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The impact of financial technology on financial inclusion and the development of banking services in Algeria

An empirical study to analyze the relationship between financial technology, financial inclusion, and the development of banking services in Algeria

أثر التكنولوجيا المالية على الشمول المالي وتطور الخدمات البنكية في الجزائر

دراسة قياسية لتحليل العلاقة بين التكنولوجيا المالية، الشمول المالي وتطور الخدمات البنكية في الجزائر

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Abstract:

This study aims to analyse the impact of financial technology on financial inclusion in Algeria over the period 2009 to 2023, using a descriptive-analytical approach. The research addresses various aspects of the subject by reviewing the theoretical framework of financial technology and financial inclusion, in addition to conducting a Bayesian econometric analysis of the relationship between financial technology, financial inclusion, and the development of banking services in Algeria, based on data published by the Bank of Algeria. The findings indicate that the advancement of financial technology serves as a key driver for enhancing financial inclusion and improving banking services in the country.
Keywords: Financial technology, Financial inclusion, Banking services, Bayesian analysis.
JEL classifications: G28, G21, O33, C11.

الملخص:

تهدف هذه الدراسة إلى تحليل أثر التكنولوجيا المالية على الشمول المالي في الجزائر خلال الفترة الممتدة من 2009 إلى 2023، وذلك بالاعتماد على منهج وصفي تحليلي. يتناول البحث مختلف جوانب الموضوع من خلال استعراض الإطار النظري للتكنولوجيا المالية والشمول المالي، بالإضافة إلى إجراء تحليل اقتصادي قياسي بايزي للعلاقة بين التكنولوجيا المالية، الشمول المالي، وتطوير الخدمات المصرفية في الجزائر، وذلك استنادًا إلى البيانات الصادرة عن بنك الجزائر. وتشير النتائج إلى أن تطور التكنولوجيا المالية يُعد محفزًا رئيسيًا لتعزيز الشمول المالي وتحسين الخدمات المصرفية في البلاد.
الكلمات المفتاحية :تكنولوجيا مالية، شمول مالي، خدمات مصرفية، تحليل بايزي.
تصنيفات JEL: G28، G21، O33، C11.

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INTRODUCTION:

In recent years, financial technology (Fintech) has progressed swiftly, fundamentally changing the manner in which financial services are provided and accessed. This progress has played a vital role in enhancing financial inclusion by improving access to financial services for those who are unbanked or underbanked. Within this framework, fintech is essential for advancing financial inclusion, particularly in developing countries such as Algeria, which aspires to close the financial gap and achieve sustainable economic advancement.

In Algeria, fintech represents a promising opportunity to improve access to banking and financial services, as it can provide innovative solutions to overcome the challenges associated with the geographical spread of banks and the high cost of traditional services through the use of e-payment applications, digital platforms, mobile money transfers and ATMs, this technology can effectively contribute to the integration of large segments of society into the formal financial system.

Research issue:

Despite significant advancements in financial technology worldwide, numerous nations, including Algeria, continue to encounter substantial obstacles in attaining financial inclusion for various societal groups, which is regarded as a primary goal of economic and social progress, facilitating secure and straightforward access to financial services for individuals and institutions.

How is fintech affecting financial inclusion and the development of banking services in Algeria?

The significance of this research is underscored by the contemporary relevance of financial technology and financial inclusion, both of which are critical topics today. The study sample is expected to yield significant findings while also identifying barriers that impede progress, thereby guiding necessary amendments and reforms aimed at achieving the ultimate objective of financial inclusion. This strategy is one that numerous nations aspire to implement and enhance. Consequently, this study aims to explore the interplay between financial technology, financial inclusion, and the advancement of banking services in Algeria, with a particular emphasis on the opportunities and challenges that the sector faces, as well as the key developments occurring within the country in this domain.

Research hypotheses:

1- Financial technology, represented by the number of ATMs in the post, contributes to enhancing financial inclusion by increasing the number of active bank accounts.

2- There is a significant positive impact of the number of depositors in banks on the development of banking services in Algeria, reflecting the role of traditional banking institutions in deepening financial inclusion.

Research objectives:

-Study the role of financial technology in promoting financial inclusion in Algeria and analyze their reality and the relationship between financial technology, financial inclusion and the development of banking services in Algeria.

-Evaluate the prevalence of the use of financial technology (e.g. banking applications, e-payments, and financing platforms) in Algeria.

-Analyze the factors that influence the adoption of FinTech, such as the availability of technological infrastructure and ATM penetration.

-Literature Review:

(Gamal Mohamed & Moharam Algarhy, 2024): 'Assessing the Impact of Financial Technology (Fintech) on Financial Inclusion in Egypt: An Applied Study' assesses the profound impact of financial technology (Fintech) on financial inclusion - a critical factor for economic development and social justice. Through empirical analysis, this study seeks to uncover the multiple ways in which Fintech is reshaping the financial landscape in Egypt, especially in terms of expanding access to financial services for underserved and unbanked groups. Data was collected from banks' financial statements from 2018 to 2022, with keywords identified in annual reports to create dummy variables for analysis, and analyzed using STATA through logistic regression to determine whether there is a significant impact or not. The results reveal that the research supports the hypothesis that FinTech has a significant impact on financial inclusion, as well as on the reliability, availability, accessibility, and efficiency of e-government services. Thus, this study contributes to providing valuable insights to the Egyptian government to develop e-payment systems and regulations that increase the availability, efficiency, and responsiveness of e-government services, thereby improving the lives of the country's residents.

