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The Impact of Digital Transformation Services Based on Information and Communication Technology on Financial Inclusion in Algeria During the Period 2010–2023

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Abstract:

This study aims to analyze the impact of digital transformation services based on information and communication technologies (ICT) on enhancing financial inclusion in Algeria, by focusing on one of the key indicators of digital infrastructure within the Global Innovation Index. Four dimensions were used to measure ICT as independent variables: ICT Access, ICT Use, Government Online Services (GOS), and E-Participation. Financial inclusion, as the dependent variable, was measured through a composite index that includes the growth of commercial bank branches and automated teller machines (ATMs) during the period 2010–2023. The study adopted a descriptive, analytical, and inductive methodology, and employed ARDL models to analyze the relationship between the variables.

The results revealed a long-term equilibrium relationship between digital transformation and financial inclusion, with varying significance and impact across the different dimensions. The study recommended the integration of government digitalization with financial services, the promotion of digital financial awareness, and the expansion of ICT infrastructure in underserved areas.

Keywords: Financial inclusion; Digital transformation; Information and communication technology; Innovation; Algeria.

JEL Classification Codes: O33; G21; C32; O57; L86.

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1. Introduction:

In recent decades, the world has witnessed rapid transformations driven by the digital revolution and the advancement of Information and Communication Technology (ICT). These changes have given rise to new models in delivering financial and banking services, significantly expanding the scope of financial inclusion recognized as a cornerstone of sustainable economic and social development. Traditional financial infrastructure is no longer sufficient to meet the evolving needs of societies. Instead, digitalization has emerged as an essential tool for integrating individuals especially vulnerable and marginalized groups into the financial system.

Within this context, financial inclusion has become a strategic objective of economic policies in many countries, particularly those aiming to foster social inclusion and reduce economic disparities. Digital transformation based on ICT plays a pivotal role in this regard, especially through facilitating access to online banking, digital payments, e-wallets, and digital financing.

Despite Algeria's efforts in recent years to develop its digital infrastructure, levels of financial inclusion remain below expectations. International indicators, such as the Global Innovation Index, reveal a noticeable gap between the availability of ICT services and their effective utilization in financial domains. This raises important questions about the actual impact of digital transformation on achieving financial inclusion.

Research Problem

While numerous international studies have examined the relationship between financial technology and financial inclusion, there is a clear shortage of applied research that investigates the impact of ICT-based digital transformation on financial inclusion in Algeria. In particular, few studies adopt a modern econometric approach that integrates institutional and financial dimensions to analyze the digital infrastructure.

In light of this, the central research question is:

To what extent do digital transformation services based on ICT contribute to supporting and enhancing financial inclusion in Algeria during the period 2010–2023?

Research Hypothesis

H_0: There is no statistically significant impact of ICT-based digital transformation services (ICT access, ICT use, online government services, and e-participation) on financial inclusion in Algeria during the period 2010–2023.

H_1: ICT-based digital transformation services have a statistically significant impact on financial inclusion in Algeria during the period 2010–2023.

Importance of the Study: The Importance of this study lies in its attempt to fill a research gap within the Algerian context by assessing the relationship between digital transformation and financial inclusion using international data and indicators. The findings are expected to provide practical recommendations for policymakers to better align financial digitalization with the country's broader developmental goals.

Objectives of the Study: This study aims to:
- Analyze the relationship between the dimensions of ICT (access, usage, online government services, and e-participation) and financial inclusion in Algeria;
- Estimate the short- and long-term effects of digital transformation on financial inclusion using the ARDL model;
- Provide actionable recommendations to strengthen the integration between digital infrastructure and the financial inclusion framework.

Methodology: This study adopts a descriptive-analytical and inductive approach to explore and interpret the theoretical and empirical relationship between digital transformation and financial inclusion. Econometrically, the study utilizes the Auto-Regressive Distributed Lag (ARDL) model to assess both the short- and long-term impacts of ICT indicators—sourced from the Global Innovation Index—on financial inclusion indicators (such as the growth rate of commercial bank branches and ATMs) over the period 2010–2023. The analysis is carried out using data processed through Eviews 12 software.

