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FINTECH, FINANCIAL INNOVATION AND BANK PERFORMANCE: EMPIRICAL EVIDENCE ON TUNISIAN BANKS

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ABSTRACT

Conventional banks globally are investing significantly in Fintech to digitalise banking services and products while seeking technological innovation. This study seeks to examine the impact of technologies, including Internet Banking, Electronic Funds Transfer (EFT), Mobile Banking, and Automated Teller Machines (ATMs), on the financial performance of Tunisian banks. Our findings, derived from multiple linear regression, indicate that some banking innovations, including Internet Banking and Electronic Funds Transfer, exert a favourable and significant influence on the financial performance of Tunisian listed banks. These results underscore the disparate effects of various digital tools on financial success. The report underscores the necessity for Tunisian banks to prioritise high-impact Fintech solutions and reevaluate existing banking practices in response to technology advancements. It provides essential information for banking executives and policymakers seeking to promote innovation, enhance performance, and guarantee the long-term viability of the financial system.

KEYWORDS: Fintech, Mobile Banking, Internet Banking, Automated Teller Machine, Electronic Fund Transfer, Financial Performance.

1. INTRODUCTION

Following the global financial crisis of 2007–2008, the finance sector has experienced the rise of new financial entities termed "Fintech," a portmanteau of "finance" and "technology." Fintech companies have been utilising technical advancements to offer novel financial products that align with the changing demands of consumers in the digital economy (Thakor, 2018). Just as digitisation has revolutionised several sectors, Fintech has profoundly altered the financial industry. Financial technology is perceived as an integrated interaction between contemporary technologies and financial institutions, yielding an impact much surpassing the aggregate value of each component individually. Zetzsche et al. (2017) highlight two predominant trends defining contemporary Fintech: the first is the swift evolution propelled by the proliferation of big data, machine learning, technological accessibility, and artificial intelligence; the second is the growing involvement and investment of non-financial entities in the financial sector.Various recent studies examine the impact of technological developments on the performance of financial institutions (Prabu et al. 2021; Kumar et al. 2021; Thusi and Klein 2021; Pham et al. 2024). Recent empirical research highlights the transformative impact of financial technologies, including Automated Teller Machines (ATMs), Mobile Banking (MB), Internet Banking (IB), Electronic Funds Transfer (EFT), and FinTech, on the performance of banks. These technologies have transformed global banking operations by enhancing client engagement, decreasing transaction expenses, and increasing service efficiency. Notwithstanding the expanding corpus of scholarship, the North African region, especially Tunisia, remains inadequately examined. Tunisian banks are experiencing a sluggish digital transformation, impeded by structural and regulatory obstacles. Although banks persist in investing in digital tools to improve competitiveness and efficiency, the tangible effects of new technologies on financial performance remain inadequately assessed. This gap is especially pertinent considering the COVID-19 pandemic, which expedited digital adoption and altered consumer behaviour towards electronic payments. The crisis exacerbated rivalry between conventional banks and Fintech start-ups, particularly those providing AI-driven lending, big data analytics, and sophisticated digital payment systems.

This study seeks to address three primary objectives:

1. To enhance the theoretical comprehension of the correlation between technological innovation and bank performance.
2. To identify pertinent Fintech innovations and establish an appropriate empirical framework,
3. To investigate the impact of specific technologies, specifically Internet Banking and EFT, on the financial performance of Tunisian listed banks.

Our research of survey data from top executives, utilising multiple linear regression, indicates that Internet Banking and EFT significantly enhance bank performance. This study diverges from previous studies in two significant aspects. This study is the first empirical investigation of the effects of particular technical breakthroughs on the financial performance of banks in Tunisia. Secondly, the study enhances the Fintech-performance literature by elucidating the impact of digital transformation on bank competitiveness in a previously under-explored, post-pandemic emerging country. The remainder of the paper follows these procedures. Section 2 presents a conceptual framework. Section 3 delineates the theoretical framework and formulates our primary hypotheses. Section 4 delineates the research technique. Section 5 presents the principal findings. The last portion focusses on conclusions and suggestions for future research endeavours.

2. CONCEPTUAL FRAMEWORK

2.1. Fintech

Various researchers have suggested divergent definitions of Fintech, with some encompassing banks within its parameters, while others exclude them. Buchak et al. (2018) define Fintech as technology-enhanced banking products. Conversely, Thakor (2019) characterises Fintech as an innovative financial services model that circumvents conventional intermediaries, hence endangering them and omitting banks from his definition. Tang (2019) elucidates that Fintech can be perceived from two vantage points: the first pertains to conventional financial institutions integrating technologies, big data, and other innovations to improve and revolutionise their services, while the second emphasises technology firms striving to create financial services utilising these nascent technologies. The term Fintech is a contraction of "finance" and "technology," referring to contemporary start-ups that offer core financial services. Fintech refers to the application of technology to facilitate and enhance innovative financial services (Thakor 2019). It is characterised as "financial innovation driven by technology that may result in new business models, applications, processes, or products, significantly impacting

financial markets, institutions, and the delivery of financial services."

2.2. Artificial Intelligence

Despite extensive discourse among experts over the phrase "artificial intelligence," a definitive and globally acknowledged definition remains elusive. Russell and Norvig (2013) characterised artificial intelligence as an intelligent agent that executes activities. Its distinguishing feature is its automation capabilities, enabling the generation of models from data structures without human intervention (Huang et al., 2004). Additionally, a 2020 study by the Swiss Council of Finance sought to predict technology innovations and the prospective function of the World Bank. It delineated artificial intelligence as the domain focused on the creation of intelligent systems that can think and act in either a human-like or rational manner, employing self-correcting mechanisms. It is crucial to differentiate artificial intelligence (AI) from Robotic Process Automation (RPA), which automates repetitive operations and connects poorly linked systems, frequently necessitating human involvement to address operational deficiencies. Three primary branches constitute the most distinguished domains of AI in this context. Machine Learning (ML) empowers computers to acquire knowledge from experience, hence enhancing their proficiency in executing certain tasks over time. Next is Deep Learning (DL), a subset of ML that employs neural networks to enable rapid execution of complex tasks, especially those involving matrix calculations. The third domain is Natural Language Processing (NLP), wherein computers are instructed to understand and analyse extensive amounts of human language, both written and spoken, in a manner that emulates human text comprehension (Derendinger et al., 2020). Artificial intelligence (AI) is the ability of a computer or computer-operated robot to execute activities typically reserved for intelligent beings. It assists banks in enhancing their financial advice functions, particularly through the utilisation of software, and has the potential to supplant humans in straightforward decisions, and possibly in intricate decisions in the future. Baroud (2019) indicated that artificial intelligence is a technology capable of generating outcomes analogous to those produced by the human brain.

2.3. Big Data

Big Data is employed to address the challenge of the numerous databases that banking organisations can no longer manage owing to extensive financial activities. The data within Big Data facilitates the analysis of client demand without the necessity of a conventional committee review. Banking and finance increasingly utilise Big Data. The applications are numerous, and this represents merely the surface of the potential.

