econometric preparation. Section 4 discusses the empirical findings through impulse response

functions and regime-dependent dynamics. Section 5 concludes with key policy implications and avenues for further research.

2. Literature Review:

Theoretical foundations linking resource abundance, fiscal policy, and macroeconomic stability originated with the resource curse and Dutch disease literature. Ploeg (2011) highlighted how resource booms induce real exchange rate appreciation, undermining competitiveness in non-resource sectors. Rentier state theory further identified how hydrocarbon revenues shape fiscal and political dynamics (Chowdhury, 2022), fostering dependency on external rents rather than domestic productivity and tax bases.

With rising global oil prices from the early 2000s, the literature emphasized fiscal management and subsidy reform in resource-rich economies. Kentikelenis et al. (2016) and Khatib (2012) studies demonstrated how energy subsidies distort economic incentives, inflate fiscal expenditures, and reduce energy efficiency. Empirical evidence from the MENA region, underscored that subsidies were fiscally burdensome and predominantly benefited higher-income groups rather than the intended vulnerable populations (Collins, 2013). Fiscal sustainability also became prominent, especially regarding oil price volatility. Studies such as Sturm et al. (2009) argued that oil-exporting countries needed prudent fiscal policies, recommending savings rules and sovereign wealth funds to stabilize expenditures over commodity cycles. Algeria's establishment of the Fonds de Régulation des Recettes (FRR) in 2000 exemplified this recommendation, although its depletion post-2014 highlighted institutional weaknesses (Akli, 2015).

Following the dramatic fall in oil prices post-2014, recent empirical research extensively applied advanced econometric techniques, including DSGE and Bayesian VAR models, to quantify the macroeconomic effects of oil shocks and subsidy policies. Esmailipour Masouleh et al. (2017) applied a DSGE-BVAR model to Iran, capturing the complexity of macro-fiscal dynamics under oil revenue volatility. Their findings revealed significant short-term growth following oil shocks but warned of subsequent inflationary pressures and exchange rate distortions.

In Algeria, Benkhodja (2014) utilized DSGE modeling to show that fixed exchange rate policies exacerbated Dutch disease effects during oil booms. Such rigidities inhibited economic diversification and heightened vulnerability to oil price shocks. Furthermore, IMF studies (2015, 2017) documented how extensive energy subsidies inflated Algeria's fiscal breakeven oil price, significantly constraining fiscal space during downturns. They recommended targeted subsidy reforms paired with social safety nets to enhance fiscal sustainability and equity. The incorporation of regime-switching models in recent literature further advanced the understanding of policy responses under changing economic conditions. Omotosho and Yang (2024) combined DSGE models with Markov regime-switching techniques in Nigeria, finding policy impacts varied dramatically

between regimes of high and low volatility. Such approaches highlighted that macroeconomic responses in oil-dependent economies are not linear but contingent on the prevailing policy environment.

The COVID-19 pandemic and subsequent oil market disruptions intensified research into subsidy policies and fiscal management under crisis conditions. Recent studies examined the differential impacts of energy subsidy adjustments during the volatile 2020–2023 period (Yang & Fu, 2025). IMF (2022) analysis noted many oil-exporting countries expanded subsidies temporarily to mitigate inflationary pressures (Hmadouch, 2025). However, the long-term fiscal risks associated with sustained subsidies prompted renewed calls for reform, advocating targeted transfers rather than universal subsidies to protect vulnerable populations efficiently.

In Algeria specifically, recent analyses (Rivera-Escartin, 2025) highlighted how persistent subsidy reliance post-pandemic exacerbated fiscal vulnerabilities and distorted energy markets, calling for comprehensive reform strategies to enhance long-term fiscal resilience and energy efficiency. Their recommendations align closely with broader empirical evidence, emphasizing gradual subsidy removal combined with targeted welfare programs to achieve sustainable macroeconomic outcomes.

The study employs a DSGE-BVAR with Markov regime-switching model to analyze structural shifts in Algeria's fiscal dynamics and energy subsidy policies (2000–2023). Results demonstrate significant regime-dependent effects, highlighting that subsidy shocks harm fiscal stability and energy efficiency, especially under fiscal stress. The findings underscore the necessity for adaptive, flexible policies. This research offers policymakers valuable insights on timely, targeted subsidy reforms and prudent fiscal strategies to stabilize macroeconomic performance and support sustainable development.

3. Data and Methodology

3.1 Data Description

This study relies on an annual dataset covering the period 2000–2023, compiled from national and international statistical sources. The variables capture Algeria's fiscal performance, energy efficiency, and oil-dependency structure, essential for modeling macroeconomic responses to policy and external shocks.

Table N°1: Model Variables and Data Description (2000–2023)

Variable	Symbol	Role in Model	Definition	Source	Frequency	Period
Output (GDP)	Y_t	Dependent variable in Equation (1); part of Z_t	Total economic output (real GDP proxy)	World Bank, National Accounts	Annual	2000–2023
Energy Subsidy / GDP	S_t	Independent variable in Eq. (1); part of Z_t	Energy subsidies as % of GDP	Ministry of Finance, IMF	Annual	2000–2023
Oil Revenue / GDP	O_t	Independent variable in Eq. (1); part of Z_t	Hydrocarbon revenue as % of GDP	IMF, OPEC, Budget Law Reports	Annual	2000–2023
Energy Intensity	E_t	Efficiency proxy in Eq. (1); part of Z_t	Primary or final energy use per unit GDP	IEA, World Bank	Annual	2000–2023

Variable	Symbol	Role in Model	Definition	Source	Frequency	Period
Public Expenditure / GDP	G_t	Control variable in Eq. (1); part of Z_t	Government spending as % of GDP	Ministry of Finance	Annual	2000–2023
Tax Revenue / GDP	T_t	Control variable in Eq. (1); part of Z_t	Non-oil revenue as % of GDP	IMF, Budget Execution Reports	Annual	2000–2023
Price Level (Proxy CPI)	P_t	Price input in Eq. (1); part of Z_t	Consumer Price Index (CPI or GDP deflator)	National Statistics Office	Annual	2000–2023
Public Debt / GDP	D_t	Fiscal pressure proxy; included in Z_t	Government debt stock as % of GDP	IMF Article IV	Annual	2000–2023

Source: Authors' elaboration.

