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# Determinants of Non-Hydrocarbon Revenue Mobilization in Algeria: Tax Base, Compliance, and Administrative Effectiveness in an ARDL-ECM Framework

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## Abstract

This paper investigates the factors influencing the mobilization of non-hydrocarbon tax revenue in Algeria through the of tax-base expansion (final consumption expenditure, CE), tax compliance/ burden (non-hydrocarbon tax pressure, TP), and the administrative dimension (government effectiveness, GE). We applied the ARDL–ECM to annual time series data covering 2002–2024. We utilized the ADF and PP tests to show the variables are of order 1, and then tested, through the Pesaran bounds approach, to show evidence of cointegration. Specification chosen is ARDL (1,1,1,1) and CE shows a positive and long run statistically significant relationship with the growth of non-hydrocarbon tax revenue while TP is large and statistically significant whilst negative. GE is positive but statistically insignificant. In the short run, the individual differenced effects of a combination of the factors remain insignificant. There is a negative and significant error correction which shows adjustment to long-run equilibrium occurs slowly. Diagnostic and stability tests show the model is adequate. After factoring in the 2020 shock, the robustness tests documented a negative effect post 2020. This study shows the need for tax formalization, broadening the tax base, and implementing e-invoicing and risk-based tax compliance management rather than increasing tax pressure in low-compliance environments.

**JEL Classification**: H21, C32, O55

## 1. Introduction

Non-rent tax revenue mobilization is vital for fiscal sustainability and for building resilience to economic shocks, especially in economies exposed to volatile commodity prices, particularly for economies with volatile and structurally uncertain commodity pricing (Limberg, 2022). In light of the tax system perspective, reforms go beyond statutory rate adjustments, employing a more systemic approach to tax policy, which can be combined with the regulatory, administrative, political, and redistributive elements of the framework that constrains overall fiscal capacity (Besley & Persson, 2014; Limberg, 2022). Non-rent revenue comes from an economic activity. Taxpayers and firms interact with this through reporting and compliance, while tax administrations enforce rules to secure revenue collection. (Slemrod, 2019; Bellon et al., 2022).

This rationale motivated us to design an analytical framework incorporating three interlinked channels: (1) tax-base expansion (economic activity), (2) taxpayer compliance (tax burden and behavior), and (3) administrative efficiency (collection and enforcement). The practical advancement of the third channel hinges on structural compliance risk management, i.e., risk management (risk identification, assessment and prioritization, risk treatment, and impact monitoring and evaluation) as outlined by international standards (Betts, 2022). Evidence from Rwanda shows that e-invoicing increases net VAT remittances and strengthens audit capacity. These e-invoices enable the streamlining of digital audits and the lateral and automated assessment and verification of transactions, thus enhancing monitoring and collection, which adds a channel to the data-driven enforcement capacity (Kotsogiannis et al., 2025). VAT e-invoicing illustrates the significance of administration and enforcement: E-invoicing reforms increased reported sales/purchases/VAT by > 5% within 12 months, increasing the volume of reported sales, purchases, and VAT liabilities, with the effect being most pronounced among smaller businesses and in high-non-compliance industries, suggesting a combination of reduced compliance costs and increased compliance through better information (Bellon et al., 2022).

The tax-base channel is also central in resource-dependent contexts: causal evidence leveraging the of giant oil and gas revenues indicates that non-resource tax revenues can rise, driven mainly by non-resource indirect taxes and by the expansion of the consumption tax base rather than tax-rate changes (Lartey, 2024). Finally, compliance is determined not only by audits and penalties; but also, by behavioral and social mechanisms. Field evidence shows that direct social pressure (requesting a tax receipt) can significantly increase compliance and exhibit persistence in subsequent behavior (Battiston & Gamba, 2016).

Furthermore, the literature endorses the addition of an institutional/governance dimension to the frameworks: tax effort is closely associated with institutional quality, perceived legitimacy, and reduced corruption (Bird et al., 2008; Elbahnasawy et al., 2025).

Applied to Algeria (2002–2024), the dynamics of actual collection applied to Algeria are computed using the annual relative rate of change of non-hydrocarbon tax revenues, with the growth of final consumer spending acting as the base and tax pressure outside hydrocarbons acting as the burden, while the management dimension is captured using an institutional measure of the effectiveness/governance of tax administration. The research problem of the study is articulated as:

What are the short and long implications of tax pressure, consumer spending, and tax governance on the non-hydrocarbon tax revenues**?**

This study has both scientific and practical importance because it tackles a general issue that extends beyond Algeria. It helps identify which channel most strongly impacts collection and, as a result, targets policy reforms in a more effective direction than just advocating for higher collection rates. Additionally, the study tackles an overarching gap in the literature on financial resilience to shocks and aids in gap analyses of collection channels and policy recommendations (e.g., broadening the base and improving governance) with direct applicability to other contexts.

## 2. Literature Review

According to the literature on non-hydrocarbon tax revenue mobilization, revenue dynamics are determined not only by economic activity but also by tax policy (burden/pressure), governance quality, and administration efficiency in the context of informality and rent dependence. The fiscal resource curse argument posits that dependence on resource rents can diminish the motivation and ability to collect non-resource taxes. According to (Debonheur, 2025), stronger institutions tend to produce a greater volume of revenues that are not derived from resources.

Policy diagnostics: (Vellutini, 2025) identified a 2% of GDP non-hydrocarbon tax gap in Algeria and linked improvements to base broadening (i.e., rationalization of exemptions and simplification of rates) and administrative reforms (i.e., strengthening compliance and risk management tools). Nonetheless, this IMF diagnostic does not create an econometric model like an ARDL, leaving a methodological gap, especially given evidence that tax responses to shocks can be time-varying and sometimes short-lived, peaking around important adjustment moments (Abdelwahed, 2020).

Evidence from the study of macroeconomic determinants by Hanane and Toufik (2015) uses the ARDL model in an analysis of the years 1999–2018 in Algeria and establishes that there is weak revenue sensitivity to economic growth, inflation, and the REER, with effects that depend on the given time horizon. The study concludes that macroeconomic variables that can be related to consumption expenditure do not fully explain revenue behavior, and therefore, the inclusion of institutional and administrative determinants (GE) is important. In contrast to our approach, their model also does not include indicators of tax governance or non-hydrocarbon tax pressure.

