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Impact of digitalization on tax revenue collection in Algeria: An empirical study for the period 2014–2024

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Abstract---This study aims to measure the impact of digitalization on tax revenue collection in Algeria over the period 2014–2024. In the theoretical part of the study, we addressed the fundamental concepts related to the study variables, expressed as digitalization and tax revenue collection. An empirical investigation was then conducted using the Autoregressive Distributed Lag (ARDL) model, due to its ability to examine dynamic relationships between variables in both the short and long run. Tax revenue collection was considered the dependent variable, while digitalization served as the independent variable through: the number of automated machines, the information and communication technology (ICT) usage index, and the number of hours required for tax payment. Additionally, economic growth, total public tax revenues, and petroleum tax revenues were included as control variables. The study revealed several key findings, most notably the existence of a positive and significant relationship between digitalization and tax revenue collection in both the short and long run, except for the tax payment hours indicator in the long run. This confirms that advancements in technological infrastructure contribute to improving the efficiency of the tax system, reducing compliance gaps, and decreasing the hours required for tax payment. Moreover, the results indicated that the Error Correction Model (ECM) coefficient is negative and significant, estimated at –0.42, suggesting that approximately 42% of short-term deviations are corrected annually toward long-term equilibrium. This reflects the presence of a stable equilibrium relationship between the variables under study and confirms that digitalization represents a fundamental pillar for enhancing tax revenue collection in Algeria, thereby ensuring fiscal sustainability and diversifying revenue sources beyond petroleum taxation.

Keywords---Digitalization, Tax Revenue Collection, Technological Infrastructure, Fiscal Sustainability, Petroleum Taxation.

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Introduction

Digitalization is considered one of the most significant contemporary trends, receiving substantial attention from various governmental and private entities. It has become an urgent necessity to keep pace with the modern technological transformations occurring worldwide.

In this context, Algeria has embarked on implementing a series of reforms aimed at promoting and generalizing digitalization across all sectors, particularly the public sector, since 2013. The tax sector is among the most affected by digitalization due to its central role in financing the state budget and achieving social justice. Digitalization has had a notable and positive impact on tax administration, enhancing all its operations and services, improving work methods, and reinforcing the principles of transparency, efficiency, and tax compliance.

Tax revenue collection constitutes the core of the tax process and represents the optimal means of funding the state treasury. Its main objective is to collect all tax obligations from taxpayers on behalf of the public treasury through a set of legal, administrative, organizational, and mandatory procedures. Public authorities have realized that effective tax collection can only be achieved through an efficient digital administrative system that simplifies tax declaration and payment processes and strengthens taxpayers' trust in the tax administration. Among the most significant efforts by the tax administration are the adoption of electronic portals and platforms such as DJIBAAYTIC, Mousahamatek, and Tabaikum, with the activation of electronic payment processes, enabling efficient tax collection and achieving the desired tax compliance.

Research Problem:
Given the active role that digitalization currently plays across all sectors in Algeria, particularly in tax administration, to enhance its services and increase tax revenue, this study raises the following main research problem:
How does digitalization affect tax revenue collection in Algeria?
From this main problem, the following sub-questions are derived:

1. What is the nature of the relationship between digitalization indicators and tax revenue collection in Algeria for the period 2014–2024?
2. What is the strength and direction of the effect exerted by digitalization indicators on tax revenue collection in Algeria in the short and long run during the period 2014–2024?

Research Hypotheses:
Based on the research problem outlined above, the following main hypotheses are proposed:
The development of digitalization indicators in Algeria has significantly contributed to the activation of tax revenue collection.
The following subsidiary hypotheses stem from this hypothesis*:*

1. There exists a long-term cointegrated relationship between digitalization indicators and tax revenue collection in Algeria for the period 2014–2024.
2. Digitalization indicators have a significant effect on tax revenue collection in Algeria in both the short and long run for the period 2014–2024.

Study Objectives:
Our study focuses on the role played by digitalization in enhancing tax revenue collection, highlighted through the following steps:

- Identifying the most important digitalization indicators in Algeria.
- Determining the effective role of tax revenue collection in ensuring the financing of the general budget.

- Examining the nature of the relationship between digitalization and tax revenue collection.
- Assessing the impact of relying on digitalization on tax revenue levels during the period 2014–2024.

Research Methodology:
This study relies on two methodologies. First, the descriptive approach was used to address the fundamental concepts of the study variables, expressed as digitalization and tax revenue collection. Second, the quantitative empirical approach was adopted in the applied study. This scientific method relies on quantitative analysis of economic relationships, allowing us to analyze the relationship between digitalization indicators and tax revenue collection using statistical and econometric models, with the aim of testing the validity of the hypotheses empirically and determining the magnitude of their effects.

Theoretical Study:
1. Digitalization:
Digitalization has become a driving force that has transformed the structure of the world, making it resemble a small village thanks to the rapid development of information and communication technologies (ICT). This technological progress has contributed to profound changes in various forms of interactions, which have become faster, less costly, and more efficient, leaving a noticeable impact across all sectors and domains without exception.

1.1 **Concept of Digitalization**:
Several scholars and institutions have addressed the concept of digitalization. Among them:

- Digitalization is defined as: "the integration of digital technology into the business world, representing a fundamental change in the way value is created and delivered to customers, and a cultural shift that requires organizations to constantly challenge the status quo" (Yahiaoui & Korbasi, 2019, p. 148).
- It is also defined as: "a governmental project encompassing all services of institutions and various state sectors, involving the transformation of essential services related to individuals, organizations, and investments from their traditional form to smart electronic form, based on modern and advanced technologies" (Mendoura, 2021, p. 12).

From the above, digitalization can be defined as: "a process based on the use of information and communication technology (ICT) to transform information, operations, and services of all kinds from their traditional paper-based form into digital form, aiming to improve speed, efficiency, and cost-effectiveness."

