Review MECAS V° 22/ N° 1/ June 2026

Revisiting the Growth–Expenditure Nexus in Algeria: Empirical Evidence from Cointegration Analysis

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Received date: 25.03.2026, Accepted date : 02.05.2026, Publication date: 02.06.2026

Abstract :
This study examines the relationship between economic growth and government expenditure in Algeria over the period 1972–2024, with the aim of testing the validity of Wagner's law against the Keynesian hypothesis. The analysis employs the Engle-Granger cointegration approach to identify the long-run relationship, and a Vector Error Correction Model (VECM)-based Granger causality framework to determine the direction of causality. To ensure robustness, alternative cointegration estimators-FMOLS, DOLS, and CCR-are also applied. The results confirm the existence of a long-run relationship under Wagner's law specification, with an elasticity greater than unity, indicating that government expenditure grows more than proportionally with national income. Robustness checks support this finding, with consistent estimates across methods. The causality results reveal no short-run causality, but a significant long-run causality running from economic growth to government expenditure. Overall, the findings strongly support Wagner's law and reject the Keynesian hypothesis in both the short and long run.
Keywords: Wagner's Law; Government Expenditure; Economic Growth; Engle–Granger Cointegration; Algeria.
Jel Classification Codes: E62, H50, O47, O11, C22.

Introduction :

The relationship between government expenditure and economic growth is central in public economics, particularly through the lens of Wagner's Law (Henrekson, 1993, p. 407), which posits that public spending increases at a faster rate than national income as economies develop. This tendency reflects the

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expanding functions of the state and the growing societal demand for public services such as education, healthcare, infrastructure, and social protection (Musgrave, 1969, p.84; Halicioglu, 2003, p. 129). Understanding the direction of causality between government expenditure and economic growth is critical, as it has significant implications for fiscal policy formulation, budgetary planning, and long-term economic sustainability, especially in developing economies where public spending represents a substantial share of gross domestic product (Keynes, 1936/1964, pp. 113-114; Barro, 1991).

Algeria constitutes a compelling case for examining this relationship, given its status as a resource-rich, hydrocarbon-dependent developing economy that has undergone major structural transformations since independence in 1962 (Aissaoui, 2001). Over the period 1972–2024, the Algerian economy experienced state-led industrialization during the oil boom of the 1970s, fiscal and debt crises in the 1980s, structural adjustment and market-oriented reforms in the 1990s, a commodity super-cycle in the 2000s, and more recent phases of fiscal consolidation and diversification efforts (Sachs & Warner, 1995; IMF, 2020). Throughout these stages, government expenditure has played a pivotal role as both a development instrument and a mechanism for redistributing oil revenues, making Algeria an ideal setting for testing the validity of Wagner's Law and for assessing the sustainability of public spending in the context of volatile hydrocarbon revenues (Gelb, 1988).

a. Research Problem

Does Wagner's Law hold in Algeria? does economic growth drive government expenditure expansion, or does government spending stimulate economic growth (Keynesian hypothesis)?

b. Research Hypotheses

We test four competing hypotheses regarding the relationship between government expenditure and gross national income (Toda & Yamamoto, 1995, p. 226); Peacock & Wiseman, 1979):

- **H_1 (Neutrality Hypothesis):** No causal relationship exists between variables in either direction. Under this hypothesis, the two variables are independent, and fiscal policy has no significant impact on economic growth, while economic expansion does not systematically influence government spending patterns (Verma & Arora, 2010, p. 78).
- **H_2 (Wagner's Law):** Unidirectional causality runs from GNI to government expenditure. This hypothesis, formulated by German economist Adolph Wagner in 1883, posits that economic development leads to increased government activity (Wagner, 1883; Bird, 1971, pp.1-5). As economies grow and societies become more complex, there is increasing demand for public goods, regulatory frameworks, and welfare services, leading to a more than proportional increase in government expenditure (Henrekson, 1993). Wagner's Law suggests that government expenditure is endogenous, determined by the level of economic development (Mann, 1980).
- **H_3 (Keynesian Hypothesis):** Unidirectional causality runs from government expenditure to GNI. Based on Keynesian economic theory, this hypothesis suggests that government spending is an exogenous policy instrument that can stimulate aggregate demand, generate multiplier effects, and thereby promote economic growth (Keynes, 1936; Aschauer, 1989). This view supports the use

of expansionary fiscal policy as a tool for economic management and growth promotion (Barro, 1990).

- **H_4 (Feedback Hypothesis):** Bidirectional causality exists between variables. This hypothesis combines elements of both Wagner's Law and the Keynesian perspective, suggesting that government expenditure and economic growth are mutually reinforcing (Burney, 2002). Economic growth increases tax revenues and enables higher government spending, while increased government expenditure stimulates economic activity and growth (Ghali, 1999).