2.4. Financial performance

Financial performance is a metric for assessing an organization's efficacy and efficiency in attaining its objectives. Effectiveness is realised when management selects suitable objectives and strategies for their attainment. Efficiency refers to the input-output relationship whereby a specific revenue produces an optimal outcome (Karamoy and Tulung 2020). Modigliani and Miller (1963) were the pioneers in proposing the notion of business value. Numerous investigations have subsequently established the correlation between financial performance and corporate value. Fallatah and Dickins (2012) conducted an empirical study examining the influence of firm performance on its value. They utilise Return On Assets (ROA) and Return On Equity (ROE) as indicators of financial success, while employing Market to Book Equity Ratio (MBE) and Tobin's Q as metrics for corporate valuation. They demonstrate that corporate performance impacts value. Wahyu (2013) documented the influence of financial performance on corporate value. The financial performance measures include Return on Investment (ROI), Return on Equity (ROE), and Net Profit Margin (NPM), whereas the company value ratios are Tobin's Q, Price Earnings Ratio (PER), and closing price. They discovered that financial performance exerted a substantial and favourable impact on firm value. Marius et al. (2015) examine the influence of financial performance on firm value. They utilised ROA, ROE, and NPM as indicators of financial performance, while employing Tobin's Q, price-to-book ratio, and stock yield as metrics of business value. They demonstrate that for large corporations, financial success has a positive and considerable effect on value.

3. BACKGROUND AND DEVELOPMENT OF HYPOTHESES

3.1. Technological and Innovation Theories

This article's theoretical foundation is based on various recognised theories that examine the adoption and diffusion of technology and innovation, particularly in the financial and banking industries. These ideas provide insight into how technological advances influence corporate behavior, customer acceptance, and market dynamics. The

theory of Competitive Substitution between Technologies, formulated by Pistorius and Utterback (1997) and Coccia (2019), asserts that emerging and mature technologies frequently have a detrimental impact on one another, as new technologies typically supplant existing ones in competitive markets. Furthermore, Innovation Theory, initially articulated by Schumpeter (1911) and subsequently enhanced by Denning and Dunham (2010) and Sliber (2015), posits that innovation generates new consumer demands rather than merely addressing existing ones. It underscores the significance of capitalising on opportunities as a fundamental catalyst for successful innovation and indicates that financial innovation predominantly aims to augment institutional profitability. The framework integrates Diffusion of Innovation Theory, as delineated by Rogers (1995) and further developed by Barras (1988, 1990), which identifies five principal factors affecting the adoption of new technologies: relative advantage, compatibility, complexity, trialability, and observability. It additionally indicates that banks might participate in iterative cycles of innovation by adopting novel IT solutions. This research employs the Technology Acceptance Theory proposed by Davis et al. (1986, 1989) to elucidate user acceptance of these technologies, emphasising perceived usefulness and ease of use as fundamental determinants of technology adoption. The Unified Theory of Technology Acceptance, developed by Venkatesh et al. (2003, 2012), elaborates on this theory by integrating additional dimensions, including performance expectancy, effort expectancy, and social influence, all of which directly affect behavioural intention. Furthermore, Aaker and Keller's (1990) Consumer Theory presents a market-oriented perspective, indicating that new services can successfully replace older ones if they fulfil identical consumer demands. This theory use the demand curve as a mechanism to evaluate consumer reactions to fluctuations in product availability and pricing across time. Ultimately, Christensen's Disruptive Innovation Theory (1997) posits that new market entrants might deliver breakthroughs that destabilise existing market frameworks, confront established players, and result in changes in industry leadership.

3.2. Automated Teller Machine (ATM) and Bank Financial Performance

The banking sector is becoming progressively competitive. To sustain their competitive standing, banks must provide services to their clients through diverse methods. In this context, a pivotal service is the Automated Teller Machine (ATM), a product of the convergence of technology and electronics (Gümüş et al, 2015). ATM is also referred to as a "cash machine." or ATM Insert card, input PIN, and withdraw cash from the account. ATMs have many capabilities to facilitate more routine financial activities. Prabu et al. (2021) demonstrate that innovation in Automated Teller Machines (ATMs) has evolved into a significant technology inside the banking sector. Conducting a foreign exchange transaction or putting cash and cheques into a bank account is now feasible. A prosperous research domain is developing to examine the influence of numerous ATMs and their offerings on banking performance. Akhisar et al. (2015) investigate the impact of electronic banking services on banking performance. Return on Assets (ROA) and Return on Equity (ROE) were examined utilising data from 23 developed and emerging nations spanning the years 2005 to 2013. The authors assert that the quantity of bank cards in circulation (debit and credit cards) and the ratio of ATMs to branches exhibit a favourable correlation with profitability. The correlation between the number of branches and ATMs is more indicative of profitability than other metrics. In nearly all nations, consumers are more accustomed to electronic banking channels, such as ATMs, than to traditional branches, hence reducing operational expenses for these establishments. Additional studies have been conducted to examine bank profitability and financial inclusion. Kumar et al. (2021) analyse the Japanese market using a sample of 122 Japanese banks from 2004 to 2018. The authors assert that financial inclusion is crucial even in a developed country; branch closure adversely affects Japanese bank profitability, whereas the quantity of loan accounts and automated teller machines (ATMs) does not impact bank profitability. Numerous recent studies have investigated the relationship between automated teller machines (ATMs) and banking performance. Riski and Santoso (2024) investigate the impact of banking technologies, specifically Automated Teller Machines (ATMs) and mobile banking, on the financial performance of Indonesian banks. The authors employed a quantitative, associative research approach to gather panel data from six banks listed on the Indonesia Stock Exchange between 2018 and 2022. They demonstrate a substantial inverse correlation between ATM utilisation and ROA, indicating that ATM usage may diminish bank profitability. The implementation of mobile banking was determined to have a substantial beneficial impact on ROA, indicating its role in improving operational efficiency and adaptability to

changing client demands. Oboke et al. (2022) examine the impact of Automated Teller Machines (ATMs) on the financial performance of commercial banks listed on the Nairobi Securities Exchange in Kenya. Anchored in Innovation Diffusion Theory and Economic Value-Added Theory, the study employed an exploratory research approach and examined secondary panel data derived from the audited financial statements of 11 publicly listed banks from 2014 to 2020. This empirical evidence demonstrates a statistically significant and strong negative association between ATMs and Return on Equity (ROE), suggesting that an increased number of ATMs correlates with a reduced ROE. Additionally, Ele (2024) analyses the influence of online banking, ATMs, and mobile banking on the financial performance of Nigerian deposit money banks (DMBs). The research employs an ex-post facto design and utilises secondary time series data obtained from the Central Bank of Nigeria. The empirical results derived from the Autoregressive Distributed Lag (ARDL) analysis indicate a mixed effect. Internet banking exerts a statistically significant negative influence, but mobile banking demonstrates a favourable and significant effect, and ATMs also positively benefit banking performance. Bank performance is evaluated by return on investment (ROI). Monday et al. (2024) examine the influence of financial innovations on the financial performance of Nigerian deposit money banks (DMBs) utilising panel data from 2008 to 2023. Financial innovations were quantified through the utilisation of ATMs, POS terminals, internet banking (WEB), and mobile banking (MOB), and company performance was evaluated using ROA and ROE. The data was examined with Feasible Generalised Least Squares (FGLS) regression within a fixed effects panel model. This analysis concludes that ATM and POS transactions exert a statistically significant and positive influence on ROA and ROE, but WEB and MOB transactions demonstrate a positive although statistically negligible effect.