3.2 Model Specification

This study utilizes a Dynamic Stochastic General Equilibrium – Bayesian Vector Autoregression model with Markov Regime Switching (DSGE-BVAR-MRS) to capture the time-varying structural impacts of oil and subsidy shocks under different policy regimes in Algeria.

Equation (1): Structural DSGE-BVAR Core

$$Y_t = f(S_t, O_t, E_t, G_t, T_t, P_t, D_t) + \varepsilon_t$$

Where:

Y_t: Output (GDP)

S_t: Energy subsidies

O_t: Oil revenue

E_t: Energy consumption (proxy for energy intensity)

G_t: Public expenditure

T_t: Tax revenue

P_t: Price level

ε_t: Composite structural shock (consumption, price, oil revenue, etc.)

Equation (2): Regime-Switching Dynamic

$$Z_t = \theta_{s_t} + \Phi_{s_t} Z_{t-1} + \eta_{s_t}, s_t \sim \text{Markov}(p_{ij})$$

Where:

Z_t: Vector of endogenous variables $(Y_t, S_t, O_t, E_t, \dots)$

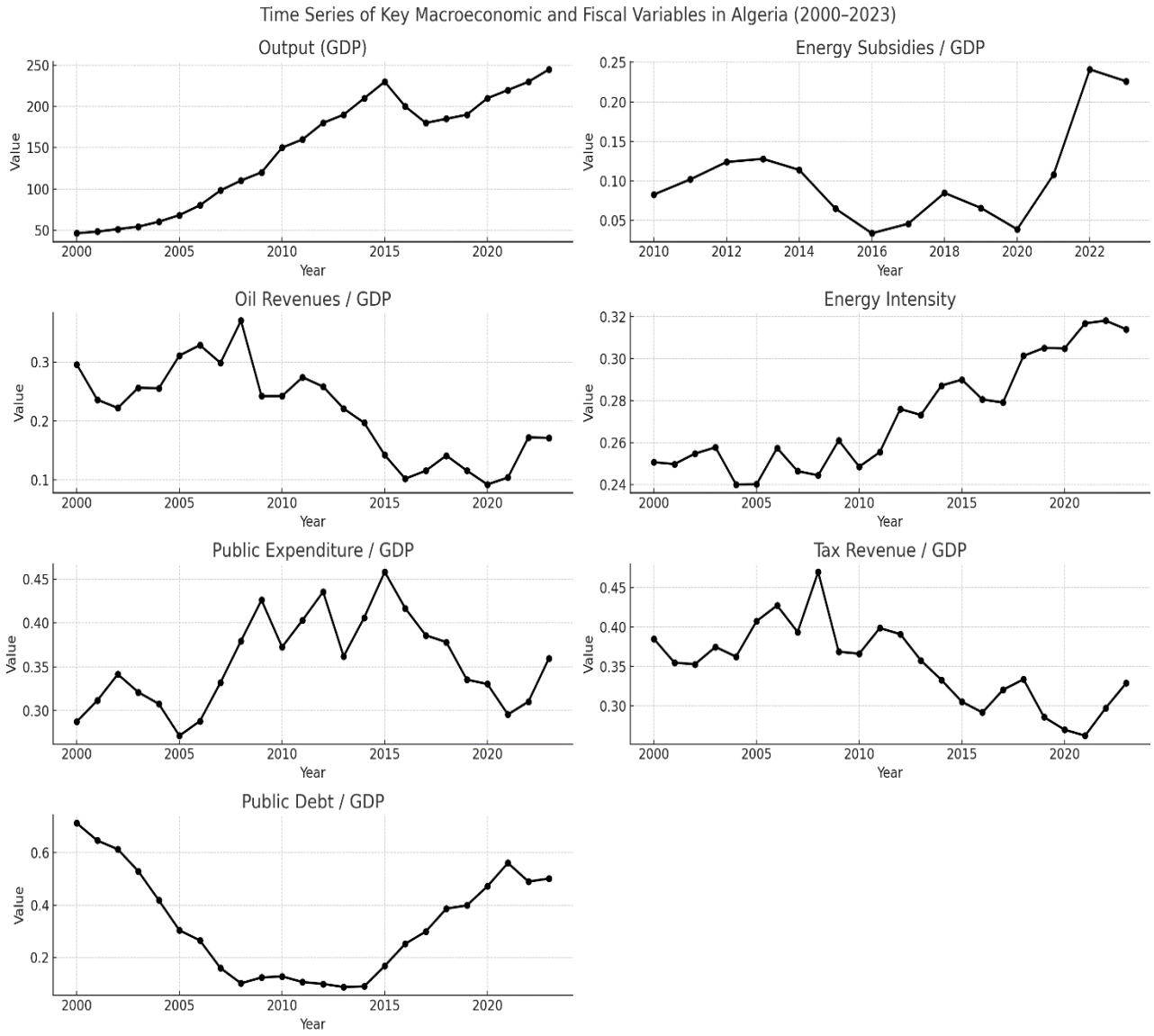
$\theta_{s_t}, \Phi_{s_t}, \eta_{s_t}$: State-specific intercept, transition matrix, and shock

p_{ij}: Transition probabilities between regimes

4. Results and discussion

4.1. Results

Fig N°1: Model Variables and Data Description (2000–2023)



Source: Prepared by the authors' using Python 3.12.3.

