The Impact of Energy Transition on Algeria's Financial Stability (1995-2025): An Econometric Study Using the NARDL Approach

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Abstract :

This study aims to analyze the impact of energy transition on financial stability in Algeria over the period (1995–2025), focusing on the role of renewable energy in shielding the general budget from the volatility of traditional resources. The study employs an econometric approach using the Non-linear Autoregressive Distributed Lag (NARDL) model to capture the asymmetric relationships between variables.

The findings reveal the existence of a long-term equilibrium and cointegration between energy transition and the fiscal balance, with a notable asymmetric effect. Specifically, the results indicate that negative shocks in energy savings (gas surplus shortages) exert a fiscal pressure far exceeding the gains generated by positive shocks. Furthermore, the results demonstrate that investment in energy alternatives, despite its short-term costs, acts as a catalyst for financial resilience in the long run. Consequently, the study recommends accelerating the integration of renewables to ensure the sustainability of the public treasury.

Keywords: Energy Transition, Financial Stability, NARDL Model, Algeria.

JEL classification codes: C22 ; Q43 ; Q42 ; H62

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Introduction :

The Algerian economy stands at a decisive historical crossroads, where the stakes of fiscal sustainability intersect with the imperatives of a comprehensive energy transition. While the general budget remains structurally dependent on hydrocarbon revenues, the features of a new energy equation are emerging, driven by global geopolitical shifts and climate pressures. Within this context, the shift toward alternative energies is no longer a mere environmental luxury; it has become an economic necessity to liberate traditional resources from the constraints of surging domestic consumption and international market volatility.

Consequently, the pivotal question has shifted from the necessity of transition to the mechanics of its implementation without jeopardizing macro-fiscal stability. Mastering the complex, asymmetric interactions between gas revenues, renewable energy integration, and fiscal equilibrium is essential for designing a roadmap toward a sustainable economy—one capable of proactively managing financial shocks rather than merely reacting to them.

Research Problem

The fiscal sustainability in Algeria relies structurally on hydrocarbon revenues. In light of the accelerating global energy transitions and the surge in domestic energy demand, a dual economic dilemma has emerged: **firstly**, the erosion of the energy surplus destined for export (natural gas) due to domestic consumption growth; and **secondly**, the public financing costs associated with renewable energy projects as a strategic alternative.

The core problem lies in the "nature of the fiscal response"; the Algerian general budget does not react to changes in the energy surplus in a simple linear fashion. Rather, it suffers from excessive sensitivity toward negative shocks (surplus shortages) that far outweighs its benefits from positive shocks. Consequently, the fundamental question arises:

How do asymmetric shocks (positive and negative) of the energy transition affect fiscal sustainability in Algeria in the short and long run?

.Sub-questions

-Is there a long-term equilibrium relationship between energy transition variables and the general budget balance in Algeria?

-How does the general budget balance respond differently to positive versus negative shocks in the natural gas surplus?

-Does public investment in renewable energy represent a burden or a catalyst for public finance in the short and long run?

Research Hypotheses

H1: There is a statistically significant cointegration relationship between energy transition indicators and the sustainability of the general budget.

H2: The relationship between the general budget balance and energy surplus shocks is characterised by asymmetry, where the impact of a deficit is more severe than the impact of an increase.

H3: The impact of public investment in renewable energy transitions from a negative effect (burden) in the short run to a positive effect (catalyst) in the long run.

Importance of the study

The significance of this study stems from addressing a contemporary issue in Algeria—the energy transition—from a purely fiscal perspective. It provides a dynamic framework for policymakers to understand the financial implications of accelerating or delaying green investment. Furthermore, it enriches the academic literature by applying a modern econometric model (NARDL) to deconstruct the complex relationship between gas rents, energy alternatives, and their impact on the stability of the public treasury.

Objective of the study

-To determine the nature of the causal and dynamic relationship between the energy transition and financial stability.

-To measure the sensitivity of the general budget to sudden shocks in the natural gas surplus destined for export.

-To evaluate the long-term economic feasibility of public investments in the renewable energy sector.

-To provide policy recommendations based on precise econometric results that contribute to a roadmap for achieving fiscal sustainability away from oil dependency.

Research Methodology

The study adopts a descriptive-analytical approach to diagnose the energy and fiscal landscape in Algeria, supported by an econometric approach using the Non-linear Autoregressive Distributed Lag (NARDL) model. This model was selected for its superior ability to capture asymmetries in economic relationships and track the adjustment dynamics between the short and long run, using annual data covering the period (1995–2025).

I.Theoretical Foundations of the Research

The theoretical framework serves as the foundation for this study to understand the relationship between energy and public finance. With the shift toward renewable energy, there is a need to discuss the role of energy transition in securing the general budget and reducing its dependence on traditional resources. This part aims to review the core concepts of energy transition and fiscal stability, as a prerequisite for the detailed analysis in the practical part.

1. The concept of energy transition

1.1.Definition

There are several definitions of energy transition, the most important of which are as follows:

"The energy transition refers to the global energy sector's shift from fossil-based systems of energy production and consumption — including oil, natural gas, and coal — to renewable energy sources like wind and solar, as well as lithium-ion batteries. This structural change is driven by the need to decarbonise economies and achieve sustainable fiscal stability through technological innovation and policy decarbonisation." (IRENA) 2019,p11)

"The energy transition represents a long-term structural change in energy systems, moving away from carbon-intensive fossil fuels towards renewable energy and energy-efficient technologies. This shift aims to ensure energy security and fiscal sustainability by diversifying the energy mix and reducing reliance on volatile commodity markets." (Smil, V 2017,p24)

"Energy transition is no longer merely a technical substitution of fuel sources; it is a comprehensive macroeconomic realignment. It involves the decoupling of economic growth from carbon-intensive energy consumption through strategic fiscal reforms, large-scale investment in renewable capital, and the restructuring of public revenue streams." (Hafner, M., & Raimondi, P. P 2023,p5)

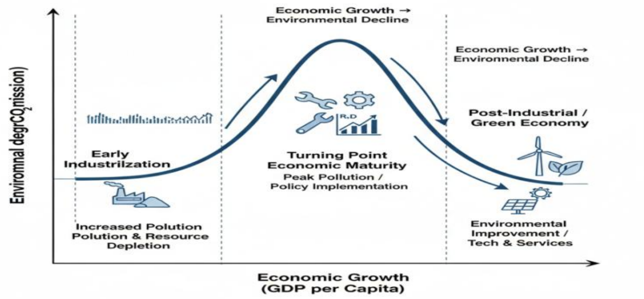
Energy transition is a long-term structural transformation of the energy system, characterised by a strategic shift from total reliance on carbon-intensive fossil fuels (oil, gas, and coal) towards a sustainable energy mix underpinned by renewable sources and clean technologies. This transition transcends mere technical adjustments; it encompasses a comprehensive reorganisation of fiscal and economic policies to ensure long-term sustainability and mitigate the systemic risks associated with the volatility of global energy markets.