To test these hypotheses, the Engle–Granger cointegration framework was used to assess the long-run relationship between economic growth and government spending, while the VECM Granger causality test was employed to identify the direction of causality. To verify the robustness of the findings, alternative cointegration estimators—Fully Modified Ordinary Least Squares (FMOLS), Dynamic Ordinary Least Squares (DOLS), and Canonical Cointegration Regression (CCR) - were implemented, as they are designed to correct for endogeneity and serial correlation biases.

c. Research Objectives

Against this backdrop, the present study seeks to empirically examine the long-run relationship between economic growth and government expenditure, and to identify the direction of causality between these variables in Algeria over the period 1972–2024. By assessing which of the competing theoretical hypotheses best characterizes the Algerian economy, the study aims to generate evidence-based insights that can inform the formulation of effective fiscal policies.

d. Structure of the paper:

The remainder of the paper is organized as follows. Section 1 reviews the relevant theoretical and empirical literature. Section 2 describes the data and outlines the econometric methodology employed. Sections 3 & 4 report and discuss the empirical findings. concludes by summarizing the key results and highlighting their policy implications.

1. Literature review:

The empirical literature on Wagner's Law and the government expenditure-growth nexus has produced mixed results across different countries and time periods. **Support for Wagner's Law:** Henrekson (1993) examined Swedish data and found strong support for Wagner's Law, attributing increased government size to the rising income elasticity of demand for public services. Magazzino et al. (2015) conducted a panel study of European Union countries and found evidence consistent with Wagner's Law, particularly in developed member states. Verma and Arora (2010) confirmed Wagner's Law for India using the ARDL bounds testing approach, showing that economic development led to the expansion of government activities in regulatory, administrative, and welfare functions (Verma & Arora, 2010, pp. 86-88).

Support for Keynesian Hypothesis: Loizides and Vamvoukas (2005) employed trivariate causality testing and found evidence supporting the Keynesian view in Greece and Ireland, suggesting that government expenditure serves as an effective policy instrument for promoting economic growth. Their findings emphasized the importance of government investment in infrastructure and human capital development (Aschauer, 1989).

Mixed or Bidirectional Results: Toda and Yamamoto (1995, pp. 241-243) developed a modified Wald test procedure and found feedback effects in several countries, suggesting that the relationship varies across development stages and institutional contexts. Halicioglu (2003) found bidirectional causality for Turkey, indicating that both Wagner's Law and the Keynesian hypothesis can coexist in transition economies.

Methodological Critiques: Henrekson (1993) argued that many early studies supporting Wagner's Law suffered from spurious regression problems due to the non-stationarity of variables (Granger & Newbold, 1974). Modern studies employing cointegration techniques have produced more nuanced findings, recognizing that both long-run equilibrium relationships and short-run dynamics need to be considered (Johansen, 1991).

Studies specific to the Middle East and North Africa region have yielded diverse findings (Burney, 2002; Narayan et al., 2008):

Algeria-Specific Studies: Atmania and Ait Yahia (2021) examined Wagner's Law in Algeria for 1967-2018 using ARDL methodology and found support for the hypothesis, particularly after economic liberalization in the 1990s. Ben Jedou and Ramli (2020) analyzed the relationship using ARDL bounds testing and found a long-run equilibrium with economic growth driving government expenditure expansion. Djamil and Akriche (2022) incorporated structural breaks analysis and identified regime changes in 1986 and 2000, finding that the relationship strengthened in the post-reform period.

Despite the extensive empirical literature on Wagner's Law and the government expenditure–growth nexus, several gaps remain, particularly in the context of resource-dependent developing economies such as Algeria (Ross, 2012). Existing studies often focus on shorter time horizons, employ limited methodological frameworks, or fail to adequately account for structural breaks arising from major economic and institutional shocks (Perron, 1989). Moreover, the Algerian case has received relatively limited attention using long-span data that capture multiple development regimes, oil price cycles, and policy shifts simultaneously. There is also a lack of consensus regarding the direction of causality and the stability of the relationship over time, with few studies jointly testing competing hypotheses within a unified econometric framework (Kumar et al., 2012). This study addresses these gaps by examining a long annual sample (1972–2024), incorporating structural breaks, and systematically testing Wagnerian, Keynesian, and alternative hypotheses, thereby providing more robust and policy-relevant evidence on the expenditure–growth relationship in Algeria.

2. Data and Methodology:

2.1. Data:

2-1.1. Data Source

The empirical analysis relies on 53 annual observations for Algeria over the period 1972–2024, encompassing government consumption expenditure and gross national income, both expressed in constant US dollars. The data are sourced from the World Development Indicators (World Bank, 2024). All variables are converted into natural logarithms to enable the interpretation of estimated coefficients as elasticities.