(Venessa, Cedrich , Vincent, & candy, 2022): 'The Utilization of Fintech to Increase Financial Inclusion in Indonesia: A Conceptual Paper' investigates the leadership role of FinTech in the Chinese authorities' efforts towards financial access using time series econometrics over the period 2010 to 2020. Financial inclusion in China, which was considered a dependent variable, was represented by the dimensions of access and utilization, respectively represented by the number of bank branches and ATMs for the first dimension, while the second dimension was represented by the number of deposit and credit accounts and the independent variables were the different dimensions of FinTech applied in the financial market, such as the number of online P2P lending platforms, The number of lenders on these platforms, online payment, mobile payment, fintech tools that help promote financial inclusion, such as the Internet, the number of mobile subscriptions, and the size of the mobile Internet market, using discriminant analysis (PCA) to calculate an overall fintech score to replace and reduce the dimensions of the underlying variables, and the results show that fintech promotes financial inclusion, specifically that only the access dimension can be enhanced by using fintech, while fintech does not positively affect the use dimension and should should encourage Chinese authorities to invest in fintech to help remove barriers to financial inclusion.

Research approach: This research was carried out using the descriptive-analytical approach to describe the various aspects of the topic by discussing the theoretical framework of FinTech and financial inclusion, in addition, to analyze the reality of FinTech and financial inclusion during the period from 2016 to 2024, as well as the standard approach to study the relationship between FinTech, financial inclusion and the development of banking financial services in Algeria during the period from 2009 to 2023.

Research structure: To accomplish this research, the work was divided as follows:

1- What is financial inclusion and its measurement indicators.

2- The concept of financial technology and its importance.

3- The effectiveness of financial technology in promoting financial inclusion in Algeria.

1-Financial inclusion:

1-1- The concept of financial inclusion: There are many concepts related to financial inclusion:.

The World Bank defines financial inclusion or a comprehensive financial system as a system that enables individuals and economic agents to benefit from financial products and services equally (tran, le thi , & le quoe, 2023, p. 2)

The Center for Financial Inclusion (CFI, 2013) defines it as a situation in which all economic agents have access to high-quality and affordable financial products and services provided by financial institutions (Emmanuel & Felix , 2023, p. 58).

Through the above, it can be said that financial inclusion is providing access to and use of formal financial services and products for individuals and businesses at the right cost and time.

1-2The importance of financial inclusion: After the relationship between financial inclusion, financial stability and economic growth was proven, financial inclusion became the focus of many governments and financial regulators, including central banks, as it is difficult to have a permanently stable financial system in light of the financial exclusion experienced by individuals and companies in many countries, and the importance of financial inclusion is as follows (Luzri, 2021, p. 17):

* Financial inclusion attracts a large number of transactions and customers by creating and encouraging competition among financial institutions (cheli et keddi 133).

*Financial inclusion stimulates business growth and development, which results in an improvement in the economy's tax revenues, and is linked to the determinants of economic growth such as savings, investment, information and communication technology, and foreign direct investment, foreign portfolio investment, real economic growth and development are all factors that promote the financial market and its development in the short term.

*Financial inclusion contributes to spreading and developing a culture of savings, promoting savings, facilitating access to credit, and contributing to economic growth through the use and development of mobile phones.

*Financial inclusion supports the support of comprehensive and effective credit inquiry systems aimed at avoiding over-indebtedness and urging a rational borrowing policy, allowing population groups to access high-quality financial services, resulting in maximizing the credit impact, as well as ensuring the ability to continue to support microfinance institutions.

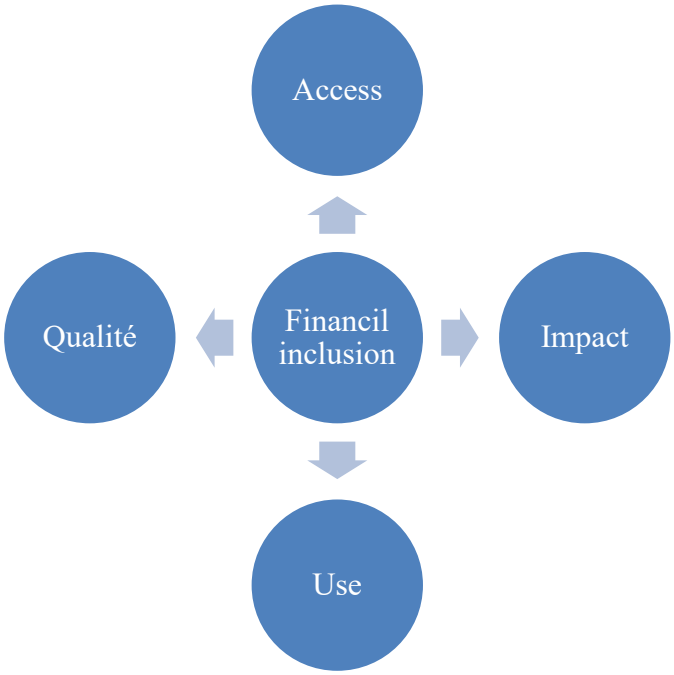
1-3-Indicators to measure global financial inclusion: It expresses the various dimensions of financial inclusion with reliable and comprehensive data, which is a crucial condition for policy-making, and the reason that makes it so is the prioritization of the aggregate sizes of the number of customers and their characteristics, thus representing the concept of financial inclusion indicators that allow setting a clear direction for policy makers by translating it into operational terms, and generally financial inclusion can be measured by the following (Kadiri & Mekidesh, 2020, p. 90):