1.2. Environmental Kuznets Curve – EKC

The Environmental Kuznets Curve (EKC) hypothesis postulates an inverted U-shaped relationship between economic growth and environmental degradation. (Grossman, G.M. and Krueger, A.B 1991,p3) In the context of this study, the EKC explains how Nations's transition toward renewable energy acts as a critical 'turning point' to decouple economic expansion from carbon-intensive energy consumption, thereby enhancing fiscal sustainability. (Way, R., Ives 2022)

The stages of this curve are illustrated in the following figure: (Way, R., Ives et al 2022,pp257-282)

Fig1.Environmental Kuznets Curve – EKC



Source: Grossman, G.M. and Krueger, A.B, 'Environmental Impacts of a North American Free Trade Agreement', National Bureau of Economic Research (NBER), Working Paper No. 3914,1991, pp. 3-5

Stage 01: The Pre-industrial/Scale-up Phase (The Ascent): In the early stages of development, the economy prioritises intensive industrialisation and resource extraction. This leads to an escalation in carbon emissions and environmental degradation. Within this context, the fiscal budget's dependency on hydrocarbons becomes highly evident.

Stage 02:The Turning Point: Upon reaching a specific income threshold, the state begins to prioritise environmental quality and the well-being of its citizens. At this stage, the government becomes financially capable of investing in clean technologies and green infrastructure.

Stage 03: The Post-industrial/Green Phase (The Descent): Environmental degradation starts to decline, driven by **energy transition**, technological innovation, and a structural shift towards a service- and knowledge-based economy.

1.3.The Nexus between EKC, Energy Consumption, and the Fiscal Budget

In this research, the EKC hypothesis can be analysed through three distinct economic effects: (Galeotti, M.et al 2009,pp2614-2615)

-The Scale Effect: Increased production leads to higher energy consumption. This exerts significant pressure on the fiscal budget due to the rising costs of energy subsidies required to sustain economic growth.

-The Composition Effect: As the economy transitions from heavy, polluting industries to technology-driven green sectors, the structure of capital expenditure (CAPEX) in the budget undergoes a fundamental shift towards sustainable assets.

-The Technique Effect: The integration of renewable energy (your independent variable) leads to enhanced energy efficiency and the adoption of cleaner production methods. This ultimately results in reduced emissions and ensures long-term fiscal sustainability.

1.4. Energy Efficiency and Technological Innovation: The Role of Research and Development (R&D) in Structural Cost Transformation:

These effects can be summarized as follows:

Lowering Marginal Costs: Renewable energy technologies are initially characterised by high upfront costs; however, through continuous innovation, the marginal cost of producing a kilowatt-hour (kWh) decreases significantly. This reduction alleviates fiscal pressure on the general budget by making clean energy a more cost-effective alternative to conventional sources. (Way et al 2022, p2060)

-Subsidy Redirection: Innovation enhances the commercial competitiveness of green technologies, enabling governments (such as the Algerian government) to gradually scale back fossil fuel subsidies. These fiscal savings can then be strategically redirected towards Research and Development (R&D), creating a virtuous cycle of sustainable investment. (Acemoglu et al 2012,148)

-Asset Longevity: Investing in high-efficiency technologies enhances the durability of energy infrastructure. This reduces long-term maintenance expenditures and minimises energy wastage, further contributing to fiscal efficiency and resource optimisation. (Jaffe et al 2002, p45)

1.5.Rentier economies between resource dependence, fiscal sustainability and energy transition

Rentier economies, including Algeria, face a dual challenge: on the one hand, they rely heavily on natural resource revenues to finance their budgets; on the other hand, they find themselves highly exposed to international price fluctuations. This section aims to explain how energy transition can be a strategic solution for achieving fiscal sustainability by reducing dependence on fossil fuels and replacing them with sustainable energy sources that ensure long-term stability. This proposal can be discussed through the following dimensions:

- Resource Dependency and the Resource Curse

In rentier economies, the Resource Curse or 'Dutch Disease' manifests through an over-reliance on hydrocarbon revenues, making the fiscal budget highly vulnerable to global price volatility, fluctuations in oil and gas prices dictate the ceiling of public expenditure. When prices collapse, the state faces a 'pro-cyclical' fiscal crisis, where public investment and social subsidies are constrained by the shrinking rent, leading to structural deficits and economic instability. (Auty, 1993,P45)

- Fiscal Sustainability in Rentier States

Fiscal Sustainability is defined as the ability of a state to maintain its long-term spending, debt obligations, and social commitments without jeopardising its solvency or requiring an abrupt fiscal correction. In states with fluctuating revenues, sustainability depends on the 'Fiscal Breakeven Oil Price'. Achieving this sustainability requires diversifying income streams and reducing the 'non-hydrocarbon primary deficit', ensuring that the state can meet its obligations even during prolonged periods of low energy prices.(Burnside, 2005,p12)

- The 'Energy Substitution' Effect on Revenue Generation

One of the most critical arguments for the energy transition is the 'Exportable Gas Surplus' concept. This mechanism suggests that every unit of solar energy consumed domestically directly displaces a unit of natural gas. This 'freed-up' gas can then be diverted from domestic consumption—where it is often sold at subsidised, low prices—to international markets at competitive global prices. Consequently, energy substitution acts as a revenue multiplier, enhancing the state's foreign exchange reserves and strengthening fiscal resilience without increasing physical production levels. (Bouznit et al ,2020, p. 1512.)

1.6.Mathematical Framework for Energy Surplus Calculation

To quantify the Exportable Gas Surplus (EGS), the following energy balance equation is employed: (Bouznit et al ,2020,p1515)

$$\mathbf{EGS = TP - (DC_{(base)} - RE_{(sub)})}$$

Where:

EGS: Exportable Gas Surplus (The volume of gas freed for international markets).

TP: Total Natural Gas Production.

DC(base): Baseline Domestic Gas Consumption.

RE(sub): The quantity of gas substituted by renewable energy generation.

The Fiscal Impact **(FI)** on the general budget is then calculated as:

FI = EGS \times (P (int) - P (dom))

Where:

P(int): International market price of gas.

P(dom): Domestic subsidised price.

2. Literature Review

Academic literature has examined the energy transition in Algeria from multiple perspectives, beginning with the environmental implications. (Bouznit et. al 2020) argued that maintaining a growth model based on fossil fuels imposes indirect financial burdens on the general budget due to escalating environmental and healthcare costs. In a parallel context, research efforts such as those by

(Aisani et al, 2021) and (Smahi et. al ,2018) shifted towards the techno-economic feasibility of alternative energies, highlighting the role of declining solar and wind energy costs in rationalising public expenditure directed towards electricity subsidies. This was further supported by (Benatia, 2020), who evaluated the national renewable energy programme as a strategic tool for reducing public equipment expenditures.

