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RESEARCH ARTICLE

# Macroeconomic and Structural Drivers of Non-Hydrocarbon Tax Revenue Performance in Algeria: An Empirical Time-Series Analysis Using the ARDL Approach (1995–2022)

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**Keywords** Non-hydrocarbon tax revenues; fiscal sustainability; tax base expansion; ARDL model; macroeconomic determinants; Algeria

**Abstract**

This study investigates the macroeconomic and structural determinants of non-hydrocarbon tax revenues in Algeria over the period 1995–2022, with the objective of identifying the key variables influencing the sustainability and effectiveness of public revenue mobilization outside the hydrocarbons sector. Given Algeria's long-standing dependence on hydrocarbon revenues, strengthening non-oil tax collection has become a central policy priority for enhancing fiscal resilience and reducing vulnerability to external shocks. The study employs a mixed methodological framework combining descriptive–analytical analysis with econometric modeling. Stepwise regression is first used to identify the most influential explanatory variables, including tax exemptions, tax pressure, the size of the tax base, and trade openness. Subsequently, the Autoregressive Distributed Lag (ARDL) model is applied to examine both short-run and long-run relationships between non-hydrocarbon tax revenues and the selected macroeconomic variables. Unit root tests confirm that the variables are integrated of order I(0) and I(1), justifying the use of the ARDL bounds testing approach. The empirical results indicate the existence of a stable long-run equilibrium relationship between non-hydrocarbon tax revenues and the explanatory variables. In particular, expansion of the tax base and improvements in economic activity exert a positive and statistically significant impact on tax revenues, while excessive tax exemptions and weaknesses in tax compliance negatively affect revenue performance. Short-run dynamics further reveal adjustment mechanisms that reflect structural rigidities within the Algerian tax system. The findings underscore the importance of broadening the tax base, rationalizing tax exemptions, reducing tax evasion, and enhancing administrative efficiency in order to strengthen

domestic revenue mobilization. The study provides policy-relevant insights for fiscal authorities seeking to design sustainable tax reforms in resource-dependent economies.

**Citation**

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## First: Introduction

The tax system occupies a central position within the public financial system both at the local and global levels, as it plays a highly significant role in the economies of states due to its multiple linkages with many variables of economic activity. Meeting the needs of the state requires an efficient tax system that provides the necessary financial resources allocated to cover the various aspects of public expenditure through which general balance and social welfare for all citizens are achieved. The state seeks to achieve its objectives by relying on its sovereign tools, namely taxes. Therefore, taxes are considered an effective means that enables the state to intervene in economic and social life. The tax has become a financial instrument that ensures a continuous, diverse, and renewable coverage of public expenditures, and it is also an effective mechanism for directing economic activity, having the capacity to realize various economic and social objectives. As a result of this importance, the public authorities have undertaken several reforms to the tax system in order to face the imbalances suffered by the state's public treasury. Most of the problems faced by developing and oil-dependent countries revolve mainly around the shortage of ordinary tax revenues due to their reliance on petroleum taxation, which results from the weakness and limitation of local production and the low level of output outside the hydrocarbons sector. Hence, the state's need has constantly increased for new sources of financing to meet its continuously growing needs.

International experiences in this field have demonstrated that the possibility of determining an optimal tax system for a given country requires that this system be born out of the economic, political, and social determinants of that society and that it evolves in a manner consistent with the changes and development of those determinants. Therefore, we find variations among the tax systems of different countries, and even within the same country over time. These experiences have also underlined the importance of coordination between the extent and level of tax reforms on one hand and the effectiveness and capacity of the administrative apparatus implementing them to adapt and improve performance rapidly on the other hand.

The success of any tax system is not measured by the amount of taxes and fees imposed, but rather by the revenues that can effectively be collected from these imposed taxes and fees. Therefore, the tax collection system constitutes an integral part of the tax system as a whole. The tax administration undertakes the implementation of the tax collection system established in the form of laws, legislation, and tax procedures, executing it with the highest levels of efficiency while attempting to adapt to modern technological developments in order to preserve public revenue and strengthen voluntary compliance by taxpayers, aiming to improve and raise the level of tax revenues with minimal cost. This is done through the development of tax legislation and the simplification of tax procedures.

Thus, collecting taxes and fees represents the fundamental mechanism through which states generate general tax revenues that enable them to finance their expenditures and investments. Due to its special nature and direct connection to the public treasury, the public authorities have established various tax laws and regulations organizing the process of tax collection, empowering the tax administration to collect all taxes and fees. However, despite the efforts made by the authorities through enacting laws, instructions, and fiscal measures to enhance the efficiency of tax collection, ordinary tax revenues have remained weak. This weakness is attributed to several factors inherent in the structure of developing economies, such as the low gross domestic product and its per capita share, weak economic growth rates, the abundance of tax exemptions, the difficulty of estimating the activity of informal private enterprises, the low level of tax awareness and culture, as well as the high levels of tax fraud and evasion.

### 1. Research Problem:

Tax revenues are controlled by a set of different factors, which vary according to their nature and the perspective through which they affect the size of tax revenues. From this standpoint, the main research question can be raised as follows:

What are the most important economic variables that determine tax revenues outside the hydrocarbons sector in Algeria?

This main problem falls under the following sub-questions:

- What are the main variables influencing and not influencing tax collection in Algeria?
- To what extent do macroeconomic variables affect tax collection in Algeria?

## 2. Research Hypotheses:

To address the previous problem and answer the various related questions, the following hypotheses were set:

- The volume of tax revenues outside the hydrocarbons sector during the period 1995–2022 is affected by all economic variables.
- There exists a long-run equilibrium relationship of statistical significance between tax collection in Algeria and a set of macroeconomic variables, with the impact of these variables differing between the short and long terms according to the ARDL model.