Institutional and governance channels (Hadjmaoui & Hanane, 2021) show that financial sector development—as a formalization proxy—affects revenue mobilization through transaction traceability and enforcement capacity. Our study uses government effectiveness (GE) following similar reasoning, though the indicator is not identical. (Zaddam et al., 2021), using nonlinear NARDL, found that corruption negatively affects revenues in the long run, explaining why raising TP may be insufficient when governance is weak and informality expands. However, their study does not integrate TP and CE within a unified framework or decompose the temporal transmission of GE shocks via dynamic multipliers—precisely our contribution.

Governance and digitalization perspectives (Laggoun & Laggoun, 2025) provide a descriptive overview of tax governance in Algeria, concluding that strengthening governance principles is necessary but without econometric quantification of GE's impact size, timing, or interaction with TP and CE. The study also provides empirical evidence (Fang et al., 2026) showing that digital tax administration reforms can improve VAT-related outcomes and reported sales, consistent with stronger compliance and traceability—channels closely aligned with GE' administrative effectiveness.

### Research gap and contribution

Previous studies link non-hydrocarbon revenues to macroeconomic factors, corruption, and informal governance, they rarely integrate economic activity (CE), tax pressure (TP), and administrative efficiency (GE) within a single ARDL–ECM framework. Furthermore, Prior studies rarely document the timing, peak, persistence of effects, despite the fact that response evidence can vary with time and institutions (Abdelwahed, 2020; Debonheur, 2025). Through the estimation of the ECM and the dynamic multipliers (ARDL), the present study fills in the gap by focusing not on whether the CE, TP, and GE affect TA but, on when they do and the duration of such effects.

## 3. Presentation of Study Variables and Analysis of Data

The analysis of non-hydrocarbon tax revenue factors in Algeria serves as the essential beginning for understanding how hydrocarbon income fluctuation makes it difficult to fund the public treasury. The research team selected variables that represent the main elements that affect tax system performance and its ability to respond to economic changes according to theoretical studies and actual research results. The study's data are sourced from (Bank of Algeria; World Bank), As detailed in the Table 1:

Table 1
Variable definitions, transformations, and data sources (Algeria, 2002–2024)

| Symbol | Operational definition (in this paper) | Unit / transformation | Data source |
|---|---|---|---|
| TA | Annual growth rate of non-hydrocarbon tax revenues (dependent variable). | Percentage points (annual growth rate, as constructed in Appendix 1). | Bank of Algeria; authors' calculations. |
| TP | Non-hydrocarbon tax pressure, defined as non-hydrocarbon tax revenues divided by non-hydrocarbon GDP. | Ratio (annual series). | Bank of Algeria; authors' calculations. |
| CE | Annual growth rate of final consumption expenditure (proxy for the tax base/economic activity). | Percentage points (annual growth rate). | Bank of Algeria / national accounts; authors' calculations. |
| GE | Government Effectiveness (WGI) used as a proxy for tax administrative effectiveness. | WGI index (approximately − 2.5 to + 2.5), annual observations. | World Bank, Worldwide Governance Indicators (WGI). |
| Source: Authors' calculations | | | |

Table 2 reports the descriptive statistics and pairwise correlations for the study variables over 2002–2024:

Table 2
Preliminary descriptive statistics and correlation matrix for variables

| Descriptive statistics/variable | TA | TP | CE | GE |
|---|---|---|---|---|
| Mean | 10.05217 | 10.31304 | 17.04348 | -0.882609 |
| Median | 8.700000 | 10.40000 | 17.90000 | -0.860000 |
| Maximum | 25.90000 | 12.60000 | 20.50000 | -0.700000 |
| Minimum | -7.700000 | 7.800000 | 12.00000 | -1.070000 |
| Std. Dev. | 8.372187 | 1.555432 | 2.646065 | 0.135285 |
| Skewness | 0.051774 | 0.042932 | -0.603614 | -0.219139 |
| Kurtosis | 2.753700 | 1.827953 | 2.179578 | 1.533739 |
| Jarque-Bera | 0.068411 | 1.323523 | 2.041721 | 2.244425 |
| Probability | 0.966373 | 0.515942 | 0.360285 | 0.325559 |
| TA | 1.000000 | -0.345893 | -0.212162 | 0.242321 |
| TP | -0.345893 | 1.000000 | 0.834560 | -0.199426 |
| CE | -0.212162 | 0.834560 | 1.000000 | -0.293495 |
| GE | 0.242321 | -0.199426 | -0.293495 | 1.000000 |

**Source**

Authors' calculations using EViews 12.

Table 2 presents the descriptive statistics and pairwise correlations for the variables from 2002 to 2024 (N = 23). Non-hydrocarbon tax revenues (TA) show extreme volatility (SD = 8.37, CV = 83%) and range from − 7.7 to 25.9. This shows Algeria's fiscal reliance on hydrocarbons and responsiveness to changes in the economic cycle. Tax pressure (TP, mean = 10.31) and consumption expenditure (CE, mean = 17.04) show a strong positive correlation (ρ = 0.83), where CE is TP's moves together in the long run. This corresponds to the consumption-driven tax base dynamics, and government effectiveness (GE) is stable (SD = 0.14) and shows a moderate positive correlation with TA (ρ = 0.24). The Jarque-Bera normality test p-value greater than 0.05 shows that most of the distributions are normal. This allows the combination of OLS estimation with ARDL. Additionally, there may be at most none of the extreme multicollinearity (max ρ = 0.83 < 0.9). These implications are the foundation for the tests of stationarity and the subsequent analysis, and so they will be presented in the next sections.

Figure 1 summarizes the stationarity diagnostics and is formally confirmed by the ADF and PP tests reported in Table 3. The unit-root tests evidence indicates that all series are at most I (1) and none is I (2), which supports the use of the ARDL bounds-testing framework.