Academic debate has transitioned towards macroeconomic performance, demonstrating a long-term positive correlation between green energy consumption and economic growth; however, this analysis remained confined to Gross Domestic Product (GDP) without a direct link to budgetary structures (Haddad et. al 2022) Conversely, more recent studies have focused on the purely fiscal dimension. Research has illustrated the capacity of energy subsidy reforms to create 'fiscal space', providing greater flexibility for the budget (Ouederni, 2023) while the potential of environmental taxes in diversifying revenues has also been explored (Belaid, & Youssef,2017) Along the same lines, the concept of 'Green Budgeting' has been introduced as a framework to enhance fiscal sustainability against oil market volatility (Laabidi& Bensaad, 2024) alongside prospective visions of green hydrogen as a future fiscal resource (Zouari, 2021)

Despite this wealth of knowledge, a significant research gap persists. Previous studies have primarily focused on the nexus between energy transition and overall economic growth (GDP), without delving into the direct impact on budgetary structure and fiscal sustainability. Furthermore, most of this literature has relied on econometric models that assume a linear, symmetric relationship, overlooking the asymmetric nature of the Algerian fiscal response to energy shocks. This leaves a deficit in understanding how the budget is influenced differently by positive and negative energy transition shocks. Consequently, this study aims to bridge this gap by employing the (NARDL) model to provide a more nuanced and dynamic analysis.

II . Methods and Materials: The Impact of Energy Transition on Algeria’s General Budget (1995–2025)

1. Econometric Research Methodology

The empirical methodology of this study stems from the necessity to examine the dynamic interaction between the structural shift in Algeria's energy mix and the sustainability of public fiscal balances. The period from 1995 to 2025 was selected to provide a comprehensive temporal framework covering several pivotal milestones in the national economy. Starting from the mid-1990s allows for the observation of macroeconomic stability following the structural reform phase, extending to the forward-looking horizons of 2025, which reflect the initial outcomes of the National Renewable Energy Programme.

The fundamental justification for this timeframe lies in the objective to track the trajectory of the "Gas Surplus" from the early conceptual stages of energy efficiency to the actual implementation of major projects. This grants the time series sufficient length (30 years) to ensure the robustness of econometric estimates and to mitigate the statistical issues associated with small sample sizes.

2. Study Variables and Data Sources

To ensure the consistency of the econometric model and to avoid issues arising from divergent units of measurement, all monetary and quantitative variables have been standardised and expressed in US Billion Dollars. This standardisation reflects an economic perspective aimed at measuring the "Direct Fiscal Impact" of the energy transition on the Public Treasury. The following table summarises the variables employed in this study:

Table 1. Description of Econometric Model Variables

Variable	Variable Nature	Symbol	Unit	Data Source
Overall Budget Balance	Dependent	BBAL	USD bn	World Bank
Energy Surplus Allocated for Export	Key	GSEX	USD bn	Calculated
Gas Export Revenues	Independent	GREV	USD bn	World Bank
Public Investments (Renewables)	Independent	REINV	USD bn	World Bank

Source: Prepared by the author

3.Mathematical Specification of the Model according to the NARDL Approach

To address the non-linear nature that may characterise the response of the general budget to energy shocks, this study adopts the Non-linear Autoregressive Distributed Lag (NARDL) model developed by (Shin et.al,2014,p289) The competitive advantage of this model lies in its ability to decompose the primary independent variable (Energy Surplus from Gas facilitated by Renewables for Export) into two cumulative components: one representing positive shocks and the other representing negative shocks. This allows for the observation of "Asymmetry" in the budgetary reaction. The mathematical equation of the model takes the following form: (Shin et.al, 2014,281-314)

$$\Delta BBAL_t = \alpha_0 + \rho BBAL_{t-1} + \theta^{+} GSEX_{t-1}^{+} + \theta^{-} GSEX_{t-1}^{-} + \beta_1 GREV_{t-1} + \beta_2 REINV_{t-1} + \sum_{i=1}^{p-1} \gamma_i \Delta BBAL_{t-i} + \sum_{j=0}^{q-1} \left(\pi_j^{+} \Delta GSEX_{t-j}^{+} + \pi_j^{-} \Delta GSEX_{t-j}^{-}\right) + \sum_{k=0}^{r-1} \phi_k \Delta GREV_{t-k} + \sum_{m=0}^{s-1} \lambda_m \Delta REINV_{t-m} + \epsilon_t$$

Where:

$\rho, \theta^{+}, \theta^{-}, \beta_1, \beta_2$: Represent the long-run coefficients

$\lambda_m, \gamma_i, \phi_k$: represent the short-run coefficients, capturing the model dynamics

Δ: Denotes the first difference operator

ϵ_t: denotes the stochastic error term (white noise)

4. Presentation and Analysis of Descriptive Statistics

Prior to proceeding with the econometric estimation, it is essential to examine the statistical properties of the study variables (BBAL, GREV, GSEX, REINV) to assess the degree of data dispersion and the nature of their distribution.

Table (02): Descriptive Statistics Results of the Study Variables

Statistic	BBAL	GREV	GSEX	REINV
Mean	-16.06	13.88	0.1	0.46
Median	-16.21	14.8	0	0.12
Maximum	5.48	25.2	1.6	4.8
Minimum	-64	3.5	0	0.01
Std. Dev.	17.99	6.25	0.31	1.06
Skewness	-0.7	-0.03	3.91	3.15
Kurtosis	2.67	1.88	18.19	12.03
Jarque-Bera	2.7	1.6	377.36	156.77
Probability	0.258	0.448	0	0
Observations	31	31	31	31

Source: Author's calculations based on EViews 13 outputs.

The Overall Budget Balance (BBAL) shows a negative mean of 16.06 billion, reflecting the structural deficit nature of the Algerian budget throughout the study period. Furthermore, the high standard deviation of 17.99 indicates sharp fluctuations in this balance, which is further evidenced by the significant gap between the maximum value (a surplus of 5.48 billion) and the minimum value (a deficit of -64.00 USD bn). Regarding the Energy Surplus (GSEX) and Public Investment (REINV) variables, the means are considerably low compared to their maximum values, with a median approaching zero in the case of energy surplus. Economically, this reflects that the energy transition process in Algeria remained subdued for a significant portion of the time series, only beginning to accelerate in recent years.

5.Unit Root and Stationarity Tests

Testing the stationarity of time series is a mandatory prerequisite before proceeding with the estimation of the NARDL model. This approach imposes specific stationarity conditions, such as the requirement for the dependent variable to be stationary at the first difference, and the strict absence of any variables integrated of order two I(2). The presence of I(2) variables would lead to the collapse of the Bounds Test, rendering the F-statistic values invalid for use. Therefore, verifying the order of integration is a confirmatory step to ensure the robustness of the selected econometric model.

The results of the stationarity tests at the level and first difference, based on the Phillips-Perron (PP) test, are presented in the following table:

Table 3. Phillips-Perron (PP) Unit Root Test Results

Variable	Model Specification	Level I(0)	1st Difference I(1)	Decision
BBAL	Constant	-0.417 (0.893)	-3.620 (0.011)**	I(1)
	Constant & Trend	-1.684 (0.733)	-3.772 (0.033)**	
GREV	Constant	-2.011 (0.280)	-5.602 (0.000)***	I(1)
	Constant & Trend	-2.175 (0.485)	-6.262 (0.000)***	
GSEX	Constant	17.541 (0.999)	-7.878 (0.000)***	I(1)
	Constant & Trend	19.353 (0.999)	-8.876 (0.000)***	
REINV	Constant	7.089 (0.999)	-6.267 (0.000)***	I(1)
	Constant & Trend	5.031 (0.999)	-7.614 (0.000)***	
Notes: (*) Significant at 1%, () Significant at 5%. Values in parentheses represent the probability (p-value).				