Our initial hypothesis is as follows:

H1: There is a positive relationship between ATM innovation and bank financial performance.

3.3. Mobile Banking (MB) and Bank Financial Performance

M-Banking serves as an intermediary mobile device connecting the user and the bank, facilitating payments and other mobile financial services without temporal or spatial constraints (Mobey, 2008). Over the past decade, mobile and other wireless markets have emerged as some of the fastest-growing sectors globally, enabling customers to connect to the internet and perform transactions through wireless devices (Varshney et al, 2010; Weitenberner et al, 2006; Wei et al, 2009; Assadi and Cudi, 2011). This presents substantial opportunity for financial institutions to deliver enhanced value offerings referred to as mobile banking. Grimes (2010) asserts that mobile phone services, encompassing SMS, Internet applications, and mobile banking, represent a novel technology with significant potential to enhance individuals' banking experiences. The Diffusion of Innovations Theory, Technology Acceptance Model (TAM), and Technology Acceptance Theory (TAT) contend that mobile banking has emerged as a strategic channel for banks to enhance responsiveness to competitive pressures and improve customer convenience (Jontathan and Chrong-Guang 2020). The new technology possesses significant potential to enhance the banking experience for retail clients and optimise bank operations; hence, banks are motivated to encourage its rapid adoption by their clientele. Thusi and Klein (2020) indicate that numerous studies have been undertaken regarding the acceptance and utilisation of these applications in emerging African nations, particularly concerning technology use. Brosig and Khindanova (2023) examined the impact of mobile banking usage on the financial metrics of banks in Colorado, namely return on assets (ROA), return on equity (ROE), and stock prices. Their empirical analysis reveals that mobile banking does not significantly impact ROA or ROE, but positively influences stock price performance, indicating that mobile services enhance investor confidence more than internal profitability. Kathuo et al. (2015) examine the influence of mobile banking transaction volume and product options on the financial performance of commercial banks in Kenya. Their findings indicated a robust positive correlation between mobile banking usage and profitability, with numerous institutions witnessing profit increases of up to 80% over a five-year span, attributed to enhanced consumer outreach and efficient service delivery via mobile platforms. Furthermore, Alayli (2023) examines the role of mobile banking during the COVID-19 epidemic via the lens of the Technology Acceptance Model. In a survey of 432 participants, the research demonstrated significant positive impacts of perceived ease of use, perceived usefulness, trust, and compatibility on bank performance, with these characteristics accounting for 34.4% of the variance in performance. Collectively, these studies underscore the increasing strategic importance of mobile

banking in enhancing client accessibility, market reputation, and financial performance, especially when aligned with user experience and trust.

The hypothesis H2 is presented as follows:

H2: There is a positive relationship between mobile banking usage and bank financial performance.

3.4. Internet Banking (IB)

Websites have emerged as a significant alternative distribution channel for the majority of banking organisations. Nevertheless, there is limited work investigating the impact of the Internet on banking performance. The proliferation and integration of the internet have recently transformed the competitive landscape for retail banks, which now predominantly deliver their services through online banking platforms (Onay and Ozsoz 2013). Several scholars analyse the effect of this transition on traditional banks within the framework of developed market economies. From this perspective, Hernado and Nieto (2006) examine the effect of establishing a transactional website on the financial performance of Spanish entities. Their findings indicate that utilising the Internet as a distribution channel leads to a gradual reduction in overhead expenses after eighteen months. The decrease in expenses results in enhanced profitability for banks, which becomes significant after eighteen months regarding ROA and three years concerning ROE. Deyoung et al. (2007) provide empirical evidence indicating that "click-and-mortar" banks in the U.S. utilised the Internet channel as a complement to, rather than a replacement for, physical locations. Other academics have also utilised ROA and ROE to assess the performance of online banks. Tunay et al. (2015) investigate the influence of internet banking on the performance of 30 European banks. They believe there is a significant correlation between internet banking and the success of Eurozone banks. They also establish a robust correlation between internet banking and bank performance. Neo-banking serves as an adjunct to the conventional banking system, depending on digital platforms and providing greater flexibility in the new payment services available to clients. Numerous empirical studies investigate the influence of internet finance and digital banking on the financial performance of commercial banks in various contexts. Dong et al. (2020) investigate the influence of internet finance on the performance of Chinese commercial banks by developing a complete internet finance index and analysing its effects on profitability, liquidity, security, growth, and overall business performance. They discovered that internet finance positively influenced profitability, security, and growth, while adversely affecting liquidity. Heshan (2023) examines the complementary and disruptive nature of internet finance in China, highlighting its capacity to reduce the intermediary role of existing banks while simultaneously fostering product innovation, technological advancement, and customer-centric changes. The empirical study conducted by Necib and Iafi (2024) evaluates the impact of internet banking on the performance of a panel of 31 French banks from 2008 to 2019. Their econometric analysis, utilising panel regression models, substantiates that internet banking has a positive and statistically significant impact on financial performance, measured by Return on Assets (ROA) and Return on Equity (ROE).

The hypothesis H3 is articulated as follows:

H3: There is a positive relationship between internet banking usage and bank financial performance.

3.5. Electronic Funds Transfer and Bank Financial Performance

Electronic funds transfer denotes the transference of monetary assets from one bank account to another using electronic methods utilising computer technology, either within a singular financial institution or between several institutions, without the direct participation of banking staff. Barnes (2015) states that electronic funds transfer is a method of sending money between bank accounts without the exchange of physical documents. It also denotes any monetary transfer executed using an electronic terminal, encompassing credit card, ATM, federal transfer, and point-of-sale (POS) transactions. It is utilised for both credit transfers, such as salary disbursements, and debit transfers. Zachariadis et al. (2017) investigate the correlation between the adoption of Society for Worldwide Interbank Financial Telecommunication (SWIFT) technology and banking performance among a meticulously chosen sample of institutions across 29 countries in Europe and the Americas. The authors demonstrate that SWIFT adoption is significantly correlated with long-term profitability. Electronic funds transfer (EFT) is highly secure, efficient, and cost-effective relative to conventional payment methods such as checks or collections. Numerous empirical studies investigate the influence of electronic banking (e-banking) technology on the financial performance of commercial banks across several geographies, including Nigeria, India, Kenya, and most of Africa. Each article analyses the impact of digital banking