The complete annual time series dataset (2002–2024) is provided in Appendix 1

## 3.1. Non-hydrocarbon tax revenues (TA):

In this analysis, we consider TA as the dependent variable for our analysis. It denotes the annual growth rate of non-hydrocarbon tax revenues. It is the actual revenue performance resulting from outcomes in three channels— (1) the size of the tax base, (2) taxpayer compliance, and (3) effectiveness of the administrative collections. Changes in legal tax rates are not the only factor influencing revenue growth. Growth also depends on tax base growth, changes in compliance, and improvements in operational efficiency ( (Independent Evaluation Group, 2023). Widening the tax base on account of formalization and reductions in exemptions raises transaction volume. According to the VAT literature, credit–invoice mechanisms generate compliance chains running through production processes, thus expanding the effective base, while exemptions and loopholes have a narrowing effect (Cnossen, 2022).

## 3.2 Non-hydrocarbon tax pressure (TP):

TP measures the actual tax burden on non-hydrocarbon activity economic activity as the ratio of non-hydrocarbon tax revenues to non-hydrocarbon GDP. It serves as a direct indicator of the extent to which domestic resources are mobilized through taxation. Compliance determinants include not only enforcement instruments but also social acceptance of the tax system (Baer et al., 2025), implying that changes in TP affect revenues through compliance dynamics (evasion, avoidance, errors, delays) rather than legal provisions alone.

## 3.3 Final Consumption Expenditure (CE):

CE represents the annual growth rate of final consumption expenditure and serves as a proxy for the level of domestic economic activity and aggregate demand. Consumer expenditure is also fashioned by using households' expectancies, as estimates shows that financial expectancies are substantially related to household behavior (Brown et al., 2023). Although more spending increases the indirect tax base, the increase in revenue depends on how formal the transaction is and if there is compliance at all. (Chan et al., 2023) mention that informal cash transactions at the micro-level and off unreported transactions that are difficult to audit, tend to underreport taxes and widen the compliance gap, which reduces the tax revenues that can be realized. To

reduce this gap, there is a need for policies that promote invoice-based transactions, as well as electronic payments and consumer incentives for documentation and effective oversight.

## 3.4 Effectiveness of tax administration (GE):

GE (Government Effectiveness from the World Governance Indicators) serves as a proxy for the effectiveness of tax administration and the quality of institutions involved in the revenue collection process. It reflects the ability of tax authorities to manage systems, revenue collection, and fraud detection (Khaltar, 2023; Alm, 2018) .Improved governance and administrative quality are associated with lower corruption, increased compliance, and better revenue performance (Savić et al., 2015). The variable completes the third explanation channel demonstrating how tax obligations and the collection process are intertwined through the compliance (registration, filing, declaration, and payment) gaps.

## 4. Study Methodology

This study moves from a purely conceptual interpretation of these relationships to an econometric testing framework which shows stability of these relationships across long, short and transitional dynamics. It establishes the dependent variable and the corresponding independent explanatory variables along the three pathways of expanding the tax base: taxpayer behavioral/compliance, efficient tax administration, and effective tax collection.

Considering the high probability of non-stationarity for time series data spanning from 2002 to 2024, the research adopts an ARDL-ECM methodology.

All estimations were performed in EViews 12 using annual data for 2002–2024 (N = 23). Unit-root testing relies on ADF tests with lag length selected by SIC (maximum lag = 2) and PP tests using Newey–West automatic bandwidth with a Bartlett kernel; all unit-root regressions include an intercept. The ARDL lag orders are selected by information criteria subject to parsimony given the annual sample, and the bounds test follows the Pesaran et al. (2001) procedure; post-estimation diagnostics include Breusch–Godfrey serial-correlation tests, Breusch–Pagan–Godfrey heteroskedasticity tests, Jarque–Bera normality tests, Ramsey RESET, and CUSUM / CUSUMSQ stability tests. The dataset used in the estimations is in Appendix 1.

The study is based on the hypothesis that non-hydrocarbon tax revenues are influenced by GE, CE, and TP. Thus, the functional specification of the ARDL model is expressed as follows:

$TA_t = f(TA_{t-i}, CE_{t-j}, TP_t - j, GE_{t-j})$

This association suggests that the current size of non-hydrocarbon tax revenues relates to its time lag as well as the current and lagged values of the selected factors of non-hydrocarbon tax revenue; the model in regression (structural equation) form is as follows

$$\varvec{TA}_{\varvec{t}} = \varvec{\alpha} + \sum_{\varvec{i}=1}^{\varvec{p}} \varvec{\beta}_{\varvec{i}} \varvec{TA}_{\varvec{t}-\varvec{i}} + \sum_{\varvec{j}=0}^{\varvec{q}_1} \varvec{\gamma}_{1\varvec{j}} \varv$$

where:

- **TA**: non-hydrocarbon tax revenue growth (dependent variable).
- **CE**: final consumption expenditure growth (as an indicator of economic activity).
- **TP**: non-hydrocarbon tax pressure (as a measure of the tax burden).
- **GE**: government effectiveness (as an institutional indicator of tax governance).
- **α**: Intercept term.
- **$\beta_1$, $\beta_2$, $\beta_3$**: Coefficients measuring the effect of each independent variable.
- **ε**: Stochastic error term.

**Clinical trial number: not applicable.**

## 5. Presentation of the Results

## 5.1 Results of the Time Series Stationarity Test (PP&ADF Test)

The analysis of the ADF and PP unit-root tests helps understand the order of integration for each series. In both tests, the default for the series is that they feature a unit root. All equations for the tests contain an intercept (constant). ADF sets the lag length automatically using the Schwarz information criterion (SIC) and a max of 2. The PP test uses a Newey-West automatic bandwidth which uses a Bartlett kernel. Unit-root evidence holds that the series are at most I (1) and none is I (2) which confirms the reliability of the ARDL bounds-testing/ECM framework.