Source: : Prepared by the researcher based on EViews 13 outputs.

Based on the interpretation of the statistical results in the previous table, it is observed that all variables in their initial state (At Level) failed to reject the null hypothesis of the presence of a unit root. Specifically, the probability values (p-values) for the Budget Balance (BBAL) and Gas Revenues (GREV) were 0.893 and 0.280, respectively. Meanwhile, the values for the Energy Surplus and Investment variables approached unity (0.99). Since these values are significantly higher than the 0.05 significance level, they statistically indicate that the series are non-stationary at their levels. Consequently, it is necessary to proceed with testing the first differences.

Upon proceeding to the First Differences, a fundamental shift occurred in the statistical properties of the series. The probability values dropped sharply to below 0.01 for the majority of the variables. For instance, the gas export revenues variable d(GREV) recorded a p-value of 0.00007 with a t-statistic of -5.60, which is significantly lower than the critical values at the 1% significance level. This collective stationarity at the first difference I(1) proves that the study's time series possess a short-term memory and revert to their equilibrium following shocks. This result paves the way for conducting the Co-integration test and constructing the NARDL model to investigate the long-term relationship between energy transition and the general budget in Algeria.

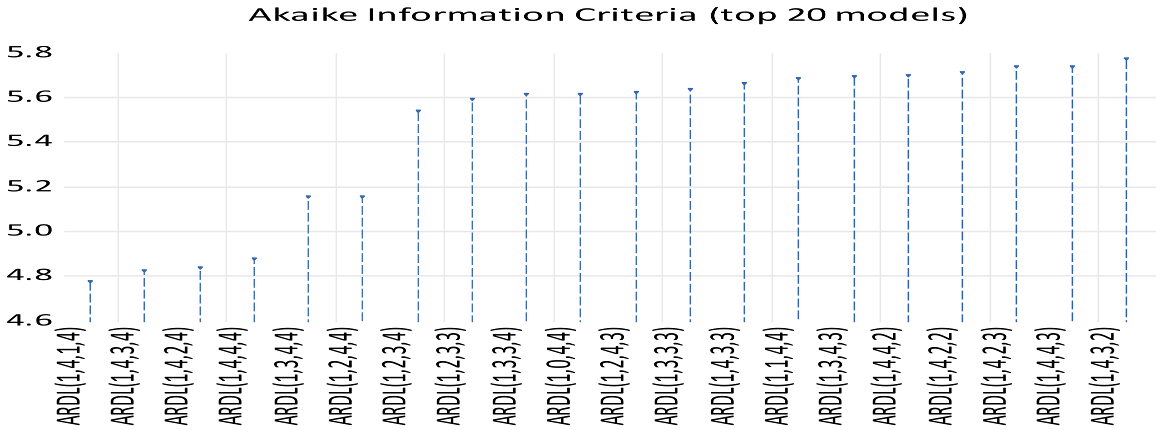
On the other hand, the Jarque-Bera test probability values for both BBAL (0.258) and GREV (0.448) are greater than the 0.05 significance level. This implies the acceptance of the null hypothesis (H0), indicating that these two variables follow a normal distribution. In contrast, the energy transition variables, GSEX and REINV, deviate from the normal distribution (Prob < 0.05). Economically, this is highly plausible; these variables experienced long periods of "latency" (zero or negligible values) followed by sudden leaps with the launch of major energy projects. This pattern led to the observed high skewness and kurtosis values.

The evident dispersion in Gas Export Revenues (GREV), in conjunction with the fluctuations in the Budget Balance, reinforces the study's hypothesis regarding the necessity of establishing a "safety valve" through energy transition. The outliers observed in the time series indicate the budget's high sensitivity to external shocks, which justifies the employment of the NARDL model, as it is uniquely capable of capturing these asymmetric shocks.

6.Co-integration Test via the Bounds Testing Approach

Having verified the order of integration and the stationarity of the variables at the first difference I(1), and prior to examining the existence of a long-term equilibrium relationship between the General Budget Balance and the independent variables explaining the Energy Transition, it is first necessary to determine the Optimal Lag Length for each variable within the model. This step is fundamental in estimating NARDL models, as the selection of the number of lags determines the short-term adjustment dynamics and directly affects the efficiency of the Bounds Test. To achieve this, an automated selection process was employed to compare a wide range of potential models based on the Akaike Information Criterion (AIC). This criterion aims to achieve the highest goodness-of-fit while minimizing the loss of degrees of freedom by minimizing the criterion value. The following figure illustrates the test results:

Fig2. Results of the Optimal Lag Length Selection



Source: : Prepared by the researcher based on EViews 13 outputs.

Based on the results illustrated in the previous figure, the model that minimizes the Akaike Information Criterion (AIC) is ARDL(1, 4, 1, 4). In this specification, the dependent variable is lagged by one period, while the explanatory variables are lagged as detailed in the following table:

Table 4. Bounds Test and Error Correction Representation

Statistical Test	Calculated Value	Significance Level	Lower Bound I(0)	Upper Bound I(1)	Decision
F-statistic	16.502	1%	4.768	6.67	Co-integration
t-statistic	-5.847	1%	-3.43	-4.6	Co-integration
Error Correction Coefficient (ECT)					
		Variable	Coefficient	t-Statistic	Probability (Prob)
		COINTEQ (-1)	-0.4293	-11.387	0

Source: : Prepared by the researcher based on EViews 13 outputs.

The results presented in the table above indicate that the calculated **F-statistic** reached **16.502**, which is a remarkably high value that exceeds the upper bound critical value **I(1)** at the **1%** significance level (**6.670**). Consequently, we reject the null hypothesis, which assumes the absence of a levels relationship, and accept the alternative hypothesis confirming the existence of a long-term **co-integration** relationship among the study variables. This implies that the budget balance, energy surplus, gas revenues, and investment move together along a long-term equilibrium path, despite short-term fluctuations.

The Error Correction Term (CointEq) is considered one of the most significant econometric results in the model. It is required to be both negative and statistically significant. In this study, the coefficient yielded a negative sign (-0.4293) with highly significant statistical results (p-value = 0.0000). This further confirms the existence of a long-term equilibrium relationship and validates the appropriateness of employing the NARDL/ARDL framework.

The coefficient value indicates that approximately 42.93% of the deviations or imbalances in the general budget balance from its short-run equilibrium are corrected within a single "year" to return to the long-run steady state. This represents a moderate-to-high speed of adjustment, reflecting the capacity of the Algerian budget to respond to transitions and shifts within the energy sector.

7.Diagnostic and Structural Stability Tests

Prior to interpreting the economic findings, the econometric integrity of the model will be verified. This involves subjecting the residuals to classic diagnostic tests—specifically examining serial correlation, heteroscedasticity, and functional form misspecification. Furthermore, the structural stability of the parameters over time will be assessed using the Cumulative Sum (CUSUM) and Cumulative Sum of Squares (CUSUMSQ) tests. These procedures ensure the accuracy and unbiasedness of the estimates, as detailed in the subsequent tables and figures.