1.2 **Characteristics of Digitalization**:
Digitalization possesses several characteristics that distinguish it from other modern technological and administrative processes, as it reshapes working methods. These include:

- **Transformative**: Digitalization is based on converting all traditional processes into digital ones using the latest ICT to enhance efficiency, reduce errors, lower costs, and deliver rapid results.
- **Flexible:** Digitalization is flexible in terms of easy modification, scalability, adaptability to different circumstances, and responsiveness to all market needs with minimal risk (Karini, 2020, p. 475).
- **Interactive:** Digitalization enables rapid interaction among various stakeholders, facilitating the provision of information easily, smoothly, and in a timely manner through digital platforms, communication channels, software, and other tools.
- **Analytical:** Digitalization is characterized by its analytical dimension, relying on advanced data analysis techniques and artificial intelligence (AI) to process information with maximum accuracy and speed.

- **Innovative:** Digitalization is inherently linked to innovation, acting as a major driver of innovation by leveraging modern digital technologies (Mohamed Walaa, 2018, p. 08).

Therefore, digitalization is distinguished by its ability to fully convert data from traditional to digital formats, ensure rapid interaction and communication, adapt flexibly to changes, rely on advanced data analysis techniques, and act as a key driver of innovation.

1.3 Objectives of Digitalization:

Digitalization aims to achieve several objectives, including:

- **Improving service quality:** Digitalization seeks to enhance the quality of services provided across all sectors by offering easy access to relevant information and services (Abdelghani, 2022, p. 45).
- **Promoting economic development:** Digitalization significantly contributes to economic development by creating new business opportunities and service delivery methods, continuously supporting innovation, and facilitating all aspects of investment procedures, thereby reinforcing economic growth (Deloitte, 2016, p. 4).
- **Enhancing communication:** Digitalization aims to make the world a "small village," fostering more interactive and participatory communities by facilitating and accelerating communication processes.
- **Attracting customers:** Digitalization helps attract more customers and maintain good, continuous relationships by effectively and smoothly meeting their needs (Abdelghani, 2022, p. 46).
- **Reducing the digital divide:** Digitalization seeks to enable all communities, regardless of geographic location or development level, to access and rely on information technology in all their operations.
- **Promoting innovation:** Digitalization creates an environment that encourages continuous innovation and development (Karini, 2020, p. 470).
- **Enhancing governance:** Digitalization aims to strengthen governance by improving management processes and transparency through providing accurate and accessible information.
- **Ensuring information security:** Digitalization works to protect data and information to the greatest extent possible and ensure compliance with legal frameworks.

1.4 Digitalization Indicators:

Digitalization can be expressed through various indicators, the most important of which include (OECD, 2020):

- **Infrastructure indicators:** Measure digital readiness at the level of governments, institutions, and other entities, including the availability and speed of internet (fixed and mobile), quality and coverage of communication networks, availability and modernity of digital devices such as ATMs, information security level, adoption of modern and efficient communication systems, reliance on cloud computing, and the ability to bear infrastructure costs.
- **Digital skills indicators:** Focus on users' ability to utilize ICT (computers, programming, artificial intelligence), including their skill level, training received, awareness culture, and innovation capabilities.
- **Digital technology usage in business indicators:** Measure the extent to which digital technology is applied in daily operations, such as the adoption of Enterprise Resource Planning (ERP) systems, Customer Relationship Management (CRM) systems, cloud services, e-commerce, big data and artificial intelligence, and cybersecurity practices.
- **Digital services indicators:** Measure the degree of digitalization in the public sector, including reliance on digital government services instead of traditional ones, availability of

open government data, and the maturity of digital public services in terms of ease of use and quality, such as reducing tax payment hours.

- **Digital innovation indicators:** Reflect investments by governments and institutions in digitalization, including the adoption of the latest technologies, development of new digital products and services, institutional flexibility in responding to changes, and continuous adoption of innovative business models.

2. Tax Revenue Collection:

Tax revenue collection is one of the main pillars for financing the general budget in Algeria, as it represents the primary source of public revenue enabling the state to implement development programs and provide public services. Given the rapid economic transformations and the growing needs of the state, tax revenue collection now requires continuous modernization and greater attention than before.

2.1 Concept of Tax Revenue Collection:

Several scholars have sought to provide a comprehensive definition of tax revenue collection, among the most important are:

- Tax revenue collection is defined as: "a set of administrative and technical procedures through which the value of the tax is transferred from the taxpayer's ownership to the ownership of the public treasury" (Beltmane, 1997, p. 45).
- It is also defined as: "a set of procedures aimed at transferring the tax liability from the taxpayer to the tax collection offices of the provincial tax directorate, which then forwards it to the central public treasury, in accordance with applicable legal and regulatory rules. The process is carried out either in cash or through equivalent instruments such as bank drafts, postal checks, or deductions" (Mabarki, 2021, p. 1076).

Accordingly, tax revenue collection can be defined as: "the process through which taxpayers discharge their obligations to the tax administration by paying their due taxes and fees to the public treasury."

2.2 Objectives of Tax Revenue Collection:

Tax revenue collection aims to achieve the following objectives:

- Provide the necessary tax revenues, which are among the most important financial resources for the state.
- Finance the state treasury and prevent reliance on external borrowing, thereby preserving the sovereignty of the state.
- Support economic development by directing tax revenues to infrastructure projects, local development, and support for emerging enterprises.
- Ensure societal welfare, development, and stability.
- Achieve tax justice by collecting all dues voluntarily or compulsorily.
- Improve public financial governance by increasing transparency, resource efficiency, and monitoring expenditures.
- Support the move toward digitalization.

Therefore, tax collection seeks to achieve multiple objectives, including financial objectives through funding expenditures and encouraging investment, and social objectives by ensuring social justice and promoting economic development through proper allocation of revenues.

2.3 Methods of Tax Revenue Collection:

The tax administration relies on several methods for tax revenue collection, including:

- **Direct Payment Method:** This method represents the general case of collection, where the taxpayer voluntarily pays the tax without delay by submitting the required tax declarations within the stipulated deadlines (Mahrazi, p. 259). The tax administration may also notify the taxpayer of the tax amount and payment deadlines, allowing them to pay voluntarily, a process

known as voluntary compliance. This method reduces collection costs and avoids penalties, and societies employing this method usually exhibit high tax awareness.