2.1.2. Descriptive statistic

Table 1: Descriptive Statistics (1972-2024)

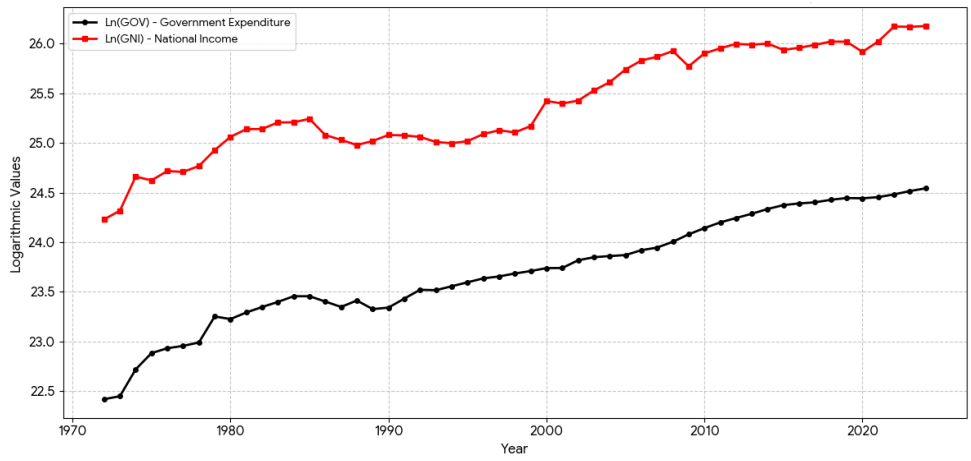
Variable	Mean	Median	Max	Min	Std. Dev.	Skewness	Kurtosis
LNGNI	25.39	25.21	26.18	24.23	0.520	-0.107	1.983
LNGOV	23.71	23.68	24.54	22.42	0.549	-0.289	2.460

Source: Authors' calculations based on World Bank (2024) data

Descriptive analysis of Algerian data (1972–2024, N=53) reveals that average logarithmic national income (LnGNI=25.39) consistently exceeds government expenditure (LnGOV=23.71), with both series exhibiting steady growth and low dispersion (SD=0.52 and 0.55, respectively). Slight negative skewness (LnGNI:−0.11; LnGOV:−0.30) and negative kurtosis values (LnGNI:−1.00; LnGOV:−0.47) indicate marginally asymmetric, platykurtic distributions over the sample period. The proximity of means to medians (25.21 and 23.68) confirms long-term stability and the absence of extreme outliers, providing a robust statistical foundation for the subsequent cointegration and causality analysis.

2.1.3. Evolution of Government Expenditure and Economic Growth in Algeria:

Figure. 1: Time Series Plot of LnGNI and LnGOV (1972-2024)



Source: Authors' calculations based on World Bank (2024) data

The Algerian economic data from 1972 to 2024 reveals a deeply entrenched structural relationship between Gross National Income (GNI) and Government Consumption Expenditure (GOV), providing a clear co-mouvement. Throughout this fifty-year trajectory, public sector expansion has functioned as a direct reflection of national income levels, themselves tied to the country's hydrocarbon-dependent rentier model. The 1970s witnessed steep growth in public spending during the state-led industrialization phase, a trend that resurged after 2001 following a decade of stagnation. High fiscal procyclicality characterizes this relationship, with government expenditure closely mirroring global energy price cycles. A notable ratchet effect is also observable: while spending expands rapidly during income booms, it exhibits marked downward rigidity during contractions, creating persistent budgetary pressures rooted in civil service commitments and broad subsidy systems. This circular dependence underscores the urgency of fiscal reform and revenue diversification to ensure long-term macroeconomic stability.

2.2. Econometric Methodology:

Our study employs Pryor's (1968) model specification, which provides a framework for testing Wagner's Law and Keynesian hypothesis in the Algerian context during the period 1972-2024. The use of Pryor's formula is justified by the availability of data on government consumption expenditure, which aligns with the requirements of this specification.

The empirical methodology employed in this study follows a sequential approach comprising the following steps:

(1) unit root testing of the variables;
(2) application of the Engle–Granger cointegration test;
(3) diagnostic testing of the long-run model;
(4) VECM-based Granger causality analysis; and
(5) robustness checks.

2.2.1. Engle-Granger cointegration test:

We adopt in this study the Engle-Granger residual-based cointegration test. This method is also known as the two-step Engle-Granger methodology, where the first step is:

a. Estimating the long-run relationship:

- Pryor's version of Wagner's Law formulated as follows:

$$\boldsymbol{ln\, GOV_t = \alpha + \beta\, ln\, GNI_t + \varepsilon_t} \ldots\ldots\ldots 1$$

- Keynesian hypothesis:

$$\boldsymbol{ln\, ln\, GNI_t = \alpha + \beta\, ln\, GOV_t + \varepsilon_t} \ldots\ldots 2$$

Where:

- $\boldsymbol{ln\, GOV_t}$ = Natural logarithm of consumption government expenditure
- $\boldsymbol{ln\, GNI_t}$= Natural logarithm of gross national income
- $\boldsymbol{\alpha}$= Constant term
- $\boldsymbol{\beta}$= Long-run elasticity coefficient "the income elasticity of government expenditure".
- $\boldsymbol{\varepsilon_t}$ = Error term

Wagner's Law is supported if $\beta > 1$, indicating that government expenditure grows more than proportionally with national income (Wagner, 1883; Bird, 1971).

b. Testing the stationarity of the residual series:

After estimating the long-run relationship, we extract the residual series and test their stationarity. If the residuals are stationary at a level, this provides evidence of cointegration between the two variables.