Table 06. Summary of Classical Diagnostic Tests

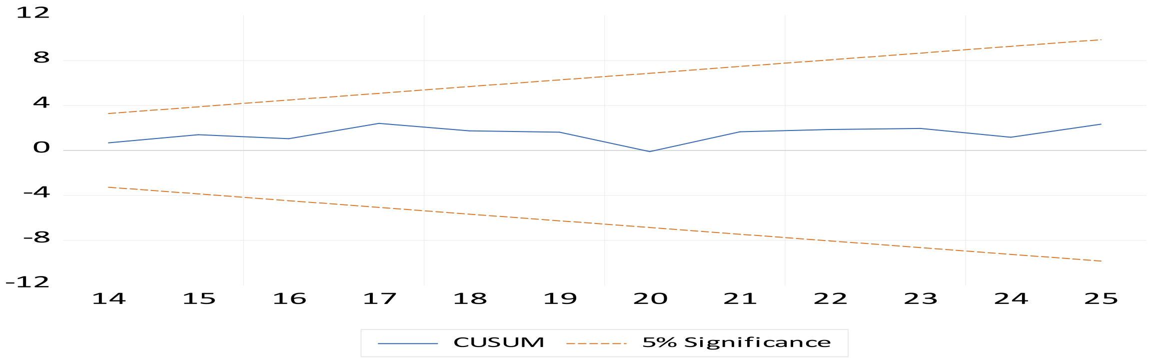
Type of Test	Test Name	Statistical Value	Probability (Prob.)
Serial Correlation	Breusch-Godfrey Serial Correlation LM Test	4.0714	0.1306
Heteroscedasticity	Heteroskedasticity Test: Glejser	15.9117	0.5987
Normality	Jarque-Bera	1.1009	0.5766

Source: : Prepared by the researcher based on EViews 13 outputs.

Based on the outputs of the diagnostic tests presented in the table above, it is evident that the estimated model satisfies all the classical assumptions regarding residuals. Drawing upon the null hypotheses of these tests—which assume the absence of econometric issues—the results indicate that all p-values associated with Serial Correlation and Heteroscedasticity tests exceed the statistical significance threshold of 0.05. Since these probability values are strictly greater than the critical value, it is statistically required to accept the null hypothesis (H0). This confirms that the model is free from fundamental econometric flaws, thereby granting the estimated parameters the reliability and efficiency necessary for robust economic analysis.

Regarding the structural stability of the model, the Cumulative Sum of Squares (CUSUM of Squares) has been represented in the figure below:

Fig3. Results of the Cumulative Sum (CUSUM) and CUSUM of Squares Tests



Source: : Prepared by the researcher based on EViews 13 outputs.

The results of the CUSUM structural stability test, as illustrated in the figure above, demonstrate that the path of the cumulative sum of squares (represented by the blue line) lies entirely within the critical confidence boundaries at the 5% significance level (represented by the two red lines). This result reflects the parameters stability across the entire study period (1995–2025), thereby negating the presence of any significant structural breaks. Furthermore, it confirms the suitability of the estimated equation in representing the phenomenon under investigation throughout the duration of the analysis.

Based on the comprehensive suite of diagnostic tests—ranging from the stationarity of time series to the bounds test for co-integration—it is evident that the estimated model satisfies all the methodological requirements of the Non-linear Autoregressive Distributed Lag (NARDL) approach. Referring to the statistical estimation outputs (Appendix No. 02), the coefficient of determination (R-squared) reached approximately 0.979. This indicates that the independent variables—comprising energy surplus (both positive and negative shocks), gas revenues, and public investments—explain 97.9% of the variations in Algeria's general budget balance. This remarkably high explanatory power is further supported by the Adjusted R-squared value of 0.925. Regarding the overall significance of the model, the F-statistic value of 18.13, with a probability of 0.0003 (strictly less than 1%), underscores the high statistical significance and validity of the model as a whole. Moving to individual significance, the majority of the estimated parameters were found to be statistically significant at the 1% and 5% levels.

8. Analysis and Discussion of Results

8.1.Economic Analysis of the Study Model

It should be noted that the economic analysis will focus specifically on statistically significant parameters in both the long and short run. Based on the following table, the results can be recorded as follows:

Table 7. Long-run and Short-run Estimation Results

Dependent Variable: D(BBAL)				
Method: ARDL				
Selected model: ARDL(1,4,1,4)				
Short-run Coefficients				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(GREV)	1.515	0.133	11.363	0.000
D(GREV(-1))	1.781	0.202	8.798	0.000
D(GREV(-2))	0.575	0.150	3.835	0.003
D(GREV(-3))	1.296	0.200	6.477	0.000
D(REINV)	-45.682	6.211	-7.355	0.000
@DCUMDP(GSEX)	114.884	12.340	9.310	0.000
@DCUMDN(GSEX)	-126.997	88.774	-1.431	0.180
@DCUMDP(GSEX(-1))	376.181	96.078	3.915	0.002
@DCUMDN(GSEX(-1))	12949.246	1238.972	10.452	0.000
@DCUMDP(GSEX(-2))	316.012	111.376	2.837	0.016
@DCUMDN(GSEX(-2))	-9836.875	920.905	-10.682	0.000
@DCUMDP(GSEX(-3))	1033.515	150.010	6.890	0.000
@DCUMDN(GSEX(-3))	-22567.594	1971.947	-11.444	0.000
C	1.280	0.609	2.100	0.060
Long-run Coefficients				
Variable *	Coefficient	Std. Error	t-Statistic	Prob.
GREV(-1)	2.123139074	0.567187	3.743282	0.001126
REINV(-1)	135.4105627	70.54548	1.919479	0.067986
@CUMDP(GSEX(-1))	560.8374013	458.2483	1.223872	0.233947
@CUMDN(GSEX(-1))	-41006.90026	12495.3	-3.28179	0.003406

Source: : Prepared by the researcher based on EViews 13 outputs.

a.Short-run Dynamics

The short-run results reveal that the general budget balance in Algeria remains governed by a structural dependency on gas export revenues. The strong positive response indicates that the budget expands and contracts in tandem with the inflows of foreign currency from hydrocarbons. This confirms that, in the short term, the budget remains at the mercy of international market fluctuations.

Regarding the variable of public investment in renewable energy, the results indicate a negative impact (inverse relationship) on the budget balance. This analysis is consistent with the "logic of capital expenditure"; at this stage, the state incurs significant financial burdens to establish the necessary energy infrastructure. These represent capital outlays that exert fiscal pressure on the budget before they can be converted into tangible returns.