Table 3
Unit-root tests

| Variable | ADF t-stat (p-val) | | PP Adj. t-stat [p-val] | | Decision at 5% |
|---|---|---|---|---|---|
| | Level | 1st Diff. | Level | 1st Diff. | |
| TA | -3.52 [0.0172] * | -4.70 [0.0016] *** | -3.51 [0.0175] * | -15.79 [0.0000] *** | I (0)/ I (1) |
| CE | -1.22 [0.6457] | -3.47 [0.0198] * | -1.22 [0.6457] | -3.36 [0.0247] * | I (1) |
| GE | -1.96 [0.2998] | -3.94 [0.0072] ** | -1.50 [0.5159] | -3.99 [0.0064] ** | I (1) |
| TP | -1.38 [0.5725] | -4.57 [0.0018] *** | -1.40 [0.5652] | -4.57 [0.0018] *** | I (1) |

Notes: The null hypothesis is “the series has a unit root.” All tests include an intercept (constant). The ADF lag length is automatically selected by SIC (max lag = 2), and PP uses the Newey–West automatic bandwidth with the Bartlett kernel. The first-difference tests use fewer observations, which is typical for small annual samples. Significance: ** p < 0.05, *** p < 0.01.

**Source**

Prepared by the authors.

Unit-root tests indicate that all series are at most I (1) and none is I (2), supporting the ARDL bounds-testing framework; specifically, CE, TP, and GE are I (1), while TA may appear I (0) or I (1) depending on the test specification.

## 5.2 Co-integration analysis

Table 4
ARDL Bounds Test for Co-integration (k = 3 Independent Variables: CE, TP, and GE)

| Model: TA = F (CE, GE, TP) | ARDL | | F-stat. | |
|---|---|---|---|---|
| Model 1 | (3,3,2,2) | | 3.209 | |
| Model 2 | (2,2,1,2) | | 1.392 | |
| Model 3* | (1,1,1,1) | | 10.334*** | |
| Critical bounds (finite sample n = 30) | 95% lower bound | 90% lower bound | 95% upper bound | 90% upper bound |
| F-statistics $_{(k=3)}$ | 3.272 | 2.676 | 4.306 | 3.586 |
| Critical Values | I (0) | | I (1) | |
| 10% | 2.37 | | 3.20 | |
| 5% | 2.79 | | 3.67 | |
| 2.5% | 3.15 | | 4.08 | |
| 1% | 3.65 | | 4.66 | |

**Note**: Lags are selected automatically by AIC with a maximum of 1 lag per variable (8 models evaluated), balancing goodness-of-fit and parsimony for a small annual sample (N = 23). This yields superior bounds. vs. higher-lag alternatives (e.g., ARDL (3,3,2,2) AIC F = 3.209, inconclusive due to overparameterization). SIC ARDL (2,2,1,2) corroborates robustness. Standard practice for a short time

**Source**

Authors’ calculations using EViews 12.

The bounds testing approach (Table 4) confirms a stable long-run relationship, with the optimal ARDL (1,1,1,1) model yielding F = 10.334***, exceeding the 1% upper bound (4.66 asymptotic; 5.966 finite n = 30). Even though other specifications, SIC ARDL (2,2,1,2) and full AIC ARDL (3,3,2,2), act as robustness checks, the small sample size (N = 23) may lead to concerns about overparametrization with greater lags. In accordance with the standard practice for annual data (Pesaran et al., 2001), lags where set to one using the AIC criteria with a maximum lag selection of one to achieve a balance between model fit and parsimony.

## 5.3 Long- and short-run Estimates

According to the long-term estimates (Table 5), final consumption expenditure (CE = 2.249, p = 0.012) coefficient is positive and significant, indicating that economic activity considerably expands the non-hydrocarbon tax base via VAT and associated taxes. On the other hand, tax pressure (TP = -6.195, p < 0.001) has a strong negative impact, which is in accordance with the Laffer curve and evasion incentivization in the case of Algeria. The GE is positive but insignificant (p = 0.543), which means that institutional constraints cause a lack of weak institutional transmission. The results emphasize the importance of expansion of the consumption-based tax system for fiscal system sustainability.

The ECM (Table 6) shows a rapid correction toward disequilibrium. The term of the error correction (ECT = -1.351, t = -8.151, p < 0.001) shows an implication of over- an adjustment speed of 135%, which is typical in small samples with strong mean reversion. Short-run dynamics are insignificant (p > 0.15) which

shows lagged/long-run dominance. This affirms the pathways framework: the balance point towards equilibrium is driven by consumption and administration, whereas tax pressure diminished revenue mobilization.

Table 5
Long-run ARDL co-integration model (1, 1, 1, 1)

| Variable | Coefficient | Std. Error | t-stat | p-value |
|---|---|---|---|---|
| CE | 2.2489 | 0.7815 | 2.878 | 0.012** |
| GE | 5.2123 | 8.3627 | 0.623 | 0.543 |
| TP | -6.1950 | 1.3784 | -4.494 | 0.0005*** |
| C | 40.2646 | 8.4607 | 4.759 | 0.0003*** |
| Note: *, **, *** significant at the 10%, 5%, 1% levels. **Source**: Authors' calculations using EViews 12. | | | | |

Table 6
Error Correction Model

| Variable | Coefficient | Std. Error | t-Statistic | p-value |
|---|---|---|---|---|
| D(CE) | 0.210 | 0.999 | 0.210 | 0.837 |
| D(GE) | -19.963 | 13.369 | -1.493 | 0.158 |
| D(TP) | 0.896 | 1.436 | 0.624 | 0.543 |
| ECT (-1) | -1.351 | 0.166 | -8.151 | 0.000*** |
| Note: *, **, *** significant at the 10%, 5%, 1% levels. **Source**: Authors' calculations using EViews 12. | | | | |

## 5.4 Dynamic multipliers (timing and effects duration)

Building on the aforementioned long-run and ECM estimates, we use dynamic multipliers to visualize when the effects of CE, TP, and GE materialize and how long they persist.

**Note**

Since dynamic multipliers are conditional on assumed paths for exogenous regressors, the baseline simulation holds future values of the regressors constant at their last observed (2024) levels, and the reported responses should be interpreted as ceteris paribus policy experiments rather than unconditional forecasts.