## 3. Research Significance:

The significance of this study stems from the importance of its subject, as it is directly related to the financial and economic dimensions of the state. The state seeks to increase the volume of ordinary tax revenues without causing economic or social imbalances. This issue has become the central focus of researchers and policy-makers, especially given the local and global economic conditions following the continuous fluctuations in oil prices and the state's will to get rid of the duality of financing.

## 4. Research Methodology:

In order to answer the research problem raised, the descriptive–analytical and experimental approaches were adopted, using the econometric model according to the Autoregressive Distributed Lag Model (ARDL) methodology.

## 5: Previous Studies

**5.1: Belouja Hassania (2016–2017)** titled "The Relationship Between the Taxpayer and the Tax Administration in Algeria," is a doctoral thesis at the Faculty of Economic, Commercial, and Management Sciences, University of Abou Bekr Belkaid. This study aimed to address the problem of the factors influencing the taxpayer's behavior toward the tax administration and the tax itself, by discussing in detail the tax relationship in Algeria—focusing on the tax administration in terms of concept, its structures, and functions, as well as the taxpayer and the detailed study of his behavior. Then, the main factors affecting the taxpayer's behavior toward the tax and the tax administration were presented, where the study concluded that the taxpayer's behavior toward the tax administration reflects his position toward taxes, either commitment or evasion. The taxpayer's view of taxation is nothing but a reflection of the economic, social, political, and administrative policies adopted by the state. Moreover, the taxpayer's behavior is the outcome of the interaction of a set of factors of different nature.

**5.2: Hafiz Khalil Ahmed et al. (2016)**, titled *Socio Economic Determinants of Tax Revenue in Pakistan: An Empirical Analysis*, published in the *Journal of Applied Environmental and Biological Sciences.* This study aimed to identify the social and economic determinants of tax revenues in Pakistan, in an attempt to deal with the issue of tax revenue shortage along with increasing non-developmental expenditures, which caused a large deficit in the budget. For this purpose, the study used annual time-series data for the period 1975–2012 and applied the ARDL regression approach. The findings showed that per capita GDP is among the most significant economic determinants of tax revenue. Likewise, the level of taxpayers' compliance is a social determinant that positively influences tax revenues. The study also found that the informal economy and the narrow tax base are negative and crucial factors in determining tax revenues in Pakistan. It suggested that the state could control its tax revenues by formalizing the informal economy, expanding the tax base, and improving institutional and political administration.

**5.3: Lakhdar Abbirat (2017–2018)** titled "The Effectiveness of the Tax System Through Collection Under the Current Economic Transformations: A Case Study of the Algerian Tax System," is a dissertation at the Faculty of Economic, Commercial, and Management Sciences, Ammar Thlidji University, Laghouat. The study aimed to deal with the problem of the tax methods and procedures followed in the tax debt collection process and their contribution to increasing the effectiveness of the tax system. It discussed the structure of the Algerian tax system, presented the mechanisms, methods, and ways of tax collection, and explored the main obstacles facing the collection process. The study concluded that the Algerian tax system remains secondary and limited in financing the general budget, still suffering from various imbalances, mainly instability, complicated and ambiguous laws, frequent amendments, and a lack of flexibility in responding to economic changes. Moreover, the study revealed that the low efficiency of tax administration employees, due to their lack of scientific and practical skills and insufficient preparation and training, is the main reason for the non-application of laws, which directly affects the tax collection process. The study further confirmed that building an effective tax system cannot be based on fixed characteristics applicable to all tax systems, since each system has its own peculiarities depending on the economic, social, and political conditions of its society.

**5.4: Kitessa Delessa Terefe and Jewaria Teera (2018)** titled *Determinants of Tax Revenue in East African Countries: An Application of Multivariate Panel Data Cointegration Analysis*, published in the *Journal of Economics and International*

*Finance.* The study aimed to determine the tax revenue determinants in East African countries using data from 1992 to 2015, employing statistical and econometric tools to achieve the research objective. A group of variables included in the model were selected to identify the most important determinants of tax revenue. According to the results of the estimated long-run equation, per capita GDP, foreign aid, trade openness, and the shares of agriculture, industry, and services had a large and positive impact on tax revenues in East African countries during the study period. On the other hand, urbanization, the official exchange rate, and inflation rate had a negative effect on the level of tax revenues relative to GDP. As for the short-term results, they indicated that lagged tax revenues (by one period) and urbanization negatively affect current tax revenues. The study also recommended that East African countries should continually adopt necessary measures to enhance the performance of each economic sector, and for the success of economic transformation, it is vital to introduce new technologies allowing for innovation in production. Moreover, political incentives should be implemented to support sustainable resource use comprehensively, in order to bridge the gaps in these economies caused by dependence on foreign aid to finance resource deficits.

**5.5: Study of Kunofiwa Tsaurai (2021), entitled "Determinants of Tax Revenue in Upper Middle-Income Group of Countries"**An article published in *The Journal of Accounting and Management*, this study aimed to investigate the determinants of tax revenues in middle-income countries, and to examine the interaction effect between foreign direct investment and financial development on the tax revenues of these countries during the period 2007–2017. The purpose was to make the study a guiding reference for middle-income countries when designing and developing tax policies that promote economic growth for their economies. A set of statistical and econometric tools were utilized, including the generalized method of moments (GMM), random effects, and also relying on the ordinary least squares (OLS) and fixed effects method. The empirical results indicated that financial development, foreign direct investment, economic growth, urbanization, human capital development, and population growth all had a positive and significant effect on tax revenues, and thus are considered positive determinants of tax revenues. Meanwhile, the exchange rate and trade openness had a negative impact on tax revenues. The study also recommended further investigation into the minimum threshold levels of these tax revenue determinants that must be achieved to reach the highest level of tax collection efficiency—namely the flows of foreign direct investment, level of urbanization, economic growth, population growth, and human capital.