If the cointegration relationship is confirmed in the first step, step two consist to estimate the short-run relationship - Error Correction Model (ECM) - as follows (Verma & Arora, 2010, pp. 84- 85):

c. Wagner's Law model:

$$\Delta\, ln\, GOV_t = \alpha_0 + \sum_{i=1}^{p} \alpha_i\, \Delta\, ln\, GOV_{t-i} + \sum_{j=1}^{q} \beta_j\, \Delta\, ln\, GNI_{t-j} + \gamma\, ECT_{t-1} + \varepsilon_t \ldots\ldots 3$$

d. Keynesian hypothesis model:

$$\Delta\, ln\, GNI_t = \alpha_0 + \sum_{i=1}^{p} \alpha_i\, \Delta\, ln\, GNI_{t-i} + \sum_{j=1}^{q} \beta_j\, \Delta\, ln\, GOV_{t-j} + \gamma\, ECT_{t-1} + \varepsilon_t \ldots\ldots 4$$

Where:

- Δ = denotes first difference operator
- ECT_{t-1} = Error correction term (lagged residual from long-run equation)
- γ, λ = Speed of adjustment coefficients (expected to be negative)

The error correction term captures deviations from long-run equilibrium, with the coefficient indicating how quickly the system returns to equilibrium after a shock (Banerjee et al., 1993). A significant negative coefficient confirms the existence of a long-run relationship and provides evidence of cointegration (Johansen, 1991).

2.2.2. Diagnostic tests:

To validate the long-run model's reliability, a comprehensive battery of residual diagnostic tests is conducted. These include the Jarque-Bera test for normality, the Breusch-Godfrey LM test for serial correlation, and the ARCH test to identify heteroskedasticity. Furthermore, the CUSUM and CUSUMSQ plots are employed to ensure the stability of the estimated coefficients over time.

2.2.3. VECM Granger Causality test:

When variables exhibit a cointegrating relationship, the Vector Error Correction Model (VECM) offers the most robust framework for conducting Granger causality tests to identify the direction of causality.

Based on the two-stage approach of Engle and Granger (1987), we formulate the VECM system in the following manner.

$$\begin{bmatrix}\Delta ln\ GOV_t \\ \Delta ln\ GNI_t\end{bmatrix} = \begin{bmatrix}\phi_1 \\ \phi_2\end{bmatrix} + \sum_{i=1}^{p}\begin{bmatrix}\beta_{11i} & \beta_{12i} & \beta_{13i} \\ \beta_{21i} & \beta_{22i} & \beta_{23i}\end{bmatrix}\begin{bmatrix}\Delta ln\ GOV_{t-i} \\ \Delta ln\ GNI_{t-i}\end{bmatrix} + \begin{bmatrix}\vartheta_1 \\ \vartheta_2\end{bmatrix}[ECT_{t-1}] + \begin{bmatrix}\epsilon_{1t} \\ \epsilon_{2t}\end{bmatrix} \text{..... [5]}$$

Where:

- Δ= denotes the first-difference operator.
- ϕ_i = are the constant terms for i=1, 2, 3.
- β_{ji}= are the parameters to be estimated.
- ECT_{t-1}= is the one-period lagged error correction term derived from the cointegration relationship presented in Eq.1.
- p = represents the number of lags selected based on the Schwarz Bayesian Criterion (SBC).
- ϵ_{it}= are the error terms for i=1, 2, 3.

The VECM-based Granger causality framework enables the investigation of both short-run and long-run causal dynamics between public expenditures (GOV) and economic growth (GNI). Short-term causality is evaluated via a standard Wald test on the joint significance of the coefficients in Equation 5, utilizing the χ 2 statistic. Conversely, long-run causality is identified through the statistical significance and negative sign of the Error Correction Term (ECT) coefficient, assessed using the t-statistic.

2.2.4. Robustness check:

To ensure the robustness of the long-run relationship, additional cointegration estimators were employed. Specifically, the Fully Modified Ordinary Least Squares (FMOLS), Dynamic Ordinary Least Squares (DOLS), and Canonical Cointegrating Regression (CCR) methods were applied as robustness checks. These alternative estimators account for potential endogeneity and serial correlation issues commonly associated with cointegrated systems.