2. Conceptual Framework and Literature Review

1.2 Conceptual Framework

a. Digital Transformation

Digital transformation refers to the fundamental change in business and service models resulting from the intensive adoption of information and communication technologies (ICT). This includes the digitization of processes and the provision of both public and private services online, including financial and banking services (Westerman et al., 2014, p. 5). Digital transformation is considered a prerequisite for enhancing financial inclusion by facilitating access to financial tools and reducing the time and cost associated with obtaining banking services.

b. Information and Communication Technology (ICT)

ICT represents the technical foundation and infrastructure upon which digital applications are built. It includes communication services, the internet, cloud computing, smartphones, and other tools that enable individuals and institutions to interact digitally (UNCTAD, 2019, p. 3). The development of ICT is often measured through four key indicators: access, usage, digital skills, and digital government services (WEF, 2020, p. 18).

c. Financial Inclusion

Financial inclusion is defined as enabling individuals and enterprises to access a wide range of appropriate and affordable financial services in a sustainable manner. This includes bank accounts, loans, insurance, and payment services (Demirgüç-Kunt et al., 2018, p. 4). Financial inclusion is a key pillar for promoting economic and social stability, reducing inequalities, and supporting inclusive development.

d. The Relationship Between Digital Transformation and Financial Inclusion

Studies indicate that digital transformation, supported by ICT, contributes to accelerating and expanding financial inclusion, particularly in developing countries, by removing geographic and bureaucratic barriers and offering innovative financial services tailored to the needs of different segments (Ozili, 2018, p. 334). However, the effectiveness of this impact depends on institutional factors such as the quality of digital services, trust in technology, and financial infrastructure.

2.2. Literature Review

The relationship between Information and Communication Technology (ICT) and Financial Inclusion (FI) has received growing attention in recent literature, with multiple studies exploring it using various methodologies and contextual frameworks. In this regard, **Li et al. (2022)** conducted a comprehensive global study employing linear regression models and mediation analysis. Their findings revealed that ICT has a positive impact on financial inclusion, though this effect varies depending on the depth and breadth of inclusion. They also highlighted disparities among countries based on the structure of their banking systems and economic positions.

In the African context, **Doku et al. (2023)** examined the impact of digital financial technologies on financial inclusion across 34 Sub-Saharan African countries using the GMM model. Their findings emphasized the importance of institutional quality in enhancing this effect. Similarly, **Mavlutova et al. (2023)** focused on the sustainable dimension of digital transformation, affirming the strong link between digital payments, financial inclusion, and operational efficiency.

In Ethiopia, **Hordofa (2024)** found that while digital transformation is expanding, it may negatively affect the long-term stability of the financial system due to weak regulatory frameworks. On the other hand, **Menza et al. (2024)** confirmed the positive role of fintech tools—such as ATMs and mobile banking—in promoting financial inclusion.

Regarding the impact of ICT on economic growth, **Nugraha & Safuan (2024)** demonstrated that ICT plays a crucial role in bridging the financial inclusion gap, particularly in low-income countries. **Wellalage et al. (2021)** supported this by showing how ICT enhances entrepreneurial financial inclusion in Africa.

Ashraf et al. (2025) established a long-term relationship between ICT infrastructure and financial development using advanced panel data models. **Adeyemo et al. (2023)** further revealed that financial inclusion and ICT have a positive effect on tax performance in Sub-Saharan Africa, underscoring their importance for financial governance.

Finally, **Chatterjee (2020)** provided supporting evidence from 41 countries that ICT-driven financial inclusion promotes economic growth. However, the study also

emphasized the need for educational and awareness policies to enhance the use of ICT in banking services, especially in developing nations.

The literature reveals a broad consensus on the positive impact of ICT on financial inclusion, though this impact varies based on institutional, regulatory, and economic contexts. It also underscores the growing importance of digital payments and ICT infrastructure in fostering inclusive finance, particularly in developing economies. Most studies agree that ICT significantly contributes to financial inclusion, but its effectiveness depends on institutional capacity, governance quality, economic structure, and financial literacy. Studies like Hordofa (2024) further stress the need for financial stability and regulatory oversight when implementing rapid digital transformations. Notably, there remains a clear gap in applied research within the Algerian context using Global Innovation Index data and ARDL models—an empirical gap that this study aims to address.

3. Methodology

3.1. Data Collection Sources

For this study, the values of the independent variables were extracted from the Global Innovation Index reports published by Cornell University, INSEAD (The European Institute of Business Administration), and the World Intellectual Property Organization (WIPO) during the period from 2010 to 2023. As for the dependent variable, its values were obtained from the data of the Bank of Algeria for the same study period. The table below presents the adopted variables and their respective data sources.