**5.6: Hamouch Khawla (2021–2022), entitled "Effectiveness of the Tax System in Reducing Tax Evasion in Algeria: An Analytical and Evaluative Study for the Period 2005–2020"** Doctoral thesis at the Faculty of Economic, Commercial and Management Sciences, University of Djilali Bounaama Khemis Miliana. The central problem of this study revolves around the extent to which the tax system is effective in reducing tax evasion in Algeria. The aim of the study was to address the issue of tax system effectiveness through the assessment and analysis of tax revenues for the period 2005–2020, in order to highlight the determinants of constructing an efficient tax system. The importance of this study lies in diagnosing and measuring the magnitude of tax evasion, as it is considered one of the main obstacles confronting the effectiveness of the tax system. The practical and econometric results indicated that tax evasion is one of the most significant determinants of the effectiveness of the tax system, as revealed by the results of tax audits which showed large sums subject to tax evasion, in addition to the high rates of the informal economy. The tax system also faces the problem of law enforcement, especially the delay in implementing the reforms planned in the early 1990s, which covered two main areas: taxation and the modernization of tax administration. The latter was delayed until the early 2000s, with considerable shortcomings in its implementation. The study also found that the high rates of tax evasion, along with the considerable volume of tax expenditure, have weakened the elasticity of the tax system.

- **DAMANI Mohamed Abderaouf (2021–2022), entitled "Corruption, Taxation and Economic Growth in Developing Countries: An Econometric Investigation Based on Panel Data Models"**Doctoral thesis in Statistics and Applied Economics at the *École Nationale Supérieure de Statistique et d'Économie Appliquée* in Kolea. The research problem centers on examining the effect of corruption on taxation and economic growth in developing countries. The objective of this thesis was to study and identify the relationship between the positive and negative effects resulting from the interaction between corruption, tax revenues, and economic growth. The importance of the study lies in the econometric analysis of the influence of corruption, in order to explain the relationship between corruption, taxes, and economic growth in developing countries, using an endogenous growth model in which both corruption and tax revenues are introduced. The study also aimed to propose certain solutions for developing countries, including Algeria, to guide their fiscal and anti-corruption policies. The research relied on dynamic panel data models using data from 70 developing countries during the period 1996–2016. The results show that the higher the corruption in countries, the greater the harmful effect of taxation on economic growth.

**Second: Econometric Modeling of the Main Economic Factors Determining Tax Collection in Algeria Outside the Hydrocarbon Sector for the Period 1995–2022**

This study aims to analyze and measure the effect of the main economic factors on tax collection in Algeria during the period 1995–2022, through examining the nature of the relationship between the studied variables. To achieve the objectives of the study, the *stepwise regression* method was first adopted in order to select the most influential economic variables on tax collection. In a second stage, the *autoregressive distributed lag model (ARDL)* was employed to measure the relationship between the dependent variable and the selected independent variables in both the short and long run, given its suitability for handling time series data with different integration orders. The econometric estimations were conducted using the *EVIEWS* software (versions 10 and 13), relying on the necessary econometric tests to verify the stability of the model and the reliability of the obtained results.

**1: Definition of the Study Variables and Their Data Sources**

Based on the economic literature and previous studies that dealt with the determinants of tax collection, a set of the most common macroeconomic variables used to explain the development of tax revenues was chosen, with the aim of constructing an econometric model that captures the nature of the relationship between these variables and tax collection in Algeria. In this context, annual data extracted from official national and international sources were used, applying the natural logarithm to some variables for variance and to improve the properties of the time series. The study variables are as follows:

- LRCF: logarithm of tax collection;
- LAF: logarithm of tax exemptions;
- PF: tax pressure;
- LFF: logarithm of tax evasion;
- LPBH: logarithm of tax base;
- LECIF: logarithm of the informal economy;
- OC: trade openness;
- LTC: logarithm of the exchange rate;
- CE: economic growth.

These variables can be summarized in the following table:

**Table No. (01): Definition of the Study Variables**

| Variables | Variable Name | Unit | Source |
|---|---|---|---|
| **RCF** | Tax collection | Billion DZD | Statistics from the Ministry of Finance, General Directorate of Taxes |
| **AF** | Tax exemptions | Billion DZD | Statistics from the Ministry of Finance, General Directorate of Taxes |
| **PF** | Tax pressure | Billion DZD | Statistics from the Ministry of Finance, General Directorate of Taxes |
| **FF** | Tax evasion | Billion DZD | Statistics from the General Directorate of Fiscal Control |
| **PBH** | Tax base | Billion DZD | Statistics from the Ministry of Finance, General Directorate of Taxes |
| **ECIF** | Informal economy | Billion DZD | Statistics from the Ministry of Finance, General Directorate of Taxes; article by Lahcene Bouriche and Aymen Salah Bennihi |
| **OC** | Trade openness | Billion DZD | Bank of Algeria; General Directorate of Customs |

| | | | |
|---|---|---|---|
| **TC** | Exchange rate | Billion DZD | World Bank |
| **CE** | Economic growth | Billion DZD | Statistics from the Ministry of Finance, General Directorate of Taxes |

**Source:** Prepared by the researcher.

**2: Stepwise Regression Model**

This model is considered one of the fully efficient methods, as it differs in its solving approach from ordinary regression models and is close to the iterative method. Moreover, it differs from other techniques used in econometrics, since it aims to find a set of correct variables for the response within the analysis. This method can be applied in two forms: the **forward stepwise method** and the **backward stepwise method** (Mustapha & Charit, 2018, p.183).