- **Advance Installments Method:** This method ensures continuous revenue for the state treasury and facilitates tax payments for the taxpayer. Instead of paying in a single lump sum, the taxpayer pays in multiple installments throughout the year. This method is based on the principle that the taxpayer estimates the installments and pays them on specified dates (Deraz & Hijazi, 2004, p. 107). The tax administration then reconciles the tax liability, requiring the taxpayer to pay any remaining balance or refund any excess, or carry forward the advance for subsequent years.
- **Withholding at Source Method:** This method involves deducting the tax at its primary source by legally authorized entities and remitting it to the tax administration on behalf of the taxpayer (Ali, 2009, p. 176). For example, companies may be legally required to withhold taxes and remit them within the specified deadlines, ensuring timely payment, reducing tax evasion, and lowering collection costs.
- **Tax Collection Certificate Method:** This method involves sending taxpayers detailed schedules of the taxes to be collected, deadlines, and related penalties. This method is considered labor-intensive and costly for the tax administration.

In conclusion, there are multiple tax collection methods aimed at simplifying the transfer of tax obligations from taxpayers to the public treasury.

Empirical Study:

Modern economic studies rely on employing statistical methods and tools to analyze the relationships between various economic variables. This approach aims to achieve precise results that provide a deep understanding of the phenomena under study, both in the short and long term (Frohn, 2006, p. 3). These methods also enable the analysis of the mutual interactions between variables, contributing to informed economic decision-making based on rigorous and objective scientific foundations. In this context, the Autoregressive Distributed Lag (ARDL) model will be adopted, as it is one of the most suitable econometric models for measuring the impact of digitalization on tax revenue collection in Algeria in both the long and short run, due to its flexibility in handling time series with different orders of integration.

1. Data Sources, Variables, and Study Model:

1.1 Data Sources:

The study data were obtained from the World Bank database and the National Office of Statistics of Algeria (ONS) for the period 2014–2024.

1.2 Study Sample:

The study sample is represented by the country of Algeria.

1.3 Methodology and Tools:

This study aims to analyze the impact of digitalization on tax revenue collection in Algeria during the period 2014–2024 by identifying the key variables of the economic model under study. Tax revenue collection represents the dependent variable, while digitalization constitutes the main independent variable, measured through three indicators: the number of Automated Teller Machines (ATM), the ICT Usage Index (TUI), and Tax Payment Hours (TPH).

The model also includes a set of control variables, namely: Economic Growth (GDP), Total Public Tax Revenue (GR), and Oil Tax Revenue (OPR). These variables were selected based on economic literature, relevant theories, and previous studies examining the relationship between digitalization and tax revenue collection, taking into account the specifics of the Algerian economy and the recent integration of digitalization into the national tax system.

The study relies on quarterly data for the period 2014–2024, extracted from the World Bank and the National Office of Statistics (ONS). The model will be estimated and its statistical adequacy tested using EViews 13, based on a linear regression model formulated according to economic theory principles. This approach aligns with the nature of the variables under study and their hypotheses, aiming to interpret the factors affecting tax revenue collection within the framework of modern digitalization.

1.4 Model Estimation

We obtain the Autoregressive Distributed Lag (ARDL) model and the following equation related to the dependent variable of tax revenue collection as follows:

TDR=f (GDP, GR, OPR, ATM, TUI, TPH) T=2014Q4−2024Q4

Accordingly, the proposed model equation in its explicit form and linear structure, after introducing the logarithm, is as follows:

$$\Delta LTDR_t = B_0 + \sum B_1 \Delta L\,TDR_{t-1} + \sum B_2 \Delta\,LGDP_{t-1} + \sum B_3 \Delta\,LGR_{t-1} + \sum B_4 \Delta\,LOPR_{t-1} + \sum B_5 \Delta\,LATM_{t-1} + \sum B_6 \Delta\,LTUI_{t-1} + \sum B_7 \Delta\,LPTH_{t-1} + \alpha_1 \Delta L\,TDR_{t-1} + \alpha_2 \Delta\,LGDP_{t-1} + \alpha_3 \Delta\,GR_{t-1} + \alpha_4\,LOPR_{t-1} + \alpha_5 \Delta\,ATM_{t-1} + \alpha_{6\Delta} lTUI + \alpha_{6\Delta} + lPTH + \varepsilon_t.$$

Where:

- Δ : refers to first-difference operators.
- Pq : represents the upper bound of the lag length for the dependent and independent variables in the model.
- B1, B2, B3, B4, B5, B6, B7 : represent the short-run relationship coefficients (Error Correction Model).
- α1, α2, α3, α4, α5, α6, α7 : represent the long-run relationship coefficients.
- (LTDR) : logarithm of direct tax revenue collection.
- (LGDP) : logarithm of economic growth (control variable).
- (LGR) : logarithm of general tax revenues (control variable).
- (LOPR) : logarithm of petroleum taxation (control variable).
- (LATM) : logarithm of the number of automated teller machines.
- (LTUI) : logarithm of the technology use index.
- (LTPH) : logarithm of tax payment hours.

2. Application of the ARDL Model

To apply the ARDL methodology, the following steps are followed:

- Conduct unit root tests for the time series.
- Test the optimal lag lengths of the model.
- Estimate the optimal lag lengths of the model.
- Estimate the ARDL model.
- Perform the Bounds Test for cointegration of the ARDL model.
- Estimate the long-run relationship.
- Conduct model diagnostic tests.
- Estimate the short-run relationship within the Error Correction Model framework.

2.1. Unit Root (Stationarity) Test for Time Series

The unit root test for time series is based on verifying the presence or absence of a Unit Root, as the existence of such a root indicates that the series is non-stationary, which may lead to spurious regression results in econometric analysis.

