

Analyzing the Impact of Fintech Adoption on the Financial Performance of Algerian Commercial Banks during the Period 2010-2024: A Panel Study Using the Autoregressive Distributed Lag (ARDL) Model

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Abstract:

This empirical study examines FinTech integration's effects on Algerian commercial banks' financial performance from 2010–2024. Using the ARDL model, it analyzes long-run cointegration and short-run adjustments between FinTech proxies (ATMs, CIB cards) and performance metrics (ROA, OP) with annual data.

Findings confirm a significant positive impact on profitability and efficiency, despite varying component effects over time. Banks employ error-correction mechanisms to address technological and economic shocks, fostering performance gains and sector resilience.

Keywords: Financial technology, financial performance, commercial banks, automated teller machine, bank cards.

Jel Classification Codes: G28 ‘G30 ‘C32 ‘G21.

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I. INTRODUCTION

In recent decades, the global banking sector has undergone profound and accelerating transformations driven by technological advancements, particularly the proliferation of financial technology (Fintech). This technology introduces innovative mechanisms to enhance banking services, reduce operational costs (Ryoo, 2019), and bolster financial efficiency, thereby directly influencing the performance and profitability of financial institutions. Recent 2024 statistics indicate that global Fintech investments have surpassed one trillion dollars, with annual growth rates exceeding 20%, reflecting a worldwide shift toward digitization and modernization in the financial sector. (Gai & ALL, 2018)

FinTech is implemented through various tools such as smart automated teller machines, digital bank cards, electronic payment systems, and mobile banking services, enabling greater access to rapid and efficient financial services (Jagtiani, 2022). International analyses in advanced economies like the United States, United Kingdom, and European Union countries confirm that banks adopting FinTech strategies achieved improvements in return on assets, operational efficiency, and reduced credit risk ratios. For instance, Bank of England reports indicate approximately 15% decline in banking transaction costs and 25% increase in customer satisfaction following FinTech solutions implementation (Haddad, 2022).

Regionally, Gulf countries and Jordan have witnessed widespread adoption of FinTech services like digital wallets and crowdfunding platforms, enhancing financial inclusion and expanding customer bases. In Algeria, commercial banks have gradually embraced these technologies, with local studies showing tangible gains in financial performance indicators despite infrastructure and regulatory challenges. Thus, the imperative arises for precise analytical studies employing advanced econometric models like the Autoregressive Distributed Lag (ARDL) to unravel the complexities of FinTech-financial performance nexus in a dynamic local context (Haddad, 2019).

This study plays a pivotal role in illuminating FinTech's contribution to achieving greater financial sustainability for banks and enhancing competitiveness in Algerian banking markets through dissecting short- and long-run impacts of these advanced technologies. It serves as a vital reference for policymakers and financial experts to formulate evidence-based strategies underpinned by contemporary analytical methodologies, thereby facilitating optimal digital transformation in the banking sector.

Grounded in annual data spanning 2010–2024, the research applies the Autoregressive Distributed Lag (ARDL) model, which provides a robust framework for probing relationships between FinTech variables and bank financial performance metrics, thereby deepening insights into the economic and

financial ramifications of digital shifts.,This elaboration underscores the scientific and practical value of harnessing FinTech as a core enabler for the banking sector amid the exigencies of the modern digital economy and persistent challenges confronting financial institutions in emerging and global markets.

1-1-Study Problem :

Despite FinTech's rapid advancement and its role in bolstering commercial banks' financial performance, significant knowledge gaps remain on its effects in local emerging markets like Algeria. The core research problem interrogates the robustness of linkages between FinTech tools (e.g., ATMs, bank cards) and banks' operational efficiency/asset profitability amid economic-technological flux. Challenges persist in econometric models like ARDL accurately modeling FinTech impacts amid variable integration disparities, transient/permanent effects, and confounders such as economic risks, regulations, and instability.

Utilizing 2010–2024 time-series data, this study dissects these dynamics in Algerian banks, pinpointing strengths/weaknesses in FinTech deployment and proffering strategies for sustainable performance enhancement.

1-2-Study assumptions :

FinTech adoption positively correlates with ROA in Algerian banks; ATMs/CIB cards enhance efficiency; component effects vary temporally (2010–2024). Literature-grounded hypotheses testable via ARDL modeling.

1-3-Study objective:

This study examines FinTech adoption's effects on Algerian commercial banks' financial performance (2010–2024), evaluating FinTech indicators (ATMs, bank cards) against ROA and operational efficiency via ARDL time-series analysis. Research advances understanding of FinTech's contributions to banking sector efficiency and sustainable growth through digital innovation..

1-4-Study Methodology :

This mixed quantitative-qualitative study analyzes FinTech's impact on Algerian commercial banks' financial performance (2010–2024) using secondary data from official reports and literature. The ARDL model examines short- and long-run dynamics between FinTech proxies (ATMs, CIB cards) and performance metrics (ROA, OP), incorporating regulatory analysis.

Findings confirm long-run positive effects on ROA but no significant OP impact, with short-run ATM negativity attributed to initial costs. Results validate ARDL robustness via stationarity, cointegration, and diagnostics.

1-5-Study Plan:The study can be divided into two main sections, plus results and recommendations:

- Theoretical framework and key prior economic studies.
- Measuring the impact of FinTech on financial performance of commercial banks.

2-Theoretical Framework and Key Prior Economic Literature:

2-1-FinTech Definition:

Financial technology (Fintech) is regarded as a primary driver of digital transformation in the global financial and banking sector, integrating modern technological tools—such as artificial intelligence, cloud computing, and blockchain technology—with financial processes to develop innovative and efficient solutions (Milian, 2019).

Fintech is defined as an ecosystem of products, services, models, and applications that leverage digital technologies to deliver and enhance traditional financial services, including electronic payments, crowdfunding, online banking, asset management, digital insurance, and intelligent data analytics. This ecosystem aims to improve financial service quality, increase efficiency, accelerate transaction processes, and expand customer access, particularly for traditionally underserved groups (Kauffman, 2018).

The Financial Stability Board (FSB) defines Fintech as "financial innovations that rely on technology to create new business models, applications, processes, or products with material effects on financial markets, institutions, and the delivery of financial services" (FSB, 2025).