Starting in 2025, imposed step shocks show a response in non-hydrocarbon tax revenue growth (TA). However, it is followed by a quick stabilization in the long-term effects of TA in Fig. 2. Increase consumption growth (CE) by + 1 percentage point, TA on impact (3.038 in 2025) grows significantly, then by 2034 it stabilizes at + 2.249. This is in line with a tax-base sustained-expansion channel. In comparison, a 1 percentage-point rise in non-hydrocarbon tax pressure (TP) results in a severe negative impact on TA (approximately − 8.369 in 2025) which stays negative for a long time as it approaches the long-run effect (approximately − 6.195 by 2034. This means that the effects of compliance deterioration/evasion are greater than the mechanical revenue effect of increased tax pressure. For governance, a + 0.1 increase in government effectiveness (GE, WGI units) yields a comparatively small negative response (− 1.327 in 2025) converging to approximately − 0.983 by 2034, indicating limited pass-through under the current specification and sample. Overall, the maximum absolute responses occur in 2025, and the paths are already close to their long-run levels from around 2029 onward.

## 5.5 Model Stability Verification and Diagnostic Tests:

Having established the timing and persistence of the responses, we next assess the stability and adequacy of the estimated ARDL–ECM using standard post-estimation diagnostic and stability tests (CUSUM and CUSUMSQ).

Table 7
Post-Estimation Diagnostic Tests (ARDL (1, 1, 1, 1))

| Test/Order | Statistic | p-value | Critical Value/Bounds | Decision |
|---|---|---|---|---|
| Serial correlation (Breusch-Godfrey LM, 2 lags) | F = 0.324 | 0.729 | - | No autocorrelation |
| Heteroskedasticity (Breusch-Pagan-Godfrey) | F = 1.209<br>ObsR²=8.288 | 0.360<br>0.308 | - | Homoskedastic |
| Ramsey RESET (squares of the fitted values) | F = 0.462 | 0.509 | - | Pass (no misspecification) |
| Normality (Jarque-Bera) | JB = 1.085 | 0.694 | $\chi^2$ (2) = 5.99 (5%) | Normal residuals |
| Multicollinearity (centered VIF) | Max = 10.75 (CE (-1)) | Mean = 6 | VIF < 10 rule | Acceptable dynamic |

**Source**

Authors' calculations using EViews 12.

Table 7 shows the adequacy of the various models in sequence. where The Breusch-Godfrey LM test (F = 0.32, p = 0.73) does not support the existence of serial correlation for the first 2 lags, and in the case of Breusch-Pagan (p = 0.36) there is support for homoskedasticity. With Jarque-Bera (p = 0.69) there is support for the residuals being normally distributed, and the Ramsey RESET test provides no evidence of functional form misspecification (F = 0.462, p = 0.509). Therefore, the ARDL specification is sufficiently specified. Additionally, the plots of CUSUM and CUSUMSQ (Fig. 3) remain within the 5% critical bounds over the period 2002–2024, confirming the stability of the parameters and the supports parameter stability and variance stability. Centered VIFs averaging 6 (max 10.75) are acceptable in lag-augmented dynamic models. These tests validate the ARDL-ECM inferences.

## 5.6 Robustness: 2020 Break (Chow Forecast and Dummy):

Given the economically motivated 2020 COVID-19 shock and the short annual sample (2002–2024, N = 23), we assess post-2020 stability using the Chow forecast test over 2020–2024. The dynamic specification is then augmented with a post-2020 step dummy (D2020) to verify whether the core inferences remain robust.

A breakpoint split at 2020 would leave only five postbreak observations (2020–2024), which is insufficient to re-estimate the full dynamic specification with multiple parameters; therefore, the Chow forecast version of the test is used.

Table 8
Chow forecast test for a 2020 break (forecast sample: 2020–2024)

| Statistic | Value | df | p-value |
|---|---|---|---|
| F-statistic | 2.3176 | (5, 9) | 0.1291 |
| Likelihood ratio | 18.2045 | 5 | 0.0027 |
| **Source**: Authors' calculations using EViews 12 | | | |

While the F-version does not reject parameter constancy at conventional levels, the likelihood-ratio version suggests sensitivity to the 2020 shock in Table 8; hence, we proceed with a dummy-augmented specification as an additional robustness check.

Table 9
Dummy-augmented dynamic specification (post-2020 step dummy)

| Variable | Coefficient | p-value |
|---|---|---|
| CE (-1) | 3.057985 | 0.0370 |
| TP (-1) | -9.613672 | 0.0004 |
| D2020 | -10.18899 | 0.0375 |
| TA (-1) | -0.500168 | 0.0152 |
| Spécification: TA = C + TA(-1) + CE + CE(-1) + TP + TP(-1) + GE + GE(-1) + D2020 | | |

**Notes**: The table reports the key coefficients of interest. **Source**: Authors' calculations using EViews 12

The post-2020 dummy enters with a negative and statistically significant coefficient (D2020 = − 10.189, p = 0.0375), consistent with an adverse shock after 2020. Importantly, the core inferences remain robust: the lagged consumption effect stays positive and significant (CE (− 1) = 3.058, p = 0.037), while the lagged tax pressure effect remains strongly negative (TP (− 1) = − 9.614, p = 0.0004), are reported in Table 9.

## 6. Discussion and conclusion:

This segment interprets the econometric findings and relates them to the prevailing literature on tax revenue mobilization.

# 6.1 Tax Base Channel: Consumption Expenditure (CE)

The positive effects of CE on tax revenue (β = 2.249, p = 0.012) correspond to (Lartey, 2024) as to how non-resource tax revenues increase as the tax base of resource-dependent economies expands as opposed to tax rate increases. This also corresponds to (Bellon et al., 2022) as VAT credit invoices are said to create tax compliance, which increases the base of tax effectiveness through tax-linked production. Over the period of 2002–2024, the coefficient (2.25) is the highest compared to (Hanane & Toufik, 2015), for Algeria, averaging β ~ 0.8, which predicts that the consumption revenue has increased due to the 2017–2022 VAT. The CE coefficient (2.25, p = 0.012) shows an supports a positive association of the consumption pathway compared to (Hadjmaoui & Hanane, 2021) who had a positive view of the financial development with a non-oil tax revenue of 1.5 coefficient using ARDL for Algeria. This larger coefficient reflects Algeria's low formalization rate, where marginal consumption growth captures previously untaxed informal transactions, offering greater revenue upside per unit expansion than financial intermediation alone.