*Access: It represents customers' access to financial services and products provided by formal financial institutions such as ATMs and bank branches, as well as their use.

Utilization: It is the depth and continuity of the financial service along with the products used and the duration of their use.

*Quality: This refers to the consumer's opinion of the financial service based on their experience with it, while understanding and measuring the nature of their relationship with the provider of this service.
*Impact: It is represented by the changes that occur in the life of the consumer of the financial service provided and that would enhance it.
The following figure shows the dimensions of financial inclusion

Fig (1):Dimensions of financial inclusion



Source: Prepared by the researchers

2-Financial technology:

2-1-The concept of financial technology:

There are many definitions of fintech, the most important of which are the following:
Fintech, which combines the terms “technology” and “finance”, refers to the technology used by innovative startups to provide financial and banking services because bankers and traders left financial centers to venture into entrepreneurship after the global financial crisis in order to rethink financial financing models through financial innovation (Harfoush, 2012, p. 726).
The Arab Monetary Fund defines it as the services and products offered that are used to improve the quality of traditional financial operations and services by relying on modern technologies that affect the level of the financial sector (Bourgba & Zaraki , 2022, p. 1057).
extends to administrative methods.

2-2-Importance and areas of fintech:

Although Fintech started late, it is currently gaining great importance, especially in some African countries and Middle Eastern countries, due to the benefits it provides, which can be summarized as follows (Benalakma & Saihi, 2018, p. 93):

- It provides alternative financing for both small and medium enterprises (SMEs).
- It contributes to the diversification of economic activity by relying on innovations to provide financial services, which enhances financial inclusion and increases its growth.
- Provides financial stability by ensuring regulatory compliance and risk management through the use of technology.
- Facilitates foreign remittances and foreign trade while ensuring the efficiency of the mechanisms used as well as the cost-effectiveness of cross-border payments.

3-Standard study: Bayesian econometric analysis of the relationship between fintech, financial inclusion, and the development of banking services in Algeria

3-1-Methodology:

This research employed a quantitative methodology to investigate the interplay between FinTech, financial inclusion, and the evolution of banking services in Algeria, utilizing econometric techniques to quantify and evaluate the extent of the interrelations among these variables. To improve the reliability and precision of the estimates, a combination of Ordinary Least Squares (OLS) and Bayesian Regression was applied within a cohesive methodological framework.

Initially, data pertaining to financial inclusion and banking technology metrics were gathered and subsequently subjected to descriptive analysis to compute arithmetic means, standard deviations, and the range of values. This phase aimed to establish a foundational understanding of the data distribution and assess the degree of variability, which is essential for identifying any outliers or potential complications that could influence later statistical analyses. A Correlation Matrix was constructed to examine the preliminary associations between the dependent variable (e.g., the number of active bank accounts) and the independent variables (e.g., the number of ATMs, the number of bank depositors, and the number of postal accounts). This process facilitated the evaluation of the degree of correlation among the variables and the identification of potential multicollinearity that could undermine the validity of the regression analyses.

The Ordinary Least Squares (OLS) method served as a foundational model, offering a general perspective on the relationship between FinTech and financial inclusion. The OLS approach estimates the coefficients of independent variables using the least squares method, under the assumption that the data are devoid of structural issues such as heteroskedasticity and autocorrelation. However, preliminary findings indicated the existence of multicollinearity and autocorrelation, necessitating the incorporation of more adaptable methodologies capable of addressing these challenges.

To address the detected statistical issues and improve the accuracy of the estimates, Bayesian regression was applied in its various versions. This methodology is based on incorporating prior information (Priors) into the estimation of model coefficients, which gives it more flexibility when the sample size is limited or there is a strong correlation between variables. Bayesian regression also allows the use of algorithms such as Markov Chain Monte Carlo (MCMC) to overcome autocorrelation in errors, which is one of its most important characteristics compared to traditional methods.

In this context, a Baseline Model was estimated focusing on the relationship between FinTech and financial inclusion, and then the models were extended by introducing additional variables such as the number of postal accounts and the number of depositors in banks, to test the

interaction of these variables with FinTech indicators in explaining the development of banking services.

Statistical tests were conducted to check the fit of the models and their ability to accurately represent the data. These tests included examining autocorrelation using the Durbin-Watson test, detecting multicollinearity via the variance inflation factor (VIF), as well as other tests related to error distribution and heteroscedasticity. Potential methodological issues were identified and corrected within a Bayesian regression framework that allows for more accurate and stable estimates in the presence of small samples or autocorrelation.