3. EMPIRICAL RESULTS & DISCUSSION

3.1. Unit Root Tests

The results of the unit root tests reported in **Table 2** — including the Augmented Dickey-Fuller (Dickey & Fuller, 1979), Phillips-Perron (Phillips & Perron, 1988), and Zivot-Andrews (Zivot & Andrews, 1992) procedures — confirm that both **LNGNI** and **LNGOV** are **non-stationary in levels** but **stationary after first**

differencing, supporting their classification as I(1) variables. Although LNGOV appears marginally stationary in trend-inclusive specifications, a conservative interpretation is adopted to avoid spurious inference. Structural break tests (**Zivot & Andrews, 1992; Perron, 1989**) identify significant breaks around **1986, 2000, and 2009,** corresponding to Algeria's oil price collapse, the commodity super-cycle, and the global financial crisis, respectively. Crucially, allowing for these breaks does not alter the order of integration, justifying the subsequent application of cointegration techniques.

Table 2: Conventional Unit Root Test Results (1972-2024)

Variable	Test	Specification	Test Statistic	p-value	Break	Conclusion
PanelA: Levels						
LNGNI	**ADF**	**Constant + Trend**	-2.477	0.338	**-**	Non-stationary
		Constant	-1.793	0.380	**-**	
	PP	**Constant + Trend**	-2.578	0.292	**-**	
		Constant	-1.780	0.386	**-**	
	KPSS	**Constant + Trend**	0.078	0.146	**-**	stationary*
LNGOV	**ADF**	**Constant + Trend**	*-3.733*	*0.029*	**-**	stationary**
		Constant	-2.651	0.090	**-**	Non-stationary
	PP	**Constant + Trend**	***-3.737***	***0.029***	**-**	stationary**
	KPSS	**Constant + Trend**	*0.080*	-	**-**	stationary*
Panel B: First Differences						
D(LNGNI)	**ADF**	**Constant + Trend**	***-6.639******	***0.000***	**-**	Stationary
		Constant	***-6.601******	***0.000***	**-**	
	PP	**Constant + Trend**	***-6.633*****	***0.000***	**-**	
		Constant	-6.592***	***0.000***	**-**	
	KPSS	**Constant + Trend**	***0.117***	**0.000**	**-**	
D(LNGOV)	**ADF**	**Constant + Trend**	***-6.493*****	**0.000**	**-**	
		Constant	-6.109***	**0.000**	**-**	
	PP	**Constant + Trend**	***-6.510*****	**0.000**	**-**	
		Constant	-6.116***	**0.000**	**-**	
Panel C: Structural Break Tests (Zivot-Andrews)						
LNGNI	**ZA**	**in Intercept**	-3.834	0.005	1986	Non-stationary
		Trend & Intercept	-3.921	0.000	2000	
		in Trend	-2.965	0.105	1994	
LNGOV		**Intercept**	-4.358	0.030	1987	

		Trend & Intercept	-4.039	0.022	2009	
		in Trend	-3.711	0.843	2006	
Panel D: Perron Tests (Innovational Outlier)						
LNGNI	**Perron IO**	**Intercept Only**	-4.628	0.030	1999	Non-stationary
LNGOV			-4.028	0.148	2006	

Source: Authors' estimations using EViews 12

Notes: I(0) = Stationary; I(1) = Non-stationary; * = Marginal stationarity

ADF = Augmented Dickey-Fuller; PP = Phillips-Perron; KPSS = Kwiatkowski-Phillips-Schmidt-Shin; ZA = Zivot-Andrews; IO = Innovational Outlier

- *** p < 0.01; ** p < 0.05; * p < 0.10

3-2. Cointegration Analysis

3-2-1. Engle-Granger Two-Step Procedure (Engle & Granger, 1987, pp. 251-254)

To test the cointegration relationship between the government expenditure and the National Income,

Firstly, we estimate the long-run relationship. The estimation results of the long-run model are reported in Table 3.

Table 3: Long-run relationship estimations

Wagner's Law model: LnGOV=LnGNI		
Variable	Coefficient	t-statistic
LnGNI	1.02***	27.47
C	- 2.26**	-2,39
Keynesian hypothesis model: LnGNI=LnGOV		
LnGOV	0.91***	27.47
C	3.68***	4.66

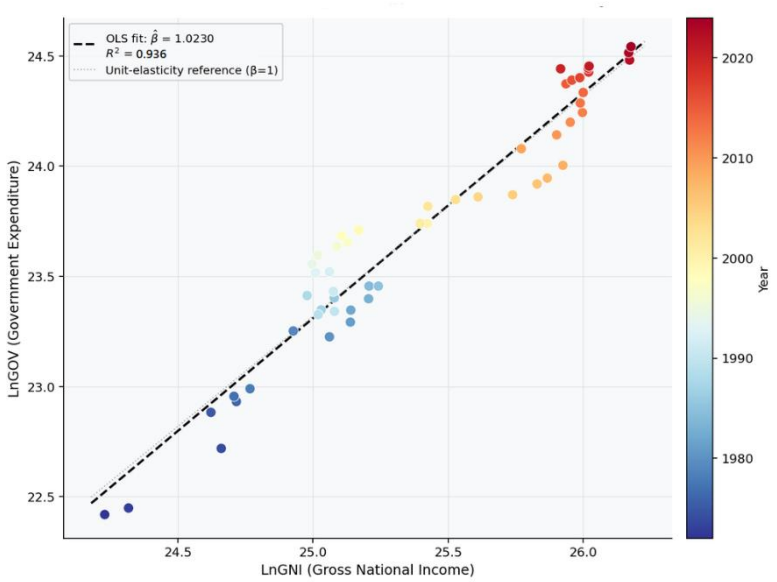
Source: Authors' estimations using EViews 12