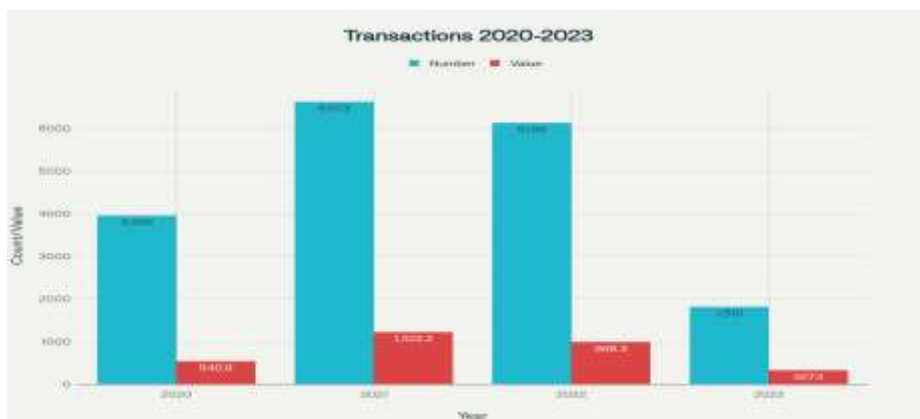
Fintech encompasses technological innovations utilizing modern digital tools to develop financial products and services, aiming to enhance operational efficiency and provide innovative solutions that promote financial inclusion and broaden access to financial services (Lee, 2018).

It also represents the fusion of technology and finance to reshape the financial sector through digital automation, big data analytics, and artificial intelligence, focusing on creating new business models that boost financial institutions' performance and service quality (Arner, 2016).

Studies further indicate that Fintech is not merely technology but a comprehensive system encompassing regulatory and operational innovation to reengineer traditional financial processes in alignment with modern digital era requirements (Philippon, 2016).

These definitions provide a clear, comprehensive view of Fintech from a contemporary scientific perspective, emphasizing its innovation and profound impact on the financial and banking system, reflecting substantial investment interest in the Fintech sector, as illustrated in the following figure.

Figure 1. Global Venture Capital Investment Activity in Fintech (2020–2023)



source :(KPMG, 2023)

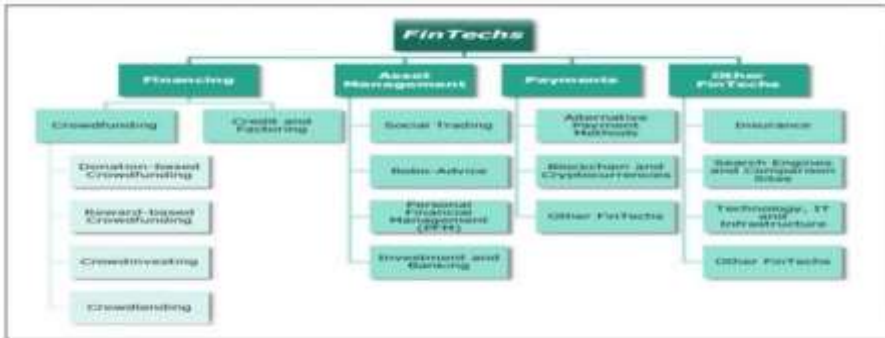
Figure 1 reveals FinTech VC funding volatility (2020–2023): 3,995 deals (\$49.9B) in 2020 peaked then declined to 6,128 (\$88.3B) in 2022 and 1,818 (\$27.3B) in 2023. Post-COVID normalization, geopolitical tensions, and market fluctuations curbed investor appetite. Despite slowdown, innovations and regulations sustain sector promise.

2-2-FinTech Fields:The four primary FinTech domains are as follows (Yang, 2023):

- **Electronic payments:** This domain forms the foundation of technological financial activity, encompassing digital payment services, electronic wallets, and rapid settlement systems that enable seamless and efficient financial transactions.
- **Digital banking services:** Includes online bank accounts, digital lending, and wealth management utilizing analytics and artificial intelligence technologies, enhancing financial service efficiency while reducing operational costs.
- **Insurtech:** Leverages data analytics, machine learning, and Internet of Things technologies to develop novel insurance products, improve customer experience, and enable precise risk assessment.
- **Crowdfunding and digital platforms:** Empowers individuals and businesses to secure funding via innovative electronic platforms, including crowdfunding, peer-to-peer lending, and other modern capital-raising methods.

These domains constitute the core pillars underpinning FinTech's development of the financial sector, directly contributing to enhanced efficiency, expanded financial inclusion, and improved service quality

Figure 2: Sectors of Financial Technology (Fintech)



source : (S&P Global Market Intelligence, 2016)

Figure 2 illustrates FinTech's diverse domains including financing, asset management, and payments via innovative technologies enhancing accessibility. Cryptocurrencies and blockchain emerge as modern alternatives accelerating transactions (Almeida, 2022).

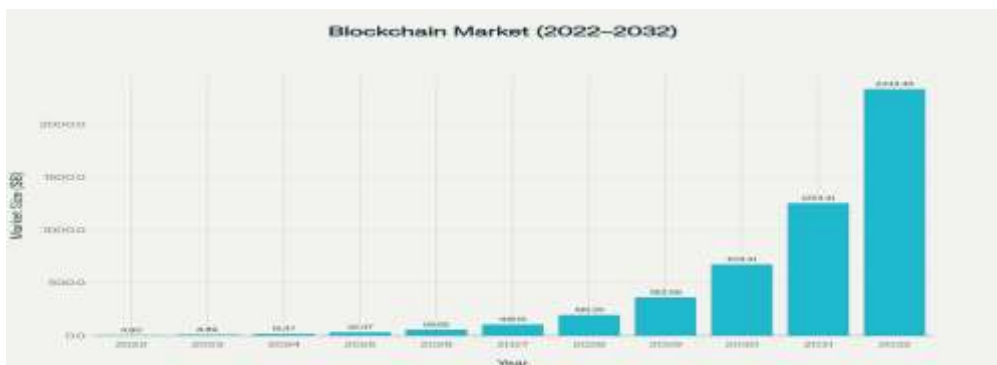
2-3 FinTech Applications and Risks

This section analyzes key applications and risks transforming financial institutions.