# 6.2 Tax Burden Channel: Tax Pressure (TP)

The strong negative long-run coefficient for TP (β=-6.195, p < 0.001) diverges from linear burden model's but corroborates the nonlinear compliance-threshold literature. (Zaddam et al., 2021) found that corruption amplifies the revenue-reducing effect of high pressure via NARDL, consistent with our result in a weak-governance context (Vellutini, 2025). This study independently identifies a 2–4% of GDP non-hydrocarbon tax gap in Algeria linked to excessive burden and evasion incentives, providing IMF-level institutional validation of our econometric finding. This study advances beyond (Vellutini, 2025) by quantifying the dynamic pathway: a 1% rise in TP reduces TA by 6.20% long-run through compliance deterioration, evasion escalation, and behavioral withdrawal—effects absent from the IMF's non-econometric diagnostic. This constitutes the study's novel contribution: the ARDL-based quantification of the TP-TA coefficient in Algeria.

# 6.3 Governance Channel: Government Effectiveness (GE)

GE's positive but insignificant long-run coefficient (β = 5.212, p = 0.543) partially contradicts previous studies (Bird et al., 2008; Elbahnasawy et al., 2025), which found that governance quality was positively associated with tax effort across developing economies. However, it is also in line with (Laggoun & Laggoun, 2025), who stated that in Algeria, the principles of tax governance are still aspirational without measurable collection consequences, indicating that situational-specific institutional constraints take precedence over contextual governance. The second novel contribution of this study is the decomposition of the latent effect of GE (5.21 despite the magnitude being insignificant), indicating the existence of some governance capacity, but this has not yet been institutionally harnessed, a finding with direct reform implications that is missing in the earlier Algerian literature.

# 6.4 ECM Dynamics and Speed of Adjustment

The ECT coefficient (-1.351, p < 0.001) shows rapid mean reversion. The over-correction (> 100%) illustrates Algeria's narrow non-hydrocarbon base volatility and small sample dynamics, in line with (Abdelwahed, 2020), who observed time-varying and at times overshooting adjustment to fiscal adjustment episodes. This forms the third novel contribution: Algeria's non-hydrocarbon revenues respond quickly but asymmetrically, suggesting that consumption shocks can counterbalance evasion effects by responding to revenues faster than TP relaxation.

The conditional ARDL dynamic multipliers reinforce the long-run ARDL estimates and provide an explicit "timing–duration" characterization of the transmission mechanisms.

A + 1 percentage-point permanent increase in consumption growth (CE) sharply increases non-hydrocarbon tax revenue growth (TA) on impact (3.038 p.p. in 2025) and then converges toward a stable long-run gain of 2.249 p.p. by 2034, which is consistent with the positive and statistically significant long-run coefficient on CE (2.2489, p = 0.012) in the cointegrating equation

Conversely, a + 1 percentage-point step increase in non-hydrocarbon tax pressure (TP) generates a large immediate contraction in TA (− 8.369 p.p. in 2025) and remains persistently negative, stabilizing around − 6.195 p.p. by 2034, mirroring the strongly negative long-run TP coefficient (− 6.1950, p = 0.0005) and supporting the interpretation that higher effective pressure induces evasion/avoidance that dominates any mechanical revenue effect beyond a compliance threshold.

For governance, a + 0.1-step increase in GE (WGI units) produces a modest negative response (− 1.327 p.p. in 2025) converging to − 0.983 p.p. by 2034; given that the long-run GE coefficient is statistically insignificant (5.2123, p = 0.543), these dynamics should be interpreted cautiously as weak and sample-dependent rather than as robust evidence of a structural governance effect.

Relative to all other response profiles, the largest absolute response contemporaneously is 2025, and by 2029, all three profiles are close to their respective long-run targets, which, alongside the ECM evidence of rapid error correction (ECT = − 1.351, p = 0.000), provides positive estimated. The timing and duration evidence from the conditional dynamic multipliers is consistent and supports the robustness checks based on the 2020 economically motivated shock. In addition, the dynamic specification adjusted to include a 2020 step dummy (D2020) demonstrates a significant negative shift while maintaining the long-run qualitative inferences—CE remains positive and TP is still strongly negative—post 2020 disturbances supporting the core transmission explanation's stability.

## 7. Conclusion and Policy Implications

The study offers the ARDL-ECM estimation method on the non-hydrocarbon tax revenue parameters in Algeria (2002–2024), analyzing and combining all three of the main channels available in the literature: economic activity vis-à-vis final consumption expenditure (CE), taxpayer's compliance in terms of tax pressure (TP), and administrative efficiency in terms of the government's effectiveness (GE). The bounds test shows evidence of cointegration (F = 10.334***, > 1% I (1) bound of 4.66 and finite 5.966), and it shows some robustness across the AIC/SIC criteria and the full diagnostic tests (LM p = 0.73, heteroskedasticity p = 0.36, JB normality p = 0.69, RESET 0.51, CUSUM/SQ stability).

Overall, the diagnostic and stability tests support the adequacy of the preferred specification for this sample made in contrast to previous analyses conducted in Algeria based on more rigid analyses.

The CE drives base expansion (coefficient = 2.25***, p = 0.012), TP erodes compliance (-6.20***, p < 0.001), and GE the estimated coefficient is positive but statistically insignificant (5.21, p = 0.543). This triad advances (Hadjmaoui & Hanane, 2021) by replacing financial proxies with direct CE/TP channels, quantifying (Vellutini, 2025) the 2–4% IMF tax gap through elasticities absent from their diagnostics, and extending (Laggoun & Laggoun, 2025) descriptive governance review with ECT-driven dynamics (-1.351***, t=-8.15). The over-adjustment speed (> 100%) signals that Algeria's narrow non-hydrocarbon base amplifies shock transmission, offering a novel methodological insight for small-sample rentier economies.

