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AI-Driven e-Business: the Future of Customer Personalization

Strategic Benefits From Smart City Initiatives – a Road Map for Intelligent Transformation

The Role of Interpersonal Relations in the Management of International Business Organizations

The Impact of Electronic Payment on Economic Growth in Algeria: a Quarterly Econometric Analysis Using the ARDL MODEL (2016–2025)

Analysis of the Application of Enterprise Information Systems for Supply Chain Management in Trade in Bulgaria

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CONTENTS

Teodora Dimitrova, Ivan Marinov

AI-Driven e-Business: the Future of Customer Personalization / 3

Mihail Chipriyanov

Strategic Benefits From Smart City Initiatives – a Road Map
for Intelligent Transformation / 15

Zdravko Lyubenov, Galina Gateva-Hristova

The Role of Interpersonal Relations in the Management
of International Business Organizations / 27

Nawal Abbes

The Impact of Electronic Payment on Economic Growth in Algeria: a
Quarterly Econometric Analysis Using the ARDL MODEL (2016–2025) / 40

Elena Valcheva

Analysis of the Application of Enterprise Information Systems for Supply
Chain Management in Trade in Bulgaria / 58

THE IMPACT OF ELECTRONIC PAYMENT ON ECONOMIC GROWTH IN ALGERIA: A QUARTERLY ECONOMETRIC ANALYSIS USING THE ARDL MODEL (2016–2025)

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Abstract: This study investigates the dynamic relationship between electronic payment indicators (e-POS terminal activity and online payments) and economic growth in Algeria, measured by Gross Domestic Product (GDP). Using the Autoregressive Distributed Lag (ARDL) approach, the study addressed the limitations of a short time series by converting annual data into quarterly frequency via statistical interpolation, resulting in a sample of 35 observations. The Bounds Test results demonstrated the absence of a long-run cointegrating relationship, suggesting that Algeria's digital payment sector remains in a transitional phase and has not yet attained structural maturity. However, short-run dynamics revealed a positive and statistically significant effect of e-POS activity at the 10% level, whereas online payments exhibited a significant negative effect. Diagnostic tests, including CUSUM, confirmed the structural stability of the model, which possesses an explanatory power (Adjusted R-squared) of 90%. The study emphasizes the necessity of localizing digital services and fostering financial inclusion to integrate the informal economy into the formal banking system. Key recommendations include strengthening cybersecurity, expanding digital payment infrastructure across regions, and encouraging financial innovation.

Key words: electronic payment, economic growth , Algeria, ARDL, Bounds Test .

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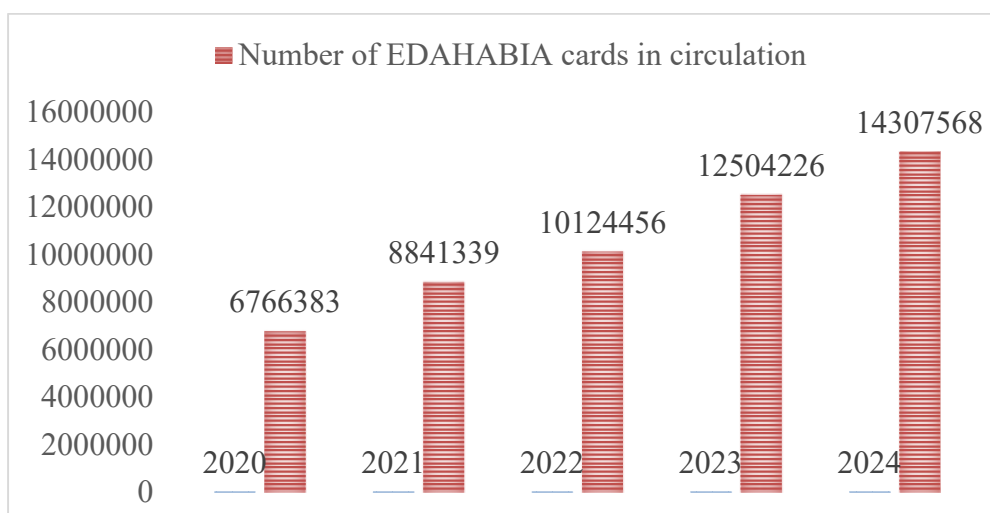
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Introduction