2-3-1 Blockchain

Blockchain catalyzes finance via smart contracts automating agreements without intermediaries, reducing costs and fraud risks. Figure 3 shows rapid market share growth

Figure 3: Global Blockchain Technology Market: Size, Share, and 10-Year Forecast (2022–2032)



source: Zion Market Research, 2025

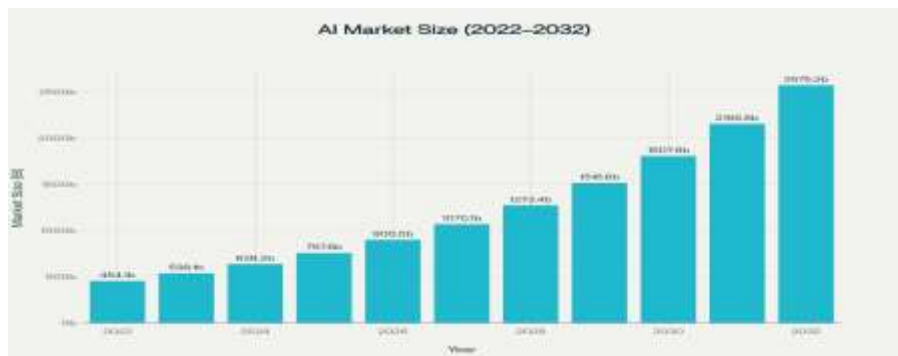
Figure 3, depicting blockchain technology market size from 2022 to 2032, illustrates accelerated growth over this period. Projections indicate market value

escalation from \$4.80 billion in 2022 to approximately \$2,334.46 billion by 2032. This remarkable expansion attributes to blockchain's fundamental benefits, fostering institutional and individual confidence, particularly in financial and banking sectors. The technology plays a pivotal role in enhancing operational efficiency, increasing transparency, and reducing costs associated with traditional financial transactions.

2-3-2 Artificial Intelligence

AI revolutionizes finance through advanced data analysis, decision-making, and automation, boosting efficiency and cutting costs. Key applications include algorithmic trading, market forecasting, portfolio management, credit diagnostics, risk management, fraud detection, and personalized services using non-traditional data for inclusion..(Fortune Business Insights2024.)

Figure (04) represents the artificial intelligence market size from 2022 to 2032 in billions of US dollars.



Source :Fortune Business Insights. (2024)

2-3-3 Remote Payment Systems

Blockchain slashes international transfer costs by 80%, speeds processing from days to seconds, and boosts transparency/security. Blockchain payment market valued at \$20.16B in 2024, projected to \$393.42B by 2032 (CAGR 43.65%). Global money supply ~\$583T by 2025. Algeria sees surging POS transactions and mobile payments.

Figure 05: Timeline of the Evolution of Remote Payment Systems

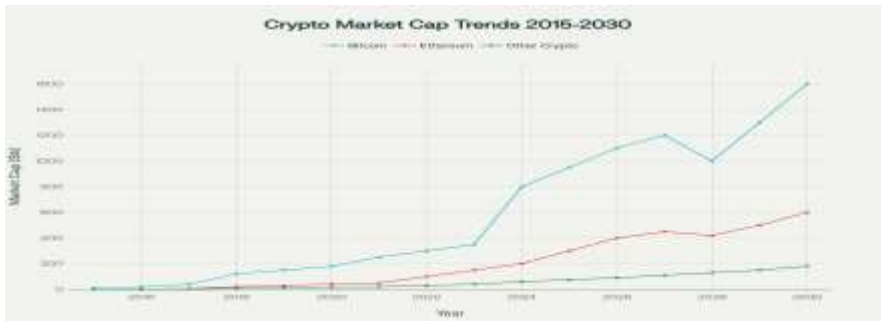


Source : Karkeraa, S. (2020).

2-3-4 Cryptocurrencies

Cryptocurrencies have experienced substantial evolution during 2020–2025, assuming a significant role in the global financial system with continued expansion in adoption by investors and institutions. The global cryptocurrency market reached approximately \$5.7 billion in 2024, projected to attain \$11.7 billion by 2030.

Figure 06: The market capitalization trend of the most important cryptocurrencies during the period from 2015 to 2030



Source : Brunetti. (2023)

2-3-5 Cloud Computing

Cloud computing represents technology enabling users to access computing resources and storage via the internet, rather than relying on local infrastructure, providing high flexibility, effective scalability, and operational cost reduction. In 2025, the global cloud computing market exhibited notable growth, reaching approximately \$912.77 billion, with projections estimating \$1.614 trillion by 2030.

Figure 07: Global cloud computing market size from 2022 to 2032 in billion US dollars



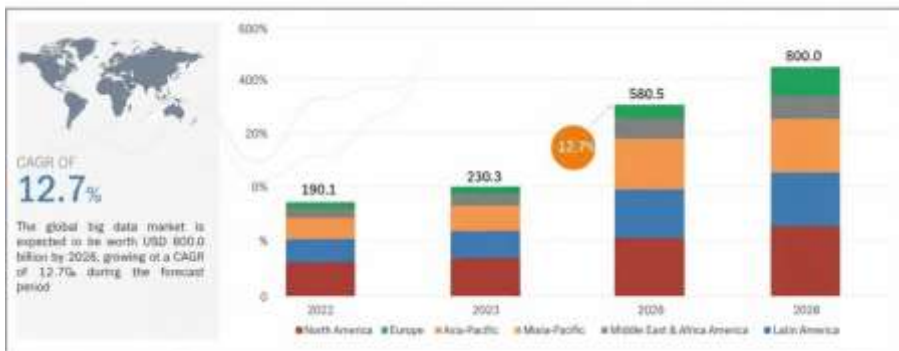
Source :Grand View Research. (2024)

80 – 91% of banks adopted cloud in 2025 (25% spending ↑), enabling 50 – 53% faster payments, superior cybersecurity, 15 – 19% revenue growth, 27% risk reduction, and cross-border expansion. Cloud drives banking efficiency/innovation.

2-3-6 Big Data

Financial institutions generate >175 zettabytes annually (30%+ growth), powering big data analytics for risk management, credit modeling, and fraud detection—70% of major banks analyze customer behavior, cutting losses up to 40%. Big data fortifies banking security/efficiency. (Gai & ALL, 2018)

Figure (08): Global Big Data Market Forecast Until 2028 (Billion USD)



Source :MarketsandMarkets. (2024)

2-4-Theoretical Framework for Bank Financial Performance

2-4-1 Definition of Bank Financial Performance

Bank financial performance measures the bank's ability to utilize financial resources for sustainable profit generation, maintaining adequate liquidity to meet obligations, and balancing risks with returns. This occurs through monitoring and analyzing multiple financial and performance dimensions reflecting the bank's actual financial health and interaction with surrounding economic-financial environment.