Three policy-actionable conclusions stand out from this ARDL-ECM study (2002–2024): First, policy could prioritize broadening the consumption base instead of increasing the rates, quantitatively, higher consumption growth is associated with higher non-hydrocarbon tax revenue growth, holding other factors constant. This can be operationalized through VAT formalization via mandatory e-invoicing for large companies, rationalization of exemptions, and incentivization of informal cash transactions, as per the IMF's recommendations, identifying a 2–4% GDP tax gap, and yielding better results in low compliance environments.

Second, the negative long-run coefficient on TP implies that additional increases in effective non-hydrocarbon tax pressure could become detrimental in low compliance situations. TP is negatively and significantly correlated with the growth of non-hydrocarbon tax revenue (β = −6.195, p = 0.0005), and this is in line with the notion that compliance responses (evasion/avoidance) would outweigh the dominant mechanical revenue effect when the burden increases. From a policy perspective, the negative results indicate a need to focus on base broadening and formalization in conjunction with risk-based compliance management, as opposed to focusing on, or relying heavily, on increased effective tax pressure.

Third, GE's positive coefficient (5.21, p = 0.543) legitimizes frontloaded spending on digital tax administration (i.e., third-party data matching systems from customs/social security), risk-based auditing, and CRM systems, converting institutional potential into real fiscal collection gains.

**Limitations and Extensions**

For annual N = 23, power is limited; short-run heterogeneity could be fine-tuned by quarterly data or NARDL asymmetry testing. For this benchmark ARDL-ECM basis, the Panel MENA, digital governance (e-filing) proxies, structural breaks, or digital governance proxies are promising extensions. Overall, this paper contributes based on the dynamic quantification of Algeria's non-hydrocarbon mobilization channels indicate that the country's path to fiscal resilience is a combination of consumption-led broadening, constrained pressure, and governance activation.

## Declarations

**Ethics and Consent**: This study relies exclusively on publicly available secondary data from official sources (Bank of Algeria, World Bank WGI) and does not involve human participants, animals, or sensitive personal information. Therefore, ethical approval was not required.

**Data Availability**: The authors constructed the dataset supporting the conclusions of this article from materials available to the public (Bank of Algeria and World Bank)

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**Conflict of Interest Disclosure Statement**: The authors have stated that they have no financial or non-financial conflicts of interest to declare.

# Author Contribution

JF compiled the dataset (2002–2024), conducted the econometric analysis in EViews (ADF/PP unit-root testing, ARDL bounds testing, ARDL-ECM estimation, diagnostics, stability tests, and robustness checks), and prepared the tables. JF wrote and edited the manuscript. GT prepared the initial draft, contributed to writing the literature review, and assisted in preparing the figures. All authors reviewed and approved the final manuscript.

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## Figures

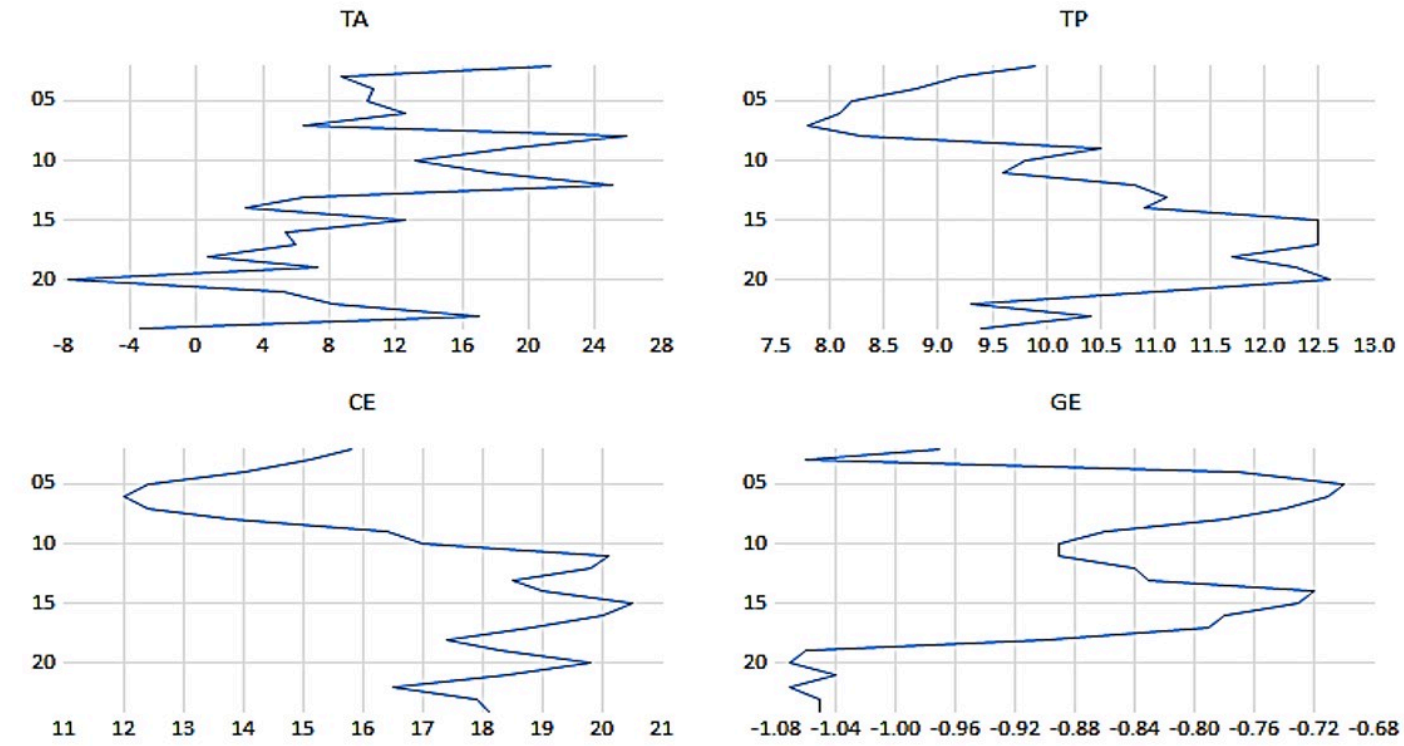



Figure 1

First Differences in Key Variables (2002–2024)