Regarding the gas energy surplus variable, the NARDL model effectively highlights the phenomenon of "asymmetry". The results show that the budget exhibits a rapid response and hyper-sensitivity to negative surplus shocks compared to positive ones. This reflects an economic reality whereby any decline in domestic consumption efficiency, or a delay in energy alternatives, leads to an immediate depletion of gas earmarked for export. Consequently, this translates into a swift deficit in the state's fiscal accounts.

b.Long-run Dynamics

Upon transitioning to the long run, a fundamental shift in the behaviour of the variables is observed, where the "economic utility" of the energy transition becomes prominently visible:

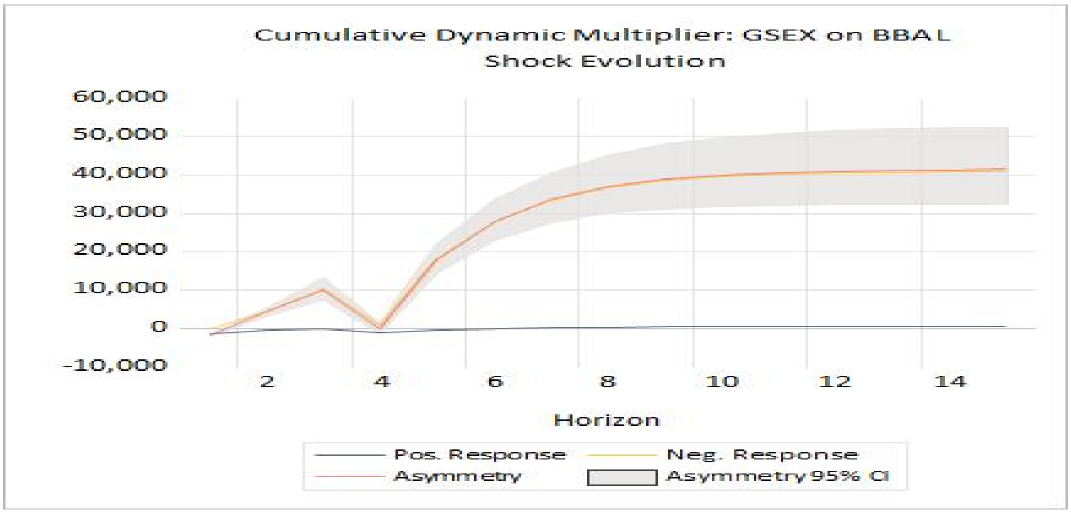
The impact of public investments shifts from the negative domain (as a fiscal burden) to the positive domain (as a catalyst). This demonstrates that spending on clean technology in Algeria represents a "profitable long-term investment", which contributes to enhancing fiscal resilience and alleviating the weight of traditional expenditures.

The gas export revenues variable continues to serve as a primary pillar of financial stability. However, its significance in the long run becomes more stabilised, owing to the role of other energy variables that begin to share the financing burden alongside traditional petroleum taxation.

The most critical finding lies in the comparative impact of positive and negative shocks to the gas energy surplus. The results demonstrate that a deficit in the gas surplus (a negative shock) represents an existential and strategic threat to the budget balance in the long run; it triggers severe fiscal deterioration as domestic consumption "swallows" the wealth intended for export. Conversely, while an increase in the surplus (a positive shock) is beneficial, it requires a longer duration and further structural adjustments to manifest its full statistical significance.

8.2.Analysis of the Cumulative Dynamic Multiplier Graph

Fig 3. Asymmetric Cumulative Dynamic Multiplier Effect



Source: Prepared by the researcher based on EViews 13 outputs.

The Dynamic Multiplier Curve is considered the most precise tool within NARDL models for tracing the adjustment path of the general budget balance in response to positive and negative shocks in the gas energy surplus over time. By interpreting the figure above, the following economic conclusions can be drawn:

The curve representing the budget's response to negative shocks in the energy surplus (indicated in yellow) shows a sharp and continuous upward trend. From an economic perspective, this signifies that any "deficit" in the gas surplus—resulting from increased domestic consumption or the lagging of renewable energy projects—generates immense and escalating pressure on the fiscal deficit. The trajectory deviates significantly from the zero line, indicating that the financial cost of losing the energy surplus does not cease immediately but rather accumulates over time.

In contrast, the response curve for positive shocks (indicated in dark blue) almost overlaps with the zero line or moves very slowly. This explains the previously obtained results regarding the statistical insignificance of positive shocks in the long run. It suggests that merely achieving a gas surplus does not immediately translate into a budget surplus; this may be due to redirecting such surplus to cover other energy gaps or delays in converting it into actual export revenues.

The red line (Asymmetry) and the surrounding shaded area represent the fundamental difference between the impacts of increases and decreases in the gas surplus. It is observed that the gap begins to widen significantly after the fourth period (Horizon 4), implying that "asymmetry" becomes a structural phenomenon in the long run. The fact that the shaded area, representing the 95%

Confidence Interval (CI), remains entirely detached from the zero line confirms the statistical significance of this asymmetry.

Furthermore, a period of fluctuation is observed at the beginning (between Horizon 2 and 4), which explains the short-run results discussed previously. During this phase, the budget remains in a state of instability due to the overlapping effects of initial investment costs and the early emergence of energy surplus. However, beyond the fourth period, the model settles into a clear divergent path.

III- Results and discussion

Based on the econometric results of the NARDL model for the period 1995–2025, the key findings of this study can be summarised in the following points:

-The Bounds Test confirms the existence of a long-term equilibrium relationship (cointegration) between the general budget balance and the explanatory variables of the energy transition. The calculated F-statistic reached 16.50, which significantly exceeds the critical upper bound values at the 1% significance level.

-The results demonstrate that the response of the general budget balance to negative shocks in energy surplus differs radically from its response to positive shocks. This distinct divergence justifies the employment of the NARDL model over traditional linear models, as it captures the non-linear complexities that linear frameworks fail to account for.

-The findings reveal that a "deficit in gas surplus"—driven by escalating domestic consumption—leads to a sharp and significant deterioration in the budget balance across both the short and long run. The magnitude of this negative impact far outweighs the positive effect resulting from an increase in surplus, highlighting a critical vulnerability in the fiscal structure.

-The results confirm that public investments in renewable energy constitute a fiscal burden in the short run (negative impact); however, they transition into a positive financial catalyst in the long run. This underscores their economic feasibility as a strategic tool for ensuring the sustainability of public finances.

- Reasonable Adjustment Speed: The Error Correction Term (ECT) value reached -0.429, which means that the Algerian economy possesses the capacity to correct approximately 43% of the imbalances affecting the budget balance within a single year to return to its long-term equilibrium path.

-Despite the significance of the energy surplus, traditional gas export revenues continue to play a pivotal role in determining the trends of the general budget balance. This underscores a persistent structural dependency, necessitating an accelerated transition to diversify financing sources and mitigate reliance on hydrocarbon volatility.

IV.Conclusion

The study's findings confirm that the relationship between the energy transition and financial stability in Algeria is a dynamic, asymmetric relationship. The general budget does not react to the energy surplus with the same magnitude in cases of increases versus decreases. Accordingly, the following results can be presented:

- The Imperative of Strategic Transition: The study demonstrates that investment in clean technology, despite its initial costs that strain the budget in the short run, acts as a financial "safety valve" in the long run. It transitions from an expenditure burden into a catalyst that supports fiscal resilience and alleviates pressure on traditional resources.
- The Dilemma of Domestic Consumption: The "asymmetry" analysis reveals that the greatest risk to the budget lies in "negative shocks" to the gas surplus. The erosion of the exportable surplus due to growing domestic consumption poses an existential threat to financial stability, as the impact of this deficit far outweighs any gains that may arise from increased gas production.
- Balancing Traditional and Alternative Sources: Despite the emergence of new energy variables as a support for the budget, the "centrality of gas" remains dominant. This structural dependency leaves the budget vulnerable to fluctuations, necessitating an accelerated integration of renewables—not only as an environmental alternative but as a necessity to diversify taxation and secure export revenues.
- Adjustment Resilience: The Error Correction Term (ECT) indicates that the Algerian economy possesses a reasonable "adjustment dynamism" (43% annually). This implies that there is a sufficient window of time for policymakers to correct fiscal trajectories, provided that proactive energy policies are adopted.