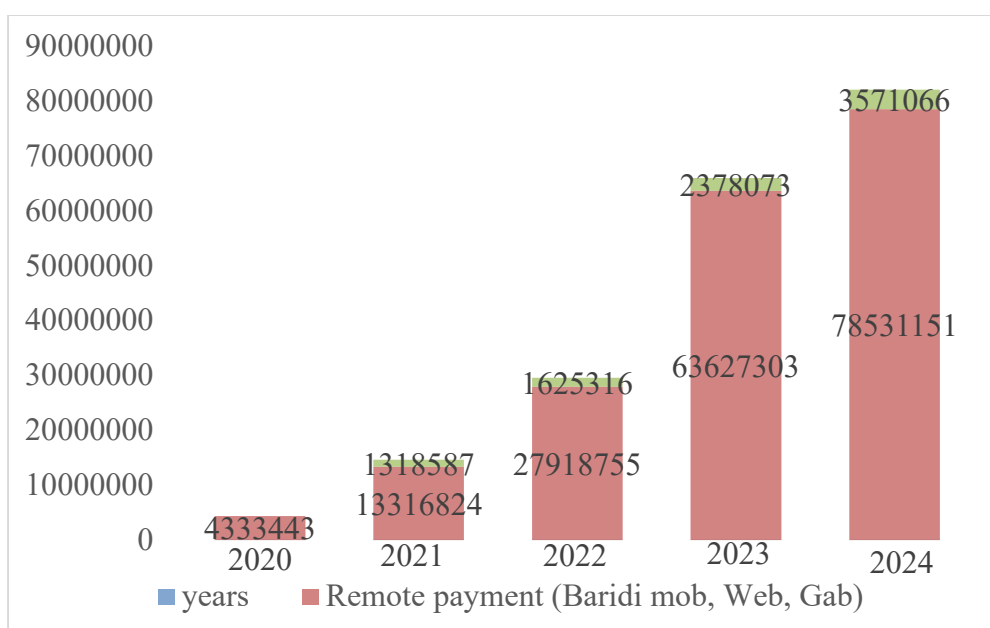
In recent decades, the world has witnessed profound transformations driven by the rapid development of information and communication technologies (ICT), leading to the emergence of the digital economy. This new economic paradigm has had a profound impact on the global business environment, leading to the emergence of new industries and multinational firms, while concurrently transforming traditional business models. Furthermore, the digital economy has become a significant contributor to global value chains (GVCs), thereby influencing the restructuring of the global economic order (Organisation for Economic Co-operation and Development (oecd, 2018)). Concurrently, the global financial services sector has undergone substantial transformations over the past decade, largely attributable to the rapid dissemination of digital technologies. The advent of electronic payment systems, mobile banking applications, blockchain-based solutions, and various financial technology (FinTech) innovations has fundamentally transformed the manner in which individuals and businesses conduct financial transactions, access credit, manage savings, and interact with financial institutions (Aziza Farmonovna Ergasheva, 2025) .Algeria experienced a relative delay in the adoption of electronic payment systems compared to many other countries, yet notable progress has been achieved in recent years, particularly since 2016. The country has witnessed a gradual expansion in the use of bank cards, online payment platforms, and mobile payment services, reflecting ongoing efforts to modernise the financial sector and promote financial inclusion within the framework of digital transformation policies (Abouz Souad, 2021).Recent years have witnessed a marked increase in the utilisation of electronic payment services in Algeria. The number of EDAHABIA cards in circulation, issued by Algeria Post, increased from 6 million at the beginning of 2020 to over 14.3 million by the end of 2024, representing an estimated increase of 100%.This increase can be attributed to two main factors. Firstly, there has been a significant increase in the number of EDAHABIA cardholders. Secondly, there has been an expansion of the range of services available on the Algeria Post commercial platform. These two factors have led to a substantial rise in the number and amount of online payment transactions, which increased by 98% between 2020 and 2024. Furthermore, the transaction amount has risen by approximately 240% over the same period (see Figure 1 and Figure 2) (Telecommunications, 2026).

Figure 1: Increase in the number of EDAHABIA cards in circulation



Source : Ministry of Post and Telecommunications of Algeria

Figure 2 : Evolution of e-payment transactions number



Source : Ministry of Post and Telecommunications of Algeria

In light of the increasing significance of electronic payments, a plethora of studies have been undertaken, including one by Abdul Azeez N. P, Mohammad Imdadul Haque. and S M. Jawed Akhtar (2022), titled : Digital Payment and Economic Growth: Evidence from India The present study focused on analysing the relationship between gross value added and a range of payment methods (credit transfers, card payments, and prepaid instruments) during the period 2011–2019. Utilising the Autoregressive Distributed Lag (ARDL) model, the findings indicated a long-run cointegration relationship between the variables, thereby substantiating the notion that financial digitalisation augments productive efficiency and stimulates consumption, which in turn exerts a favourable influence on growth rates (P & Mohammad Imdadul Haque, 2022).