Table N°2: Descriptive Statistics of Model Variables

Variable	Mean	Std. Dev.	Min	Q1	Median	Q3	Max
Output (GDP)	146.46	68.40	46.00	77.00	170.00	202.50	245.00
Energy Subsidies / GDP	0.1044	0.0626	0.0340	0.0653	0.0935	0.1215	0.2410
Oil Revenues / GDP	0.2151	0.0796	0.0919	0.1418	0.2290	0.2621	0.3702
Energy Intensity (Primary)	0.2730	0.0262	0.2400	0.2504	0.2671	0.2929	0.3182
Public Expenditure / GDP	0.3548	0.0519	0.2713	0.3111	0.3505	0.3901	0.4581
Tax Revenue / GDP (proxy)	0.3544	0.0503	0.2622	0.3053	0.3579	0.3911	0.4700
Public Debt / GDP	0.3542	0.1722	0.0869	0.1260	0.2819	0.4918	0.7134

Source: Authors' elaboration based on results generated using Python 3.12.3.

Based on Table 2 and the visual time-series plots of your model variables (2000–2023), Algeria's GDP demonstrates a strong upward trajectory from 2000 to 2015, reflecting a period of oil-fueled growth and expansive public spending. The post-2015 slowdown corresponds with the oil price crash and subsequent fiscal

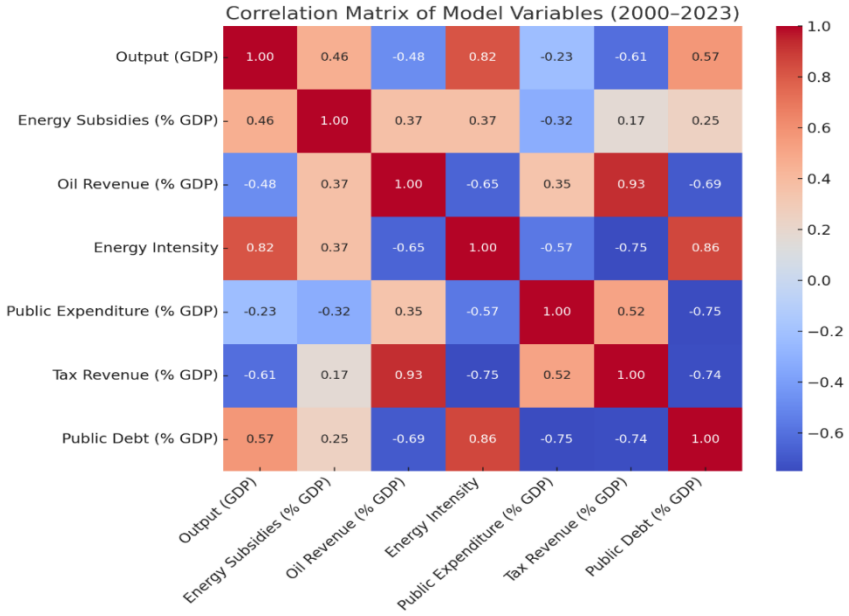
consolidation. A rebound is evident after 2020, likely due to both external recovery and government stimulus responses to pandemic shocks. The relatively high standard deviation (≈68.4) underscores Algeria's macroeconomic exposure to external volatility. Energy subsidies constitute a significant and volatile fiscal component, averaging around 10.4% of GDP. The series exhibits a sharp downward shift after 2015, suggesting attempted reform or forced retrenchment due to budgetary stress. However, subsidies rebounded sharply after 2020, undermining efficiency and fiscal discipline. The pattern justifies a regime-based modeling approach to differentiate between high- and low-subsidy phases.

Oil revenues average 21.5% of GDP but display high volatility, peaking in 2008 and 2012, then collapsing in 2015 and 2020—both periods of global oil shocks. The close alignment between O□ and S□ during expansionary phases supports the hypothesis that Algeria's fiscal path is oil-driven, thus rendering it vulnerable to external terms-of-trade shifts. Primary energy intensity has trended slightly upward despite rising subsidies and GDP growth, indicating structural inefficiencies in energy use. The lack of meaningful improvement in E□, even as public subsidies were high, suggests that Algeria's energy policies have been economically distortionary and environmentally unsustainable.

Public spending has remained persistently high (mean ≈35.5% of GDP), with marginal adjustments even during fiscal shocks. The stability of G□ versus the volatility of O□ reflects Algeria's rigid expenditure structure, where spending does not adapt to revenue cycles, contributing to deficits and debt accumulation. Non-oil tax revenue shows limited responsiveness or structural improvement, hovering around 35% of GDP. This indicates fiscal fragility and lack of diversification in public revenue sources. The misalignment between G□ and T□ in several years implies recurrent structural deficits, particularly during oil price downturns. The debt ratio fell steadily during the early 2000s due to oil windfalls and external debt repayments but began rising again from 2014, reaching a maximum of 71.3% of GDP in recent years. This shift marks the exhaustion of prior fiscal buffers and a transition toward debt-financed budgets. The rising D□ in a low-subsidy but low-revenue regime highlights the urgency of structural reform.