**Table No. (02): Stepwise Regression Model**

Dependent Variable: LRCF
Method: Stepwise Regression
Date: 03/10/24 Time: 22:59
Sample: 1995 2022
Included observations: 28
Number of always included regressors: 1
Number of search regressors: 8
Selection method: Stepwise backwards
Stopping criterion: p-value forwards/backwards = 0.1/0.1

| Variable | Coefficient | Std. Error | t-Statistic | Prob.* |
|---|---|---|---|---|
| C | -1.238655 | 0.013628 | -90.88869 | 0.0000 |
| LPBH | 0.975744 | 0.004261 | 228.9700 | 0.0000 |
| PF_ | 0.030807 | 0.000838 | 36.76326 | 0.0000 |
| LAF | 0.018602 | 0.004142 | 4.491090 | 0.0002 |
| OC_ | 0.003913 | 0.001132 | 3.456074 | 0.0021 |

| | | | |
|---|---|---|---|
| R-squared | 0.999870 | Mean dependent var | 3.011293 |
| Adjusted R-squared | 0.999847 | S.D. dependent var | 0.376556 |
| S.E. of regression | 0.004650 | Akaike info criterion | -7.743380 |
| Sum squared resid | 0.000497 | Schwarz criterion | -7.505486 |
| Log likelihood | 113.4073 | Hannan-Quinn criter. | -7.670654 |
| F-statistic | 44255.12 | Durbin-Watson stat | 2.275136 |
| Prob(F-statistic) | 0.000000 | | |

Selection Summary

Removed CE_
Removed LTC
Removed LFF
Removed LECIF

*Note: p-values and subsequent tests do not account for stepwise selection.

**Source:** Prepared by the researcher based on the outputs of *Eviews10*.

The table above shows that the optimal combination which gives statistical significance to the independent variables is the model that includes the variables of tax incentives (LAF), tax pressure (PF), tax base (LPBH), and trade openness (OC).

**3: Stability of Time Series**

Before applying any model, it is first necessary to determine the degree of stability of the time series, as it represents an essential preliminary step that must be carried out for several reasons (Ben Sghir, 2020, p. 140). The stability of time series can be identified through the graphical curve or by using unit root detection tests such as the Dickey-Fuller test and the Phillips-Perron test, which help in determining the appropriate method to make the series stable (Ben Sghir, 2020, p. 141).

**a. : Unit Root Test**

**Table No. (03): Results of Phillips-Perron Test**

**UNIT ROOT TEST TABLE (PP)**

| | | LRCF | OC_ | LPBH | LAF | PF_ |
|---|---|---|---|---|---|---|
| **At Level** | | | | | | |
| With Con... | t-Statistic | -1.5516 | 0.7440 | 0.0734 | -6.7647 | -3.8943 |
| | ***Prob.*** | ***0.4928*** | ***0.9909*** | ***0.9575*** | ***0.0000*** | ***0.0063*** |
| | | n0 | n0 | n0 | *** | *** |
| With Con... | t-Statistic | -0.3890 | 0.4970 | -1.9474 | -5.3149 | -1.8763 |
| | ***Prob.*** | ***0.9828*** | ***0.9987*** | ***0.6025*** | ***0.0010*** | ***0.6388*** |
| | | n0 | n0 | n0 | *** | n0 |
| Without C... | t-Statistic | 5.0767 | 1.4505 | 3.7346 | 0.3504 | 0.9556 |
| | ***Prob.*** | ***1.0000*** | ***0.9598*** | ***0.9998*** | ***0.7790*** | ***0.9052*** |
| | | n0 | n0 | n0 | n0 | n0 |
| **At First Difference** | | | | | | |
| | | d(LRCF) | d(OC_) | d(LPBH) | d(LAF) | d(PF_) |
| With Con... | t-Statistic | -4.0319 | -4.1887 | -3.7655 | -7.6429 | -5.5250 |
| | ***Prob.*** | ***0.0047*** | ***0.0032*** | ***0.0088*** | ***0.0000*** | ***0.0001*** |
| | | *** | *** | *** | *** | *** |
| With Con... | t-Statistic | -4.1788 | -4.6401 | -3.7169 | -8.9991 | -6.8651 |
| | ***Prob.*** | ***0.0148*** | ***0.0053*** | ***0.0391*** | ***0.0000*** | ***0.0000*** |
| | | ** | *** | ** | *** | *** |
| Without C... | t-Statistic | -2.0790 | -4.0382 | -2.5465 | -7.2903 | -5.3086 |
| | ***Prob.*** | ***0.0383*** | ***0.0003*** | ***0.0131*** | ***0.0000*** | ***0.0000*** |
| | | ** | *** | ** | *** | *** |

**Source:** Prepared by the researcher based on the outputs of Eviews10.

The results of the Phillips-Perron test showed that the variables of tax incentives (LAF), tax pressure (PF), tax base (LPBH), trade openness (OC), and tax collection (LRCF) are not stable at the level I(0) at a significance level of 5%. However, after taking the first differences, these variables became stable of the first order I(1) at the same significance level of 5%. Hence, it is possible to apply the ARDL methodology, which is used in small samples, as is the case in this study (n=28).