Recommendations

-Implementing strict mechanisms to rationalise domestic natural gas consumption: In order to protect the "exportable surplus", which the study proved that its shortage causes a sharp and asymmetric deterioration in the budget.

-Expanding renewables as a financial necessity: Accelerating the implementation of solar energy projects (such as the Solar 1000MW project), not only from an environmental perspective but as an economic tool to free up additional quantities of gas for export purposes, which increases state revenues.

-Leveraging long-term yields: Since the study proved the transformation of green investment from a "cost" to a "yield" in the long run, the government must allocate sustainable investment funds to finance alternative energy projects away from annual budget fluctuations.

- Diversifying taxation sources: Starting the design of a "green taxation" system that encourages companies to adopt clean energy solutions, contributing to the creation of new revenue sources for the budget that reduce the absolute dependency on traditional petroleum taxation.

-Adopting early warning models: Based on the high sensitivity of the budget to negative shocks, it is recommended to activate prospective models (such as the NARDL used in the study) to monitor the domestic energy balance and predict any gaps that may affect the budget balance before they occur.

-Supporting the localisation of energy technology: To reduce the "initial costs" of investment that appeared as a burden in the short run, local manufacturing of renewable energy equipment must be encouraged to reduce the import bill and alleviate the initial financial pressure.

v .Bibliography List

1.Acemoglu, D., Aghion, P., Bursztyn, L. and Hemous, D. (2012). «‘The Environment and Directed Technical Change.» *The American Economic Review* 102, n° 01.

2.Aisani, A., Madani, K., Mortada, J. and Bacha, S.(2021). «‘Energy Transition in Algeria: Challenges and Opportunities.» *Journal of Cleaner Production* 280, n° 01.

3.Auty, R. M.(1993). *Sustaining Development in Mineral Economies: The Resource Curse Thesis.* Routledge, London.

4.Belaid, F., & Youssef, M.(2017). «Environmental Kuznets Curve, energy consumption and economic growth: Evidence from Algeria.» *Energy Economics* , n° 67 .

5.Ben Jebli, M. and Belloumi, M. (2017).« Investigation of the environmental Kuznets curve hypothesis: The role of renewable energy and trade in Algeria.» *Renewable and Sustainable Energy Reviews*, n° 71 .

6.Benatia,D.(2020).«The Algerian electricity sector:Structure, performance, and strategy.»*Economic Research Forum.*https://erf.org.eg/publications/the-algerian-electricity-sector-structure-performance-and-strategy/ (Consilted5/20/2025).

7. Bouznit, M., Pablo-Romero, M. D. P. and Sánchez-Braza, A.(2020) «‘The determinants of renewable energy consumption in Algeria.» *Energies* .13, n° 6 .

8.Burnside, C. (2005).*Fiscal Sustainability in Theory and Practice* .: World Bank, Washington.

9. Galeotti, M., Lanza, A., & Pauli, F. (2009). «On the robustness of the Environmental Kuznets Curve hypothesis: The role of energy.» *Ecological Economics* 68, n° 10 .

10.Grossman, G.M. and Krueger, A.B.(1991). «'Environmental Impacts of a North American Free Trade Agreement.» National Bureau of Economic Research (NBER), Working Paper No. 3914

11. Haddad, B., Liazid, A. and Ferreira, P. (2022). «The Impact of Renewable Energy Consumption on Economic Growth: Evidence from Algeria.» *Renewable and Sustainable Energy Reviews* 154 .

12.Hafner, M., & Raimondi, P. P.(2023). *The Global Energy Transition: Key Challenges and Prospects.* UK: Springer Nature., 2023.

13.IRENA.(2019) .*Global Energy Transformation: A Roadmap to 2050. Abu Dhab.* International Renewable Energy Agency, 2019.

14. Jaffe, A.B., Newell, R.G. and Stavins, R.N. (2002). «'Environmental Policy and Technological Change.» *Environmental and Resource Economics* 22 .

15.Laabidi, Y., & Bensaad, A. (2024).«Towards a Green Energy Budgetary Framework in Algeria: Transitioning from Hydrocarbon Dependence to Sustainable Fiscal Policy. Journal of Economic.» *Management and Commercial Sciences* 17, n° 01 .

16.Ouederni, S.(2023). «The dynamic link between renewable energy, fossil fuel consumption, and economic growth: New evidence from resource-rich economies.» *Environmental Science and Pollution Research* 30, n° 15 .

17.Shin, Y., Yu, B., & Greenwood-Nimmo, M.(2014) . *Modelling Asymmetric Cointegration and Dynamic Multipliers in a Nonlinear ARDL Framework. In Festschrift in Honor of Peter Schmidt* . Springer. New York.

18.Smahi, A., Benhabib, A., & Ziani, A.(2018). «The effect of energy consumption on economic growth in Algeria: An empirical analysis.» *International Journal of Energy Economics and Policy* 8, n° 4 .

19.Smil, V.(2017). *Energy Transition: Global and National Perspectives.* Vol. 2nd edn.: Praeger , Oxford.

20. Way, R., Ives, M. C., Mealy, P., & Farmer, J. D. (2022). «'Empirically grounded technology forecasts and the energy transition.» *Joule* 6, n° 9 .

21.Zouari, A.(2021). «The prospects of green hydrogen production in Algeria: Economic opportunities and fiscal implications.» *Journal of Renewable Energies (Revue des Energies Renouvelables* 24, n° 01 .

VI. Annexes

Appendix 1. Historical Data of Fiscal and Energy Indicators (1995-2025)

Table 1. Gas Exports Value (Billion USD)

Year	Gas Exports(Billion USD)	Year	Gas Exports(Billion USD)
1995	3.50	2010	16.20
1996	4.65	2011	19.40
1997	5.10	2012	20.10
1998	4.20	2013	18.70
1999	5.80	2014	16.90
2000	8.95	2015	11.20
2001	8.40	2016	9.50
2002	8.15	2017	11.80
2003	10.30	2018	15.10
2004	12.10	2019	12.40
2005	17.50	2020	8.10
2006	19.80	2021	17.50
2007	20.40	2022	24.60
2008	25.20	2023	21.80
2009	14.80	2024	20.00
		2025	18.30

Source: World Bank Data and Estimates (1995–2025).

Table 2. Public Investments in Renewable Energy (Billion USD)

Year	Public RE Investments	Year	Public RE Investments
1995	0.012	2010	0.120
1996	0.012	2011	0.120
1997	0.013	2012	0.150
1998	0.014	2013	0.220
1999	0.014	2014	0.350
2000	0.015	2015	0.450
2001	0.018	2016	0.180
2002	0.022	2017	0.150
2003	0.030	2018	0.200
2004	0.040	2019	0.120
2005	0.045	2020	0.180
2006	0.050	2021	0.450
2007	0.065	2022	0.850
2008	0.080	2023	1.900
2009	0.110	2024	3.500
		2025	4.800 (est.)