In addition to the research conducted by Eyup Kahveci and Tugrul Gurgur (2025), the publication entitled 'Digital Payments and Sustainable Economic Growth' should be consulted. The present study employed an autoregressive vector model (VAR) for the period 2006–2023, in order to analyse transmission mechanisms and to gather evidence from an emerging economy, i.e. Turkey. Granger causality tests revealed a positive, long-run reciprocal relationship between digital payments and gross domestic product. The study also revealed the transmission channels of this effect, showing that electronic payments primarily stimulate growth by increasing household consumption and boosting financial intermediation, whilst their impact on productivity remained less clear. The study concluded that policymakers should give priority to the strengthening of digital financial infrastructure in order to ensure inclusive and sustainable growth (Eyup Kahveci, 2025).

As well as the research by Li, He; Malim, Nurhafiza Abdul Kader; Du, Xuyang; Xu, Zaijuan(2026), titled : Interaction Effects of Digital Platforms and Technological Innovation on China's Economic Growth: Panel Data Evidence (2013–2023). This assertion was supported by data obtained from 30 Chinese provinces. Utilising fixed-effects models, the study demonstrated a statistically significant positive impact of electronic payments and e-commerce on GDP; a 1% increase in digital platform activity contributes to a 0.0344% rise in the growth rate. The findings concluded that coordination between digital transformation and investment in research and development (R&D) doubles the positive impact on economic performance, highlighting the importance of integration between technological and economic policies (Li, Malim, Du, & Xu, 2026).

Despite the research momentum surrounding electronic payments in Algeria, a review of the extant literature reveals that the majority of studies adopt descriptive approaches and focus on regulatory frameworks. There is a clear scarcity of econometric studies measuring the direct impact on economic growth, particularly during the post-2016 period, which witnessed an unprecedented surge in digital payment adoption. In light of this, the present study

aims to address this knowledge gap by modelling the relationship between electronic payments and economic growth in Algeria using the Autoregressive Distributed Lag (ARDL) model, which allows for the estimation of both short- and long-term relationships. The central question guiding this study is: What is the impact of electronic payment methods on economic growth in Algeria during the period from the first quarter of 2016 to the fourth quarter of 2025? Furthermore, does a short-run and long-run equilibrium relationship exist between the study variables according to the ARDL approach based on quarterly data?

The following main hypothesis is hereby formulated:

H : There is a statistically significant positive effect, in both the short and long term, of electronic payment indicators on economic growth in Algeria .

H1: The utilization of Electronic Point of Sale (e-POS) terminals is expected to have a significant positive impact on Algeria's Gross Domestic Product (GDP) in both the short and long run.

H2: The increase in Online Payment Activity transactions is expected to have a positive and significant impact on Algeria's Gross Domestic Product (GDP) in both the short and long run.

Figure 3. The study model

Source: Author's estimations

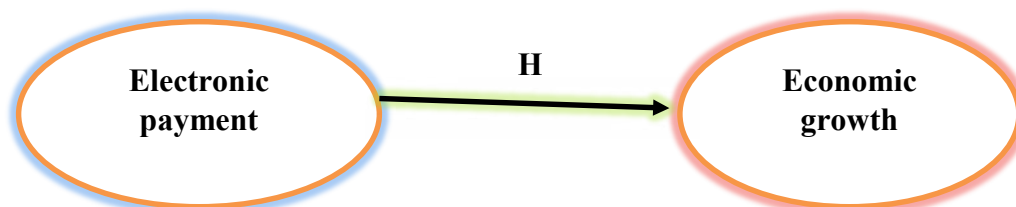
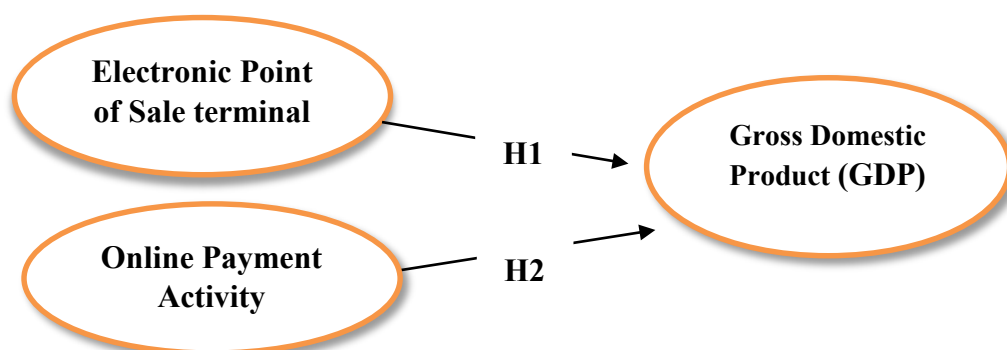


Figure 4: the model is expressed as

Source: Author's estimations



Literature Review

The increasing use of new communication technologies and the need for specific payment mechanisms for e-commerce have led to the development of e-payments, i.e. payments that are initiated and processed electronically. The Eurosystem, which has the statutory task of promoting the smooth operation of payment systems and to ensure overall financial stability, is considering its role in furthering the efficient and secure operation of these new payment instruments and systems (Bank, 2002). Electronic payment is a specific instance of non-cash payment, defined as an electronic transaction conducted between business actors, buyers and sellers, facilitated via the internet or electronic network (Indra Eka Wardana Toii, 2025).