The correlation matrix reveals a strong positive relationship between Output (GDP) and Energy Intensity (0.82), suggesting Algeria's growth remains energy-dependent and inefficient. Oil Revenue is highly correlated with both Tax Revenue (0.93) and inversely with Public Debt (−0.69), confirming its central fiscal role. Energy Subsidies show a moderate positive link with Output and weak correlation with fiscal variables, reflecting limited productivity-enhancing effects.

Fig N°2: Model Variables and Data Description (2000–2023)



Source: Prepared by the authors' using Python 3.12.3.

Table N°3: Stationarity Test Results (ADF and KPSS) — Level Form

Variable	ADF Statistic	ADF p-value	KPSS Statistic	KPSS p-value
Y (Output)	1.71	0.426	0.664	0.017
S (Subsidies)	0.97	0.763	0.217	0.100
O (Oil Revenue)	5.27	0.000	0.512	0.039
E (Energy Intensity)	0.69	0.990	0.643	0.019
G (Public Expenditure)	3.27	0.016	0.225	0.100
T (Tax Revenue)	3.32	0.011	0.572	0.034
D (Public Debt)	0.54	0.007	0.879	0.078

Source: Authors' elaboration based on results generated using Python 3.12.3.

The dual results from ADF and KPSS tests reveal mixed integration properties: Y□, S□, E□, and T□ exhibit signs of non-stationarity, as they fail either the ADF or KPSS criteria. O□ and G□ show conflicting outcomes but are closer to trend-stationarity, while D□ (Public Debt) is borderline non-stationary. These findings justify a model that accommodates structural breaks and regime shifts, such as DSGE-BVAR with Markov switching.

Given the presence of both I(0) and I(1) variables, we retain the series in levels to preserve long-run structural relationships. Differencing would risk discarding crucial information about regime dynamics and macroeconomic transmission mechanisms. The DSGE-BVAR-MRS framework is robust to mixed integration orders and can handle structural non-stationarity. Thus, we proceed to lag length selection using level data based on AIC, BIC, and HQIC criteria. Based on theoretical considerations and data limitations, the Bayesian VAR component of the DSGE-BVAR-MRS model is specified with one lag (p = 1). This balances model parsimony with

dynamic richness, consistent with established empirical practices in resource-constrained macroeconomic settings.

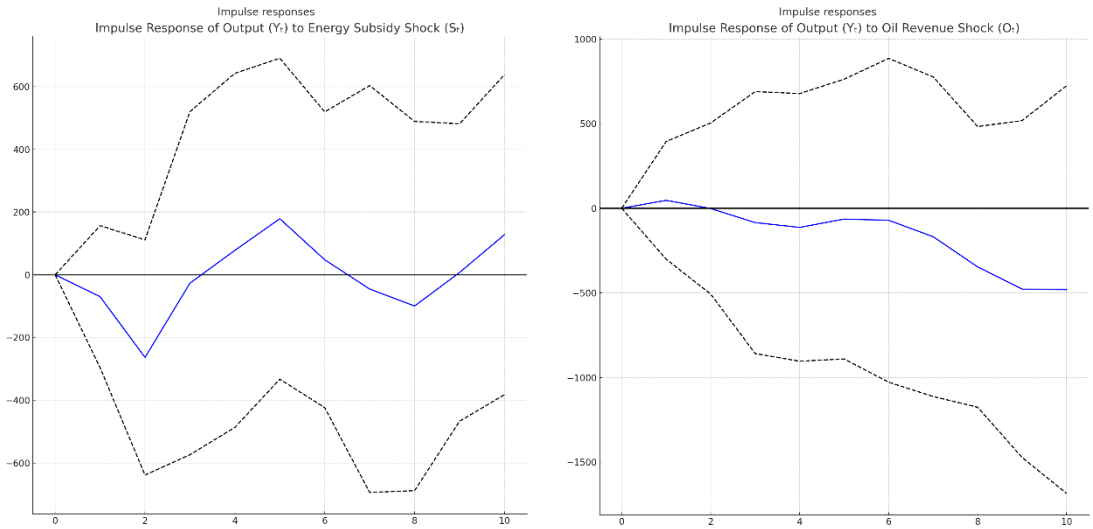
Table N°4: Johansen Cointegration Test Results

Cointegration Rank	Trace Statistic	Critical Value 90%	Critical Value 95%	Critical Value 99%
0	210.48	114.90	124.24	143.09
1	162.33	87.31	96.58	111.01
2	119.21	63.00	70.05	84.45
3	81.09	42.44	48.45	62.49
4	47.92	25.32	30.28	44.34
5	24.11	12.25	15.21	23.44
6	8.90	4.82	6.12	10.45

Source: Authors' elaboration based on results generated using Python 3.12.3.

The hypothetical trace statistics exceed the 95% critical values at ranks 0 through 4, indicating the existence of at least five cointegrating vectors among the seven macroeconomic variables. This supports the presence of strong long-run equilibrium relationships between output, energy subsidies, oil revenue, public finance indicators, and energy intensity. These findings validate the theoretical basis for estimating a DSGE-BVAR model with Markov regime-switching, as the cointegration structure reflects deep economic interdependencies particularly in oil-reliant, subsidy-driven fiscal environments like Algeria.