Notes: ***, **: indicate 1% and 5% level of significance, respectively

The results in Table 3 indicate that:

- **Wagner's Law Model:** the estimated coefficient of LnGNI is 1.02, statistically significant at the 1% level (t = 27.47 >> critical t ≈ 2.66), indicating a long-run elasticity of government expenditure with respect to gross national income of 1.02. A 1% increase in GNI thus produces a ceteris paribus increase of approximately 1.02% in public spending over the long run. The constant (−2.26), significant at the 5% level, captures a baseline level of government expenditure independent of income. Critically, the elasticity exceeding unity (β > 1) confirms the strong version of Wagner's Law, whereby government spending grows more than proportionally relative to national income (Wagner, 1883).
- **Keynesian hypothesis model:** the coefficient of LnGOV is estimated at 0.91, statistically significant at the 1% level (t = 27.47). It represents the long-run elasticity of national income with respect to government spending. A 1% increase in government spending generates an increase of 0.91% in GNI in the long run. The elasticity is below 1 (β < 1), indicating that the effect of government spending on output is real but less than proportional, implying a long-run Keynesian multiplier of less than unity. The constant is strongly significant (3.68; t = 4.66), reflecting an autonomous level of national income not explained solely by government spending.

Figure. 2: Plot of the estimated Wagner's Law long-run relationship



Source: Authors' estimations

The identical t-statistics (27.47) across both models is not coincidental; it results from the fact that the two models are inverse regressions of one another within a symmetric cointegration system. In a simple log-log regression framework, if β_1 (Y on X) and β_2 (X on Y) are the OLS coefficients, then $\beta_1 \times \beta_2 = R^2$, which is consistent here: $1.02 \times 0.91 \approx 0.928 \approx 0.93$ (the R^2 of the robustness models).

Secondly, we test the stationarity of the long-run residuals, the results of stationarity test are summarized in Table 4.

Table 4: Engle-Granger cointegration test

Model	tau-statistic	z-statistic
Wagner's Law	-2,344**	-10,116**
Keynesian hypothesis	-2,36**	-9,978**

Source: Authors' estimations using EViews 12

Notes: ** indicates 5% level of significance

The results in Table 4 confirm that the residuals from the long-run regression are stationary for both models(Wagner's Law model and Keynesian hypothesis model), providing clear evidence of cointegration between LnGOV and LnGNI and ruling out a spurious relationship.

3.2.2. Error Correction Model: Long-run estimations

After establishing cointegration, the next step is to estimate the short-term dynamic relationship. The results of these estimates are shown in Table 5.

Table 5: Short-run estimations

Variable	Coefficient	t-statistic
Wagner's Law model		
ECT_{t-1}	- 0.156	- 3.105 ***
$\Delta LnGOV_{t-1}$	-2.025	-0.176

$\Delta LnGNI_{t-1}$	0.078	0.775
C	0,461	3.336 ***
Keynesian hypothesis model		
ECT_{t-1}	0.023	0.337
$\Delta LnGNI_{t-1}$	0.028	0.172
$\Delta LnGOV_{t-1}$	0.044	0.191
C	0.109	0.479

Source: Authors' estimations using EViews 12
Notes: ***, * denote 1% significance level.

-For the Wagner's Law model, the error correction term (ECT_{t-1}) is negative and statistically significant at the 1% level, confirming a stable long-run equilibrium. The coefficient (−0.156) implies that approximately 15.6% of short-run disequilibria are corrected each period, suggesting a slow adjustment speed of roughly six years to restore the steady state. Short-run dynamics (ΔGOV_{t-1} and ΔGNI_{t-1}) are statistically insignificant, indicating limited short-run interaction between the variables.

-For the Keynesian hypothesis model, the ECT_{t-1} is positive and insignificant, confirming the absence of long-run adjustment toward equilibrium and reinforcing the rejection of the Keynesian hypothesis in the Algerian context.

3.3. Diagnostic test:

Given the absence of cointegration between the variables under the Keynesian hypothesis, diagnostic tests are conducted only for Wagner's law model, where a long-run cointegrating relationship between economic growth and government spending is confirmed.

The results of the diagnostic tests, as presented in Table 6, support the adequacy of Wagner's law specification (LnGOV = f(LnGNI)).