2-4-2 Dimensions and Indicators of Financial Performance

Profitability

Profitability constitutes the core element reflecting bank efficiency in generating profits from available assets and resources. Key indicators include return on assets (ROA) and return on equity (ROE).

Liquidity

Liquidity represents capacity to meet short-term financial obligations, essential for preventing crises; liquidity ratios such as turnover ratio and liquid assets ratio confirm the bank's ability to convert assets to cash rapidly without losses.

Capital Adequacy

Capital adequacy ratio (CAR) gauges banks' loss absorption capacity, expressed as capital-to-risk-weighted assets ratio per Basel standards (minimum 8%). Financial ratio analysis evaluates performance via statement relationships despite nomenclature variations, revealing strengths/weaknesses for strategic decisions. Integrated ratios provide precise financial position insights relative to historical/sector benchmarks, forming essential performance/planning foundation

"Table No01.: Most Common Financial Ratios for Performance Analysis

Ratio	Definition
Activity	The institution's efficiency in performing its daily operations
Liquidity	The institution's ability to meet its short-term obligations on due dates
Financial Solvency	The institution's ability to meet its long-term obligations
Profitability	The institution's ability to generate profits from its resources
Valuation	The measure of the outcome per share or ownership interest

**"Source: Prepared by the author based on financial literature regarding
performance analysis ratios.**

5-2 FinTech and Banking Performance Relationship

FinTech drives banking innovation, efficiency, and satisfaction via automation reducing errors/costs (electronic payments, digital loans). Enhances inclusion by overcoming barriers, expanding customer bases. Improves service quality/personalization boosting loyalty. Studies show complex ROA/ROE effects; credit cards/non-cash volumes positively correlate with ROE (Philippon, 2016).

6-2 Digital Financial Technologies Adopted in Algerian Banking Sector

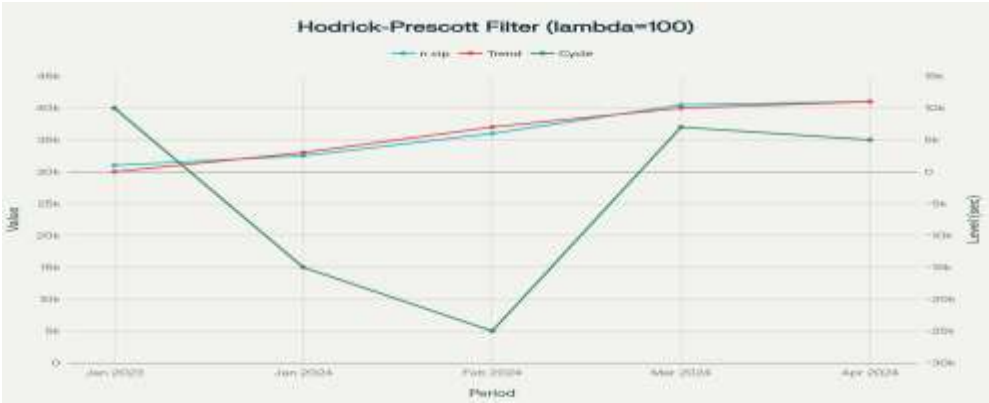
This section addresses various digital financial means and technologies utilized in Algeria's banking sector.

1-6-2 Bank Cards

Bank cards of various types represent primary means enhancing FinTech utilization in banking, embodying prominent manifestations of digital banking transformation. Algeria's People's Credit Bank pioneered bank card issuance, launching several types in 1990, including "Cash" withdrawal cards and international "Visa" cards. In 2002, the Interbank Payment System project launched to enhance coordination among Algerian banks across transactions. This initiative modernizes digital payment means, develops institutional relationships, and improves banking service quality. In 2004, the shared Carte Interbancaire (CIB) card compliant with international EMV standards issued to meet security and efficiency requirements in financial transactions.

The following table illustrates shared bank payment cards (CIB) numbers alongside prepaid cards distinguished by diverse usage, including bill payments and subscription renewals for customers

Figure No (09): Number of CIB Bank Cards and Gold Cards Circulating in Algeria



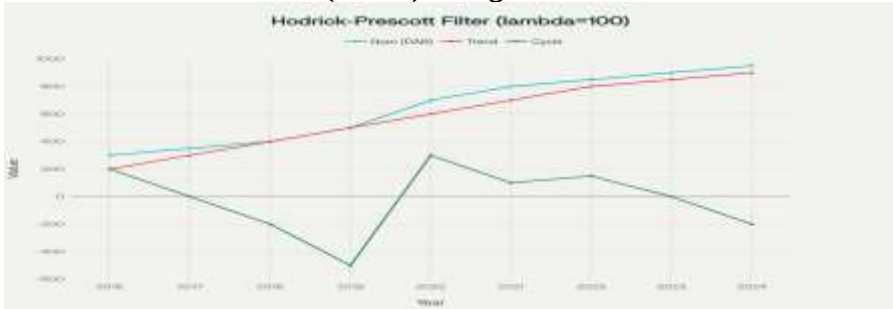
"Source: Prepared by the researcher based on outputs from EViews 12 software."

Figure 9 shows Algeria's CIB cards exhibiting statistically significant upward trend (Hodrick-Prescott filter at 5%) from Q1 2023–Q4 2024 . Numbers rose from 20,222,203 (2023) to 21,042,326 (April 2024; +822,123), driven by digitization, e-commerce, and cashless preference. This signals continuous growth in payment infrastructure

2-6-2 Cash Withdrawals via Automated Teller Machines (ATM)

With diverse bank card types issued in Algeria, their utilization across financial operations—whether withdrawals or payments—became essential. Prominent among these card uses is cash withdrawal via ATMs widespread across Algerian bank branches, facilitating and simplifying traditional withdrawal procedures

"Figure No. (10): Total Number of Operational Automated Teller Machines (ATMs) in Algeria."



"Source: Prepared by the researcher based on outputs from EViews 12 software."

Figure 10 demonstrates that Hodrick-Prescott filter application results indicate a trend component value with statistical significance at the 10% level. This signifies time's meaningful impact on the time series evolution representing total operational bank ATMs (ATM) in Algeria. Accordingly, ATM numbers exhibited continuous increase over time.