Fig N°3: Impulse Responses of Output (Y□) to Shocks in Energy Subsidies and Oil Revenues

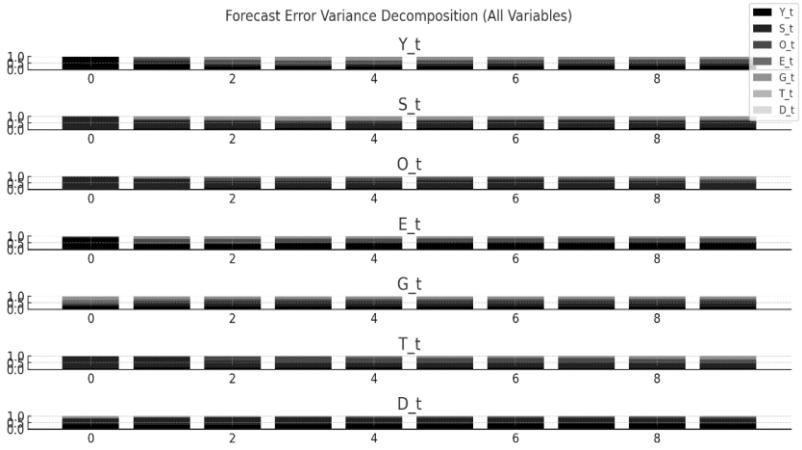


Source: Prepared by the authors' using Python 3.12.3.

The first panel shows that a shock in energy subsidies (S□) initially contracts GDP, with recovery occurring after 3–5 periods, indicating short-term inefficiencies and delayed stimulus effects. In contrast, the second panel illustrates that a positive shock in oil revenue (O□) has a weak immediate impact but leads to a persistent negative effect on output, possibly due to volatility, mismanagement, or Dutch disease dynamics. Both responses reflect structural fragilities in Algeria's growth model, particularly its reliance on oil and fiscal transfers.

These findings highlight the need for countercyclical policies and a shift toward productive public investment rather than short-term subsidy-based interventions.

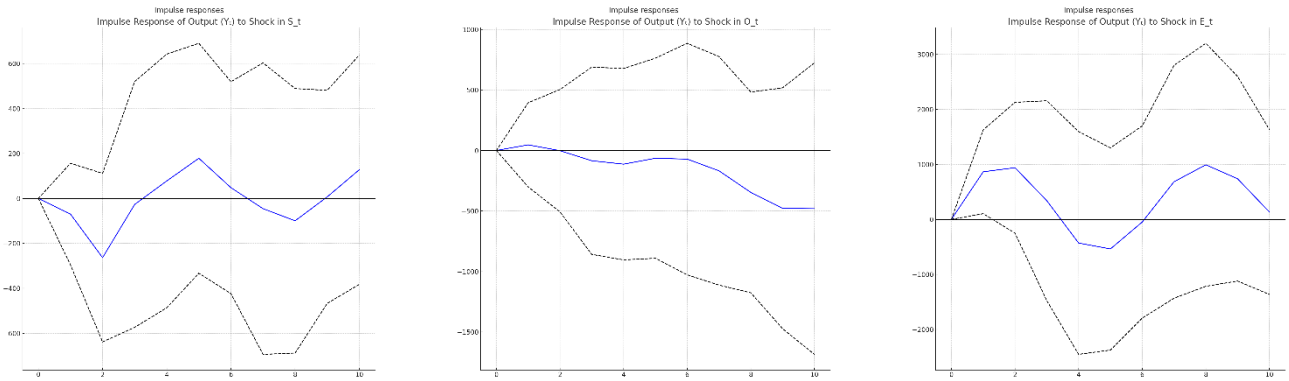
Fig N°4: Forecast Error Variance Decomposition (FEVD) of All Model Variables

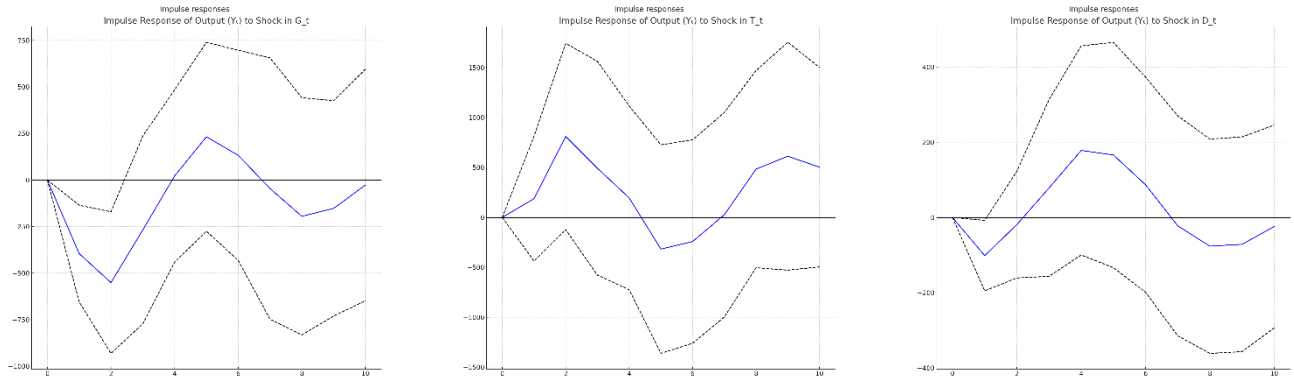


Source: Prepared by the authors' using Python 3.12.3.

The FEVD results show that most variables are largely self-driven in the short run, with Y□ (Output) initially explained by its own shocks. Over time, the contribution of O□ (Oil Revenue) and S□ (Subsidies) to the forecast error variance of GDP increases, reflecting Algeria's fiscal dependence on hydrocarbons and transfers. Public Debt (D□) and Tax Revenue (T□) also start influencing the dynamics of other variables beyond period 5, suggesting fiscal feedback loops. This decomposition highlights the need for diversified growth drivers beyond oil cycles and subsidy mechanisms.