Table (1): Data Sources for Study Variables

Source Type	Issuing Entity	Variable	Code	Measurement
Primary / International	Global Innovation Index (Cornell University, INSEAD, WIPO)	Government Online Services (Independent 1)	GOS	Quantitative (% percentage)
Primary / International	Global Innovation Index (Cornell University, INSEAD, WIPO)	ICT Access (Independent 2)	ICT_ACCESS	Quantitative (% percentage)
Primary / International	Global Innovation Index (Cornell University, INSEAD, WIPO)	ICT Use (Independent 3)	ICT_USE	Quantitative (% percentage)
Primary / International	Global Innovation Index (Cornell University, INSEAD, WIPO)	E-Participation (Independent 4)	E_P	Quantitative (% percentage)
Primary / National	Bank of Algeria	Dependent Variable (Financial Inclusion)	FI	Quantitative (% percentage)

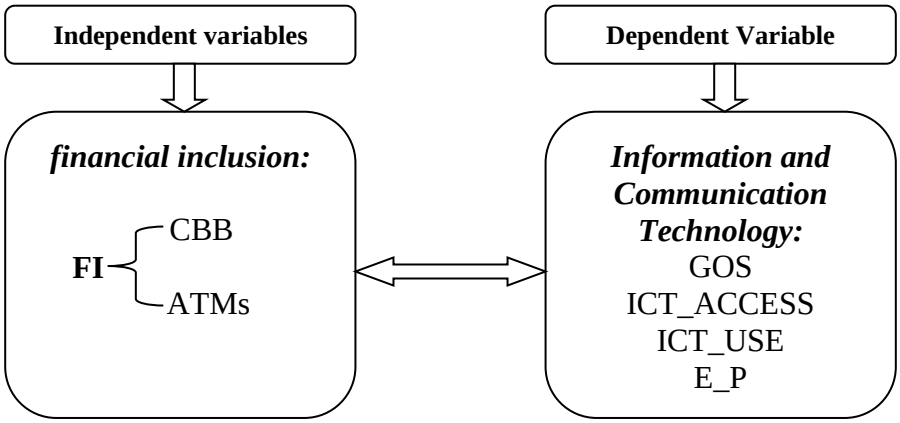
Source: Prepared by the researcher

2.3. Study Variables: To measure the impact of the independent variables on financial inclusion in Algeria during the study period, the following variables were adopted:
Dependent Variable: This is represented by the composite index of financial inclusion, which was constructed using the *Principal Component Analysis* (PCA) method by combining two variables: the growth in the number of bank branches and the growth in the number of automated teller machines (ATMs). This index is denoted as **FI**.
Independent Variables: These include:

- **Government Online Services (GOS);**
- **Access to Information and Communication Technology (ICT_ACCESS);**
- **Use of Information and Communication Technology (ICT_USE):**
- **E-Participation (E_P).**

Accordingly, the study model can be illustrated as follows:

Figure (1): The Study Model



Source: Prepared by the researcher

It is worth noting that due to the limited number of observations resulting from the short length of the time series used, which spans from 2010 to 2023 (Obs = 14), the annual time series were converted into semi-annual time series. This transformation was made to increase the number of observations (Obs = 28), which facilitates the estimation of both long-term and short-term relationships. Accordingly, the study model becomes as follows:

$$\text{IF} = \int GOS, ICT_ACCESS, ICT_USE, E_P$$

4. Results and Discussion

4.1. Time Series Stationarity Test:

The stationarity of time series is a fundamental prerequisite for applying the ARDL methodology. The time series must be stationary either at level, at first difference, or a combination of both. To test this, the Phillips-Perron test is employed, which is based on the following hypotheses:

• Null hypothesis (H_0): The time series is non-stationary, i.e., it contains a unit root.

• Alternative hypothesis (H_1): The time series is stationary, i.e., it does not contain a unit root.

A significance level of 10% is considered the maximum threshold for rejecting the null hypothesis and accepting the alternative hypothesis. The results of this test are presented in the following table:

Table (2): Results of the Phillips-Perron Test for Time Series Stationarity

Source: Eview

UNIT ROOT TEST RESULTS TABLE (PP)
Null Hypothesis: the variable has a unit root

		FI	E_P	GOS	ICT_ACC...	ICT_USE
At Level						
With Constant	t-Statistic	-2.1873	-0.8363	-1.5361	0.3037	1.0242
	Prob.	***0.2152***	***0.7917***	***0.4999***	***0.9739***	***0.9956***
		n0	n0	n0	n0	n0
With Constant & Trend	t-Statistic	-2.9750	-2.0971	-1.5363	-2.6063	-1.8999
	Prob.	***0.1576***	***0.5234***	***0.7901***	***0.2805***	***0.6258***
		n0	n0	n0	n0	n0
Without Constant & Trend	t-Statistic	-2.2271	1.1225	0.0641	3.1617	3.1102
	Prob.	***0.0275***	***0.9276***	***0.6944***	***0.9991***	***0.9990***
		**	n0	n0	n0	n0
At First Difference						
		d(FI)	d(E_P)	d(GOS)	d(ICT_A...	d(ICT_USE)
With Constant	t-Statistic	-3.7193	-2.5638	-2.8381	-1.3267	-2.0413
	Prob.	***0.0101***	***0.0135***	***0.0674***	***0.0000***	***0.0685***
		**	**	*	***	*
With Constant & Trend	t-Statistic	-3.5309	-2.4540	-2.9110	-0.4305	-2.2873
	Prob.	***0.0576***	***0.0457***	***0.0759***	***0.0802***	***0.0250***
		**	**	*	*	**
Without Constant & Trend	t-Statistic	-3.6109	-2.4260	-2.9599	-2.1024	-1.2344
	Prob.	***0.0009***	***0.0175***	***0.0048***	***0.0365***	***0.0933***
		***	**	***	**	*

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Output

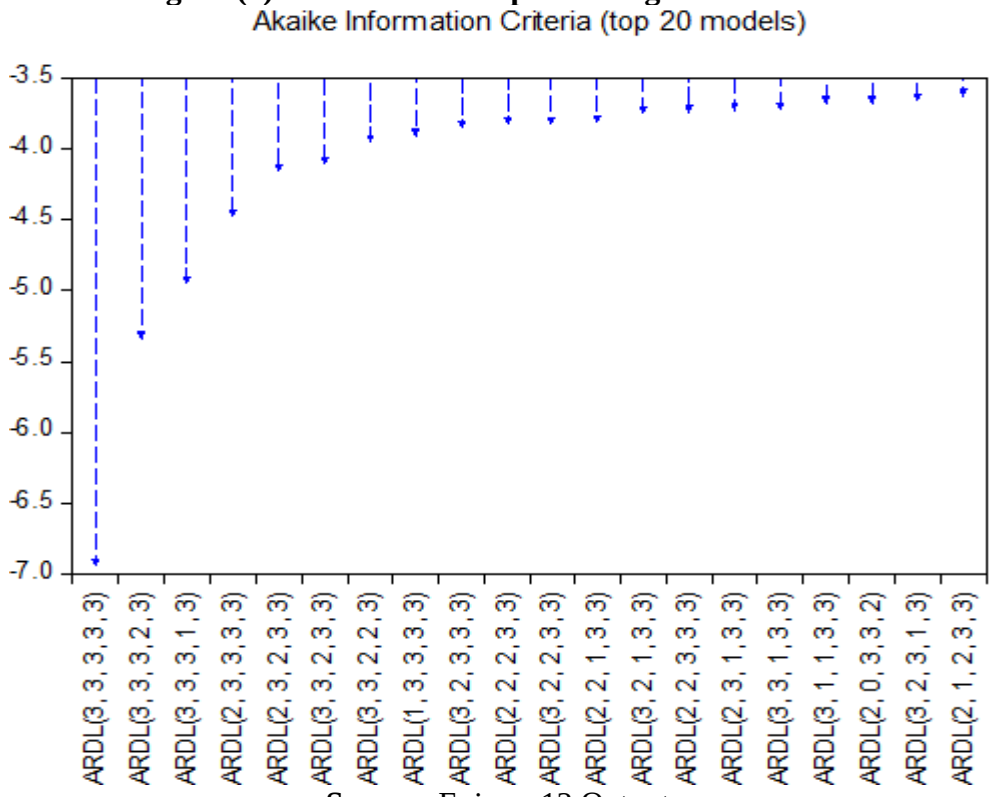
As shown in Table (2), which presents the results of the unit root test, the variables under study are stationary at the first difference level (I(1)). This is evidenced by the p-values being less than 10% in all cases (with constant, with constant and trend, and without constant and trend). Therefore, we reject the null hypothesis and accept the

alternative hypothesis, indicating that there is no unit root. Since all the series are stationary at the I(1) level, the ARDL methodology can be applied.

4.2. Results of the Optimal Lag Selection Test:

The test for selecting optimal lag lengths using the Akaike Information Criterion (Top 20) allows for estimating the best-fitting econometric model for the variables used in the study. The results of this test are illustrated in the following figure:

Figure (2): Results of the Optimal Lag Selection Test



Source: Eviews 12 Output

Based on the results illustrated in the figure above, the optimal mathematical model among 768 models is ARDL(3,3,3,3,3). This means that the dependent variable (FI) has 3 lags, and the same applies to the independent variables GOS, ICT_ACCESS, ICT_USE, and E_P, respectively. Accordingly, the model is written as follows:

$$\Delta FI_t = C_0 + \sum_{i=1}^{3} \alpha_1 \Delta FI_{t-1} + \sum_{i=1}^{3} \alpha_2 \Delta GOS_{t-1} + \sum_{i=1}^{3} \alpha_3 ICT_ACCESS_{t-1} + \sum_{i=1}^{3} \alpha_4 \Delta ICT_USE_{t-1} + \sum_{i=1}^{3} \alpha_5 \Delta E_P_{t-1} + \beta_1 FI_{t-1} + \beta_2 GOS_{t-1} + \beta_3 ICT_ACCESS_{t-1} + \beta_4 ICT_USE_{t-1} + \beta_5 E_P_{t-1} + \varepsilon_t$$

Where:

- **Δ:** First-order differences

- **C_0:** Constant term
- **t:** Time trend
- **ε_t:** Random error term
- **$\alpha_1, \alpha_2, \alpha_3, \alpha_4, \alpha_5$:** Short-run relationship coefficients
- **$\beta_1, \beta_2, \beta_3, \beta_4, \beta_5$:** Long-run relationship coefficients

4.3. Bounds Testing for Cointegration

The Bounds Test is conducted to examine the existence of a long-run relationship among the variables using the F-statistic. Since the critical values do not follow standard distributions, they are compared with the critical values provided by Pesaran et al. (2001). This methodology does not require the variables to be integrated of the same order; it can be applied to a mixture of I(0) and I(1) variables. The null hypothesis H_0 states that there is no long-run relationship among the study variables, while the alternative hypothesis H_1 posits that a long-run relationship does exist, as follows:

$$H_0 : \beta_1 = \beta_2 = \beta_3 = \beta_4 = 0$$

$$H_1 : \beta_1 \neq \beta_2 \neq \beta_3 \neq \beta \neq 0$$

The results of this test are presented in the following table:

Table (3): Bounds Test Results for Co-integration

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
		Asymptotic: n=1000		
F-statistic	648.7602	10%	2.2	3.09
k	4	5%	2.56	3.49
		2.5%	2.88	3.87
		1%	3.29	4.37

Source: Eviews 12 Output

Based on the results obtained in Table (3), we find that the value of the F-statistic (Fisher) = 648.7602 exceeds the lower and upper critical bounds at all levels of significance (10%, 5%, 2.5%, and 1%). Therefore, we conclude that there is a long-run co-integrating relationship among the study variables.

4.4. Estimation of the Long-Run Relationship:

After confirming the existence of a long-run co-integrating relationship among the study variables, the long-run coefficients can now be estimated, as shown in the following table:

Table (4): Estimation Results of the Long-Run Relationship

Levels Equation
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GOS	-0.172416	0.027089	-6.364696	0.0031
ICT_ACCESS	0.066591	0.030852	2.158390	0.0971
ICT_USE	-0.056416	0.017607	-3.204098	0.0328
E_P	-0.007855	0.014582	-0.538688	0.6187
C	2.603272	0.460957	5.647534	0.0048

EC = FI - (-0.1724*GOS + 0.0666*ICT_ACCESS -0.0564*ICT_USE -0.0079 *E_P + 2.6033)

Source: Eviews 12 Output

- There is a **significant negative long-term relationship** between **Financial Inclusion (FI)** and **Government Online Services (GOS)**, as evidenced by a p-value of **0.0031**, which is below the 5% significance level. This indicates that a **1% increase in GOS leads to a 17% decrease in FI**. This could be explained by a gap between the digitization of government services and their direct integration with the digital financial system. In other words, the digitization of government services has not yet translated into actual or effective use of digital financial services by individuals. This may result from the **lack of true integration** between e-government portals and financial inclusion platforms, or **citizens' lack of trust** in e-government services.
- There is a **positive and significant long-term relationship** between **FI** and **ICT Access**, with a p-value of **0.0971**, which is below the 10% significance threshold. This means that a **1% increase in ICT_ACCESS leads to a 6% increase in FI**. This indicates that improving technological infrastructure (such as internet penetration, mobile phones, and communication networks) facilitates access to digital financial services. This is a logical result, as **greater access to technology enhances individuals' ability** to participate in the modern financial system — for example, by opening digital bank accounts, using e-payment systems, or adopting finance-related apps.
- There is a **significant negative long-term relationship** between **FI** and **ICT Use**, confirmed by a p-value of **0.0328**, which is less than 5%. This suggests that a **1% increase in ICT_USE leads to a 5% decrease in FI**. Although access to ICT supports financial inclusion, the current use of ICT seems to have a **negative and significant effect on FI**.