3-2-variables:

Below is a table of the variables used in the standardized analysis:

Table(1): Variables used in the standard analysis

Symbol	Variable	Role in the Model	Measurement / Unit	Description
ACC_ACT_t	Number of active accounts (in DZD)	Dependent variable (used to measure the development of banking services)	Number of active accounts annually	Represents the number of bank accounts used regularly
ATM_P_t	Number of postal ATMs	Independent variable (represents FinTech infrastructure)	Number of ATMs in the postal network	Reflects the level of digital banking services expansion via postal services
DEP_B_t	Number of bank depositors	Independent variable (main indicator of financial inclusion)	Number of depositors annually	Reflects the level of financial inclusion through the number of individuals owning bank accounts
CCP_t	Number of postal accounts	Independent variable (additional factor in financial inclusion)	Number of active postal accounts	Reflects the use of alternative financial services through postal accounts
ϵ_t	Random error	Source of random variation in the model	Estimated value from the statistical model	Represents unexplained factors that may influence active accounts

Source: Prepared by the researchers

The dependent variable is the number of active accounts in dinars ACC_ACT_t, a measure that reflects the extent to which individuals engage with banking services and the extent to which they engage in banking activities. Therefore, this variable is an indicator of the development of banking services in the Algerian market and allows monitoring the prevalence of active financial transactions.

As for the independent variables, the number of ATMs in the postal sector (ATM_P_t) reflects the extent of the spread and adoption of financial technology in the postal sector, as the presence of ATMs is associated with providing the necessary infrastructure for electronic transactions and reducing barriers to accessing banking services, making it a vital factor in promoting financial inclusion.

The number of depositors in banks DEP_B_t reflects the extent to which individuals accept the traditional banking system and is a key indicator of the level of financial inclusion, as the higher the number of individuals with bank accounts, the stronger the presence of the financial sector in society. On the other hand, the value of CCP_t indicates the extent of the spread of financial alternatives outside the traditional banking system, given the importance of the role of postal institutions in attracting a category of individuals who are not involved in the banking sector. This is in addition to the unexplained factors absorbed by the random error ϵ_t, which represents the rest of the effects that are not explicitly covered by the model.

Based on these variables, a standard model is proposed:

$$ACC_ACT_t=\beta_0+\beta_1 ATM_P_t+\beta_2 DEP_B_t+\beta_3 CCP_t+\epsilon_t$$

Where:

ACC_ACT_t represents the number of active accounts in dinars as the dependent variable and reflects the level of individuals' use of active banking services, making it an accurate indicator of the development of banking services in Algeria.

ATM_P_t represents the number of ATMs in the post, which is an indicator of the prevalence of digital banking services and the ease of access to financial services in different regions.

DEP_B_t represents the number of depositors in banks, a key indicator of the level of financial inclusion, as these variables reflect the ability of the banking system to attract new customers and promote bank savings.

CCP_t represents the number of postal accounts, which is an important factor in analyzing financial inclusion, given the role played by postal institutions in providing easy financial services to citizens who are not covered by the traditional banking system.

ϵ_t represents the random error in the model, which takes into account unexplained factors that may affect the number of active accounts in dinars.

The model assumes that fintech plays a central role in promoting financial inclusion, which in turn leads to the development of banking services. This model is in line with the economic literature that emphasizes that technological innovations in the financial sector contribute to expanding the scope of banking services, increasing the efficiency of financial operations, and improving customer experience. This model was selected based on the following factors:

The model is based on a theoretical framework that links FinTech to increasing the level of financial inclusion, and thus affects the development of banking services. The choice of this relationship is in line with the contemporary economic literature that sees financial innovation as a key factor that expands the scope of banking services supports the efficiency of financial operations and enhances the customer experience. The study was also keen to include variables such as the number of depositors and postal accounts, given their different roles in financial inclusion, whether through traditional or alternative channels.

This model acquires additional importance in light of the limited size of the available sample, which consists of annual data covering the period 2009 to 2023, as the use of Bayesian modelling is more compatible with such circumstances, as it provides flexibility in estimating parameters and dealing with issues of multicollinearity and autocorrelation. This helps in reaching more stable results, especially when there are differences in the levels of financial inclusion or the geographical spread of ATMs and postal accounts. The model is also based on financial growth theories that link the increasing introduction of technology in the banking system to higher transaction efficiency and the ability of the financial sector to attract a larger segment of customers, especially in light of the increasing reliance on digital services and e-payments.