The e-Payment system was trialled by three significant consumers.

a)- Client or Consumer: It can be posited that every internet user can be regarded as a potential consumer. It is imperative to devise a method that will ensure trust and security in e-Payment transactions.

b) -Merchant or Trader :The term 'Trader' refers to a consumer who sells goods or services to other consumers and conducts business using e-Payment. In this case, it is imperative that the business method employed for e-Payment is secure, in order to ensure that consumers have confidence in it and are willing to conduct transactions.

c)- The role of the bank, payment gateway or trust central authority is that of a third-party intermediary. This is a common practice among financial institutions, as it enables them to handle, validate and authorise transactions attempted by consumers and merchants via e-Payment (Silalahi, 2022).

E-payment and Economic Growth

The advent of e-payment systems has precipitated a congruence in the global payment systems with the contemporary trend of transactions among individuals, businesses and governments (Odi, 2013).The internationalisation of financial transactions appears to be inevitable in the near future. In order to facilitate this, it is essential that there is homogeneity and uniformity of the electronic payment process (Aldaas, 2021). The process of settling transactions has been rendered more straightforward and expeditious. E-payment systems are important mechanisms used by individuals and organisations as a secure and convenient way of making payments over the Internet. They also represent a gateway to technological advancement in the field of the world economy (Slozko, 2015).

The utilisation Online Payment Activity of electronic payments has been demonstrated to engender significant economic efficiencies by reducing the time required for financial transactions and conserving other resources. This

approach facilitates enhanced oversight, thereby enhancing the capacity to identify and investigate any potential misuse or fraudulent activities. Moreover, the involvement of the private sector fosters innovation, leading to a more diverse array of products and services within the domain of electronic payment systems. The utilisation of electronic payment systems has been demonstrated to engender a reduction in intermediary costs, thereby enhancing the efficiency of the involved parties. The advent of electronic commerce and online business has given rise to a novel market for information technology products and services. The implementation of e-payment systems within government services and benefit provision can be both straightforward and extensive (Aldaas, 2021)

Data And Methodology

1. Variables Used in the Analysis

Table 1

<i>Variables Definition and Data Sources</i>			
Source	Proxy/ Measurement	Symbol	Variable Type
World Bank	The logarithm of Gross Domestic Product	LNGDP	Dependent
GIE Monétique	The logarithm of Electronic Point of Sale (e-POS) terminals transactions	LNE-POS	Independent
GIE Monétique	The logarithm of Online Payment Activity	LNOPA	Independent

Source: Author' estimations

In light of the restricted availability of annual time series for electronic payment variables in Algeria (2016–2024), which fail to offer adequate degrees of freedom to estimate an ARDL model, a interpolation technique was employed to transform the data from an annual to a quarterly frequency using EViews. The objective of this step is to augment the sample size from 9 observations to 36, thereby facilitating more efficient and consistent estimates and ensuring the stability of the bounds test results. The approach adopted in the present study is quantitative and analytical in nature, with the EViews 12 programme being utilised for the purpose of analysis.

The following equation has been defined and employed for the purpose of testing the hypothesis:

$$\text{LN(GDP)}_t = \beta_0 + \beta_1 \text{LN(E-POS)}_{t-1} + \beta_2 \text{LN(OPA)}_{t-1} + \varepsilon_t$$

β_0 : Constant (intercept)

β_1, β_2 : Coefficients

ε : Error term

2.The study employed the following model: ARDL (Autoregressive Distributed Lag Model)

The ARDL cointegration technique was first developed by (Pesaran, 1999). and subsequently refined by (pesaran, 2001).The ARDL (Autoregressive Distributed Lag) method is an econometric approach that is frequently employed to examine dynamic relationships between variables over time, particularly when these variables are of different integration orders (I(0) or I(1)) and potential cointegration between them is under consideration. This methodological approach permits the concurrent evaluation of short- and long-term impacts within a malleable framework, obviating the necessity for all series to be integrated into the same sequence (Blancheton, 2020).The augmented-autoregressive-distributed-lag (ARDL) model is a hybrid model that integrates an autoregressive (AR) model with distributed lags.

The following variables are to be considered in order to provide an explanation. The aforementioned principle is expressed in the following formal statement:

$$Y_t = \phi + \sum_{i=1}^p a_i Y_{t-i} + \sum_{j=0}^q b_j X_{t-j} + \varepsilon_t$$

In this model, the dependent variable is denoted by Y_t , the explanatory variables by X_t , and the parameters p and q . The respective lag orders are represented by ϕ , a constant, and ε_t , an error term assumed to be white noise (Seabold, 2010) (Kripfganz, 2023).