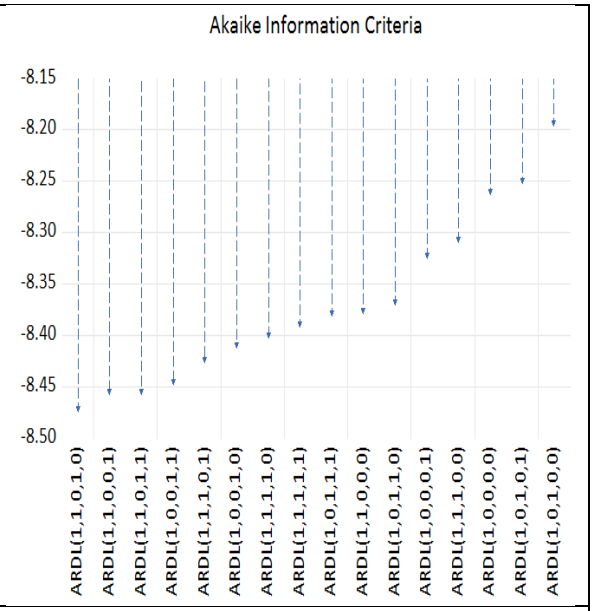
**b. : Determining the Lag Period**

Before conducting the cointegration test, it is first necessary to determine the optimal lag periods, based on the Akaike criterion, which provides the lowest statistical value. Accordingly, ARDL(1,1,0,1,0) is the optimal model, and the value of this criterion is Akaike (-8.472377), as shown in the following results:

| **Table No. (04): The optimal lag periods for the ARDL model** | **Figure No. (01): The optimal lag periods for the ARDL model** |
|---|---|

Model Selection Criteria Table
Dependent Variable: LRCF
Date: 03/11/24 Time: 09:38
Sample: 1995 2022
Included observations: 27

| Model | LogL | AIC* | BIC | HQ | Specification |
|---|---|---|---|---|---|
| 6 | 122.377088 | -8.472377 | -8.088425 | -8.358208 | ARDL(1,1,0,1,0) |
| 7 | 122.152494 | -8.455740 | -8.071789 | -8.341571 | ARDL(1,1,0,0,1) |
| 5 | 123.145891 | -8.455251 | -8.023306 | -8.326811 | ARDL(1,1,0,1,1) |
| 13 | 122.019129 | -8.445861 | -8.061910 | -8.331692 | ARDL(1,0,0,1,1) |
| 3 | 122.725647 | -8.424122 | -7.992176 | -8.295682 | ARDL(1,1,1,0,1) |
| 14 | 120.532516 | -8.409816 | -8.073858 | -8.309918 | ARDL(1,0,0,1,0) |
| 2 | 122.402199 | -8.400163 | -7.968217 | -8.271723 | ARDL(1,1,1,1,0) |
| 1 | 123.256889 | -8.389399 | -7.909460 | -8.246688 | ARDL(1,1,1,1,1) |
| 9 | 122.109243 | -8.378462 | -7.946517 | -8.250022 | ARDL(1,0,1,1,1) |
| 8 | 120.088131 | -8.376899 | -8.040941 | -8.277001 | ARDL(1,1,0,0,0) |
| 10 | 120.968961 | -8.368071 | -7.984120 | -8.253902 | ARDL(1,0,1,1,0) |
| 15 | 119.360821 | -8.323024 | -7.987066 | -8.223126 | ARDL(1,0,0,0,1) |
| 4 | 120.139797 | -8.306652 | -7.922700 | -8.192483 | ARDL(1,1,1,0,0) |
| 16 | 117.509281 | -8.259947 | -7.971983 | -8.174320 | ARDL(1,0,0,0,0) |
| 11 | 119.364324 | -8.249209 | -7.865258 | -8.135040 | ARDL(1,0,1,0,1) |
| 12 | 117.621263 | -8.194168 | -7.858210 | -8.094270 | ARDL(1,0,1,0,0) |




**Source:** Prepared by the researcher based on the outputs of Eviews13.

**4: Results of the Bound Test for Co-integration (The Bound Test Approach to Co-intégration)**

To verify whether there is a long-run equilibrium relationship between the main factors that affect tax collection (LRCF)—namely tax incentives (LAF), tax pressure (PF), tax base (LPBH), and trade openness (OC)—the Bound Test was used. The co-integration relationship is tested through two hypotheses (Remache & Slimane, 2024, p.539-540):

Null hypothesis: There is no co-integration relationship.

Alternative hypothesis: There is a co-integration relationship.

This test is conducted by comparing the Fisher statistic with the critical values proposed by **Pesaran and Al (2001)**. If:

- Fupper critical < Fcal: the null hypothesis is rejected, and the alternative hypothesis is accepted, meaning there is co-integration.
- Fupper critical > Fcal: the null hypothesis is accepted, meaning there is no co-integration.
- Fupper value > Fcal > Flower critical: the test result is inconclusive (the zone of doubt).

The following table shows the results of the Bound Test:

**Table No. (05): Results of the Bound Test (The Bound Test)**

⊟ Bounds Test

Null hypothesis: No levels relationship
Number of cointegrating variables: 4
Trend type: Rest. constant (Case 2)
Sample size: 27

| Test Statistic | Value |
|---|---|
| F-statistic | 464.333805 |

⊟ Bounds Critical Values

| | 10% | | 5% | | 1% | |
|---|---|---|---|---|---|---|
| Sample Size | I(0) | I(1) | I(0) | I(1) | I(0) | I(1) |
| 30 | 2.525 | 3.560 | 3.058 | 4.223 | 4.280 | 5.840 |
| Asymptotic | 2.200 | 3.090 | 2.560 | 3.490 | 3.290 | 4.370 |

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

**Source:** Prepared by the researcher based on the outputs of Eviews13.

The results of the table above showed that the calculated Fisher statistic value (F = 464.33) is greater than both the lower and upper critical values at the statistical significance levels of 1%, 2.5%, 5%, and 10%. Therefore, the alternative hypothesis is accepted, meaning that there exists a long-run equilibrium relationship between the independent variables and the tax collection (LRCF) as the dependent variable.