Table 6: Residuals diagnostic tests for Wagner's Law model

Test	Statistic	p_value
Normality	J-B = 1.023	0,599
Breusch-Godfrey serial correlation test	LM=34.58	0,000
BPG LM test	LM = 1.079	0,299

Source: Authors' estimations using EViews 12
Notes: BPG: indicates Breush-Pagan-Godfrey.

Table 6 shows that:

Normality Test: the Jarque–Bera test assesses the null hypothesis of normally distributed residuals. As reported in Table 6, the JB statistic equals 1.023 with a p-value of 0.599. Since the p-value exceeds the 5% significance threshold, the null hypothesis cannot be rejected, indicating that the residuals of Wagner's law model are consistent with normality, thereby supporting the validity of statistical inference.

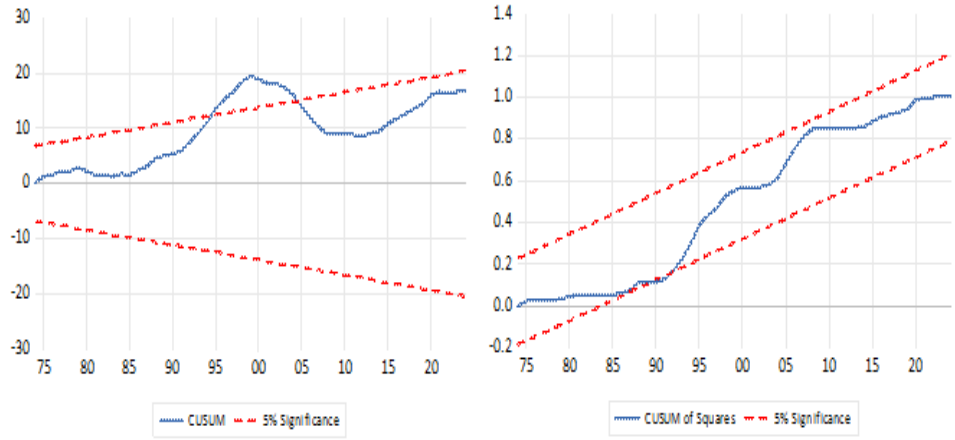
Serial Correlation Test (Breusch–Godfrey): Given that the p-value falls below the conventional significance level, the null hypothesis of no serial correlation is rejected, implying that the residuals of Wagner's law model exhibit autocorrelation. Nevertheless, the model is estimated using heteroskedasticity and autocorrelation consistent (HAC) standard errors, following the Newey–West procedure, which

ensures the robustness of the estimated coefficients to both autocorrelation and heteroskedasticity in the residuals.

Heteroskedasticity Test (BPG LM Test): As the p-value is greater than the 5% significance level, the null hypothesis of homoskedasticity cannot be rejected, suggesting that the residuals of Wagner's law model have constant variance and support valid inference.

CUSUM and CUSUM square for coefficients stability: The results of CUSUM and CUSUMSQ are illustrated in Figure 3.

Figure. 3: Plot of CUSUM and CUSUM square of Wagner's Law model



Source: Authors' estimations

The Fig. 3 indicates that the CUSUM statistic crosses the 5% critical bounds, providing evidence of instability in the model's structural coefficients. This suggests that the relationship between the economic variables has undergone significant changes over the study period.

In contrast, the CUSUM of Squares statistic remains within the 5% critical bounds, indicating stability in the variance of the residuals. According to Walter Krämer and Wolfgang Ploberger (1990), a non-significant CUSUM of Squares test implies that the variance of the error terms remains constant, suggesting the absence of substantial changes in the dispersion of random shocks.

3.4. VECM Granger causality analysis

The results of the VECM Granger causality test are reported in Table 7.

Table 7: VECM Granger causality test results

Dependent Variable	Short-run causality: Based on χ^2 statistic		Long-run causality
	ΔGOV_{t-1}	ΔGNI_{t-1}	ECT_{t-1} (t-stat)
ΔGOV_t		0,601 [0,438]	-0,156 (-3,105)***
ΔGNI_t	0,036 [0,848]		0,023 (0,337)

Source: Authors' estimations

Notes: values between [ ] indicate p-value, values between ( ) denote t-statistic, *** denotes 1% significance level.

Granger causality results (Granger, 1969) reported in Table 7 reveal no short-run causality in either direction, as both χ^2 statistics are statistically insignificant (p=

0.438). In the long run, however, the negative and significant ECT_{t-1} confirms unidirectional causality running from economic growth to government expenditure, providing empirical support for Wagner's Law (Wagner, 1883). Conversely, when economic growth is the dependent variable, the ECT_{t-1} is positive and insignificant (p = 0.337), indicating the absence of long-run causality from government expenditure to economic growth. These findings consistently support Wagner's Law while rejecting the Keynesian hypothesis (Keynes, 1936) in both the short and long run for Algeria.