Results And Discussion

1. Descriptive statistics

The following table presents the descriptive statistics for the variables used in this study, covering the quarterly period from **2016:Q1 to 2025:Q4**. The summary statistics provide an overview of the data's central tendency and dispersion, including the mean, median, maximum, minimum, and standard deviation for each series (**LNGDP, L NE-POS and LNOPA**).

Since the original data were collected on an annual basis and transformed into a quarterly frequency, these statistics reflect the intra-year variations and the steady progression of electronic payment indicators in the Algerian context during the studied period.

Table 2

Descriptive Statistics of the Study Variables (2016:Q1 – 2025:Q4)

	LN(E-POS)	LN(OPE)	LN(GDP)
Mean	21.93331	27.34950	29.74092
Median	22.77556	27.94001	29.72685
Maximum	25.70048	29.11200	29.83369
Minimum	16.52422	25.31659	29.68452
Std. Dev	2.790531	1.512098	0.045915
Skewness	-0.484065	-0.247804	0.829715
Kurtosis	2.138070	1.280433	2.607599
Jarque-Bera	2.800333	5.337561	4.361529

Source: Author's calculation using Eviews 12 application

2. Time Series Stability Test (ADF Test) and Test (PP Test)

Table 3

The result of the unit root measure

	AT THE LEVEL		AT FIRST DIFFERENCE	
Variable	ADF	PP	ADF	PP
LNGDP	-0.151 (0.9356)	0.03424 (0.9555)	-6.0451 (0.0000)	-6.07151 (0.0000)
LN E-POS	-0.67888 (0.8391)	-2.40603 (0.1466)	-3.72062 (0.008)	-8.35347 (0.0000)
LNOPA	-0.8205 (0.8020)	-0.7604 (0.8190)	-6.6977 (0.0000)	-6.6429 (0.0000)

Source: Author's calculation using Eviews 12 application

The findings of the ADF test and PP test (Table 3) indicate that all the variables fixedness at the first difference I (1). It is imperative to elucidate thoroughly the fixedness of the variables prior to estimating the model in order to validate correct application. In order to reach the conclusion of this study, the researchers employed unit root measures, including the Augmented Dickey-Fuller (1981) and Phillips-Perron (PP) test (1988).

3. The ARDL-Bounds Test approach was employed to examine the cointegration

3.1. Optimal Lag Length Selection

Table 4

Model Selection Criteria

Model Selection Criteria Table

Dependent Variable :LY

Data:11/05/2026 Time :22:14

Sample:2016Q1 2025Q4

Included Observations:35

model	LogL	AIC*	BIC	HQ	Adj. R-sq	Specification
1	102.550227	-5.517156	-5.250525	-5.425115	0.904724	ARDL(1,1,1)
3	100.679265	-5.467387	-5.245194	-5.390686	0.897508	ARDL(1,0,1)
4	97.698458	-5.354198	-5.176444	-5.292837	0.882396	ARDL(1,0,0)
2	97.843646	-5.305351	-5.083159	-5.228650	0.879479	ARDL(1,1,0)

Source: Author's calculation using Eviews 12 application

The **Model Selection Criteria** table presents the evaluation of different ARDL specifications. Based on the **Akaike Information Criterion (AIC)**, the **ARDL(1, 1, 1)** model was identified as the top-performing model, indicated by the asterisk (*) next to its value (**-5.517**). This model also demonstrates a high **Adjusted R-squared of 0.904**, confirming that 90.4% of the variations in the dependent variable (LY) are explained by the dynamic regressors in the model.

The figure displays the top models evaluated by the Akaike Information Criterion (AIC) to determine the optimal lag structure. Among the evaluated specifications, the ARDL(1, 1, 1) model was selected as the most appropriate because it achieved the minimum AIC value (approximately -5.52). Selecting the model with the lowest AIC ensures that the lag structure is parsimonious while capturing the essential dynamics between electronic payment indicators and economic growth.