Source: World Bank Data and Estimates (1995–2025).

Table 3. Gas Consumption and Energy Savings (Billion USD)

Year	Domestic Gas Consumption	Energy Savings for Export	Year	Domestic Gas Consumption	Energy Savings for Export
1995	0.95	0	2011	6.80	0.012
1996	1.15	0	2012	7.20	0.015
1997	1.20	0	2013	7.50	0.018
1998	0.90	0	2014	7.10	0.020
1999	1.10	0	2015	5.20	0.025
2000	2.15	0	2016	4.30	0.042
2001	2.40	0	2017	4.90	0.050
2002	2.60	0	2018	5.80	0.058
2003	3.40	0	2019	4.20	0.062
2004	4.20	0	2020	3.10	0.035
2005	5.40	0	2021	11.20	0.120
2006	6.20	0	2022	21.50	0.320
2007	6.50	0	2023	14.80	0.260
2008	8.80	0	2024	13.40	0.750
2009	4.50	0	2025	11.50	1.600 (est.)
2010	6.10	0			

Source: Prepared by the author based on World Bank Data Estimates and (1995–2025).

Table 4. Public Fiscal Indicators (Billion USD)

Year	Revenues	Expenditures	Balance	Year	Revenues	Expenditures	Balance
1995	12.40	15.52	-3.12	2010	54.67	86.67	-32.00
1996	12.91	15.27	-2.36	2011	71.23	106.85	-35.62
1997	14.14	15.43	-1.29	2012	74.84	108.39	-33.55
1998	13.22	16.10	-2.88	2013	68.75	101.25	-32.50
1999	14.24	15.91	-1.67	2014	66.67	104.94	-38.27
2000	16.13	15.73	0.40	2015	48.04	86.27	-38.23
2001	19.22	18.83	0.39	2016	42.73	71.82	-29.09
2002	18.95	19.82	-0.87	2017	47.75	63.96	-16.21
2003	23.51	22.61	0.90	2018	55.17	74.14	-18.97
2004	29.17	27.50	1.67	2019	54.17	70.83	-16.66
2005	36.15	33.42	2.73	2020	41.41	60.94	-19.53
2006	43.84	38.36	5.48	2021	52.59	60.08	-7.49
2007	46.58	47.95	-1.37	2022	63.60	82.93	-19.36
2008	64.29	60.00	4.29	2023	68.10	100.20	-32.10
2009	52.78	73.61	-20.83	2024	67.70	113.50	-45.80
				2025	64.00	128.00	-64.00

Source: World Bank Data and Estimates (1995–2025).

Appendix 2: Statistical and Econometric Study Tables

Table5.Stability tests

UNIT ROOT TEST TABLE (PP)

	At Level	BBAL	GREV	GSEX	REINV
With Con...	t-Statistic	-0.4173	-2.0116	17.5410	7.0898
	Prob.	0.8938	0.2805	1.0000	1.0000
		n0	n0	n0	n0
With Con...	t-Statistic	-1.6841	-2.1753	19.3533	5.0313
	Prob.	0.7333	0.4854	0.9999	1.0000
		n0	n0	n0	n0
Without C...	t-Statistic	0.4466	0.0056	13.3518	8.0218
	Prob.	0.8046	0.6766	1.0000	1.0000
		n0	n0	n0	n0
	At First Difference	d(BBAL)	d(GREV)	d(GSEX)	d(REINV)
With Con...	t-Statistic	-3.6206	-5.6026	-7.8786	-6.2672
	Prob.	0.0115	0.0001	0.0000	0.0000
		**	***	***	***
With Con...	t-Statistic	-3.7722	-6.2625	-8.8761	-7.6150
	Prob.	0.0330	0.0001	0.0000	0.0000
		**	***	***	***
Without C...	t-Statistic	-3.4678	-5.1735	-7.2783	-6.6263
	Prob.	0.0012	0.0000	0.0000	0.0000
		***	***	***	***

Table 6. Estimated Model

Sample: 2000 2025
Included observations: 26
Dependent lags: 1 (Automatic)
Automatic-lag linear regressors (4 max. lags): GREV REINV
Automatic-lag dual non-linear regressors (4 max. lags): GSEX
Deterministics: Unrestricted constant and no trend (Case 3)
Model selection method: Akaike info criterion (AIC)
Number of models evaluated: 125
Selected model: ARDL(1,4,1,4)

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
BBAL(-1)	-0.429386	0.111599	-3.847570	0.0063
GREV(-1)	-0.911647	0.168123	-5.422491	0.0010
REINV(-1)	58.14343	18.01902	3.226781	0.0145
@CUMDP(GSEX(-1))	240.8158	230.1370	1.046402	0.3302
@CUMDN(GSEX(-1))	-17607.80	4171.020	-4.221461	0.0039
D(GREV)	1.514668	0.210808	7.185072	0.0002
D(GREV(-1))	1.780876	0.279904	6.362465	0.0004
D(GREV(-2))	0.574626	0.390054	1.473196	0.1842
D(GREV(-3))	1.295581	0.269425	4.808690	0.0019
D(REINV)	-45.68151	13.98975	-3.265356	0.0138
@DCUMDP(GSEX)	114.8838	12.34041	9.312971	0.0000
@DCUMDN(GSEX)	126.9973	299.4693	0.424075	0.6842
@DCUMDP(GSEX(-1))	376.1813	381.9769	0.984827	0.3575
@DCUMDN(GSEX(-1))	12949.25	3394.892	3.814332	0.0066
@DCUMDP(GSEX(-2))	316.0124	435.6882	0.725318	0.4918
@DCUMDN(GSEX(-2))	-9836.875	2565.827	-3.833803	0.0064
@DCUMDP(GSEX(-3))	1033.515	387.0787	2.670039	0.0320
@DCUMDN(GSEX(-3))	-22567.59	4751.189	-4.749884	0.0021
C	1.279699	2.140737	0.597784	0.5688

R-squared	0.979004	Mean dependent var	-2.397308
Adjusted R-squared	0.925013	S.D. dependent var	8.928849
S.E. of regression	2.445054	Akaike info criterion	4.775364
Sum squared resid	41.84804	Schwarz criterion	5.694742
Log likelihood	-43.07973	Hannan-Quinn criter.	5.040112
F-statistic	18.13284	Durbin-Watson stat	2.263315
Prob(F-statistic)	0.000343		

Table 7. Boundary testing

Bounds Test

Null hypothesis: No levels relationship
Number of cointegrating variables: 4
Trend type: Unrest. constant (Case 3)
Sample size: 26

Test Statistic	Value
F-statistic	16.502709
t-statistic	-5.847570

Bounds Critical Values

	10%		5%		1%	
Sample Size	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
F-Statistic						
30	2.752	3.994	3.354	4.774	4.768	6.670
Asymptotic	2.450	3.520	2.860	4.010	3.740	5.060
t-Statistic						
Asymptotic	-2.570	-3.660	-2.860	-3.990	-3.430	-4.600

* I(0) and I(1) are respectively the stationary and non-stationary bounds.