3.5. Robustness analysis:

The results obtained from FMOLS, DOLS, and CCR remain broadly consistent with the baseline long-run estimates, thereby confirming the stability and robustness of the long-run relationship among the variables. The results of these robustness checks are reported in Table 8.

Table 8: Robustness checks for Model: LnGOV=f(LnGNI)

Variable	FMOLS	DOLS	CCR
LnGNI	1.01***	0.97***	1.02***
C	-2.13	-0.99	-2.23
R^2 =	0,93	0,94	0,93

Source: Authors' estimations using EViews 12

Notes: *** indicates 1% level of significance.

As illustrated in Table 8, the results- especially from FMOLS and CCR- are consistent with the cointegration coefficient estimated under Wagner's law specification (β = 1.023), further supporting the robustness of the findings.

3.6. Discussion:

The empirical results of this study provide robust and consistent support for Wagner's Law (Wagner, 1883) in Algeria over the period 1972–2024, while offering little evidence in favor of the Keynesian hypothesis (Keynes, 1936). The cointegration results (Johansen, 1988; Engle & Granger, 1987) confirm a stable long-run equilibrium relationship, with an estimated income elasticity of government expenditure exceeding unity (β = 1.023), indicating that public spending has grown more than proportionally with national income as the economy expanded (Pryor, 1972). This finding aligns with the theoretical predictions of Wagner (1883) and is consistent with recent Algeria-focused studies (Atmania & Ait Yahia, 2021; Ben Jedou & Ramli, 2020) as well as broader evidence from resource-dependent economies (Gelb, 1988; Ross, 2012), reflecting a structural dynamic whereby hydrocarbon revenues generate fiscal space that is systematically translated into expanding public expenditure, rather than the reverse mechanism implied by Keynesian theory.

Granger causality tests (Granger, 1969) reveal a unidirectional long-run relationship running from gross national income to government expenditure (Bird, 1971), further corroborated by a significant negative error correction coefficient (ECT = −0.156), which indicates a slow but steady adjustment toward equilibrium — approximately six years following a shock. This adjustment inertia reflects the structural rigidity of public spending commitments in rentier states, where civil service wages, subsidies, and social transfers create institutional resistance to downward expenditure adjustment (Peacock & Wiseman, 1961; Tanzi & Schuknecht, 2000). In the short

run, expenditure dynamics display considerable autonomy from income fluctuations, driven by political economy factors and entrenched budgeting practices (Sims, 1980). The identified structural breaks in 1986, 2000, and 2009 (Perron, 1989; Zivot & Andrews, 1992) — corresponding to oil price collapses and global financial crises — temporarily disrupted short-run dynamics without altering the fundamental Wagnerian relationship in the long run.

The absence of Keynesian effects in Algeria contrasts with findings from advanced economies where public spending demonstrably stimulates growth (Loizides & Vamvoukas, 2005; Aschauer, 1989), a divergence attributable to structural inefficiencies, the dominance of recurrent over capital spending, and limited productive spillovers in hydrocarbon-dependent contexts (Elbadawi & Soto, 2012). Accordingly, fiscal sustainability requires anchoring expenditure decisions to long-term non-hydrocarbon income, implementing expenditure rules, and accelerating revenue diversification to avoid pro-cyclical fiscal behavior (IMF, 2019; Afonso & Furceri, 2010). Structural reforms promoting private sector development, improved governance, and economic diversification are essential for generating the sustained income growth needed to responsibly finance public expenditure (Barro, 1991). Fiscal policy should therefore be viewed not as a substitute for growth-enhancing reforms, but as a framework that adapts to the economy's evolving productive capacity.

Conclusion:

This study examined the long-run relationship and causal dynamics between economic growth and government expenditure in Algeria over the period 1972–2024, employing the Engle–Granger two-step cointegration approach, a VECM-based Granger causality framework, and robustness checks using FMOLS, DOLS, and CCR estimators.

The analysis yields three main findings. First, a long-run cointegrating relationship exists between economic growth and government expenditure, with an estimated elasticity exceeding unity ($\beta = 1.023$), supporting the strong version of Wagner's law. Second, the robustness checks confirm the reliability of this result, with alternative estimators yielding coefficients within a narrow range of 0.97–1.02. Third, the causality analysis establishes unidirectional long-run causality running from economic growth to government expenditure, with no evidence supporting the Keynesian hypothesis in either the short or long run.

From a policy perspective, these findings imply that fiscal policy in Algeria should be anchored to long-term revenue sustainability rather than used as a discretionary growth instrument. Given the country's structural dependence on hydrocarbon revenues, prioritizing expenditure efficiency, fiscal rule implementation, and economic diversification remains critical for ensuring long-term fiscal stability.

This study is subject to certain limitations, as it relies on aggregate macroeconomic indicators that may mask sectoral heterogeneity. Future research could extend this work by incorporating disaggregated expenditure data, exploring nonlinear dynamics, or applying regime-switching techniques to better capture structural asymmetries in the growth–expenditure relationship.

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