2-6-3 "Profitability Analysis Measures and Indicators in Algerian Banks"

Among Algerian banks' profitability indicators, return on assets (ROA) and return on equity (ROE) feature prominently, as illustrated in the following table:

**"Table No. (02): Profitability indicators of Algerian banks, including ROE
(Return on Equity) and ROA (Return on Assets)."**

Year	(%) ROE	(%) ROA
2024	*16.0	*1.6
2023	15.6	1.5
2022	13.47	1.38
2021	14.35	1.72
2020	11.62	1.43
2019	14.08	1.51
2018	22.41	2.42
2017	17.84	2.01
2016	18.14	1.86
2015	20.60	1.93

**"Source: Prepared by the researcher based on the Annual Reports of the Bank of
Algeria 2022.**

The table illustrates profitability indicators for Algerian banks, represented by two primary metrics: return on equity (ROE) and return on assets (ROA), spanning 2015 to 2022. Varying indicator values signify profitability fluctuations across these years, influenced by multiple economic and regulatory factors. ROE reflects bank efficiency in utilizing capital for profit generation, while ROA indicates capacity to generate earnings from total assets.

These metrics serve as vital tools for evaluating bank financial performance and analyzing growth and profitability strategies within Algeria's banking sector.

2-7 The most important economic literature of the past:

*The study conducted by **Hisyam Haris Nugroho (2023)**, titled "The Impact of Financial Technology on Banking Profitability," published in the journal *Ikrath-Ekonomika Indonesia*, examines the influence of financial technology on the profitability of banks by analyzing two key indicators: Return on Equity (ROE) and Return on Assets (ROA). Utilizing multiple linear regression analysis through SPSS 25, the study reveals that financial technology exerts a statistically significant positive impact on banking profitability. However, it also identifies a notable negative effect on operational aspects. These findings underscore the

multifaceted nature of financial technology's impact on banking performance, highlighting the importance of considering both its benefits and operational challenges. (Nugroho, 2023)

*The study conducted by **Yao Yang (2023)**, titled "Research on the Influence of Financial Technology on the Profitability of Small and Medium-sized Commercial Banks," published in *Frontiers in Business, Economic and Management*, examines the profitability of urban and agricultural commercial banks and their responsiveness to financial technology. The results indicate that financial technology positively enhances the profitability of these banks, albeit with notable disparities; urban banks demonstrate higher profitability and greater sensitivity to financial technology compared to rural banks. The analysis, covering the period from 2015 to 2020, utilized SPSS software and applied multiple linear regression models to investigate the relationship between bank profitability and financial technology indicators. This study underscores the varying impact of financial technology across different banking sectors characterized by distinct geographic and operational contexts. (Yang, 2023)

*The study conducted by **Pinjaman Saizal, Osman Zaiton, and Zhou Tian Xiang (2023)**, titled "The Impact of Financial Technology on Commercial Banks: A Case Study in China," published in the *Malaysian Journal of Social Sciences and Humanities*, aims to examine the effect of financial technology on the financial performance of commercial banks in China. The research relies on annual data collected from a sample of local commercial banks over the period from 2011 to 2020. These data were analyzed using the dynamic panel data model, specifically the Generalized Method of Moments (GMM). The findings reveal that financial technology exerts a statistically significant negative impact on the return on assets (ROA) of commercial banks. Consequently, the study concludes that financial technology has an overall adverse effect on the financial performance of banks. This underscores the complex nature of financial technology's influence on banking operations and highlights the necessity for further investigation into its potentially negative consequences. (Pinjaman, 2023)

*The study conducted by **Haneen A. Al-Khawaja and Abdul Razzak Alshehadeh (2022)**, titled "Financial Technology as a Basis for Financial Inclusion and Its Impact on Profitability," published in the *International Journal of Profitability Evidence from Commercial Banks*, aimed to investigate the role of financial technology tools and their effectiveness in advancing financial inclusion indicators and enhancing bank profitability. The research focused on a case study of the Jordan Commercial Bank over the period from 2010 to 2019. Using SPSS software and multiple regression analysis, the study revealed that financial technology significantly accelerated financial inclusion by providing innovative financial services, enabling broader segments of society to access credit at lower costs, while also increasing the bank's profitability throughout the

study period. These findings highlight the critical importance of integrating financial technology within banking strategies to promote financial sustainability and inclusive economic growth. (Khawaja, 2022)

*The study by **Di He (2022)**, entitled "The Impact of Financial Technology on the Profitability of Commercial Banks - Based on Science and Technology and Artificial Intelligence," presented at the 4th International Conference on Economic Management and Model Engineering (ICEMME 2022) in Nanjing, China, employs Stata 16.0 to develop a fixed-effects regression model to investigate the influence of financial technology integration on bank profitability. The study analyzes financial data from 15 Chinese banks spanning 2012 to 2020. Empirical results indicate a negative impact of financial technology advancements on the profitability of commercial banks, attributed to the absence of a standardized quantitative metric for financial technology development. The digital financial inclusion index utilized may not fully capture the actual technological progress, thereby potentially affecting the accuracy of the findings. This research underscores the necessity for standardized measurement tools to enable a more accurate assessment of financial technology's effect on banking performance(He.2023)

The research gap : addressed by this study pertains to the critical need for a more comprehensive and context-specific examination of the effects of financial technology on the financial performance of commercial banks in Algeria. Previous investigations have predominantly concentrated on varied geographical banking contexts or have utilized differing methodological frameworks, which limits their applicability to the Algerian market. By employing the Autoregressive Distributed Lag (ARDL) model within the specific economic and institutional milieu of Algeria, this study is uniquely positioned to capture both short-term and long-term dynamic interactions between key profitability metrics and the adoption of financial technology. Moreover, the research encompasses a recent time frame characterized by accelerated technological advancements, while meticulously considering the distinctive regulatory environment, adoption rates, and adaptive capacities of Algerian banks. Consequently, the study offers an original and substantive contribution that broadens the scholarly understanding of underexplored variables and dimensions within the nexus of financial technology and banking performance in Algeria.