instruments, including ATMs, mobile banking, electronic funds transfer (EFT), point of sale (POS), and online banking, on profitability and efficiency. Mustapha (2018) examines the influence of electronic payment technology on the performance of deposit money banks in Nigeria from 2012 to 2017. The research employs panel least squares regression and dynamic correlation models to analyse the relationship between e-payment adoption and banking outcomes. The research evaluates four primary platforms: ATM, POS, Mobile Banking, and Electronic Fund Transfer. Empirical evidence indicates that POS, Mobile Banking, and Electronic Fund Transfer substantially improve bank performance owing to their cost efficiency and extensive reach, but ATM operations detrimentally impact performance due to elevated infrastructure and maintenance expenses. Abukar (2019) asserts that the rising popularity of EFT for online bill payment paves the way for a paperless environment, rendering checks, stamps, envelopes, and paper bills obsolete. Furthermore, EFT contributes to reduced administrative costs, enhanced efficiency, streamlined accounting, and improved productivity. Chauhan et al. (2023) analyse the influence of e-banking on the profitability of public sector banks in India following the COVID-19 pandemic. This study examines the ten largest public sector banks by market capitalisation from 2007 to 2021, use return on assets (ROA) as the principal performance parameter. The research employs an Ordinary Least Squares (OLS) regression model utilising digital payment instruments, such as credit cards, debit cards, electronic funds transfer (EFT), and point of sale (POS) systems, as metrics for e-banking adoption. The findings indicate a substantial positive correlation between e-banking and bank profitability. The study by Sirengo and Muturi (2022) seeks to evaluate the influence of electronic banking services on the performance of commercial banks in Kenya, concentrating on four primary channels: mobile banking, Electronic Funds Transfer (EFT), Point of Sale (POS), and Automated Teller Machines (ATM). The sample encompassed all licensed commercial banks in Kenya, and secondary data were analysed from Central Bank of Kenya publications spanning the period from 2015 to 2019. The research utilised a panel regression model to analyse the correlation between electronic banking channels and financial performance, quantified by Return on Equity (ROE). The results indicated that EFT and POS transactions significantly enhanced bank performance, whereas mobile banking and ATM transactions exhibited either negative or negligible benefits. Mwakera et al. (2024) investigate the impact of electronic banking, particularly mobile banking and Electronic Funds Transfer (EFT), on the financial performance of commercial banks in Kenya. The study utilises a descriptive design and quantitative methodology, employing multiple regression analysis to examine the association between the independent variables (mobile banking and EFT) and financial performance metrics. The findings indicate a robust and statistically significant positive correlation between mobile banking, electronic funds transfer, and financial performance. The study determined that mobile banking markedly decreases operational expenses and enhances consumer accessibility, whereas electronic funds transfer (EFT) amplifies the frequency of daily transactions, both factors leading to an enhanced return on assets (ROA) and market share for financial institutions.

The hypothesis H4 is stated as follows:

H4: There is a positive relationship between electronic funds transfer and the financial performance of banks.

3.6. Fintech

Emerging technological competitors have profoundly contested conventional commercial banks, relegating them to the periphery of the financial sector. Consequently, banks have experienced a decline in their supremacy over lucrative industry sectors. Furthermore, changes in customer behaviour have transformed both the variety of services provided by banks and their public perception. This change has heightened competition between traditional banks and emergent technology-driven financial entities (McKinsey, 2016). Conventional banks under pressure to adopt artificial intelligence to mitigate loan default risks, ensure consumer security in payment processing, and facilitate task automation. According to Christensen (1997), new entrants offering more convenient and profitable products and services derived from emerging technology might instigate market competition. In this context, Fintechs represent disruptive developments within the market that foster competition. Phan et al. (2020) investigate the impact of FinTech companies on the performance of Indonesian banks. They present evidence of the contemporary effect assessment of FinTechs conducted on four banking performance indicators: ROE, ROA, NIM, and YEA. They observe that the inclusion of an extra FinTech firm in the financial services sector leads to a drop in NIM, ROA, ROE, and YEA. Serge et al. (2019) analysed a sample

of 170 banks from 2009 to 2015 and identified a positive and substantial correlation between the duration of mobile money utilisation by banks and their performance, as measured by several measures of profitability, efficiency, and stability. Serge et al. (2019) further illustrate that enhanced revenue diversification and improved access to deposits are potential mechanisms by which banks engaged in mobile money enhance their profitability. Their findings demonstrate the beneficial impact of collaboration between banks and mobile network carriers in delivering mobile money services. Kayed et al. (2024) examine the impact of internal financial technology (FinTech) integration on the performance of Jordanian commercial banks. The study utilises a sample of 13 banks in Jordan, encompassing the period from 2010 to 2019. The results indicate that FinTech advancement in banks enhances profitability and mitigates risk-taking behaviour. The analysis reveals no substantial effect of FinTech on stock returns. Almashhadani and Almashhadani (2023) investigate the correlation between FinTech adoption and banking performance in the United Arab Emirates (UAE). The sample comprises 19 banks operating in the UAE, and the study employs a quantitative methodology. The findings indicate a substantial and favourable impact of FinTech on critical performance metrics, namely Return on Assets (ROA) and Return on Equity (ROE), implying that FinTech enhances bank profitability and overall financial performance. The research conducted by Pham et al. (2024) examines the influence of FinTech advancement on banking performance in Vietnam. The study examines quarterly data from 15 publicly traded Vietnamese commercial banks spanning from Q1 2019 to Q2 2021. The researchers employed a text mining methodology to assess FinTech growth by analysing keyword frequency from financial news websites, whereas bank performance was measured using ROA, ROE, and NIM. The findings demonstrate that FinTech advancement favourably impacts bank profitability, evidenced by increased returns on assets and equity. Nonetheless, no substantial correlation was identified between FinTech and net interest margin, indicating that although digital innovation enhances profitability, it may not currently influence interest-derived earnings.

The hypothesis H5 is proposed as follows:

H5: There is a negative relationship between Fintech and the financial performance of banks.

In conclusion, this study contributes to the literature by providing empirical evidence on the effectiveness of banking technologies in Tunisia, using a comprehensive dataset of local banks and performance indicators.

4. RESEARCH METHODOLOGY

4.1. Sample and Data

This study investigates the impact of financial innovations on the financial performance of publicly listed Tunisian banks, utilising survey data gathered from questionnaires distributed to senior executives. The selection of this data collection instrument is based on a comprehensive literature review and a preliminary survey that was developed and evaluated through informal interviews with five top banking executives. These interviews allowed us to ascertain the clarity and applicability of the questionnaire. Insightful observations enabled us to enhance the clarity and objectivity of our questionnaire. The questionnaire targeted the senior management of banks listed on the Tunisian stock exchange; the enquiries were formatted as multiple-choice, and the respondents' identities were kept confidential. The final questionnaire consists of 20 mandatory questions on banking innovations and their effects on bank performance. Secondly, the questionnaire was administered via Google Forms and disseminated on LinkedIn to facilitate the automatic collection of replies in real-time. The weblink was disseminated to the senior executives of the banks, accompanied by a letter elucidating our research, and they subsequently shared the link with their colleagues. Given that the number of questionnaire respondents did not surpass 30, we printed the questionnaire and distributed it to the managers of the bank branches in Nasrya, Sfax, and Beb Bhar, where banks are concentrated. The questionnaire was sent to the bank directors through LinkedIn, Facebook, and in-person visits to their offices, where it was subsequently shared with their colleagues. Consequently, it is impossible to ascertain the group of individuals to whom the questionnaire was delivered. Respondents were authenticated by LinkedIn. Survey participants provided their complete name, job designation, and email address.