To verify the property of stationarity, several tests are used, the most important of which are the Augmented Dickey–Fuller Test (ADF) and the Phillips–Perron Test (PP) (Dickey, 1979, pp. 427–431). The optimal lag length was determined and the stationarity was tested using the EViews software.

The tests were conducted on three models:

- Trend and Intercept Model
- Intercept-only Model
- None (no intercept, no trend)

According to the following hypotheses:

- **Null Hypothesis (H0):** Presence of a Unit Root
- **Alternative Hypothesis (H1):** Absence of a Unit Root

Table No (01): Unit Root Test Results Using Augmented Dickey–Fuller (ADF) Test

Variable	At Level			At First Difference			Order of Integration
	t-Statistic	Stationarity Result	Critical Values	t-Statistic	Stationarity Result	Critical Values	
LTDR	Trend and Intercept	-1.74 (0.71)	Non-stationary at 5%	Trend and Intercept	-6.45 (0.00)	Stationary at 1%	**I(1)**
	Intercept	-0.66 (0.84)	Non-stationary at 5%	Intercept	-6.52 (0.00)	Stationary at 1%	
	None	1.73 (0.97)	Non-stationary at 5%	None	-6.08 (0.00)	Stationary at 1%	
LGDP	Trend and Intercept	-1.91 (0.62)	Non-stationary at 5%	Trend and Intercept	-6.82 (0.00)	Stationary at 1%	**I(1)**
	Intercept	-0.13 (0.93)	Non-stationary at 5%	Intercept	-6.79 (0.00)	Stationary at 5%	
	None	1.71 (0.97)	Non-stationary at 5%	None	-6.40 (0.00)	Stationary at 1%	
LGR	Trend and Intercept	-2.04 (0.55)	Non-stationary at 5%	Trend and Intercept	-7.23 (0.00)	Stationary at 1%	**I(1)**
	Intercept	-2.30 (0.17)	Non-stationary at 5%	Intercept	-6.95 (0.00)	Stationary at 1%	
	None	1.91 (0.98)	Non-stationary at 5%	None	-6.40 (0.00)	Stationary at 1%	
LOPR	Trend and Intercept	-2.12 (0.52)	Non-stationary at 5%	Trend and Intercept	-6.31 (0.00)	Stationary at 5%	**I(1)**
	Intercept	-1.40 (0.56)	Non-stationary at 5%	Intercept	-6.39 (0.00)	Stationary at 1%	
	None	0.62 (0.84)	Non-stationary at 5%	None	-6.40 (0.00)	Stationary at 1%	
LTUI	Trend and Intercept	0.007 (0.99)	Non-stationary at 5%	Trend and Intercept	-7.92 (0.00)	Stationary at 1%	**I(1)**
	Intercept	-1.31 (0.61)	Non-stationary at 5%	Intercept	-7.37 (0.00)	Stationary at 1%	
	None	-1.31 (0.61)	Non-stationary at 5%	None	-6.40 (0.00)	Stationary at 5%	
LTPH	Trend and Intercept	-1.85 (0.65)	Non-stationary at 5%	Trend and Intercept	-6.62 (0.00)	Stationary at 1%	**I(1)**
	Intercept	-0.97 (0.28)	Non-stationary at 5%	Intercept	-6.46 (0.00)	Stationary at 1%	
	None	-0.97 (0.28)	Non-stationary at 5%	None	-6.40 (0.00)	Stationary at 1%	

Variable	At Level			At First Difference			Order of Integration
LATM	Trend and Intercept	-2.31 (0.41)	Non-stationary at 5%	Trend and Intercept	-6.49 (0.00)	Stationary at 1%	**I(1)**
	Intercept	-1.42 (0.55)	Non-stationary at 5%	Intercept	-6.40 (0.00)	Stationary at 1%	
	None	0.94 (0.90)	Non-stationary at 5%	None	-6.40 (0.00)	Stationary at 1%	

Source: Prepared by the researcher based on the outputs of EVIEWS 13.

The results of the Augmented Dickey–Fuller unit root test (ARDF – Augmented Dickey–Fuller) confirm that the time series of the study variables are non-stationary at level. The dependent variable becomes stationary at the first difference I(1), and the independent variables also become stationary at the first difference I(1). Therefore, we reject the null hypothesis H_0 stating the presence of a unit root and accept the alternative hypothesis indicating the absence of a unit root, at significance levels of 5% and 1%. Since all the study variables are stationary at the I(1) level, the Autoregressive Distributed Lag model (ARDL) will be applied, as it satisfies the condition that time series must be stationary either at level or at the first difference.

2.2. Optimal Lag Length Selection

Based on the Akaike Information Criterion (AIC), the optimal lag structure was determined. The model (1, 1, 1, 1, 1, 0, 1) was identified as the optimal specification, as illustrated in the following figure.

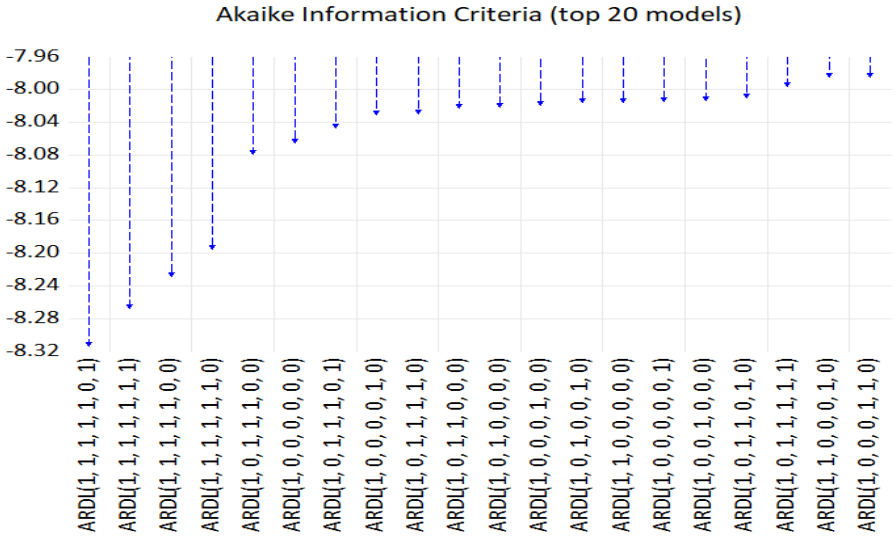

Figure No (01) : Results of Optimal Lag Length Test
Source: Prepared by the researcher based on the outputs of EVIEWS 13.