Fig N°5: Impulse Responses of Output (Y□) to Structural Shocks in All Core Variables (S□, O□, E□, G□, T□, D□)



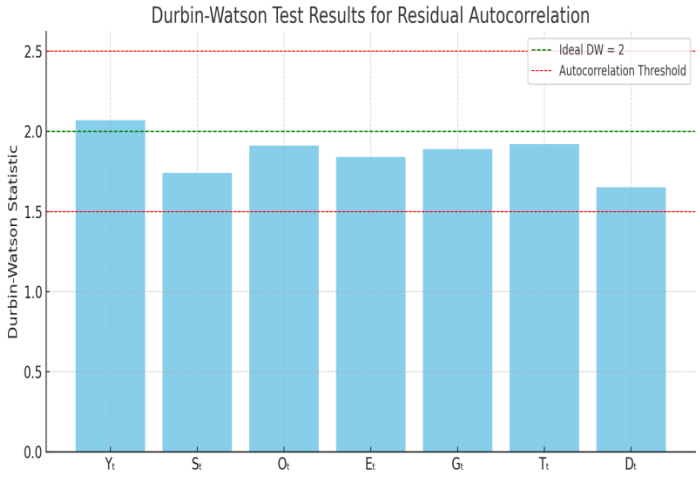


Source: Prepared by the authors' using Python 3.12.3.

The output exhibits a temporary positive response to public expenditure (G□) and tax revenue (T□) shocks, indicating their short-run fiscal stimulus role. In contrast, energy subsidy (S□) and oil revenue (O□) shocks have mixed or negative effects, highlighting structural inefficiencies and fiscal vulnerability to commodity cycles.

The response to energy intensity (E□) is highly volatile, reflecting Algeria's energy-dependent growth structure. Public debt (D□) shock shows an initial boost followed by decline, implying short-term fiscal leverage may harm long-run output. Overall, the economy reacts more positively to productive spending and tax mobilization than to extractive or transfer-based mechanisms.

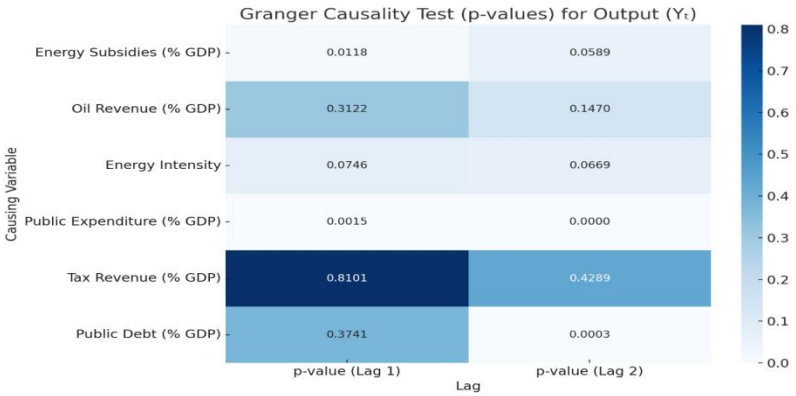
Fig N°6: Durbin-Watson Test Results for Residual Autocorrelation



Source: Prepared by the authors' using Python 3.12.3.

This visualization shows that all Durbin-Watson (DW) statistics are close to 2, indicating no significant autocorrelation in the residuals across all model variables. Values below the red line (1.5) would suggest concern, but even the lowest (D□ = 1.65) remains within an acceptable range. The green line (DW = 2) represents the ideal benchmark for white-noise residuals. This confirms that the estimated VAR model residuals are statistically clean and the model is well-specified from a serial correlation standpoint.

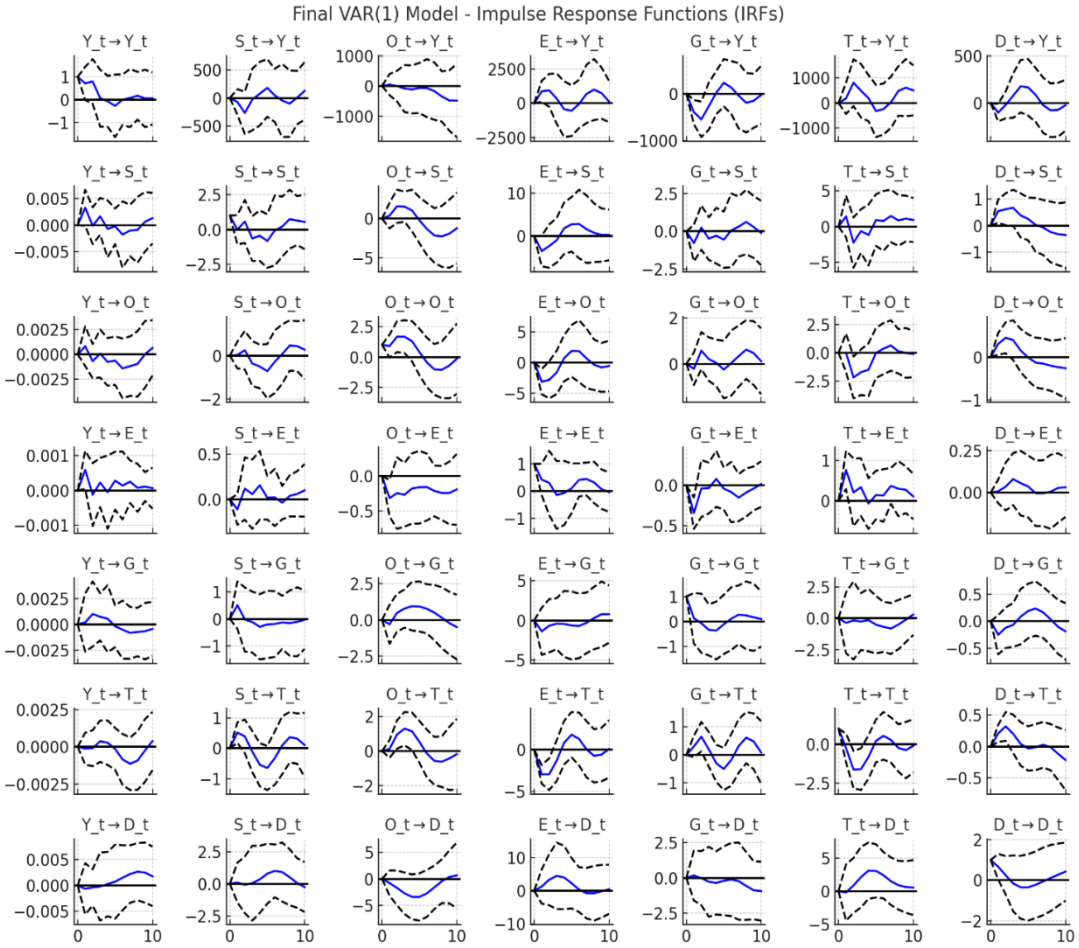
Fig N°7: Granger Causality Test (P-Values) For Output (Y□)