3-3-Results:

Table(2): Descriptive statistics for the variables used in the model

Variable	Number of views (Obs)	Mean	Standard deviation (Std. Dev.)	minimum (Min)	Maximum (Max)
Number of active accounts in dinars ACC_ACT_t	15	10,900,000	1,294,670	8,566,479	12,800,000
Number of ATMs in the post ATM_P_t	15	1,110.2	484.86	443	1,943
Number of bank depositors DEP_B_t	15	11,000,000	1,230,127	8,332,261	12,300,000
Number of mail accounts CCP_t	15	19,400,000	2,222,150	15,100,000	23,600,000

Source: Prepared by the researchers, based on STATA 18 outputs

The table above presents the basic statistics of the variables used to analyse the impact of FinTech on financial inclusion and the development of banking services in Algeria:

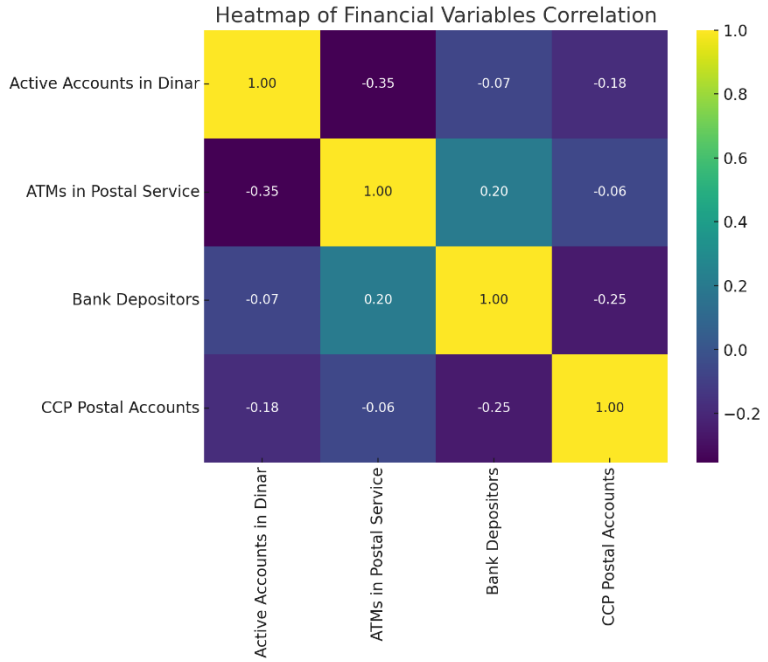
The count of active accounts in dinars (ACC_ACT_t) serves as a crucial metric for assessing the advancement of banking services in Algeria, reflecting customer engagement with active banking offerings. The average number of active accounts stands at 10.9 million, suggesting a substantial banking clientele. However, the data exhibits considerable variability, evidenced by a standard deviation of 1.29 million accounts, highlighting significant annual fluctuations. The active accounts range from a low of 8.57 million to a high of 12.8 million, indicating a steady increase in the adoption of banking services. The number of ATMs in the post (ATM_P_t) acts as a barometer for the proliferation of digital banking services and the accessibility of financial infrastructure. The average number of ATMs is recorded at 1,110, with a standard deviation of 484.86, signifying notable annual differences in ATM availability, which spans from a minimum of 443 to a maximum of 1,943, illustrating a gradual progression in the digitization of financial transactions. The number of depositors in banks (DEP_B_t) is a vital indicator of financial inclusion, reflecting the banking system's capacity to attract new clients. The average number of depositors is 11 million, indicating a robust level of financial inclusion. Nonetheless, the data shows a degree of variability, with a standard deviation of 1.23 million depositors. The depositor count ranges from a minimum of 8.33 million to a maximum of 12.3 million,

suggesting annual fluctuations that may be influenced by economic and regulatory factors affecting individuals' decisions to open bank accounts.

Number of postal accounts (CCP_t): This variable reflects the prevalence of alternative financial services, as many individuals in Algeria rely on postal accounts instead of traditional bank accounts. The arithmetic mean of the number of postal accounts is 19.4 million, indicating the significant role these accounts play in promoting financial inclusion. However, the high standard deviation of 2.22 million accounts indicates large variations in postal account opening rates between years. The number of postal accounts ranges from a minimum of 15.1 million to a maximum of 23.6 million, reflecting the growing trend towards the use of these financial channels.

The descriptive analysis indicates distinct differences in the data distribution across various variables, highlighting the necessity for employing sophisticated analytical techniques like Bayesian regression to investigate the evolving interactions among FinTech, financial inclusion, and the advancement of banking services. It is evident that the quantity of postal accounts and bank depositors exhibits comparatively lower variability than the number of ATMs at post offices, suggesting a degree of stability in consumer behaviour regarding conventional financial services, whereas ATM availability continues to experience considerable fluctuations.

Fig(2):Correlation matrix



Source: Prepared by the researchers, based on STATA 18 outputs

The heatmap illustrates the correlation between four key financial variables: active accounts in Dinar, ATMs in the postal service, bank depositors, and CCP postal accounts. The results reveal predominantly weak correlations, with the strongest relationship being a moderate negative correlation (-0.35) between the number of ATMs in the postal service and the number of active accounts in Dinar. This may suggest that as access to ATMs increases, reliance on active Dinar accounts slightly decreases, possibly due to greater adoption of electronic payment alternatives. Other correlations, such as between bank depositors and CCP postal accounts (-0.25) or between ATMs and bank depositors (0.20), remain weak, indicating limited direct interaction

between these financial indicators. Overall, the weak interdependence among the variables suggests that each operates somewhat independently within the financial ecosystem, warranting further investigation using more comprehensive, real-world data to validate these patterns.
Additionally, the strength of the correlation among certain variables may point to a potential multicollinearity problem, highlighting the need for advanced statistical techniques, such as Bayesian regression, to mitigate estimation distortions and ensure result accuracy.