This apparent paradox could be explained by the fact that current ICT usage is still **predominantly for non-financial purposes** (such as entertainment or personal communication), rather than for banking or financial services. It may also reflect a **lack of digital financial literacy** among a large portion of users, or the **low quality or limited availability** of digital financial services.

- There is a **negative but statistically insignificant long-term relationship** between **FI** and **E-Participation (E_P)**, as shown by a p-value of **0.6187**, which is higher than the 10% threshold. This indicates **no statistically significant relationship** between electronic participation (e.g., e-voting, online discussions with the government, digital civic engagement) and financial inclusion in the long run. This might be due to the fact that **e-participation is not inherently linked to the use of financial or banking services**, but rather focused on social or political issues, which do not necessarily translate into financial or economic activity. It may also reflect **weak integration** between e-participation platforms and digital finance systems.

5.4. Estimating the Short-Run Relationship within the Error Correction Model Framework

The penultimate step in estimating the ARDL model involves identifying the short-run relationship coefficients and estimating the Error Correction Model (ECM), which measures the speed at which short-term disequilibria adjust back to long-run equilibrium. The data presented in Table (5) shows the estimated effects of the independent variables related to ICT-based digital transformation services on financial inclusion in the short term:

Table (5): Estimated Results of the Short-Run Relationship and the Error Correction Model

ECM Regression
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(FI(-1))	0.068820	0.011333	6.072327	0.0037
D(FI(-2))	-0.608685	0.003794	-160.4349	0.0000
D(E_P)	-0.218220	0.003078	-70.90691	0.0000
D(E_P(-1))	0.108996	0.004928	22.11851	0.0000
D(E_P(-2))	0.234354	0.004750	49.34266	0.0000
D(GOS)	0.195752	0.002147	91.18424	0.0000
D(GOS(-1))	0.048411	0.001431	33.81867	0.0000
D(GOS(-2))	0.146907	0.001829	80.33945	0.0000
D(ICT_ACCESS)	0.181781	0.002153	84.42505	0.0000
D(ICT_ACCESS(-1))	-0.041368	0.001387	-29.83605	0.0000
D(ICT_ACCESS(-2))	0.050385	0.001480	34.03992	0.0000
D(ICT_USE)	-0.168507	0.003248	-51.88752	0.0000
D(ICT_USE(-1))	-0.020014	0.002683	-7.459801	0.0017
D(ICT_USE(-2))	-0.351154	0.004901	-71.64290	0.0000
CointEq(-1)*	-0.637537	0.006812	-93.58559	0.0000

R-squared	0.999955	Mean dependent var	-0.234063
Adjusted R-squared	0.999886	S.D. dependent var	0.507626
S.E. of regression	0.005419	Akaike info criterion	-7.328780
Sum squared resid	0.000264	Schwarz criterion	-6.592496
Log likelihood	102.9454	Hannan-Quinn criter.	-7.133443
Durbin-Watson stat	3.820867		

Source: Eviews 12 Output

It is observed that the Error Correction Term (ECM) is negative and statistically significant at a probability level much lower than 1%, with a value of (-0.637537). This result indicates that the dependent variable, represented by FI (Financial Inclusion), requires approximately $1/0.637537 \approx 1.6$ years (i.e., about two years) to correct the short-term disequilibrium and return to the long-term equilibrium level. This means that the deviation of FI from its equilibrium value in period (t-1) will be corrected by approximately 77.2% in period (t). Furthermore, the obtained R-squared value is 0.99, which is very close to one, indicating that the explanatory variables account for approximately 99% of the variation in FI.

6.4 Model Validity Testing:

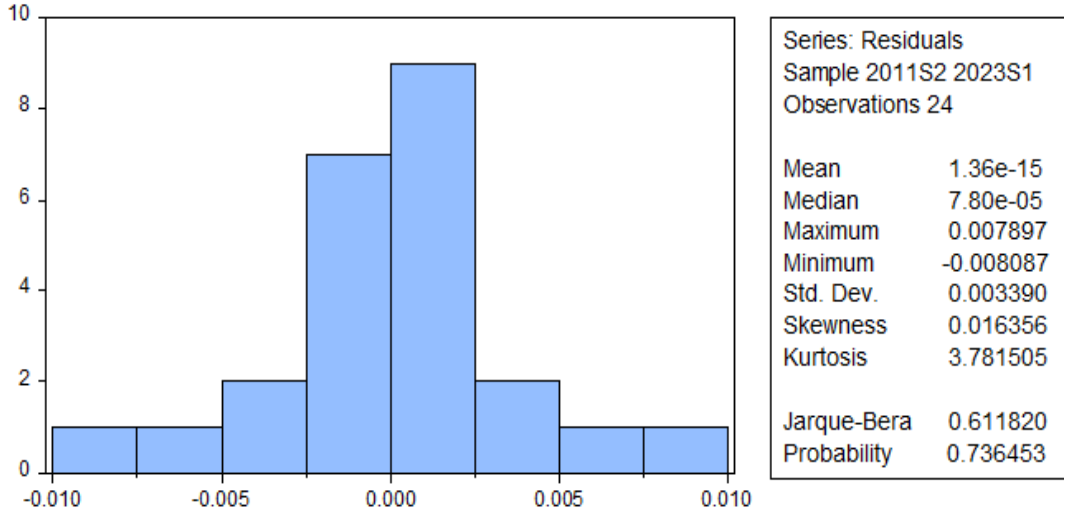
To ensure the validity of the selected model according to the Akaike Information Criterion (AIC), a set of diagnostic tests must be performed on the residual series. These tests include the following:

a. Normality Test of the Residual Series:

To verify whether the residuals are normally distributed, the Jarque-Bera test is conducted.

The results of this test are illustrated in the following figure:

Figure (3): Normality Test of the Residual Series



Source: Eviews 12 Output

Based on the results shown in Figure 3, the probability value (p-value) of the Jarque-Bera statistic is greater than 0.05. This indicates that the residuals are normally distributed (the normality hypothesis is accepted). Therefore, we conclude that the residuals follow a normal distribution within the 95% confidence interval.

B. Serial Correlation of Residuals and Heteroscedasticity:

To test for serial correlation of residuals and heteroscedasticity, we rely on the **Breusch–Pagan–Godfrey test**, which primarily depends on the **Lagrange Multiplier (LM) statistic**, and the **ARCH test**, which performs a self-test for first-order heteroscedasticity. These tests are used to verify the null hypothesis of **"no heteroscedasticity."** The estimation results of both tests are presented in the following tables:

Table (6): Results of the Residual Variance Stability Test

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	0.952833	Prob. F(16,10)	0.5508
Obs*R-squared	16.30495	Prob. Chi-Square(16)	0.4319
Scaled explained SS	2.342338	Prob. Chi-Square(16)	1.0000

Source: Eviews 12 Output

Table (7): Results of the Residual Variance Homoscedasticity Test

Heteroskedasticity Test: ARCH

F-statistic	0.007102	Prob. F(1,24)	0.9335
Obs*R-squared	0.007692	Prob. Chi-Square(1)	0.9301

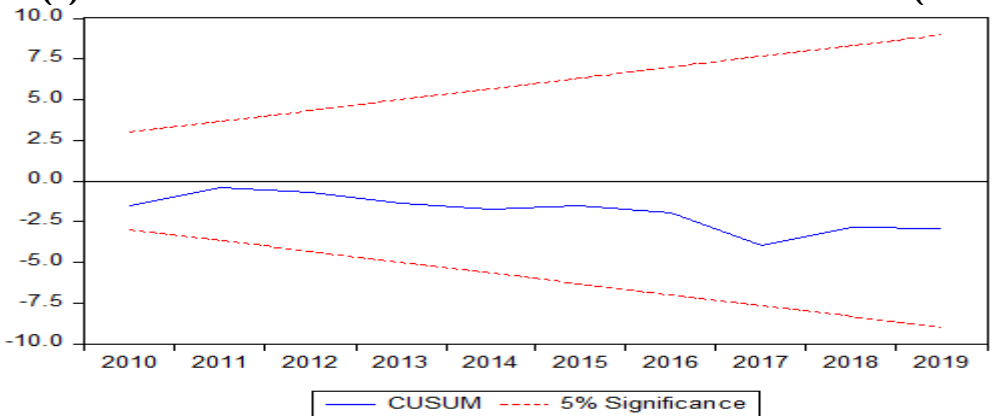
Source: Eviews 12 Output

The results indicate that the **Fisher probability** values in both the Breusch–Pagan–Godfrey and ARCH tests are greater than 5%, which leads us to accept the null hypothesis, meaning that the residual variances are not time-dependent. Therefore, we can conclude that the model is almost free from statistical problems.