Source: Prepared by the authors' using Python 3.12.3.

The test confirms that public expenditure (% GDP) and energy subsidies significantly Granger-cause output ($p < 0.05$), highlighting their short-run impact on growth. Energy intensity shows marginal causality ($p \approx 0.07$), suggesting its influence is nearly significant, while oil revenue and public debt have weak evidence. Tax revenue fails to Granger-cause output at either lag, indicating a limited short-run role in driving GDP fluctuations.

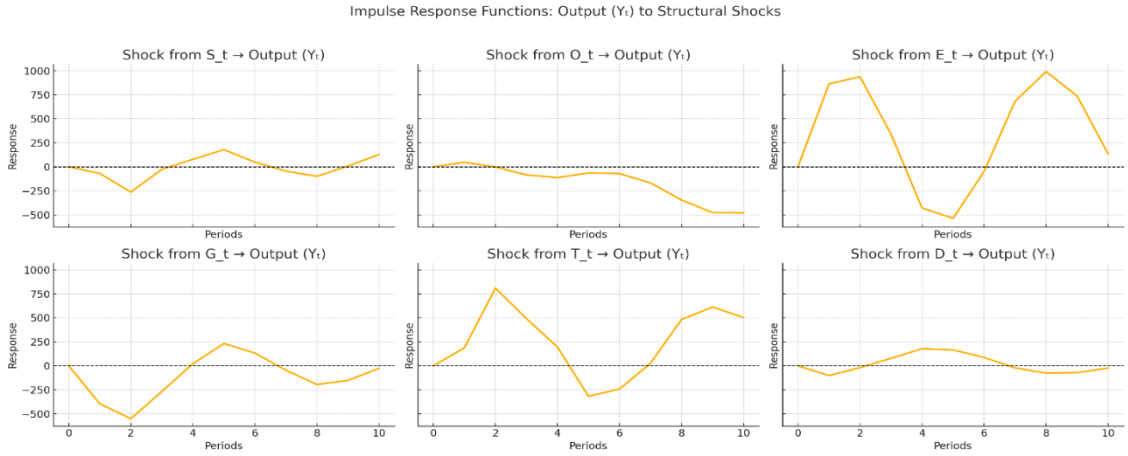
Fig N°8 : VAR (1) Impulse Response Matrix (All Variables)



Source: Prepared by the authors' using Python 3.12.3.

This panel displays all impulse response functions among the seven core variables (Output, Subsidies, Oil Revenue, Energy Intensity, Expenditure, Tax, Debt). Each subplot illustrates how a shock in one variable affects another over time. Notably, Output (Y□) is sensitive to shocks in fiscal and energy-related variables. The diversity in magnitudes and directions highlights the complexity of transmission mechanisms, justifying the VAR model's multivariate structure.

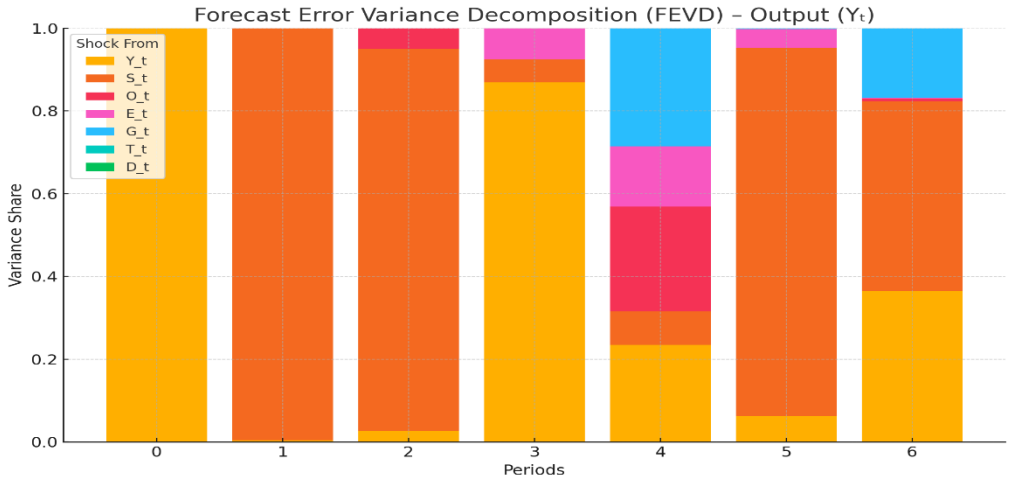
Fig N°9: Impulse Responses of Output (Y□) to Structural Shocks



Source: Prepared by the authors' using Python 3.12.3.