Akaike Information Criteria

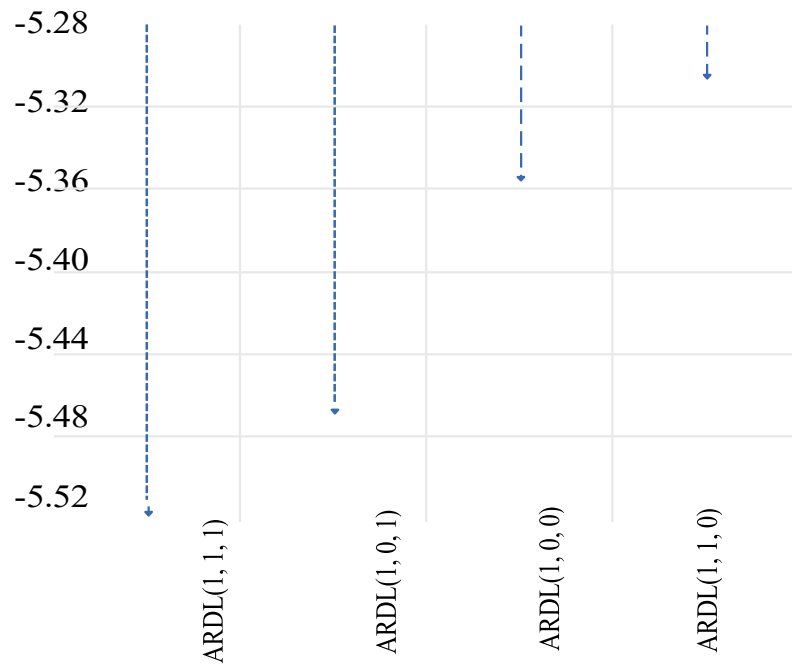


Figure5. Akaike information criteria

Source: Author's calculation using Eviews 12 application

3.2. ARDL Bounds Test

1. Testing the Hypotheses of the ARDL Bounds Test

H₀ : There is no cointegration relationship between variables (no long-term relationship).

H₁ : There is a cointegration relationship between the variables (there is a long-term relationship between the variables)

The results of the bounds test shown in the table indicate that the F-statistic value of (1.90) was below the lower critical values at a 5% significance level. Consequently, the null hypothesis is accepted, implying that there is no long-run cointegration relationship between electronic payment methods and economic growth in Algeria during the period (2016–2025).

Table 5. ARDL Long Run Form and Bounds Test
Source: Author's calculation using Eviews 12 application

ARDL Long Run Form and Bounds Test				
Dependent Variable : D(LY)				
Selected model : ARDL (1 ,1,1)				
Case2 : Restricted Constant and No Trend				
Date :11/05/2026 Time : 22 :29				
Sample :2016Q1 2025Q4				
Included Observations:35				
Conditional Error correction Regression				
Variable	Coefficient	Std,Error	T-Statistic	Prob
C	2.881385	2.171509	1.326904	0.1949
LY(-1)*	-0.099824	0.073494	-1.358266	0.1849
LX1(-1)	0.001344	0.003664	0.366706	0.7165
LX2(-1)	0.002315	0.006205	0.37301	0.7119
D(LX1)	0.011813	0.006345	1,861717	0.0728
D(LX2)	-0.030771	0.011824	-2.602404	0.0144
*P-Value Incompatible With T-Bounds Distribution				
levels Equation				
Case2 : Restricted Constant and No Trend				
Variable	Coefficient	Std,Error	T-Statistic	Prob
LX1	0.013461	0.035685	0.377224	0.7088
LX2	0.023187	0.064695	0.358408	0.7226
C	28.86458	1.08548	26.59153	0.0000
EC=LY-(0.0135*LX1+0.0232*LX2+28.8646)				
F-Bounds Test			Null Hypothesis: No levels relationship	
Test Statistic	Value	Signif	I(o)	I(1)
Asymptotic:n=1000				
F-statistic	1.902217	10%	2.63	3.35
K	2	5%	3.1	3.78
		2,50%	3.55	4.38
		1%	4.13	5
Actual Sample Size 35			Finite Sample:n=35	
		10%	2.845	3.623
		5%	3.478	4.335
		1%	4.948	6.028

-The impact of electronic payment terminal usage on GDP, utilising a rigorous scientific approach to analyse the data. The findings demonstrate that, in the short term, there is a statistically significant and positive relationship between payment activity at the electronic payment terminal and GDP, at the 10% significance level. The positive impact can be attributed to the fact that the widespread use of TPE terminals in shops and commercial premises accelerates

the velocity of money. In lieu of customers having to wait to withdraw cash from ATMs, the transaction is executed instantaneously, thereby prompting immediate consumption and enhancing the efficiency of small commercial transactions. This, in turn, has a direct bearing on an increase in GDP. However, the long-term implications are negligible. The absence of any discernible impact can be attributed to the fact that these devices remain confined to specific sectors, such as retail and tourism services, and have not yet attained the stage of 'full financial inclusion' that would precipitate a transformation in the macro-economic structure. Moreover, there is as yet no indication that reliance on them has had a radical effect on the saving or investment habits of Algerian citizens.