3-Measuring FinTech Impact on Commercial Banks' Financial Performance

To estimate FinTech's impact on financial performance from 2010 to 2024, the following variables were considered: the first independent variable represented automated teller machines (ATM) count, while the second independent variable comprised bank cards (CIB). Dependent variables included return on assets

(ROA) as the primary dependent variable and operational efficiency (OP) as the secondary dependent variable. Relationships among these variables were analyzed to quantify FinTech's effect on bank financial performance indicators during the study period

Table 03: Variables and Study Period of the Standard Model

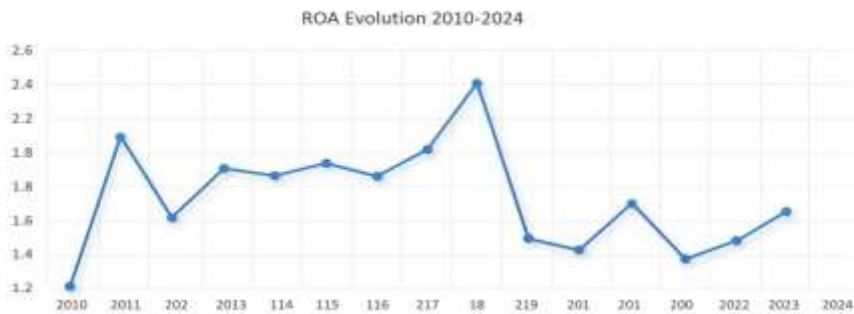
Study Period	Number of Observations	Variable	Code	Source
2024–2010	15	Return on Assets	ROA	Bank of Algeria
		Operational Efficiency	OP	Ministry of Finance Reports
		Number of ATMs	ATM	Bank of Algeria
		Bank Cards	CIB	Bank of Algeria

Source: Prepared by the researchers

Analysis of study variables evolution—both dependent and independent—over the study period from 2010 to 2024.

3-1 Return on Assets Evolution

"Figure (11) illustrates the development of Return on Assets over the period from 2010 to 2024."



"Source: Prepared by the researcher based on outputs from EViews 12 software."

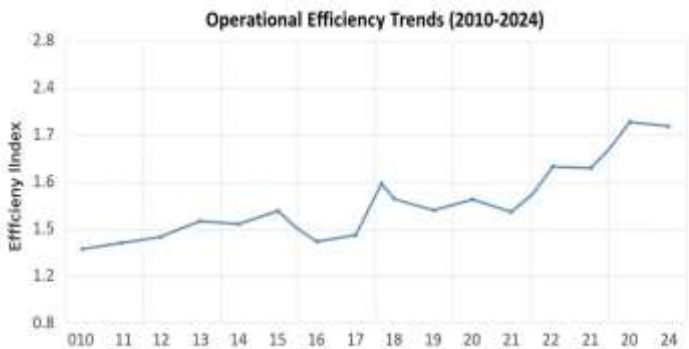
Figure 11 illustrates return on assets evolution from 2010 to 2024, revealing notable fluctuations in the ROA rate with successive periods of increases followed by declines throughout the study period. A sharp decline is particularly evident in 2019, attributable to economic and regulatory shocks significantly impacting financial performance.

3-2 Operational Efficiency Evolution

The following figure presents operational efficiency evolution over the study period spanning 2010 to 2024

"Figure (12) depicts the evolution of operational efficiency during the period

from 2010 to 2024."



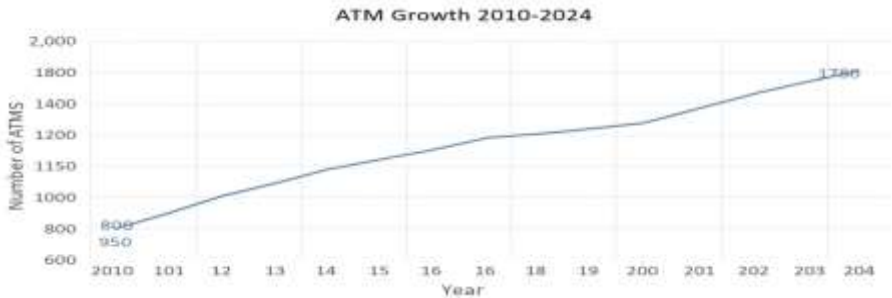
"Source: Prepared by the researcher based on outputs from EViews 12 software."

Figure 11 depicts operational efficiency evolution from 2010 to 2024, revealing persistent fluctuations throughout this period. Initially, relative stability was observed followed by slight improvement, then operational efficiency experienced notable decline reaching its lowest levels in 2017. Following this downturn, the indicator gradually improved amid continued fluctuations, peaking in 2024.

3-3 ATM Evolution

The following figure illustrates ATM evolution over the period spanning 2010-2024.

"Figure (13) illustrates the development of ATMs (Automated Teller Machines)



"Source: Prepared by the researcher based on outputs from EViews 12 software."

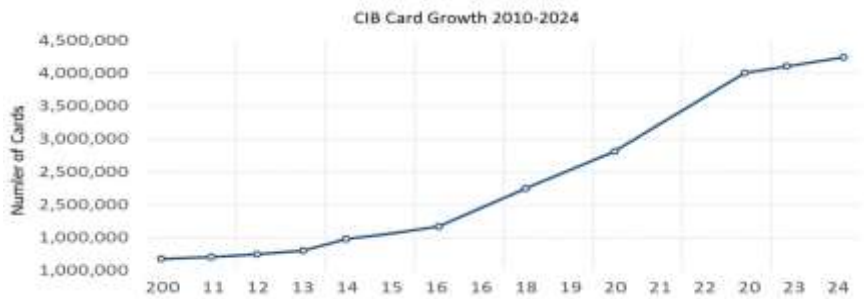
Figure depicting ATM count evolution from 2010 to 2024 reveals notable increase from period commencement in 2010, sustaining upward trajectory through 2020. That year registered slight decline attributable to COVID-19 economic shock. ATM numbers subsequently resumed growth post this phase,

recording tangible development in subsequent years.

3-4 Bank Cards Evolution

The following figure illustrates FinTech evolution spanning the study period from 2010 to 2024.

"Figure (14) shows the development of bank cards during the period from 2010 to 2024."



"Source: Prepared by the researcher based on outputs from EViews 12 software." Figure depicting bank card count evolution from 2010 to 2024 reveals notable increase in total cards throughout the study period. Initial years from 2010 to 2013 exhibited relatively stable growth, followed by continuous gradual increase persisting to present.

3-5 Stationarity Testing of Variables

Prior to model estimation, time series stationarity testing proves essential to verify variable integration orders. The following table presents time series stationarity test results using the Augmented Dickey-Fuller (ADF) test

"Table (04): Results of the Augmented Dickey-Fuller (ADF) Time Series Stationarity Test"

Level/First Difference	Variable	none	Trend+intercept	intercept
Level	LnROA	0.4	0.01	0.01
First difference	LnROA	0.001	0.08	0.02
Level	LngATM	0.01	0.5	0.1
First difference	LngATM	0.09	0.1	0.03
Level	LnOP	0.5	0.1	0.05
First difference	LnOP	0.0000	0.1	0.0008
Level	LngCIB	0.5	0.08	0.008
First difference	LngCIB	0.0000	0.0001	0.0003

"Source: Prepared by the researcher based on outputs from EViews 12 software."