Based on the results presented above and relying on the Akaike Information Criterion (AIC) via EVIEWS, the optimal lag lengths for the study variables within the ARDL model were determined. The results indicate that the optimal model is (1, 1, 1, 1, 1, 0, 1), which achieved the lowest AIC value compared to the other proposed models. Accordingly, this model was adopted to estimate the short- and long-term relationships between the study variables, as it represents the most statistically efficient specification.

2. 3. Cointegration Bounds Test

To verify the existence of a long-term equilibrium relationship among the variables, the Bounds Test was applied. The table below presents the detailed results of this test, based on the following hypotheses:

- **Null hypothesis (H_0):** There is no cointegration relationship among the variables.
- **Alternative hypothesis (H_1):** There is a cointegration relationship among the variables.

Table No 02: Bounds Test

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic : n=1000	
F-statistic	7.517622	10%	1.99	2.94
K	6	5%	2.27	3.28
		2.5%	2.55	3.61
		1%	2.88	3.99
			Finite	
Actual Sample Size	39		Sample: n=40	
		10%	2.218	3.314
		5%	2.618	3.863
		1%	3.505	5.121
			Finite	
			Sample: n=35	
		10%	2.254	3.388
		5%	2.685	3.96
		1%	3.713	5.326

Source: Prepared by the researcher based on the outputs of EVIEWS 13.

The table above presents the results of the cointegration test using the Bounds Test methodology. The results indicate that the calculated F-statistic, equal to 7.51, exceeds the critical lower bound values at most significance levels (Pesaran, 2001, pp. 289–326). Accordingly, the null hypothesis, which states that there is no cointegration relationship among the variables, is rejected. This indicates the existence of a long-term equilibrium relationship between the independent variables and the dependent variable, tax revenue (TDR).

2.4. Estimation of the Proposed Model Parameters for the Dependent Variable (TDR)

After confirming the existence of a cointegration relationship among the variables, the following model was estimated:

Dependent Variable: LTDR
Method: ARDL
Date: 10/06/25 Time: 17:24
Sample (adjusted): 2014Q2 2023Q4
Included observations: 39 after adjustments
Maximum dependent lags: 1 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (1 lag, automatic): LGDP LGR LOPR LATM LTPH LTUI

Fixed regressors: C
Number of models evalulated: 64
Selected Model: ARDL(1, 1, 1, 1, 1, 0, 1)

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LTDR(-1)	0.577200	0.140339	4.112896	0.0003
LGDP	0.246362	0.030600	8.051060	0.0000
LGDP(-1)	-0.148739	0.047657	-3.121013	0.0044
LGR	0.588613	0.029501	19.95214	0.0000
LGR(-1)	-0.357714	0.090045	-3.972600	0.0005
LOPR	0.286164	0.012793	22.36842	0.0000
LOPR(-1)	-0.160801	0.040736	-3.947434	0.0005
LATM	0.252137	0.014919	16.90042	0.0000
LATM(-1)	-0.144646	0.038227	-3.783892	0.0008
LTPH	-0.024177	0.011152	-2.167914	0.0395
LTUI	-0.073604	0.021752	-3.383750	0.0023
LTUI(-1)	0.047279	0.024226	1.951588	0.0618
C	-0.046718	0.396901	-0.117708	0.9072

R-squared	0.999868	Mean dependent var	8.689032
Adjusted R-squared	0.999807	S.D. dependent var	0.239479
S.E. of regression	0.003328	Akaike info criterion	-8.311504
Sum squared resid	0.000288	Schwarz criterion	-7.756983
Log likelihood	175.0743	Hannan-Quinn criter.	-8.112547
F-statistic	163.9199	Durbin-Watson stat	1.793441
Prob(F-statistic)	0.000000		

Figure N0 02 : the Proposed Model Parameters for the Dependent Variable (TDR)
Source: Prepared by the researcher based on the outputs of EVIEWS 13

On the table above, the coefficient of determination (R^2) is estimated at 99.98%, which is acceptable and indicates that 99.98% of the variations in tax revenue (TDR) are explained by the independent variables. Furthermore, the F-statistic = 163.91 is significant and exceeds the critical table value, indicating that the model is statistically significant.

2. 5. Model Quality and Validity Tests

Relying on the ARDL (1.1.1.1.1.0.1) model for estimating short-term and long-term effects, it is necessary to verify the model's performance using a set of tests as follows:

2.5.1 Test for Autocorrelation (Breusch-Godfrey Correlation IM Test)

We will test for the presence of autocorrelation in the residuals, proposing the following hypotheses:

- **Null Hypothesis (H_0):** The residuals are not autocorrelated.
- **Alternative Hypothesis (H_1):** The residuals are autocorrelated.

Table No 03: Test breusch - Godfrrey Correlation lm test

Heteroskedasticity Test: Breusch-Pagan-Godfrey			
Null hypothesis: Homoskedasticity			
F-statistic	1.697777	Prob. F(12,26)	0.1255
Obs*R-squared	17.13398	Prob. Chi-Square(12)	0.1446
Scaled explained SS	22.46015	Prob. Chi-Square(12)	0.0327

Source: Prepared by the researcher based on the outputs of EVIEWS 13.

The above test indicates that the model does not suffer from heteroskedasticity, as the probability value (Prob. Chi-Square) is 0.14, which is greater than the significance level of 0.05. Therefore, we accept the null hypothesis, which states that the residuals are homoscedastic, and reject the alternative hypothesis.