C. Stability Test of the Model's Structure:

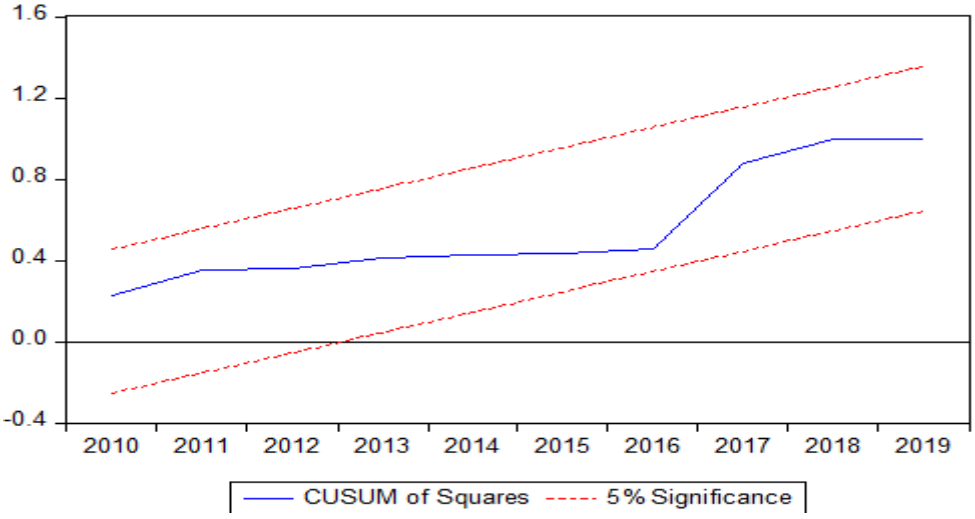
To ensure that the data used in this study is free from any structural changes, we employ the Cumulative Sum (CUSUM) test and the Cumulative Sum of Squares (CUSUMSQ) test. These two tests are among the most important in this field because they indicate two essential aspects: the presence of any structural changes in the data, and the degree of consistency between long-run and short-run parameters. Structural stability of the estimated parameters is confirmed when the graphical plot of the CUSUM test lies within the critical bounds at a 5% significance level.

Figure (4): Results of the Cumulative Sum of Recursive Residuals Test (CUSUM)



Source: Eviews 12 Output

Figure (5): Cumulative Sum of Squares Test (CUSUM of squares)



Source: Eviews 12 Output

It is observed that the CUSUM and CUSUM-square curves lie within the critical bounds, indicating the stability of the model parameters.

5. Conclusion:

This study aimed to analyze the impact of digital transformation services based on information and communication technology (ICT) on financial inclusion in Algeria, using the Autoregressive Distributed Lag (ARDL) model over the study period. The results revealed the existence of a long-term equilibrium relationship between the studied variables, confirming the integration of digital and technological dimensions with the trajectory of financial inclusion.

The long-term estimation highlighted a significant negative effect of Government Online Services (GOS) on financial inclusion, reflecting weak integration between the digitization of public services and the digital financial system. This indicates the need to strengthen coordination between state institutions and financial service providers to ensure that digital government transformation effectively supports financial inclusion goals.

In contrast, ICT access (ICT_ACCESS) showed a significant positive effect on financial inclusion, underlining the importance of investing in digital infrastructure as a prerequisite for expanding access to modern financial services, especially in remote and rural areas.

On the other hand, the study found a significant negative relationship between ICT use (ICT_USE) and financial inclusion, which reflects a dual challenge: the lack of digital financial literacy and the absence of functional guidance in using technology for financial purposes. Technology use for entertainment or personal reasons does not contribute to financial inclusion unless it is purposefully and institutionally directed toward banking and financial transactions.

E-Participation (E_P), however, did not exhibit a significant relationship with financial inclusion. This suggests that digital civic or political engagement practices remain disconnected from economic and financial structures and require further integration within a comprehensive strategic framework linking digital participation with financial empowerment.

In the short term, results from the Error Correction Model (ECM) showed a relatively rapid adjustment toward equilibrium following temporary shocks, with about 77% of disequilibrium corrected within the following year. This indicates a strong equilibrium relationship among the variables and a prompt financial system response to digital transformation in the short run.

Methodologically, the diagnostic tests confirmed that the estimated model has strong statistical properties. The residuals were normally distributed, with no autocorrelation or heteroskedasticity. Additionally, structural stability tests (CUSUM and CUSUM of Squares) demonstrated that model parameters remained stable within the critical bounds, reinforcing the credibility of the findings.

The study recommends:

- Strengthening the link between government digital transformation and digital financial services by developing integrated electronic portals that provide seamless access to banking and financial services.
- Emphasizing digital financial education in public education and training programs to ensure that technology usage becomes an effective tool for financial inclusion.
- Expanding internet and telecommunications coverage, particularly in marginalized areas, to guarantee equitable access to the digital environment.
- Encouraging innovation in digital financial services (e.g., e-wallets, digital banks, and crowdfunding platforms) and linking them to public services to achieve developmental integration.
- Embedding the concept of financial inclusion within national digital transformation policies to ensure strategic alignment with sustainable development goals.

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