Alternatively, they were directly solicited within the bank. A total of 60 replies were gathered, of which 45 originated from the designated target population. Five questions were removed due to incomplete responses. The statistical analysis was performed on 40 valid questionnaires. Tables 1 and 2 illustrate the distribution and dispersion of the sample responses, respectively.

Table 1: Distribution of Sample Responses.

Responses	
Number of responses obtained at the beginning	60
Number of responses from the target population	45
Number of excluded questionnaires	5
Final sample	40

In this study, we aim to analyze the impact of investment in banking innovations on the financial performance of banks listed on the Tunis Stock Exchange. We remind you that forty members of the Bank Staff answered the questionnaire in its entirety. Due to missing data, the sample was reduced to include only the 11 listed banks. The following table presents the list of banks included in our study.

Table 2: Listed Banks Included in the Survey.

Abbreviation	Bank Name
AB	Amen Bank
ATB	Arab Tunisian Bank
ATTIJARI Bank	ATTIJARI Bank
BH	Banque de l'habitat
BNA	Banque national d'agricoles
BT	Banque de Tunis
BTE	Banque de Tunisie et des Emirats
STB	Société tunisienne de banque
UBCI	Union bancaire pour le commerce et l'industrie
UIB	Union internationale de banques
BIAT	Banque internationale arabe de Tunisie

4.2. Variable Measures

The survey responses were analysed to identify five independent factors and one dependent variable. The dependent variable is Bank Financial Performance (FP), whilst the independent variables denoting financial innovations comprise Automated Teller Machines (ATM), Mobile Banking (MB), Internet Banking (IB), and Electronic Funds Transfer (EFT). The data gathered via Google Forms was transferred to an Excel spreadsheet and organised across 40 participants. Scores for each of the five independent variables were calculated manually using a predetermined set of items. Table 3 delineates the essential components utilised to compute the score for each variable. The score was computed using the methodology established by Abukar et al. (2019).

Table 3: Main Items of Independent Variables.

Score Variable	Score Measure	Item
Automated Teller Machine Score (ATMs)	$ATMs = \sum_{i=1}^{4} ATM$	- The existence of the ATM ; - The cost of maintaining ATMs ; - Accessible services of ATMs and - The frequency of use of ATMs by customers.
Internet Banking Score (IBs)	$IBs = \sum_{i=1}^{4} IB$	- The existence of a mobile application of the bank ; - The profit generated by mobile banking ; - The impact of mobile banking on operational costs and - The impact of mobile banking revenues on the bank's revenue margin.
Mobile Banking Score (MBs)	$MBs = \sum_{i=1}^{4} MB$	- The existence of an online bank ; - The impact of internet banking on bank revenues ; - The influence of internet banking on operational costs and return on assets and - The effect of internet banking on revenue margin.
Electronic funds transfer score (EFTs)	$MBs = \sum_{i=1}^{4} MB$	- The existence of the EFT service ; - The effect of Electronic Funds Transfer on revenue ; - The influence of Electronic Funds Transfer on operational costs and - The impact of EFT revenue on the bank's revenue margin.
Fintech Score (FINTECHs)	$FINTECHs = \sum_{i=1}^{4} FINTECH$	- Profits generated by ATM, EFT, mobile banking and internet banking activities ; - The monopolization of banks in the financial sector ; - The influence of the introduction of Fintech startups on the market share of banks and - The impact of blockchain and artificial intelligence technologies on the performance of banks.

4.3. Empirical Study Model

We employ OLS regression model to examine the association between financial innovation and financial performance.

Our model is presented as follows:

$$FP_i = \alpha + \beta_1 ATMs_i + \beta_2 IBs_i + \beta_3 MBs_i + \beta_4 EFTs_i + \beta_5 FINTECHs_i + \varepsilon_i$$

Where :
i: Questionnaire
FP: Financial Performance

α: The intercept
ATMs: Banking Innovation Score in Automated Teller Machines
IBs: Mobile Banking Innovation Score
MBs: Internet Banking Innovation Score
EFTs: Electronic Funds Transfer Innovation Score
FINTECHs: Fintech Score
ε : Term of Error

5. DATA ANALYSIS AND RESULTS

5.1. Descriptive Analysais

Table 4 provides our descriptive statistics. It shows that the highest mean score of financial innovations is attributed to MBs and EFTs, the lowest mean score is associated to ATMs.

Table 4: Descriptive Statistics.

Variables	Mean	Minimum	Maximum	Standard Deviation
ATMs	2.000	1	4	0.816
MBs	3.700	0	4	0.723
IBs	3.100	0	4	0.598
EFTs	3.650	2	4	0.533
Fintechs	3.375	2	4	0.667
FP	3.165	2.4	3.8	0.399

The financial performance can be measured by ROA, ROE, and NIM. We present in Table 5 the Pearson Correlation Matrix in order to study the interactions between all variables.

Table 5: Pearson Correlation Matrix.

Score	ATMs	MBs	IBs	EFTs	Fintechs	FP
ATMs	1					
MBs	0.043 (0.0790)	1				
IBs	0.058 (0.717)	0.315 (0.027) **	1			
EFTs	0.289 (0.042) **	0.119 (0.462)	0.018 (0.911)	1		
Fintechs	0.297 (0.031)	0.310 (0.025) **	0.380 (0.012) **	0.234 (0.146)	1	
FP	0.392 (0.012) **	0.293 (0.031) **	0.728 (0.000) ***	0.373 (0.017) **	0.261 (0.091) *	1
*, **, *** significant correlation at 10%, 5%, 1% respectively.						