2.5.2 Heteroskedasticity Test (ARCH)

Table No 04: Heteroskedasticity Test (ARCH)

Heteroskedasticity Test: ARCH

F-statistic	0.109452	Prob. F(1,36)	0.7427
Obs*R-squared	0.115183	Prob. Chi-Square(1)	0.7343

Source: Prepared by the researcher based on outputs from EVIEWS 13

The results of the heteroskedasticity test above show that the Prob. Chi-Square value reached 0.73, which is greater than 0.05. Accordingly, the null hypothesis can be accepted, indicating that the residuals are homoscedastic and that there is no heteroskedasticity problem in the model.

2.5.3 Normality Test of Residuals (Histogram-Normality Test)

Next, we conduct the normality test of the residuals, with the following hypotheses:

- **Null hypothesis (H_0):** The residuals are normally distributed.
- **Alternative hypothesis (H_1):** The residuals are not normally distributed.

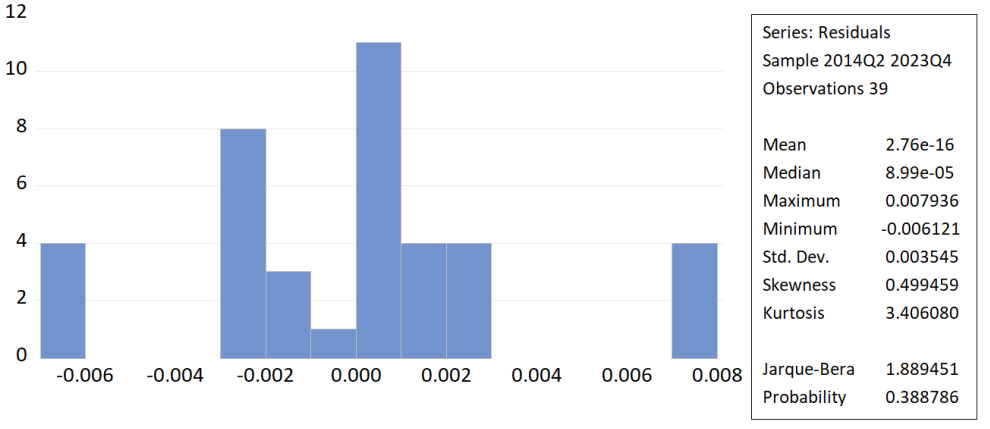

Figure No 03 : Normality Test of Residuals (Histogram-Normality Test)
Source: Prepared by the researcher based on outputs from EVIEWS 13

From the results of the normality test, we observe that the Prob Jarque–Bera value equals 0.38, which is greater than the significance level of 0.05. Therefore, the null hypothesis is accepted, indicating that the residuals do not violate the normality assumption and are normally distributed.

2.5.4 Stability Test:

The structural stability of the estimated model coefficients within the Error Correction Model (ECM), derived from the Autoregressive Distributed Lag (ARDL) model, is verified using the CUSUM and CUSUM of Squares (CUSUMSQ) tests proposed by Brown, Durbin, & Evans. These tests ensure that the data are free from structural breaks that could affect the stability of the model.

The figure below illustrates the results of the CUSUM and CUSUMSQ tests, showing the stability of the model's coefficients over the studied period.

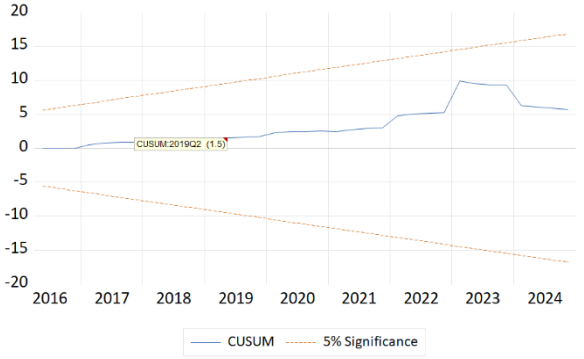

Figure No 04 : Results of the CUSUM Stability Test

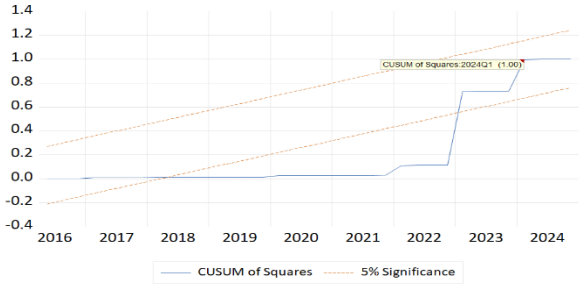

Figure No 05 : Results of the CUSUMSQ Stability Test
Source: Prepared by the researcher based on outputs from EVIEWS 13

From the two figures above, it is evident that the CUSUM and CUSUM of Squares statistics remain within the 5% critical bounds throughout the sample period. This indicates that the model's parameters are stable and that there is no evidence of structural breaks, thereby strengthening the credibility of the estimated results.

6. Estimation of the short- Term and long- Term relationships and the Error Correction Model (ECM):

The ECM incorporates the lagged error correction term, which measures the speed at which short-term deviations from long-term equilibrium are corrected. If the coefficient of the error correction term is negative and statistically significant at $p < 0.05$, it indicates the presence of a long-term equilibrium relationship between the variables. The absolute value of this coefficient represents the speed at which the system returns to equilibrium after a temporary short-term shock.