-The short-run results reveal a negative and statistically significant impact of electronic payments on economic growth in Algeria. Specifically, the coefficient of D(LX2) is negative (-0.0307) and significant at the 5% level, indicating that an increase in electronic payment transactions may initially reduce economic growth. This result may be explained by the current structure of digital spending in Algeria, where a substantial portion of online payments is directed toward imported goods and foreign digital services. Consequently, the rise in digital imports contributes to an increase in imports (M), which negatively affects net exports and GDP. Initially higher investment costs are required to secure digital platforms, costs which may exceed the direct economic returns in the early stages. This is of little consequence in the long term, however, as the digital economy in Algeria is still in an 'accumulation' phase. It is evident that these payments have not yet become a driver of domestic production or e-commerce that creates sustainable added value.

3.3. Normality Test

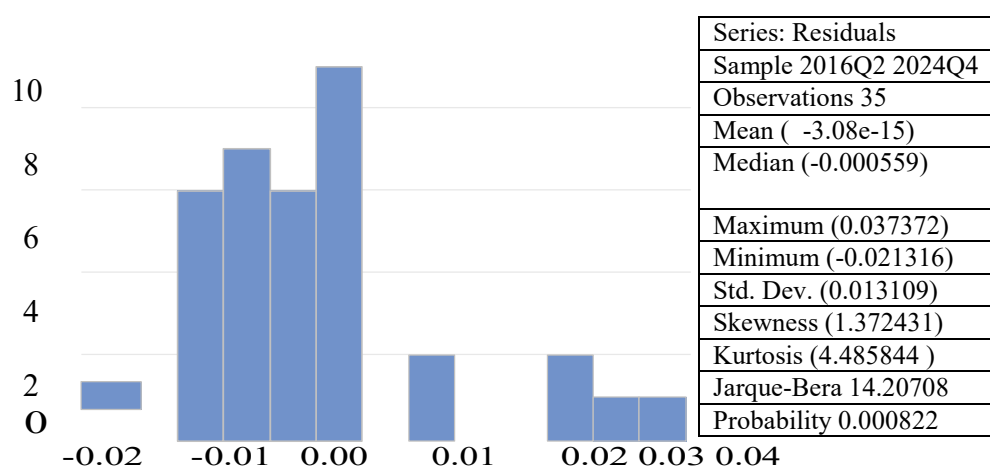


Figure 6. **Histogram – Normality Test**

Source: Author's calculation using Eviews 12 application

In order to verify whether the residuals in the estimated model follow a normal distribution, the Jarque-Bera test was applied. The results presented in Figure 6 demonstrate that the Jarque-Bera statistic was 14.20708, with a p-value of 0.000822. Given that the p-value is below the 5% significance level (0.05), it can be concluded that the residuals are not normally distributed over the study period. This phenomenon can be attributed to two primary factors: the constrained sample size and the conversion of annual data into quarterly observations. The observed deviation from the normal

distribution of residuals can be attributed to irregular spikes in electronic payment indicators in Algeria, particularly during the COVID-19 pandemic period (2020–2021). This period was characterised by a remarkable surge in online payments, resulting in a deviation from the standard distribution of residuals.