**5: Estimation of the ARDL Model**

Using the stepwise regression model, the optimal model that ensures the significance of the independent variables was obtained, as shown in the following table:

**Table No. (06): Results of the ARDL Model Estimation**

Dependent Variable: LRCF
Method: ARDL
Date: 03/11/24 Time: 09:37
Sample: 1996 2022
Included observations: 27
Dependent lags: 1 (Automatic)
Automatic-lag linear regressors (1 max. lags): LPBH OC_ LAF PF_
Deterministics: Restricted constant and no trend (Case 2)
Model selection method: Akaike info criterion (AIC)
Number of models evaluated: 16
Selected model: ARDL(1,1,0,1,0)

| Variable | Coefficient | Std. Error | t-Statistic | Prob.* |
|---|---|---|---|---|
| LRCF(-1) | 0.061597 | 0.029594 | 2.081411 | 0.0512 |
| LPBH | 0.951240 | 0.027732 | 34.30066 | 0.0000 |
| LPBH(-1) | -0.035211 | 0.021111 | -1.667867 | 0.1117 |
| OC_ | 0.002991 | 0.000787 | 3.802615 | 0.0012 |
| LAF | 0.003449 | 0.004257 | 0.810181 | 0.4279 |
| LAF(-1) | 0.007993 | 0.004266 | 1.873690 | 0.0764 |
| PF_ | 0.028983 | 0.000840 | 34.51724 | 0.0000 |
| C | -1.151540 | 0.039408 | -29.22132 | 0.0000 |

| | | | |
|---|---|---|---|
| R-squared | 0.999947 | Mean dependent var | 3.034361 |
| Adjusted R-squared | 0.999927 | S.D. dependent var | 0.363010 |
| S.E. of regression | 0.003102 | Akaike info criterion | -8.472377 |
| Sum squared resid | 0.000183 | Schwarz criterion | -8.088425 |
| Log likelihood | 122.3771 | Hannan-Quinn criter. | -8.358208 |
| F-statistic | 50865.08 | Durbin-Watson stat | 1.949270 |
| Prob(F-statistic) | 0.000000 | | |

*Note: p-values and any subsequent test results do not account for model selection.

**Source:** Prepared by the researcher based on the outputs of Eviews13.

The results of Table No. (06) indicate the following:

- **Partial Significance:** From the results of the t-test (Student test), it appears that all variables are significant at a 5% level (since the probability value *Prob* is less than 5%), in addition to the significance of the constant term.
- **Explanatory Power:** The value of the determination coefficient is R2=0.9999R^2 = 0.9999R2=0.9999, which means that the variables tax incentives (LAF), tax pressure (PF), tax base (LPBH), and trade openness (OC) together explain 99.99% of the variation in tax collection. The remaining percentage is due to other factors not included in the model.
- **Overall Significance:** The calculated Fisher value F-statistic=1156.97F\text{-statistic} = 1156.97F-statistic=1156.97 is significant (*P = 0.000* less than 5%). This means that the model has overall significance and can be relied upon in analyzing the relationship between the studied variables.

**6: Diagnostic Tests of the Model:**

To ensure the quality of the estimated model and verify the absence of econometric problems, the following tests were conducted:

- **Autocorrelation Test:**

**Table (07): Results of the Autocorrelation Test**

Breusch-Godfrey Serial Correlation LM Test:
Null hypothesis: No serial correlation at up to 2 lags

| | | | |
|---|---|---|---|
| F-statistic | 0.292593 | Prob. F(2,17) | 0.7500 |
| Obs*R-squared | 0.898485 | Prob. Chi-Square(2) | 0.6381 |

**Source:** Prepared by the researcher based on Eviews13 outputs.

The results of the autocorrelation test showed that the probability value of the calculated Fisher test (F-statistic) is greater than the 5% significance level; thus, we accept the null hypothesis, meaning that the model does not suffer from the problem of autocorrelation between random errors.

**7: Heteroskedasticity Test:**

**Table (08): Results of the Heteroskedasticity Test**

Heteroskedasticity Test: Breusch-Pagan-Godfrey
Null hypothesis: Homoskedasticity

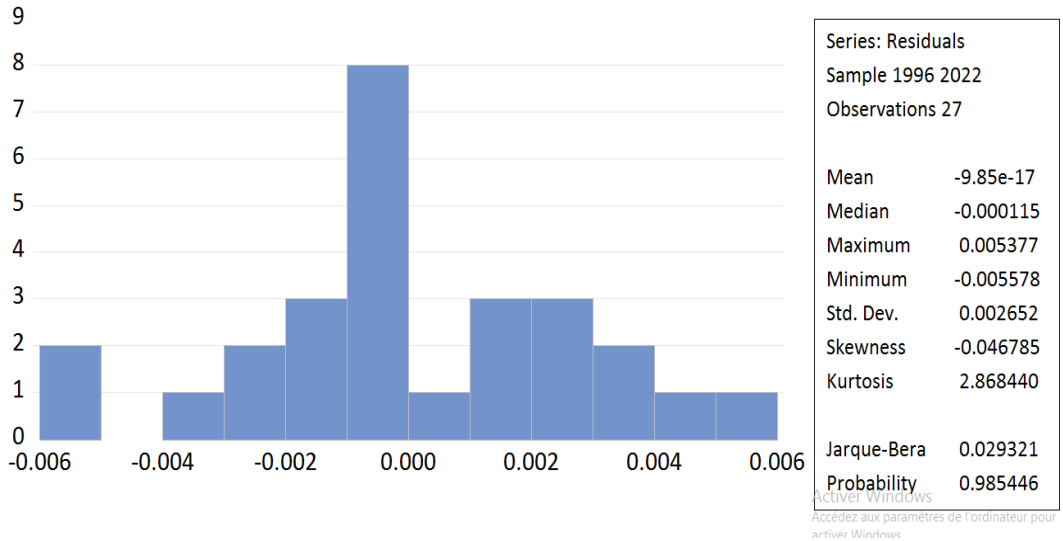
| | | | |
|---|---|---|---|
| F-statistic | 1.706722 | Prob. F(7,19) | 0.1672 |
| Obs*R-squared | 10.42330 | Prob. Chi-Square(7) | 0.1658 |
| Scaled explained SS | 4.822078 | Prob. Chi-Square(7) | 0.6817 |

**Source:** Prepared by the researcher based on Eviews13 outputs.

The results of the heteroskedasticity test indicate that the probability value of the calculated Fisher test (F-statistic) is greater than the 5% significance level; therefore, we accept the null hypothesis, which means that the model does not have the problem of non-constant variance in the errors.