Table(3): Normalized multiple linear regression results as a prototype

Number of variables: 15
Period :2009 to 2023
dependent variable : ACC_ACT_t
F(3, 11) = 52.01
Prob > F = 0.0000
R-squared = 0.9341
Adj R-squared = 0.9162
Root MSE = 3.7e+05

Variables	Coefficient	Standard error (Std. Error)	value t	P-value (P>|t|)	Minimum Trust Period 95%	Maximum Trust Period 95%
ATM_P_t	1318.679	437.7488	3.01	0.012	355.2	2282.157
DEP_B_t	0.5819222	0.1464553	3.97	0.002	0.2595764	0.9042681
CCP_t	-0.0078424	0.0665642	-0.12	0.908	-0.1543492	0.1386644
Constant	3236272	2184292	1.48	0.167	-1571323	8043867

Residual	1.5454e+12	11	1.4049e+11
Total	2.3466e+13	14	1.6762e+12

Source: Prepared by the researchers, based on STATA 18 outputs

The value of R^2=0.9341 indicates that 93.41% of the changes in the number of active dinar accounts are explained by the independent variables included in the model, reflecting a strong fit of the model. The adjusted value of AdjR^2=0.9162 remains high, indicating that the addition of variables did not lead to the introduction of unnecessary variables. The value of F(3,11)=52.01 with Prob>F=0.0000 indicates that the model as a whole is statistically significant, i.e. there is a significant relationship between the independent variables and the dependent variable.
Looking at the coefficients of the independent variables, we note that the number of ATMs in the post has a positive and significant effect on the number of active accounts in dinars, as the coefficient value of 1318.679 means that as the number of ATMs increases by one unit, the

number of active accounts increases by 1318.68 accounts on average. This effect is statistically significant at a significance level of P=0.012, indicating that this variable is significant in explaining active accounts.

The number of depositors in banks also has a significant and positive effect, as the coefficient value of 0.5819 means that increasing the number of depositors by one unit leads to an increase in active accounts by 0.58 accounts, which is statistically highly significant at P=0.002. This reflects the importance of financial inclusion in increasing banking activity. In contrast, we find that the number of postal accounts does not show a significant effect on the number of active accounts in dinars, as P=0.908, which means that this variable is not statistically significant, and the coefficient value is negative and close to zero (-0.0078), indicating that postal accounts do not affect active bank accounts. Finally, the value of the constant _c ons=3,236,272 is insignificant at P=0.167, indicating that there are other factors that may affect active accounts that were not included in the model.

Table(4): Results of the multicollinearity test (VIF)

	VIF	1/VIF
ATM_P_t	4.49	0.222757
DEP_B_t	3.23	0.309171
CCP_t	2.18	0.458649
Mean VIF: 3.30		

Source: Prepared by the researchers, based on STATA 18 outputs

The Variance Inflation Factor (VIF) test is designed to assess the extent of multicollinearity among independent variables, as elevated VIF values suggest a strong correlation between these variables, potentially resulting in unreliable estimates within the regression model. The findings reveal that the variable representing the number of ATMs has the highest VIF value of 4.49, followed by the number of depositors in banks at 3.23, and the number of postal accounts, which has the lowest VIF value of 2.18. Generally, multicollinearity is deemed problematic when VIF values surpass the threshold of 10, while values ranging from 5 to 10 indicate moderate multicollinearity that warrants attention, and values below 5 are considered acceptable and do not significantly affect the model. Given that the average VIF is 3.30, it can be inferred that multicollinearity is not a significant concern in this model.

Table (5): Results of various statistical tests

Statistical test	P-value	Calculated statistic	Analyse and interpret

Autocorrelation test (Durbin-Watson)	-	2.30	The Durbin-Watson test indicates that there is no significant autocorrelation in the errors, as the calculated value is close to 2, meaning that the null hypothesis of no autocorrelation cannot be rejected, and therefore the errors in the model are time independent.
Heteroscedasticity Test(Breusch-Pagan/Cook-Weisberg)	0.5803	0.31	The result indicates that there is no heterogeneous variance issue, as the probability value (0.5803) is significantly higher than the significance level of 0.05, which means that the null hypothesis that variance is constant across predicted values is accepted, and therefore the model's conclusions will not be affected by error heterogeneity.
Shapiro-Wilk test for normal distribution of residuals	0.84838	0.96935 (W)	This test reflects that the residuals follow a normal distribution, as the probability value is very high (0.84838), which means that the null hypothesis that the errors are normally distributed is not rejected, and therefore there is no issue affecting the accuracy of the model estimates.
Model Specification Test (Ramsey RESET)	0.3587	1.24 (F-statistic)	This test indicates that the model does not suffer from the issue of missing variables, as the probability value of 0.3587 is higher than 0.05, which means accepting the null hypothesis that the model is correctly specified and does not need modifications or adding new variables.