Interpretation of the Short -term relationship

The table above presents the estimation results of the Error Correction Model (ECM), which reflects the short-term relationship between the dependent variable and the independent variables included in the study

Table No 05 : Estimation of the Error Correction Model (ECM) for the Short-Term Relationship in the ARDL Model

ARDL Error Correction Regression
Dependent Variable: D(LTDR)
Selected Model: ARDL(1, 1, 1, 1, 1, 0, 1)
Case 2: Restricted Constant and No Trend
Date: 10/06/25 Time: 17:39
Sample: 2014Q1 2024Q4
Included observations: 39

ECM Regression
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LGDP)	0.246362	0.023044	10.69114	0.0000
D(LGR)	0.588613	0.021140	27.84315	0.0000
D(LOPR)	0.286164	0.009597	29.81659	0.0000
D(LATM)	0.252137	0.011540	21.84969	0.0000
D(LTUI)	0.073603	0.016925	4.348908	0.0002
CointEq(-1)*	-0.422800	0.107705	-3.925519	0.0006

.**Source: Prepared by the researcher based on outputs from EVIEWS 13**

The test results present the following insights:

- The Error Correction Term (ECM) coefficient is negative and statistically significant with cointeq(-1) = -0.42, reflecting the presence of a short-term equilibrium relationship between the study variables, adjusting toward long-term balance. This indicates that 42% of the short-term deviation can be corrected in the long term, confirming that the study variables are cointegrated.
- The economic growth variable (LGDP) shows a positive and statistically significant relationship with tax revenue at the 5% significance level. A 1% increase in economic growth leads to a 0.24% increase in tax revenue, highlighting the positive impact of economic activity on enhancing the state's capacity to mobilize tax resources in the short term.
- The general tax revenue variable (LGR) also shows a positive and significant relationship with tax revenue at the 5% significance level. A 1% increase in general tax revenue results in a 0.58% increase in tax collection, confirming the strong interdependence within the tax system and the effectiveness of fiscal policy in mobilizing resources in the short term.
- The oil taxation variable (LOPR) exhibits a positive and significant effect on short-term tax revenue at the 5% level. A 1% increase in oil taxation leads to a 0.28% rise in tax revenue, reflecting the critical role of oil revenues in Algeria's tax collection system. While this impact is important, its moderate magnitude indicates that other factors—such as tax administration efficiency, tax base diversification, and overall economic conditions—also influence total tax collection.
- The number of automated machines (LATM) has a positive and significant effect on tax revenue, showing that greater use of automated systems improves collection efficiency. A 1% increase in automated machines raises tax revenue by 0.25%, highlighting the positive role of digitalization in enhancing tax administration accuracy.
- The Technology Use Index (LTUI) is positively and significantly associated with tax revenue in the short term. The estimated coefficient (0.07) indicates that a 1% increase in technology

use results in a 0.07% rise in tax revenue, emphasizing the role of digitalization in streamlining electronic filing and payment, reducing errors and delays, and improving transparency. This positive relationship also reflects the contribution of ICT adoption to reducing tax evasion and increasing compliance, thereby enhancing the efficiency and effectiveness of the tax system.

Interpretation of the long-term relationship:

After confirming the presence of a long-term relationship, the next step is to estimate the long-term coefficients, which will illustrate the sustained impact of the independent variables on tax revenue over time.

Table No.: Long-Term Coefficient Estimates of the ARDL Model

Levels Equation
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LGDP	0.230896	0.067118	3.440141	0.0020
LGR	0.546120	0.049995	10.92351	0.0000
LOPR	0.296505	0.028900	10.25961	0.0000
LATM	0.254237	0.028438	8.940187	0.0000
LTPH	-0.057182	0.029058	-1.967853	0.0598
LTUI	0.062262	0.036865	3.688923	0.0009
C	-0.110497	0.925660	-0.119372	0.9059

Source: Prepared by the researcher based on outputs from EVIEWS 13

The long-term estimation results indicate the following:

- The coefficient of economic growth (LGDP) is positive and statistically significant at the 5% level with tax revenue (TDR). The estimated coefficient shows that a 1% increase in economic growth leads to a 0.23% increase in tax revenue. This positive relationship reflects that improved economic performance expands the productive base, increases incomes and profits, which in turn raises tax collection across different types of taxes. It also demonstrates that strong economic activity enhances the state's capacity to mobilize internal resources, reducing dependence on petroleum taxation as the main revenue source. Thus, economic growth is not only a development driver but also a fundamental factor for the sustainability of public finances and the efficiency of the tax system in the long term.
- The coefficient of general tax revenue (LGR) is positive and statistically significant at the 5% level, indicating that an increase in general tax revenues contributes to higher overall tax collection. A 1% increase in general tax revenues leads to a 0.54% increase in tax revenue, reflecting the pivotal role of general revenues in supporting total tax collection and achieving fiscal balance.
- The coefficient of oil taxation (LOPR) is positive and statistically significant at the 5% level, meaning that a 1% increase in oil taxes leads to a 0.29% increase in tax revenue in the long run. This shows the positive role of petroleum revenues in enhancing long-term tax collection, given the significant reliance of public finances on oil income.
- The coefficient of number of ATMs (LATM) is positive and statistically significant at the 5% level. A 1% increase in the number of ATMs increases tax revenue by 0.25% in the long term, demonstrating the contribution of automated machines in facilitating tax payments and increasing tax collection efficiency.

- The coefficient of Technology Use Index (LTUI) is positive and significant at the 5% level. A 1% increase in technology usage results in a 0.06% increase in tax revenue in the long term. This reflects the effect of digitalization in transforming traditional activities into technological processes, improving the tax system, streamlining administrative operations, and serving as a powerful tool to increase tax revenue through simplified electronic payment methods, such as bank cards, postal accounts, online platforms, and e-filing.
- Finally, the coefficient of tax payment hours (LTPH) is negative and statistically significant at the 5% level. A 1% increase in tax payment hours leads to a 0.05% decrease in tax revenue in the long run. This is explained by the use of digital portals and platforms as a new approach for filing and payment, which has reduced waiting times for taxpayers at tax offices. This change is attributed to the digitization of tax administration since 2014, followed by the adoption of the "Djibayatic" electronic portal and several other platforms, allowing remote and online tax payments, which positively impacted the reduction of waiting hours.

Results and Hypotheses Testing

This section of the study aims to determine the impact of digitalization on tax revenue in Algeria for the period 2014–2024, relying on the ARDL methodology (Autoregressive Distributed Lag Model), which provides a comprehensive approach to the research problem. The results are summarized as follows:

1 Unit Root Test Results *:* Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests confirm the presence of a unit root at the level for all study variables. Therefore, the independent variables were not stationary at the level. However, after first differencing, all study variables (dependent and independent) became stationary.