- **Residual Normality Test:**

**Figure (02): Results of the Normal Distribution Test of Residuals**




**Source:** Prepared by the researcher based on Eviews13 outputs.

The results of the residual normality test reveal that the probability of the Jarque-Bera statistic is greater than the 5% significance level, therefore we accept the null hypothesis, which means that the residuals follow the normal distribution.

**8: Estimation of the Error Correction Model and the Short- and Long-Run Relationship**

After confirming the existence of a long-run equilibrium relationship between tax incentives (LAF), tax pressure (PF), tax base (LPBH), trade openness (OC), and tax collection, it becomes possible to estimate the error correction model and the short- and long-run relationship.

- **Error correction term and short-run relationship**

**Table No. (09): Estimation of the Error Correction Model and the Short-Run Relationship**

Dependent Variable: D(LRCF)
Method: ARDL
Date: 03/11/24 Time: 09:37
Sample: 1996 2022
Included observations: 27
Dependent lags: 1 (Automatic)
Automatic-lag linear regressors (1 max. lags): LPBH OC_ LAF PF_
Deterministics: Restricted constant and no trend (Case 2)
Model selection method: Akaike info criterion (AIC)
Number of models evaluated: 16
Selected model: ARDL(1,1,0,1,0)

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| COINTEQ* | -0.938403 | 0.015819 | -59.32252 | 0.0000 |
| D(LPBH) | 0.951240 | 0.012477 | 76.24058 | 0.0000 |
| D(LAF) | 0.003449 | 0.002290 | 1.506165 | 0.1451 |

| | | | |
|---|---|---|---|
| R-squared | 0.992436 | Mean dependent var | 0.040726 |
| Adjusted R-squared | 0.991806 | S.D. dependent var | 0.030490 |
| S.E. of regression | 0.002760 | Akaike info criterion | -8.842747 |
| Sum squared resid | 0.000183 | Schwarz criterion | -8.698765 |
| Log likelihood | 122.3771 | Hannan-Quinn criter. | -8.799934 |
| F-statistic | 1574.545 | Durbin-Watson stat | 1.949270 |
| Prob(F-statistic) | 0.000000 | | |

* p-values are incompatible with t-Bounds distribution.

**Source:** Prepared by the researcher based on the outputs of Eviews13.

- **Error corection term:**

The error correction coefficient has a value of CointEq(-1) = (0.9384), and it is statistically significant (P = 0.00000) at the 5% level with a negative sign (-), which indicates the validity of the error correction model and confirms the existence of a co-integration relationship between the variables included in the model. This parameter value also indicates that it is the coefficient of the speed of error correction, meaning that when the tax collection variable deviates or is disturbed in the short run from its equilibrium value in period (t-1), this deviation will be corrected in period (t) by 93.84%.

- **Short-run relationship:**The results of the estimation of the short-run relationship showed the following:

– There is no statistically significant relationship between tax incentives (LAF) and tax collection (LRCF) in the short run, because the probability value *Prob* is greater than 5%; this is consistent with economic theory, due to the fact that full exemptions are granted on most taxes and fees related to any economic activities throughout the period of activity from the beginning of the project until the start of operation. Under these incentives, investors benefit from a full exemption from the value-added tax during the implementation period, then the exemptions from taxes and fees during the exploitation period range between three and ten years.

– The tax base variable (LPBH) has a positive and significant effect on tax collection (LRCF) in the short run, where an increase of 1% in the tax base (LPBH) leads to an increase in tax collection (LRCF) by 0.95124%; this is in line with economic theory, since it is an established fact that any increase affecting the tax base will appear in tax revenues. This is under the assumption that it is fully collected without evasion or fraud during the determination of the tax bases, which is what appears from the model.

- **Long-run relationship:**

**Table No. (10): Estimation of the Long-Run Relationship**

Cointegrating Specification

Deterministics: Rest. constant (Case 2)

CE = LRCF(-1) - (0.976157*LPBH(-1) + 0.003187*OC_ + 0.012192*LAF(-1) + 0.030886*PF_ - 1.227128)

Cointegrating Coefficients

| Variable * | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| LPBH(-1) | 0.976157 | 0.003716 | 262.6957 | 0.0000 |
| OC_ | 0.003187 | 0.000843 | 3.779064 | 0.0010 |
| LAF(-1) | 0.012192 | 0.004924 | 2.476276 | 0.0214 |
| PF_ | 0.030886 | 0.000975 | 31.66431 | 0.0000 |
| C | -1.227128 | 0.011682 | -105.0464 | 0.0000 |

Note: * Coefficients derived from the CEC regression.