Source: Authors' calculations using EViews 12

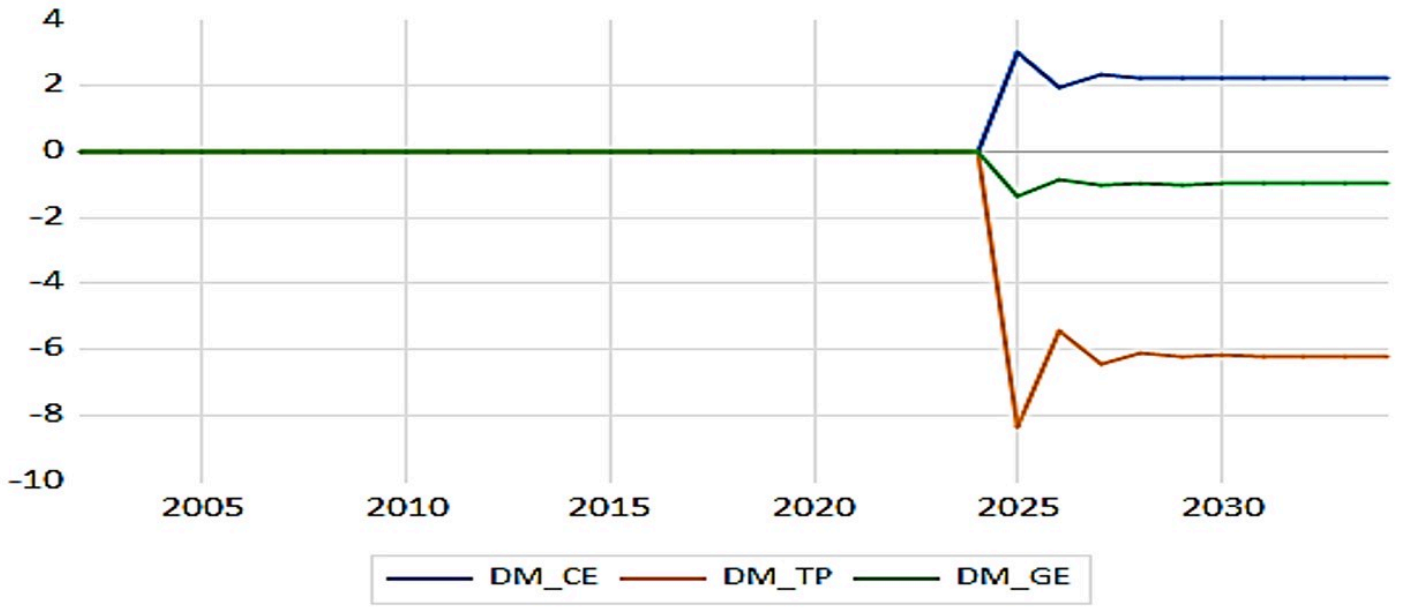



Figure 2

Conditional dynamic multipliers of TA to step shocks in CE, TP, and GE

Note: Step shocks are CE +1 p.p., TP +1 p.p., and GE +0.1 (WGI units); the y-axis reports the response of TA in percentage points relative to the baseline path.

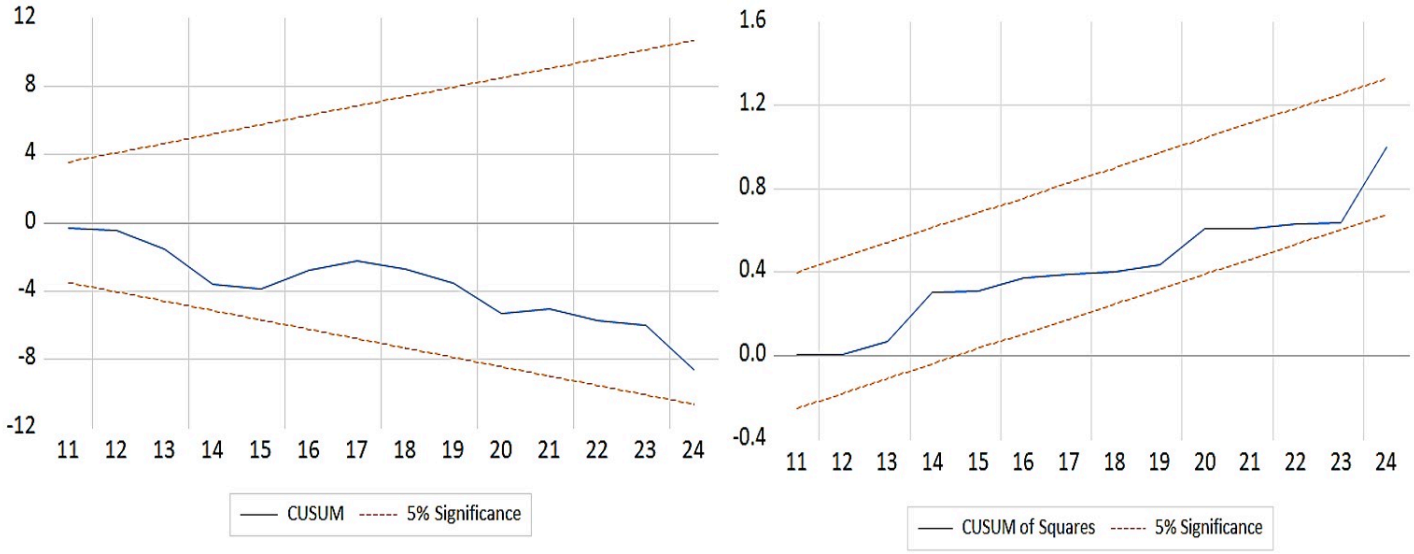



**Figure 3**

**CUSUM (left) and CUSUM of squares (right) tests of the model stability**

**Source:** Authors' calculations using EViews 12.

## Supplementary Files

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- Appendix1.docx