Source: Prepared by the researchers, based on STATA 18 outputs

Based on these results, it can be concluded that the model estimated using ordinary linear regression (OLS) satisfies the required statistical assumptions, as there is no significant autocorrelation between errors, no heterogeneous variance, the distribution of residuals is normal, and the model does not suffer from the issue of missing variables. These results enhance the reliability of the obtained coefficient estimates and support the transition to the use of Bayesian regression to provide more accurate estimates in line with the nature of the economic data under study.

Table(6): Bayesian regression results

Index	value
Number of Views (N)	15
Number of MCMC iterations	55,000

Burn-in (unused samples)	5,000
Effective MCMC sample size	50,000
Acceptance Rate	60.02%
Min Efficiency	0.001014
Avg Efficiency	0.01853
Log Marginal Likelihood	-738,512.57

Independent Variable	Mean	Standard Deviation (Std. Dev.)	Standard Error (MCSE)	Median	Bayesian confidence interval 95%
Number of ATMs in the post (ATM_P)	784.7989	0.5316	0.0168	784.8094	[783.6823, 785.8836]
Number of depositors in banks (DEP_B)	0.7786	0.00013	0.0000035	0.7786	[0.7784, 0.7789]
Number of Postal Accounts (CCP)	0.0779	0.00007	0.000002	0.0779	[0.0778, 0.0781]
Constant (_cons)	1163.268	0.7883	0.0249	1163.280	[1161.62, 1164.887]

Index	value
Variance(sigma²)	641,513.7
Standard Deviation (	354,203.3
Standard Error (MCSE)	49,740.3
Median	637,272.7
Bayesian confidence interval 95%	[60,432.04, 1,226,609]

Source: Prepared by the researchers, based on STATA 18 outputs

The selected number of observations (N) = 15 was determined based on the availability of data pertaining to the primary indicators of the study. This relatively small sample size renders Bayesian regression a suitable method, as it is capable of yielding more precise estimates even with limited data. To ensure the robustness of the findings and achieve statistical convergence, the number of MCMC iterations was established at 55,000, which is adequate for encompassing the probability distribution of the coefficients and reducing random fluctuations in the estimates.

Given that the initial iterations may be influenced by unstable starting values, a burn-in period of 5,000 iterations was implemented. This approach allows the model to circumvent the initial phase of non-convergent estimates, thereby ensuring that the final sample is not skewed by initial values that do not accurately reflect the true distribution of the coefficients. Following the exclusion of these iterations, the effective MCMC sample size was 50,000, which significantly enhances the accuracy of the probability distribution estimates of the coefficients and bolsters the reliability of the model's results.

The findings from the Bayesian regression analysis reveal a positive and statistically significant correlation between the quantity of ATMs available and the number of active accounts measured in dinars, with an impact coefficient of 784.7989 and a very narrow confidence interval of [783.6823, 785.8836]. This suggests that an increase of one ATM corresponds to a notable rise in active accounts. These findings align with economic theories positing that

improved access to banking services via the expansion of digital financial infrastructure promotes financial inclusion, particularly in nations experiencing growth in the fintech industry. The variable representing the number of bank depositors exhibited a positive coefficient of 0.7786, accompanied by a narrow confidence interval of [0.7784, 0.7789]. This suggests that a rise in the number of depositors correlates with an increase in active accounts denominated in dinars. This correlation is anticipated, as a growing number of depositors signifies enhanced banking awareness and a greater reliance on banking services, thereby facilitating the expansion of financial services. These findings lend support to the hypothesis that FinTech significantly contributes to attracting a larger demographic to the banking sector, which in turn positively influences the advancement of banking services.

The analysis of postal accounts (CCP) reveals a positive coefficient of 0.0779, indicating that while these accounts have a beneficial impact; their influence is relatively minor compared to other variables. This suggests that postal accounts do not play a pivotal role in driving the number of active accounts; rather, they may serve a supplementary function that aids in the dissemination of non-bank financial services. Consequently, it is recommended that fiscal policies aimed at enhancing financial inclusion should prioritize the advancement of digital banking systems over a reliance on traditional postal accounts.

Furthermore, the constant (_cons) value of 1163.268 implies the existence of additional factors influencing the number of active accounts that are not captured in the current model. This is anticipated; as the evolution of banking services is influenced by a multitude of elements, including fiscal policies, financial literacy levels, technological advancements, and the degree to which customers embrace digital services.

3-4-Discussion: The results of this analysis support the main hypotheses of the study:

- The robust positive correlation observed between the quantity of ATMs and the number of active accounts underscores the significant influence of FinTech in enhancing financial inclusion. This finding aligns with the hypothesis that FinTech facilitates the dissemination of digital financial services and improves accessibility to these services.
- The strong association between the number of bank depositors and active accounts indicates that conventional banking institutions continue to play a crucial role in fostering financial inclusion, thereby supporting the hypothesis that a greater number of customers utilizing banking services correlates with increased financial inclusion.
- However, it is noteworthy that while postal accounts have a beneficial effect, their influence is comparatively less significant than other factors, indicating that in Algeria; financial inclusion predominantly relies on banks and FinTech rather than traditional postal accounts.