**Source:** Prepared by the researcher based on the outputs of Eviews13.

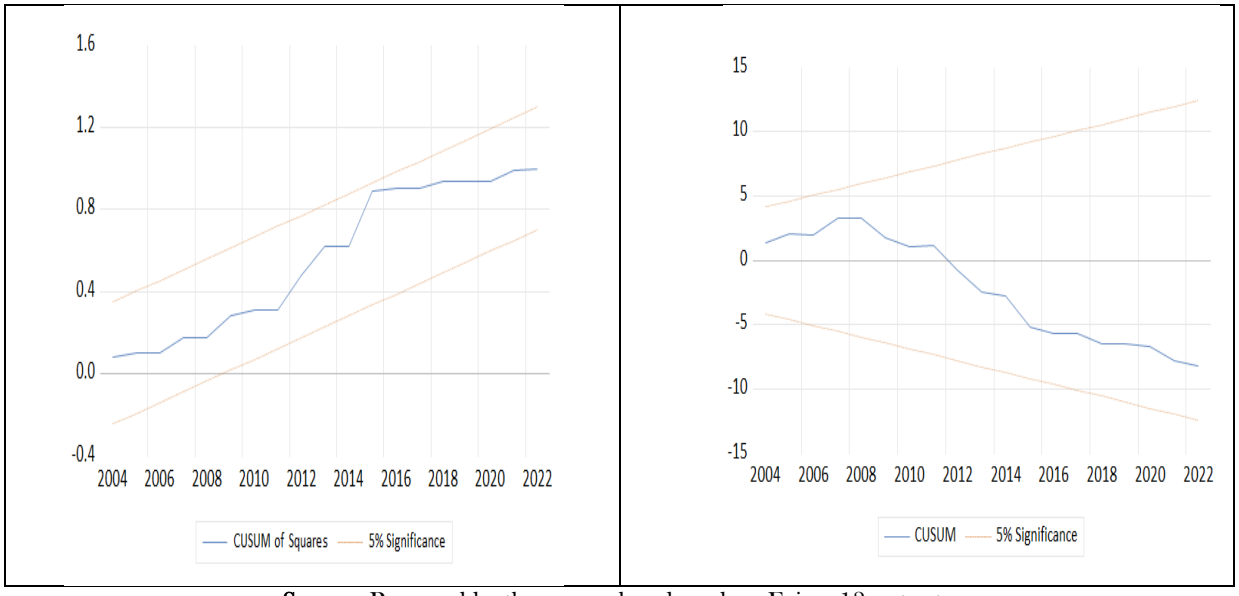
The long-run relationship can be expressed in the following form:
EC = LRCF - (0.012192*LAF(-1)* + *0.030886*PF + 0.976157*LPBH(-1)* + *0.003187*OC - 1.227128)

- The variable of fiscal advantages (LAF) affects positively and significantly the tax revenues (LRCF) in the long run, where an increase of 1% in fiscal advantages (LAF) leads to an increase of 0.012192% in tax revenues (LRCF). This result is consistent with the economic theory, since the main objective behind granting fiscal advantages is to encourage investment and guarantee new taxable bases, which, in the future, increase the revenues of the state treasury. However, despite the positive impact of fiscal advantages on tax collection, this effect remains weak when compared to the cost of such fiscal advantages.
- The variable of fiscal pressure (PF) affects positively and significantly the tax revenues (LRCF) in the long run, where an increase of 1% in fiscal pressure (PF) leads to an increase of 0.0308% in tax revenues (LRCF). This result, however, contradicts with the economic theory which states that when the rate of fiscal pressure exceeds certain levels, it can reduce the state's fiscal revenues. The optimal rate is estimated around 25%. What could explain this positive and significant relation in Algeria between fiscal pressure and tax collection in the long term is the fact that fiscal pressure levels improved through the years without exceeding the optimal limit of 25%, which made its impact positive on tax revenues.
- The variable of taxable base (LPBH) affects positively and significantly the tax revenues (LRCF) in the long run, where an increase of 1% in taxable base (LPBH) leads to an increase of 0.976157% in tax revenues (LRCF). This is consistent with the economic theory, which states that when the GDP per capita increases – representing the taxable base of the taxpayer upon whom taxes are imposed – income and expenditure taxes tend to rise more. This confirms that the measures aiming to broaden the taxable bases and seek new ones have a positive and significant effect on fiscal revenues, and they are better than measures that keep the old tax bases while merely raising tax and fee rates.
- The variable of trade openness (OC) affects positively and significantly the tax revenues (LRCF) in the long run, where a 1% increase in trade openness (OC) leads to an increase of 0.003187% in tax revenues (LRCF). This finding aligns with some previous studies, as removing customs barriers and facilitating trade flows contributed to the rise of tax revenues in the long term, as a result of the expected expansion in import demand.

**9: Structural Stability:**

To verify the structural stability of the ARDL model parameters, we used the CUSUM test (Cumulative Sum of Recursive Residuals) and the CUSUM of Squares test (Cumulative Sum of Squares of Recursive Residuals). The results are illustrated in the following figures:

| Figure (04): Cumulative sum of squares of recursive residuals | Figure (03): Cumulative sum of recursive residuals |
|---|---|




**Source:** Prepared by the researcher, based on Eviews13 outputs.

We notice from the graphical representation that the form of the CUSUM and CUSUM of Squares tests shows two central lines within the confidence bounds at a 5% significance level, which indicates the existence of structural stability in the estimated model during the study period.

**Conclusion:**

This study aimed to clarify the effect of the most important economic variables determining non-hydrocarbon tax revenues in Algeria during the period from 1995 to 2022, by using the ARDL model.

- The results of the regression model showed that the optimal combination that achieves significance includes the variables of fiscal advantages, fiscal pressure, taxable base, and trade openness, which represent the main determinants of tax collection.
- To increase tax collection volume, it is necessary to reduce the scope of informal activity and fight tax evasion in order to broaden the taxable bases. An increase of 1% in the taxable base leads to an increase of 0.95% in tax collection, which highlights the importance of fiscal control measures against tax evasion.
- Despite the positive long-term effect of fiscal advantages on tax collection, where an increase of 1% in these advantages leads to an increase of 0.012% in tax collection, this rate remains low throughout the study period when compared to the cost of the fiscal advantages relative to regular tax revenues.
- The Algerian tax system needs to be reactivated in order to improve the levels of fiscal pressure, to reach the optimal range or at least similar ratios to neighboring countries, because any increase of 1% in fiscal pressure leads to an increase of 0.030% in tax collection.

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