3.4 Structural Stability Test (CUSUM)

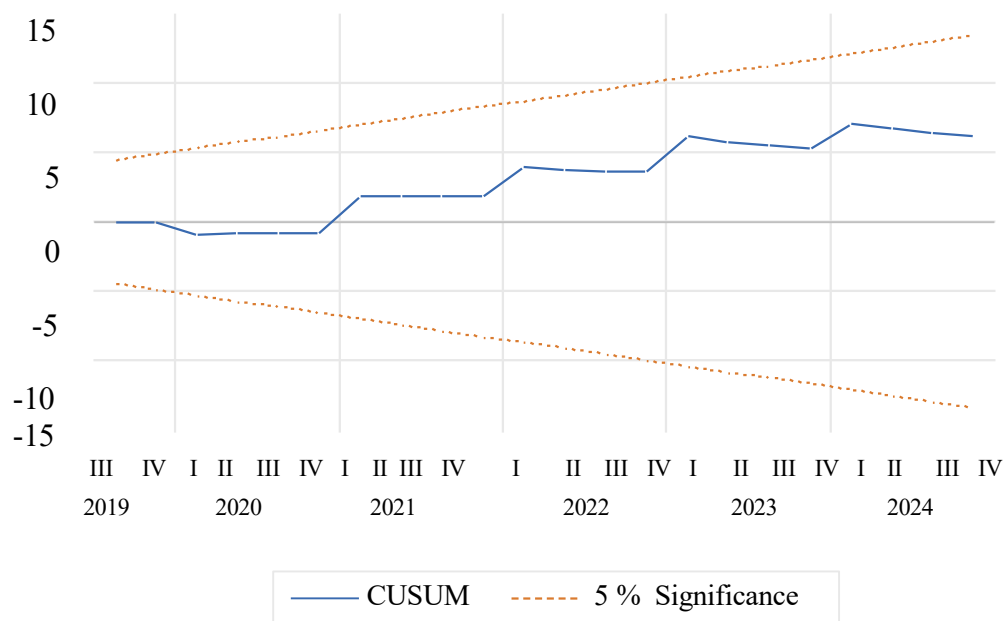
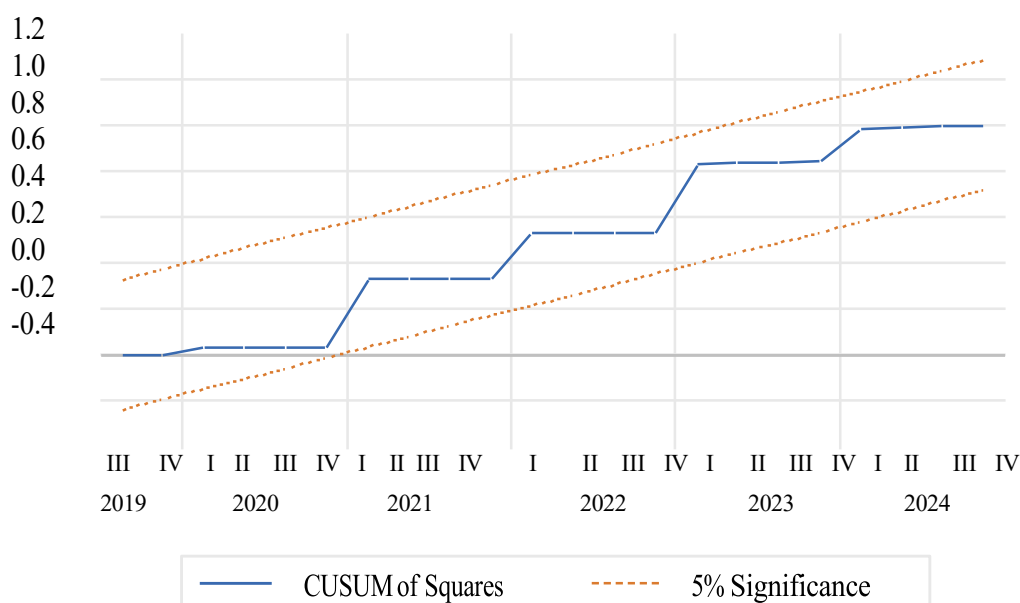


Figure 7. CUSUM

Source: Author's calculation using Eviews 12 application



Figur 8. CUSUM of Squares

Source: Author's calculation using Eviews 12 application

Despite the fact that the residuals do not satisfy the assumption of normality (Jarque-Bera test), the CUSUM and CUSUM of Squares structural stability tests demonstrate that the estimated ARDL model demonstrates a high degree of stability. The plots for both tests fall within the confidence limits at a 5% significance level, indicating that the parameters are stable and consistent over time. This stability serves to compensate for the absence of normality, thereby confirming the reliability of the model's results for economic interpretation.

The Jarque-Bera test yielded a significant result; however, the structural stability tests (CUSUM) demonstrated that the model is fully stable. In the context of modern econometrics, greater emphasis is placed on parameter stability than on the normal distribution of residuals in small samples. This is due to the fact that parameter stability ensures that results are not due to temporary random shocks.

Conclusions

In conclusion, it is evident that digital transformation has become one of the most significant factors influencing the development of contemporary economic and financial systems. Electronic payment methods have been shown to facilitate financial transactions, reduce the use of cash, promote financial inclusion, and improve the efficiency of economic activity.

In this study, an Autoregressive Distributed Lag (ARDL) model was employed to estimate the impact of electronic payment methods on economic growth in Algeria during the period 2016–2025. The standardised results in the short run demonstrated that electronic payment terminals (e-POS) exhibited a statistically significant positive impact on GDP, reflecting their role in stimulating instant consumption and accelerating the velocity of money. Conversely, online payments were found to have a negative impact on GDP due to these payments being directed towards the import of services and goods, such as the purchase of foreign services and products (e.g. software subscriptions, purchases from international websites, and overseas bookings), as well as the absence of a long-term symbiotic relationship. These findings suggest that the fintech sector remains in a transitional phase and has not yet reached the stage of sustainable structural impact despite government reforms, the spread of digital technology, and the increasing use of bank cards. The informal sector in Algeria remains a significant component of the economy, with a substantial portion of transactions conducted in cash. This has the effect of constraining the extent to which digitalisation can be implemented, as it is predominantly restricted to the 'formal sector'. This situation consequently undermines the potential for broader and long-term economic impact. The phenomenon of weak digital integration is a salient issue in contemporary discourse. Electronic payments are currently considered to be merely a means of payment and have not yet evolved into an integrated system that supports 'supply chains' or 'industrial production' – sectors that are likely to make a significant difference in the long term. It is evident that the full potential of electronic payments in the Algerian economy has yet to be realised.

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