Results indicate all study time series exhibit stationarity, rejecting the null hypothesis (H₀) of non-stationarity at 5% statistical significance level.

Study variables comprise two independent and two dependent variables as follows: LngATM: Natural logarithm of ATM evolution.

LngCIB: Natural logarithm of bank cards evolution

LnROA: Natural logarithm of return on assets

LnOP: Natural logarithm of operational efficiency.

ARDL model construction proceeds as follows:

Model 1: Assesses FinTech impact—represented by natural logarithms of ATM and bank cards evolution—on financial performance measured by natural logarithm of ROA.

Model 2: Measures identical FinTech impact on financial performance proxied by operational efficiency.

Model 1 estimation employs Autoregressive Distributed Lag (ARDL) approach. The study model equation can thus be formulated as follows:.

$$\text{Lnroa}t = c + \beta t \text{Lnroa}t-1 + \gamma_0 \text{Lngatm}t + \gamma_1 \text{Lngatm}t-1 + \gamma_2 \text{Lngatm}t-2 + \delta_0 \text{Lngcibt} + \varepsilon_t$$

"Table (05): Results of the Autoregressive Distributed Lag (ARDL) Model"

Variable	Coefficient	.Prob
(1-)LNROA	0.203577	0.1432
LNGATM11	0.272456	0.4502
(1-)LNGATM11	1.132743	0.0167
(2-)LNGATM11	1.345487	0.0067
LNGCIB	0.442765	0.0021
C	9.420007-	0.0006
R ²	0.9868	
.stat-F	88.67	
Prob(F)	0.000015	

"Source: Prepared by the researcher based on outputs from EViews 12 software."

Table 05 presents Autoregressive Distributed Lag (ARDL) model results, with determination coefficient (R-squared) estimated at 0.98, indicating independent variables explain approximately 98% of dependent variable (LnROA) variations. This signifies strong explanatory power.

Estimated probability value (Prob) of 0.000015 reflects high statistical significance, satisfying the significance condition where Prob(F-statistic) < 5%. Accordingly, the model demonstrates adequacy for necessary diagnostic testing

"3-5-1 Cointegration Test: Bound Test"

"Table (06): Results of the Cointegration Test Using the Bound Test"

statistic-F	k	Sample Size
34.65935	2	12
Significance	I(0) (n=35	I(1) (n=35
%10	2.845	3.623

%5	3.478	4.335
%1	4.948	6.028

"Source: Prepared by the researcher based on outputs from EViews 12 software."

Table 06 presents Bounds Test results, with F-statistic value approximately 34, compared against upper bound (4.33) and lower bound (3.47) at 5% significance level. This comparison rejects the null hypothesis (H_0) denying long-run equilibrium relationship, as F-statistic exceeds both bounds at 5% significance. Consequently, the alternative hypothesis (H_1) confirming long-run equilibrium relationship among variables LnROA, LnATM, and LnCIB is accepted. This affirms sustained stability in relationships between independent and dependent variables, indicating enduring long-term impact of independent variables on the dependent variable.

3-5-2 Estimation of the Long-Run Relationship

Following confirmation of long-run relationship among independent variables (LngCIB, LngATM) and dependent variable (LnROA), the subsequent step involves estimating parameters of this long-run equilibrium relationship. This estimation aims to quantify independent variables' impact on the dependent variable and test the hypothesis positing positive effects from independent variables (LngATM, LngCIB) on LnROA.

In simplified terms, results indicate FinTech positively influences bank financial performance profitability, reflecting direct positive relationship between them. That is, FinTech integration into banking systems contributes to enhanced bank profitability.

"Table (07): Variable Parameters of the Study Model in the Long-Run Relationship"

Variable	Coefficient	Std. Error	Statistic-t	.Prob
LNGATM	3.1898	0.5552	5.74	0.0012
LNGCIB	0.5559	0.0418	13.29	0.0000
C	6.1776-	0.5055	12.22-	0.0000
statistic-F	k	(%5) (I(0	(%5) (I(1	
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34.659	2	3.10	3.87	

"Source: Prepared by the researcher based on outputs from EViews 12 software."

Table 07 presents study model variable parameters, revealing the first independent variable coefficient (LngATM) at +3.18, while the second independent variable coefficient (LngCIB) stands at +0.55—both bearing positive signs. This indicates direct positive relationship between independent and dependent variables, whereby increases in both LngATM and LngCIB elevate return on assets rate (LnROA).

3-5-3 Estimation of the Short-Run Relationship:"

"Table (08): Estimation of the Short-Run Relationship"

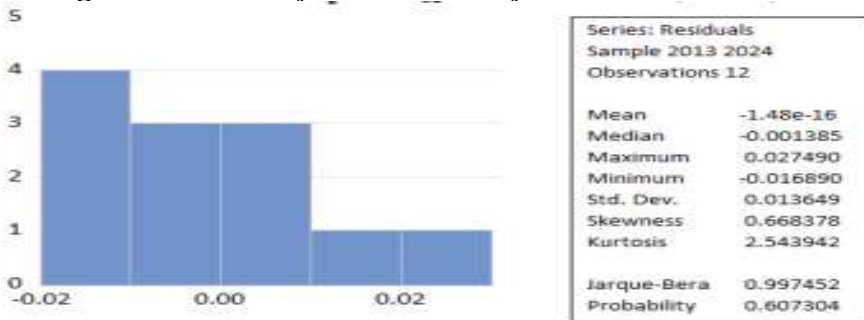
Variable	Coefficient	.Prob
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D(LNGATM)	0.2725	0.2340
((1-D(LNGATM(	1.1355-	0.0010
(1-)CointEq	0.7964-	0.0000
squared-R	Adj. R ²	Watson-Durbin
0.9621	0.9537	2.96

"Source: Prepared by the researcher based on outputs from EViews 12 software."
Table 08 shows LnGATM as sole short-run significant variable (negative coefficient -1.13, temporary). Long-run reveals positive independent variable effects on returns. Negative short-run impact from FinTech transition shocks; significant negative ECM confirms long-run equilibrium reversion

"3-6 Model Quality Test"

"Figure 15: Summary of the Normality Test for Random Errors"



"Source: Prepared by the researcher based on outputs from EViews 12 software."
The test's probability value is estimated at 0.60, exceeding the conventional significance level of 0.05, compelling rejection of the null hypothesis (H_0) and acceptance of the alternative hypothesis (H_1). Accordingly, residuals follow a normal distribution, with no violation of the normality assumption

3-6-1-Arch test:

Table 09: Arch test

	Value	Probability
statistic-F	0.004104	0.9503
squared-Obs*R	0.005013	0.9436

"Source: Prepared by the researcher based on outputs from EViews 12 software."
Table 09 indicates the probability value reached 0.9, exceeding the minimum required threshold of 0.05, signifying model errors exhibit no autocorrelation problem. Accordingly, we fail to reject the null hypothesis and accept the alternative hypothesis, confirming model error stability and absence of serial correlation affecting errors over time. This enhances result reliability and efficiency.