These findings reflect the importance of fintech development as a tool to promote financial inclusion and the development of banking services in Algeria.

Based on this, several policies can be proposed to promote this trend:

-Expanding digital infrastructure: Promote ATM penetration, expand banking applications, and develop e-payment systems to facilitate financial access to larger segments of society.

-Promote integration between banks and postal services: Although postal accounts have not had a significant impact, the integration of postal services with digital banking systems may contribute to improving financial inclusion.

-Incentivize the use of digital channels: Launch financial literacy programs to encourage individuals to use digital banking apps and financial solutions instead of relying on traditional methods.

-Adopt policies that encourage fintech: Encourage innovation in the banking sector by supporting fintech start-ups and introducing technologies such as block chain and artificial intelligence to provide more efficient financial solutions.

The findings indicate that enhancing the presence of postal ATMs and bank depositors is essential for boosting the number of active accounts, which in turn fosters financial inclusion in Algeria. While postal accounts have a restricted impact, forthcoming banking policies ought to prioritize the advancement of digital infrastructures to guarantee enduring financial inclusion.

Supplements:

```
. summarize ACC_ACT ATM_P DEP_B CCP
```

Variable	Obs	Mean	Std. dev.	Min	Max
ACC_ACT	15	1.09e+07	1294670	8566479	1.28e+07
ATM_P	15	1110.2	484.8567	443	1943
DEP_B	15	1.10e+07	1230127	8332261	1.23e+07
CCP	15	1.94e+07	2222150	1.51e+07	2.36e+07

```
. regress ACC_ACT ATM_P DEP_B CCP
```

Source	SS	df	MS		
Model	2.1921e+13	3	7.3070e+12	Number of obs	= 15
Residual	1.5454e+12	11	1.4049e+11	F(3, 11)	= 52.01
				Prob > F	= 0.0000
				R-squared	= 0.9341
				Adj R-squared	= 0.9162
Total	2.3466e+13	14	1.6762e+12	Root MSE	= 3.7e+05

ACC_ACT	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
ATM_P	1318.679	437.7488	3.01	0.012	355.2	2282.157
DEP_B	.5819222	.1464553	3.97	0.002	.2595764	.9042681
CCP	-.0078424	.0665642	-0.12	0.908	-.1543492	.1386644
_cons	3236272	2184292	1.48	0.167	-1571323	8043867

```
. vif
```

Variable	VIF	1/VIF
ATM_P	4.49	0.222757
DEP_B	3.23	0.309171
CCP	2.18	0.458649
Mean VIF	3.30	

```
. estat dwatson

Durbin-Watson d-statistic(  4,    15) =  2.300001

. estat hettest

Breusch-Pagan/Cook-Weisberg test for heteroskedasticity
Assumption: Normal error terms
Variable: Fitted values of ACC_ACT

H0: Constant variance

    chi2(1) =   0.31
Prob > chi2 = 0.5803

. predict residuals, residuals
variable residuals already defined
r(110);

.
. swilk residuals

                  Shapiro-Wilk W test for normal data

    Variable |        Obs       W           V         z       Prob>z
-------------+-------------------------------------------------------
   residuals |         15    0.96935      0.594    -1.030    0.84838

. estat ovtest

Ramsey RESET test for omitted variables
Omitted: Powers of fitted values of ACC_ACT

H0: Model has no omitted variables

 F(3, 8) =   1.24
Prob > F = 0.3587



. bayes, nomleinitial mcmcsize(50000) burnin(5000): regress ACC_ACT ATM_P DEP_B CCP

Burn-in ...
note: invalid initial state.
Simulation ...

Model summary
------------------------------------------------------------------------------
Likelihood:
  ACC_ACT ~ regress(xb_ACC_ACT,{sigma2})

Priors:
  {ACC_ACT:ATM_P DEP_B CCP _cons} ~ normal(0,10000)                      (1)
                         {sigma2} ~ igamma(.01,.01)
------------------------------------------------------------------------------
(1) Parameters are elements of the linear form xb_ACC_ACT.

Bayesian linear regression                      MCMC iterations  =     55,000
Random-walk Metropolis-Hastings sampling        Burn-in          =      5,000
                                                MCMC sample size =     50,000
                                                Number of obs    =         15
                                                Acceptance rate  =      .6002
                                                Efficiency:  min =    .001014
                                                             avg =     .01853
Log marginal-likelihood = -738512.57                         max =     .02793

------------------------------------------------------------------------------
             |                                                     Equal-tailed
             |      Mean   Std. dev.     MCSE     Median  [95% cred. interval]
-------------+----------------------------------------------------------------
ACC_ACT      |
       ATM_P |   784.7989   .5316315    .01677   784.8094   783.6823   785.8836
       DEP_B |   .7786396   .0001295   3.5e-06   .7786365   .7783766   .7789141
         CCP |   .0779457   .0000685   2.0e-06   .0779467   .0777998   .0780859
       _cons |   1163.268   .7883502    .024893    1163.28    1161.62   1164.887
-------------+----------------------------------------------------------------
      sigma2 |   641513.7   354203.3   49740.3   637272.7   60432.04    1226609
------------------------------------------------------------------------------
```

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