2 Since the study variables are stationary at the first difference (I(1)), the ARDL model was applied to ensure the time series were stable at the first difference.

3. Long-Run Cointegration (Bounds Test): The Bounds Test results indicate the existence of a long-term equilibrium relationship between the independent variables representing digitalization and the dependent variable (TDR – tax revenue).

This confirms the validity of the first hypothesis, which asserts the presence of a long-term cointegration relationship between the independent variables and tax revenue collection during the period 2014–2024.

4. Short-Term Results:

- The model (1.1.1.1.1.0.1) ARDL was selected based on AIC and S/HW criteria.
- The error correction term (ECM) is negative cointeq(-1) =0.42 and statistically significant, indicating a short-term equilibrium relationship among the study variables and a long-term adjustment toward equilibrium. This means 42% of the short-term deviation is corrected in the long run, confirming cointegration among the variables.
- The economic growth variable (GDP) has a positive and significant relationship with tax revenue at the 5% significance level. A 1% improvement in economic performance leads to a 0.24% increase in tax revenue in the short term.
- The general tax revenue (LGR) coefficient is positive and significant at 5%, indicating that a 1% increase in general tax revenues raises tax revenue by 0.58%, demonstrating the effectiveness of the Algerian tax system in mobilizing resources in the short term.
- Oil taxation (LOPR) has a positive and statistically significant impact at the 5% level, with a 1% increase leading to a 0.28% rise in tax revenue. However, this effect is relatively limited due to unexpected oil price shocks, indicating the need for additional factors, such as improved tax administration, broadening the tax base, and overall economic conditions, to support tax collection. This suggests that enhancing tax revenue relies not solely on petroleum taxes but on diverse and sustainable collection mechanisms, largely driven by digitalization.
- The number of ATMs (LATM) shows a positive and significant effect on tax revenue. A 1% increase in ATMs leads to a 0.25% increase in tax revenue, highlighting the positive effect of

automation on simplifying tax procedures, reducing human errors, and accelerating payment processes.

- The Technology Use Index (LTUI) has a positive and significant effect, where a 1% increase in technology usage raises tax revenue by 0.07%. This emphasizes the critical role of technology in modernizing tax administration, facilitating electronic filing and payments, improving processing accuracy, reducing administrative waste, and ultimately increasing collection efficiency. Digitalization thus acts as a key driver for long-term financial sustainability.

This analysis highlights that digitalization significantly enhances both short- and long-term tax revenue performance.

5. Long-Term Results

- The estimation results indicate that economic growth (GDP) has a positive and statistically significant effect on tax revenue at the 5% significance level. The estimated coefficient shows that a 1% increase in economic growth leads to an approximate 0.23% rise in tax revenue. This positive relationship reflects that improved economic performance increases income and profits, which in turn raises tax collection. Hence, economic growth is not only a driver of development but also a key factor in enhancing the efficiency of the tax system in the long term.
- The general revenue (GR) variable also exhibits a positive and significant relationship with tax revenue at the 5% level. A 1% increase in general revenue results in an approximate 0.54% increase in tax revenue, indicating that general revenues remain a strong and continuous driver of tax collection.
- Oil taxation (OPR) shows a positive and statistically significant effect at 5%, with a 1% increase in oil taxes leading to a 0.29% rise in long-term tax revenue. This highlights the critical role of petroleum revenues in sustaining long-term fiscal resources.
- The number of ATMs (LATM) has a positive and significant relationship with tax revenue at 5%. A 1% increase in ATMs increases tax revenue by approximately 0.25% in the long term. The widespread adoption of automated machines indicates a positive development of the financial sector's digital infrastructure, enhancing transparency, trust, and collection speed while reducing tax evasion. This underscores the positive impact of digitalization on improving tax administration efficiency and long-term resource sustainability.
- The Technology Use Index (TUI) also shows a positive and significant effect at 5%. A 1% increase in TUI raises tax revenue by approximately 0.06% in the long run. Reliance on technology by both the tax administration and taxpayers has facilitated services, simplified filing and payment procedures, reduced errors, and consequently improved tax collection. Digitalization thus becomes a strategic tool to enhance tax revenue, sustain financial resources, and promote tax compliance through modernization and increased efficiency of the tax system.
- Tax payment hours (LTPH) have a negative and significant effect at 5%. A 1% increase in payment hours reduces tax revenue by approximately 0.05% in the long term. This reflects the shift from traditional to electronic filing and payment methods. With the implementation of digital platforms, such as the "Djibayatic" portal launched in 2016, taxpayers no longer spend long hours waiting, which has significantly reduced the burden and improved efficiency.

These results confirm the second hypothesis, asserting that independent variables—number of ATMs (LATM), Technology Use Index (LTUI), and tax payment hours (LTPH)—have a statistically significant impact on tax revenue in Algeria in both the short and long run for the period 2014–2024.

Recommendations:

Based on the discussions and findings of our study, the following recommendations can be proposed:

1. Strengthen the technological infrastructure:
   Continuously develop and expand the digital infrastructure within the tax administration to ensure higher efficiency in data processing and tax collection.
2. Generalize the use of digital portals and platforms:
   Promote the adoption of electronic declaration and payment platforms across all provinces, to facilitate procedures for taxpayers and improve the speed of tax collection.
3. Enhance digital awareness among tax administration employees and taxpayers:
   Organize continuous training programs and workshops to familiarize both employees and taxpayers with modern digital methods of tax declaration and payment, ensuring optimal use of technology.
4. Adopt smart applications to support tax compliance:
   Develop digital applications that remind taxpayers of deadlines for declaration and payment, and help monitor transactions electronically, reducing delays and administrative inefficiencies.
5. Expand sources of tax collection beyond petroleum taxation:
   Encourage diversification of tax revenue sources through developing the digital tax system and implementing incentive policies to increase the efficiency of collection from non-oil sectors.

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