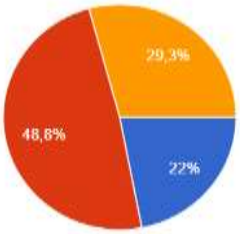
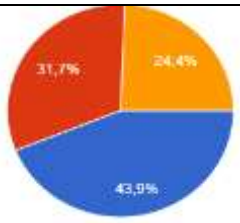
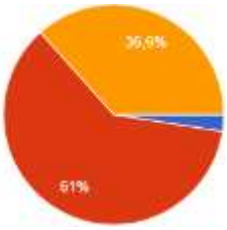
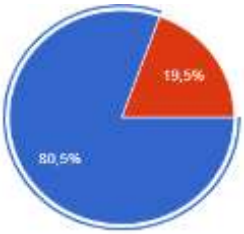
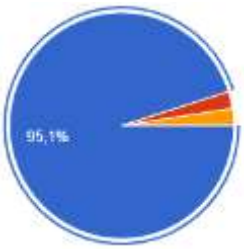
The analysis indicates correlation coefficients (r) of 0.392 for ATMs, 0.293 for mobile banking (MBs), 0.728 for internet banking (IBs), 0.373 for electronic fund transfers (EFTs), and 0.261 for Fintechs. The results demonstrate a positive correlation between these factors and financial performance, indicating that an increase in the utilisation of these banking technology correlates with enhanced financial performance. The correlation between the independent variable, ATM innovation, and the dependent variable, financial performance (FP), is both positive and statistically significant at the 5% level. There is a positive and significant correlation between Mobile Banking Innovation and Financial Performance (FP) at the 5% level. The correlation between Internet Banking Innovation (IBs) and Financial Performance (FP) is positive at a significance level of 1%. The correlation between the independent variable Electronic Fund Transfer (ETFs) and Financial Performance (FP) is both positive and statistically significant at the 5% level. The explanatory variable, Fintechs, is positively and strongly correlated with Financial Performance (FP) at the 10% level. This outcome is anticipated as the independent factors included in the study exert a direct or indirect impact on the bank's profitability and, thus, on its performance. While all independent factors are significant and elucidate the dependent variable, a correlation exists among certain independent variables, notably between IBs and MBs. This indicates an issue of multicollinearity between these two variables. This issue is addressed by retaining one of the two variables, and given the necessity of internet connectivity for the mobile application, we select IBs. Given the substantial correlation between Fintechs and IBs as well as MBs, we referred to the literature to select IBs once more for model construction. Multicollinearity is a concern between ATMs and EFTs. Electronic funds transfer (EFT), as a recent and substantial technology innovation facilitating monetary transactions between bank accounts via computer systems, is preferred over ATMs for inclusion in the model. Owing to the multicollinearity detected among the different variables, the model identifies internet banking (IBs) and EFTs as the principal explanatory variables for financial performance (FP).

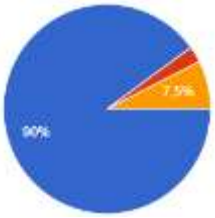
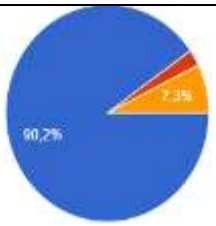
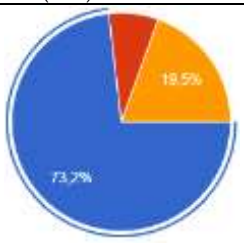
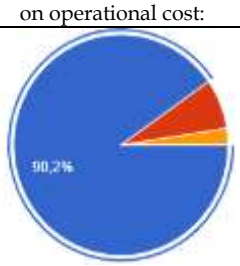
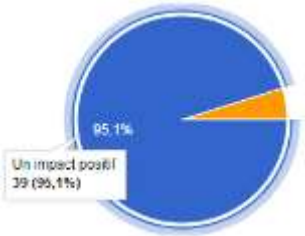
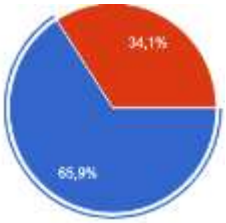
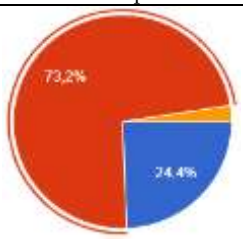
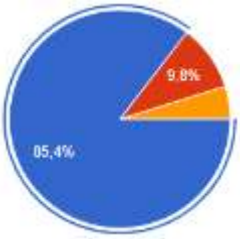
5.2 Distribution of Responses on Variable-Based Innovation

Table 6 presents the distribution of replies categorised by Automated Teller Machine, Mobile Banking, Internet Banking, Electronic Fund Transfer, and Fintech. Regarding Automated Teller Machines, our findings indicate that the majority of respondents concurred that ATMs incur an average maintenance cost, resulting in favourable profitability throughout their economic lifespan, and 61% said that the usage frequency of ATMs by clients is likely average. Respondents concurred that ATM services present a more appealing option for depositors, with 43.9% affirming that ATMs facilitate convenient access to

their deposits. Moreover, the findings in Table 6 indicate that 95.1% of respondents affirm that Mobile Banking positively influences revenue. Additionally, 97.6% concur that Mobile Banking reduces operational costs, thereby enhancing asset returns for the bank, while 87.8% believe that Mobile Banking positively affects the banking income margin. Despite 80.5% of respondents concurring that investment in Mobile Banking is mostly motivated by bank profitability. A certain number of enquiries were conducted to assess the impact of Banking Innovation on the financial performance of Tunisian banks listed on the stock exchange. Ninety percent of respondents concurred that Internet Banking positively impacts income. 85.4% of respondents affirm the bank's income producing capacity. 90.2% of respondents indicated that Internet Banking minimises possible costs and enhances the return on assets for the Bank. Participants concurred that Internet revenue positively influences the Bank. Table 6 indicates that 73.2% of respondents perceive electronic funds transfer as having a beneficial impact on income augmentation. The Electronic Funds Transfer system has depleted the Bank's revenue production capacity. Moreover, 90.2% of participants concurred that Electronic Funds Transfer influenced the reduction of operational expenses. 95.1% of respondents demonstrated that revenues from Electronic Funds Transfer positively influenced the banks revenue margin. 75.6% of respondents acknowledged that financial innovations, specifically ATMs, mobile banking, internet banking, and electronic funds transfer, positively influence bank profitability. The distribution of responses indicates that 65.9% of participants assert that banks operate as monopolies within the financial sector, despite the Tunisian financial system's longstanding lack of focus on banking institutions. Furthermore, 73.2% of respondents believed that with the advent of Fintech Startups, banks will maintain their monopoly if they significantly invest in technology advances. 85.4% of bankers reported that emerging financial technologies, including digitalisation, artificial intelligence, and Big Data, positively influenced bank performance.

Table 6: Dispersion of Responses.