Table 10 Breusch-Godfrey Serial Correlation LM Test:

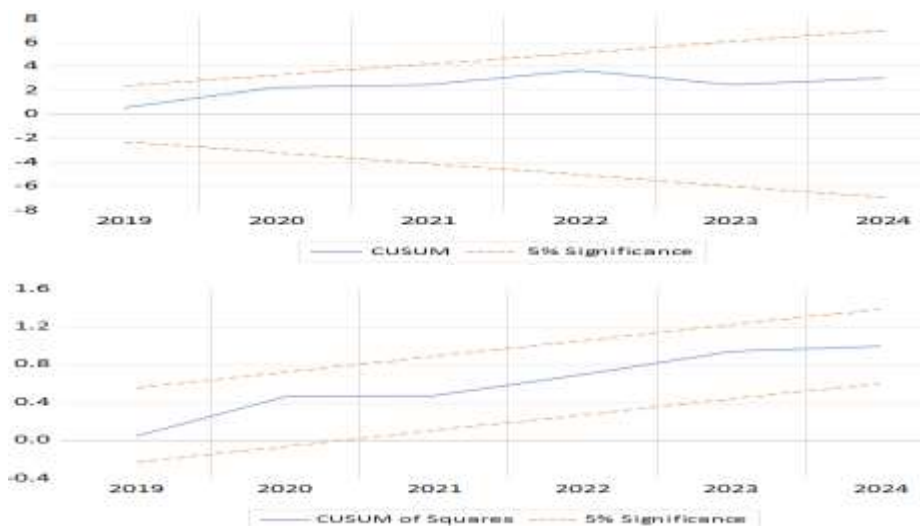
	Value	Probability
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statistic-F	3.964393	0.1124
squared-Obs*R	7.976120	0.0185

"Source: Prepared by the researcher based on outputs from EViews 12 software."

Table 10 presents Breusch-Godfrey autocorrelation test results, with probability value of 0.1124 exceeding the 0.05 significance level, indicating model errors satisfy no-autocorrelation condition. Accordingly, the null hypothesis (H_0) is rejected and the alternative hypothesis (H_1) accepted, confirming absence of autocorrelation among model errors. This bolsters model robustness and validity.

Figure16: the cusum and cosum of Squares.



"Source: Prepared by the researcher based on outputs from EViews 12 software."

Figure 16 demonstrates that ARDL model estimated parameters via CUSUM and CUSUM of Squares tests lie within critical bounds at 5% significance level. This confirms consistency between long-run and short-run relationship results. Accordingly, no structural breaks occurred in model data during the study period

4-Conclusion:

Following empirical results confirmation and theoretical framework comparison, the subsequent step involves interpreting findings, discussing outcomes, and hypothesis testing based on the Autoregressive Distributed Lag (ARDL) model. The general hypothesis posits FinTech exerts positive direct impact on commercial banks' financial performance—a proposition affirmed by results. The study reveals statistically significant positive relationship between FinTech indicators—ATMs and CIB cards—and return on assets (ROA). ATMs demonstrate greater ROA impact than bank cards, attributable to ATMs serving

as direct banking infrastructure facilitating immediate financial service access and revenue enhancement, whereas card effects hinge on user behavior, digital technology acceptance, and associated credit risks. Despite variable intercorrelation, ATMs emerge as more effective distribution channels than cards reliant on robust infrastructure and usage assurance.

Results indicate statistically significant short-run negative relationship between ATMs and ROA, reflecting temporary adverse impact. This attributes to high capital costs of ATM procurement and installation imposing initial financial burden. The system nonetheless reverts to long-run equilibrium exhibiting positive FinTech effects on returns.

Conversely, ARDL model results reveal no statistically significant relationship between independent variables (ATM, CIB) and dependent variable operational efficiency (OP). This proves logical as ATM and card expansion boosts ROA while incurring elevated operational costs—like maintenance and lost cards—offsetting efficiency gains. ATMs and cards primarily constitute customer-oriented services rather than internal process restructuring tools.

The study limits scope to traditional FinTech indicators (ATM, CIB), excluding modern innovations like mobile payments, crowdfunding, and blockchain. Comprehensive FinTech operational cost reduction impact requires broader study encompassing all contemporary tools.

This prompts rejection of the hypothesis asserting positive FinTech impact on operational costs. FinTech emerges as fundamental factor positively influencing commercial bank performance through service diversification/development, profitability enhancement, and banking operation efficiency. Scientific and practical findings confirm FinTech adoption opens new horizons via enhanced competitiveness, cost reduction, and customer base expansion. Modern technologies like ATMs and bank cards improve financial performance despite initial costs and short-run effects. FinTech thus proves vital for banking stability and sustainable growth amid evolving economic environments.

Recommendations

Continued emphasis on modern financial innovations adoption within banking sector recommended, increasing reliance on latest FinTech enhancing performance and efficiency. Study underscores financial inclusion enhancement importance, particularly remote/underserved areas, ensuring universal financial service access.

Customer financial literacy elevation essential to encourage effective FinTech utilization. University-bank collaboration strengthening and joint scientific

research support recommended for contextually appropriate Algerian market solutions development.

Banks must invest in digital infrastructure development ensuring FinTech system security/efficiency to bolster customer confidence.

Advanced training strategies adoption for banking personnel essential to enhance modern FinTech handling skills.

Government/regulatory authorities encouraged to foster innovation-friendly environments with clear regulatory frameworks supporting sustainable FinTech growth.

Public-private partnerships enhancement recommended to expand digital financial services providing entrepreneur/SME-appropriate financing solutions. FinTech integration initiatives in community financial education—particularly youth—supported to elevate digital financial literacy and strengthen national digital economy.

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