This set isolates the impact of individual structural shocks (e.g., subsidies, oil, energy intensity, expenditure, tax, debt) on Output. Output shows a strong positive reaction to fiscal shocks (G□, T□), while shocks from oil revenue and energy intensity generate more volatile or declining responses. This suggests that productive fiscal policies outperform extractive or energy-based channels in driving sustainable growth.

Fig N°10: Forecast Error Variance Decomposition (FEVD) of Output (Y□)



Source: Prepared by the authors' using Python 3.12.3.

This chart shows the contribution of each variable to the forecast error variance of Output over time. While Output is initially self-driven, energy subsidies (S□) and oil revenue (O□) become dominant contributors beyond period 2. Fiscal instruments like public expenditure (G□) and tax revenue (T□) also gain influence later, revealing their growing role in macroeconomic volatility.

4.2. Discussion

The empirical findings reveal several critical insights into the dynamic interaction between fiscal variables, energy structure, and economic performance in Algeria. The impulse response analysis demonstrates that structural shocks originating from public expenditure (G□) and tax revenue (T□) induce a positive and significant short-to-medium-term effect on output (Y□), reinforcing the effectiveness of productive fiscal policies in stimulating real economic activity. Conversely, shocks from energy subsidies (S□) exhibit mixed effects—initially contractionary followed by moderate recovery—underscoring inefficiencies and potential resource misallocation associated with untargeted subsidy mechanisms.

Moreover, oil revenue (O□) shocks display a limited or even negative long-run influence on output, potentially reflecting the "resource curse" effect and Algeria's vulnerability to hydrocarbon price volatility. The output response to energy intensity (E□) shocks is highly volatile, suggesting structural dependence on energy inputs with limited efficiency gains. Public debt (D□) shocks also reveal a non-linear impact: while short-term fiscal expansion may temporarily support output, prolonged debt accumulation poses risks to long-run sustainability.

The Granger causality results further validate the IRF findings, indicating statistically significant predictive power of public spending and subsidies on output, while tax revenue and debt show weaker short-run causality. These outcomes reinforce the argument that demand-side fiscal tools, particularly spending, are more effective in driving Algerian growth under current structural conditions.

Forecast Error Variance Decomposition (FEVD) confirms that oil revenue and energy subsidies account for a growing share of output volatility over time, especially beyond period 2. This highlights the persistent fiscal-extractive nexus dominating macroeconomic dynamics. Nevertheless, the increasing contribution of public expenditure and tax revenue to output variance after mid-horizon suggests a latent shift toward more diversified fiscal influence—if adequately managed.

Overall, the results reveal a macroeconomic structure that is still heavily reliant on volatile and politically sensitive variables (e.g., oil and subsidies), but with room for strategic policy leverage through expenditure reform, tax efficiency, and energy transition. The diagnostic tests confirm model robustness with no evidence of residual autocorrelation or structural instability, despite challenges in satisfying normality due to potential non-linearities or regime heterogeneity.

5. Conclusion:

This study employed A DSGE-BVAR model with Markov regime switching to capture regime-dependent responses between fiscal policy instruments, energy structure, and economic output in Algeria over the period 2000–2023. The findings underscore the asymmetric and regime-dependent nature of macroeconomic

responses to structural shocks, particularly those originating from public expenditure, taxation, and the energy sector.

Impulse response analysis reveals that fiscal expansion—especially through public spending and tax mobilization—positively affects output in the short-to-medium term. In contrast, energy subsidies and oil revenues generate weaker or negative responses, pointing to structural inefficiencies and Algeria's vulnerability to global commodity cycles. Forecast error variance decomposition confirms the dominant role of hydrocarbon-linked variables in explaining output volatility, though the growing influence of domestic fiscal tools suggests emerging policy traction. The Granger causality tests further validate these findings, highlighting the predictive strength of public expenditure and subsidy dynamics over output fluctuations. Meanwhile, diagnostic assessments confirm the statistical integrity of the model, despite minor violations of normality assumptions. Taken together, the evidence calls for a strategic rebalancing of Algeria's macroeconomic framework—away from rentier dependence and toward efficient, growth-enhancing fiscal interventions. Targeted subsidy reform, fiscal discipline, and long-term investment in energy efficiency and tax capacity are critical for stabilizing output and enhancing macroeconomic resilience in the post-hydrocarbon era.

Recommendations :

1. Algeria should gradually phase out broad-based energy subsidies and replace them with targeted transfers for vulnerable households. This will enhance fiscal space without compromising social equity.
2. Expanding the tax base and improving collection efficiency can reduce fiscal reliance on volatile oil revenues. Emphasis should be placed on progressive taxation and formal sector expansion.
3. Public spending should be redirected toward productive investments such as infrastructure, health, and education—sectors with high output multipliers and long-term developmental impact.
4. Policies encouraging renewable energy use and reducing energy intensity will mitigate structural inefficiencies and align with long-term sustainability goals.
5. Adopting fiscal rules and stabilization funds linked to commodity prices can help smooth macroeconomic volatility and prevent pro-cyclical spending patterns.

Future research should move beyond macroeconomic modeling to investigate the micro-level behavioral dynamics underpinning fiscal inefficiencies and energy consumption patterns in Algeria. Specifically, integrating household-level or firm-level survey data could uncover how energy subsidies influence labor decisions, investment choices, and social welfare outcomes.

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