Automated Teller Machine		
The cost of maintaining ATMs	Accessible services of ATMs	The frequency of using ATMs by customers
 Low, Medium, High	 Have all services available (money transfer, deposit, withdrawal). Have the withdrawal only. Missing services (money transfer and deposit)	 Low, Medium, High
Mobile Banking		
Investments in Mobile Banking	The effect of Mobile Banking on income	Do revenues from Mobile Banking have an impact on the Banking Revenue Margin?
 • Are motivated by profit to the bank generated • Investment is not motivated by the profit generated for the bank. No investments.	 Low, Medium, high	 Yes, it allows to reduce the costs and thus makes the assets of the bank profitable. Yes, it increases costs and therefore minimizes the profitability of the bank's assets No, mobile banking does not affect operational costs.
Internet Banking		
The effect of Internet Banking on income	The influence of Internet Banking on potential costs and return on assets?	The Effect of Internet Banking on Income:

 Positive effect. Negative effect. No effect.	 Yes, it reduces potential costs and improves return on assets. Yes, it increases the potential costs and destroys the return on assets. No effect.	 Positive effect. Negative effect. No effect.
Electronic Fund Transfer		
The effect of electronic funds transfer (EFT) on income:	The influence of electronic funds transfers on operational cost:	The impact of revenue from electronic funds transfer on the bank's revenue margin is:
 Positive effect. Negative effect. No effect.	 Decreases operational cost. Increases operational cost. No influence.	 Positive impact. Negative impact. No impact
Dispersion of responses of Fintech		
Banks are monopolies in the field of finance:	Following the introduction of Fintech startups, banks can keep their market place:	Digitalization, Big data, and artificial intelligence impacting bank performance:
 Yes. No	 Absolutely. Yes, provided that they invest massively in technological innovation. They can no longer keep their market place.	 Positive impact. Negatif impact. No impact

5.3. Validity and Significance of the Model

Skewness, Kurtosis, and the "Jarque-Bera" test statistic allow us to verify the normality of the studied series. Figure 1 represents the histogram that verifies the Skewness and Kurtosis coefficients.

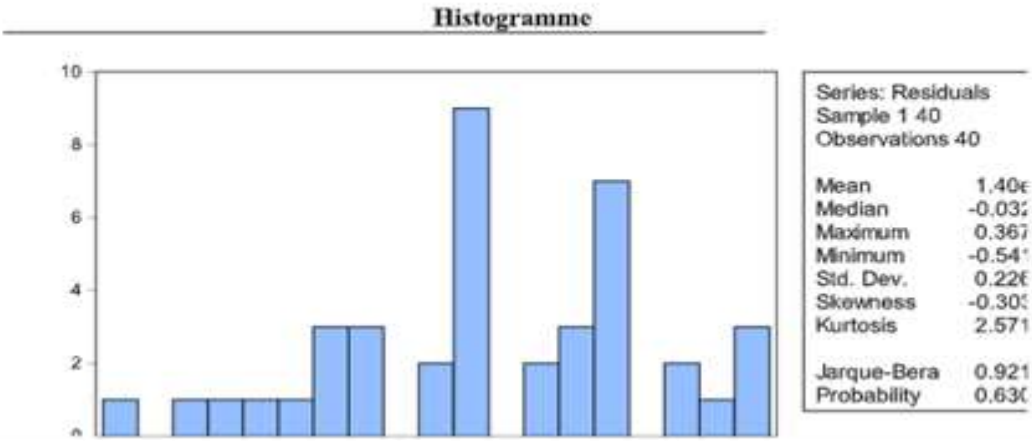
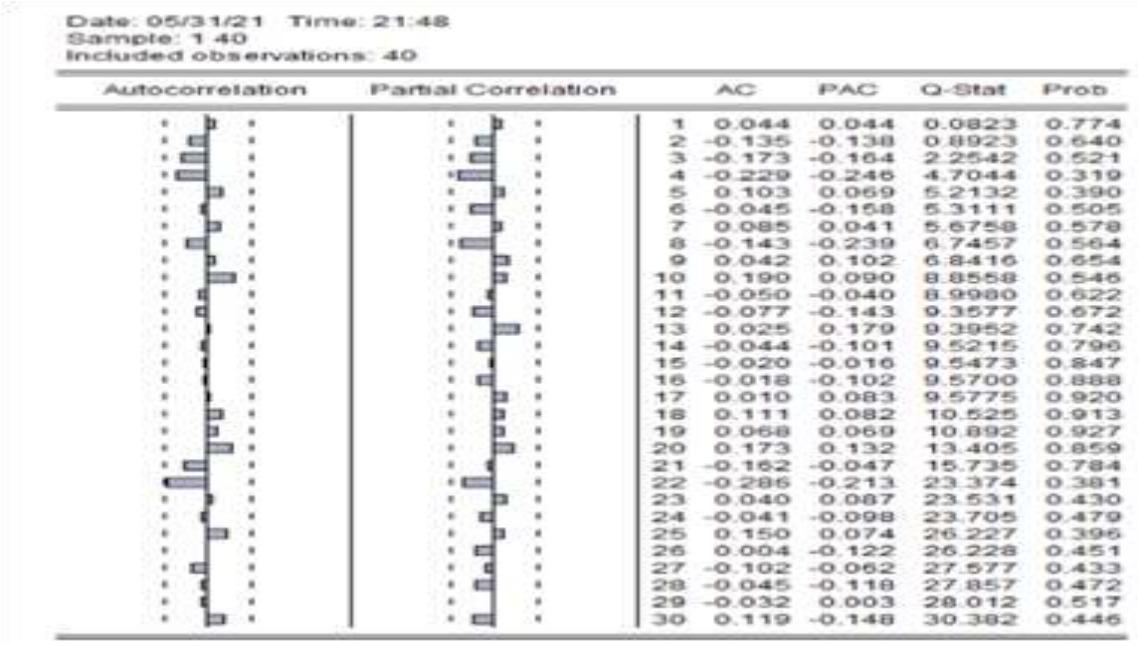


Figure 1: Histogram.

Figure 1 displays results indicating that the kurtosis value is approximately 3, suggesting that the residuals are normally distributed. Additionally, the Skewness value is near zero, which reflects a symmetric distribution resembling the normal curve. Furthermore, the Jarque-Bera test supports the assumption of normality, as the p-value exceeds 0.05, leading to the acceptance of the null hypothesis that the residuals follow a normal distribution. Figure 2 presents the correlogram of the residuals to test the autocorrelation of the errors.



	AC	PAC	Q-Stat	Prob
1	0.044	0.044	0.0823	0.774
2	-0.135	-0.138	0.8923	0.640
3	-0.173	-0.164	2.2542	0.521
4	-0.229	-0.246	4.7044	0.319
5	0.103	0.069	5.2132	0.390
6	-0.045	-0.158	5.3111	0.505
7	0.085	0.041	5.6758	0.578
8	-0.143	-0.239	6.7457	0.564
9	0.042	0.102	6.8416	0.654
10	0.190	0.090	8.8558	0.546
11	-0.050	-0.040	8.9980	0.622
12	-0.077	-0.143	9.3577	0.672
13	0.025	0.179	9.3952	0.742
14	-0.044	-0.101	9.5215	0.796
15	-0.020	-0.016	9.5473	0.847
16	-0.018	-0.102	9.5700	0.888
17	0.010	0.083	9.5775	0.920
18	0.111	0.082	10.525	0.913
19	0.068	0.069	10.892	0.927
20	0.173	0.132	13.405	0.859
21	-0.162	-0.047	15.735	0.784
22	-0.286	-0.213	23.374	0.381
23	0.040	0.087	23.531	0.430
24	-0.041	-0.098	23.705	0.479
25	0.150	0.074	26.227	0.396
26	0.004	-0.122	26.228	0.451
27	-0.102	-0.062	27.577	0.433
28	-0.045	-0.118	27.857	0.472
29	-0.032	0.003	28.012	0.517
30	0.119	-0.148	30.382	0.446

Figure 2: Correlogram of the Residuals.

Figure 3. Shows a White's Test for error heteroscedasticity.

Heteroskedasticity Test: White

F-statistic	1.068654	Prob. F(5,34)	0.3948
Obs*R-squared	5.432461	Prob. Chi-Square(5)	0.3654
Scaled explained SS	3.651883	Prob. Chi-Square(5)	0.6005

Figure 3: Heteroscedasticity Test of Errors.

The correlogram of the model residuals and White's test confirm the above results. Indeed, the correlogram shows the absence of auto-correlation of the errors because all the peaks of the auto-correlation function are insignificant (they are within the limits of significance, probability >0.05). The White test allows us to accept the hypothesis of homoscedasticity of the errors (P-value >0.05).

The coefficient of determination R2 is an indicator that allows us to judge the quality of the linear regression. Table 7 indicates that R2 is greater than 50%, it equals 68%, therefore the good quality of the linear adjustment is confirmed.

Table 7: The coefficient of determination R2

Variable	Coefficient
R2	0.680113

5.3. Multivariate Results and Discussion

To evaluate the impact of new technologies on financial performance, both IBs and EFTs are regressed against financial performance metrics. The coefficients of the independent variables are presented in Table 8. The coefficient of IBs exhibits a favourable correlation with financial performance. A one-unit rise in online banking innovation results in a 0.183 enhancement in the financial performance score. The hypothesis H3 has been validated. The coefficient of EFTs exhibits a positive and strong correlation with financial performance. An enhancement in financial performance of one unit of electronic fund transfer service innovation results in a 0.290 improvement in financial performance. Our hypothesis H4 has been validated. Electronic fund transfers and internet banking are a financial innovation that improves the performance of Tunisian banks listed on the stock exchange. The results of the present study align closely with extensive prior empirical research that underscores the supplementary function of internet banking in improving the financial performance of commercial banks. Research by Hernando and Nieto (2006), Deyoung et al. (2007), and Delgado et al. (2007) indicates that internet banking enhances bank

profitability and operational efficiency while preserving traditional banking services. Tunay et al. (2015) and Onay and Ozsos (2015) similarly conclude that digital banking augments the adaptability of traditional banking, especially in providing innovative and customer-centric financial services. Recent studies have yielded consistent findings. Dong et al. (2020) demonstrate that internet finance has a beneficial impact on profitability, security, and growth. Wang (2023) affirms its complementary function by highlighting its contribution to product innovation and customer-centric change. Necib and Lafi (2024) indicated that, within the French environment, internet banking significantly enhances financial performance metrics, including ROA and ROE. The uniformity of these findings across various countries and banking systems substantiates the validity of the current study's conclusions and affirms the significance of internet banking as a strategic instrument to enhance banks' financial performance within the Tunisian setting. The current study's results indicate a favourable and significant correlation between Electronic Funds Transfer (EFT) and bank performance, aligning with other prior research' conclusions. Abukar and Abdulla (2019), Chauhan et al. (2023), Sirengo and Muturi (2022), and Mwakera et al. (2024) all indicated that EFT augments bank profitability and efficiency by means of cost reduction, enhanced transaction processing, and elevated operational productivity. Zachariadis et al. (2017) demonstrate that the implementation of SWIFT technology significantly enhances long-term profitability, hence reinforcing the notion that financial innovations, including EFT and SWIFT, positively influence banking performance. The alignment of these findings with the present study bolsters the increasing empirical evidence regarding the strategic significance of digital financial technologies in enhancing bank performance. These data substantiate the notion of performance improvement driven by innovation in the financial sector. According to the Resource-Based View (RBV), internet banking (IB) and electronic fund transfer (EFT) technologies are regarded as strategic resources that enhance competitive advantage when they possess value, rarity, and inimitability. These innovations yield quantifiable enhancements in financial performance by optimising operating efficiency, minimising transaction costs, and augmenting customer experience. The findings corroborate the notion of competitive substitution, suggesting that banks utilising modern digital channels are more adept at addressing market demands than those dependent on traditional systems. Moreover, investment in digital technology is imperative, not discretionary. Bank management must prioritise the ongoing enhancement and optimisation of Internet Banking (IB) and Electronic Funds Transfer (EFT) services, guaranteeing their accessibility, security, and alignment with client expectations. Complementary measures, such personnel training and customer engagement programs, can enhance the efficacy of these technologies. Consequently, including digital transformation into fundamental banking strategy is essential for maintaining profitability and improving the long-term competitiveness of Tunisian banks.

Table 8: Multiple Linear Regression Results.

Variable	Coefficient	Standard Error	t-statistic	Probability
C	1.536	0.2681	5.729	0.0000
IBs	0.183	0.0232	7.905	0.0000
EFTs	0.290	0.0696	4.163	0.000

6. CONCLUSION

This research is driven by the rapid digitalisation of the banking sector resulting from the COVID-19 pandemic. Consequently, examining the measures implemented by banks to maintain their market share throughout the pandemic and the accompanying economic slowdown is critically important due to the emergence of Fintechs. The rivalry among the banks is more intense. This crisis has highlighted the imperative for reform within banks to guarantee their solvency and operational management, while also fostering economic activity. These factors necessitate a reevaluation of the conventional banking model. This research analysed the effect of investment in financial technologies on the financial performance of Tunisian banks listed on the stock exchange. Utilising a structured survey administered to top executives, we developed variable scores for application in the empirical model. The regression analysis demonstrates that both Internet Banking and Electronic Funds Transfer (EFT) exert a favourable and significant influence on bank performance. These findings possess significant consequences for institutions, sectors, and individuals. The research establishes a robust correlation between essential aspects of FinTech and financial success, emphasising the contribution of these technologies to improved operational

efficiency and competitive edge. The findings underscore the necessity of expediting digital transformation within the Tunisian banking industry, prompting governments and financial institutions to enhance investments in digital infrastructure and innovation. This study enhances the literature by offering empirical information regarding the efficacy of banking technologies in Tunisia, utilising an extensive dataset of domestic banks and performance metrics. Furthermore, it aids in cultivating local knowledge and awareness about the advantages of FinTech adoption, directing banks, regulators, and consumers towards more sophisticated and forward-looking financial practices. Based on these findings, the report advocates for sustained investment in Internet Banking and Electronic Funds Transfer as a strategic need for enhancing bank performance in Tunisia. Notwithstanding these contributions, the study possesses certain drawbacks. The utilisation of survey data introduces potential response bias, especially considering the subjective character of executive self-reporting. Secondly, the sample size is quite limited and consists solely of listed banks, thereby limiting the generalisability of the findings to the entire Tunisian banking sector, including unlisted or regional smaller banks. Future research may address these limitations by broadening the sample to encompass a more wide array of banking institutions and including qualitative methodologies, such as interviews or case studies, to enhance comprehension of strategic decision-making in FinTech adoption.

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