



Exploring the Influence of Digitalization Strategies on Bank Performance: Evidence from Tunisian Banking sector

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Abstract

This study investigates the impact of digitalization strategies on the financial and environmental performance of Tunisian banks. The methodology consists of two parts: establishing the data sample criteria and interpreting the results, with data analysis conducted using SPSS and linear regression. The findings reveal a positive relationship between digitalization and financial performance, driven by improved customer relationships and competitive advantages. Key factors such as investments in payment tools, digital channels, and internet security contribute to enhanced bank performance. The research highlights that banks offering digitalized services exhibit better profitability, financial stability, and transparency, thereby fostering a positive environmental footprint. The study emphasizes the need for banks to adopt digitalization to improve performance and sustainability, providing valuable implications for regulators, policymakers, and investors. Regulators should establish supportive frameworks to encourage digital innovation, policymakers must prioritize infrastructure development, and investors should recognize the long-term benefits of investing in digitally advanced banks.

Keywords

Competitive advantages, Digitalization, Financial performance, Environmental performance, Banking sector

1. Introduction

The adoption of digitalization has emerged as a key catalyst for significant changes across various economic sectors, notably the banking industry. This technological evolution, marked by the rapid emergence of innovative technologies such as artificial intelligence, the Internet of Things, and blockchain, has fundamentally reshaped the strategies, operations, and interactions of banks with their environment. Indeed, technological advancements have led to the emergence of new sectors within the realms of payment and financing, both integral components of the banking system (Bartnik et al., 2018; Sung, 2021). Hence, as highlighted in a study by Aniqoh et al., (2022), banks should expedite the adoption of digital banking services. In alignment with this trend, the Central Bank of Tunisia (BCT) has introduced the "BCT FINTECH" website to foster collaboration with FinTechs. Additionally, the BCT has initiated programs such as the "Regulatory Sandbox" and "BCT-Lab" to adapt processes in response to technological advancements.

Indeed, the impact of digitalization extends well beyond improving operational efficiency. It exerts a decisive influence on the redefinition of traditional banking performance parameters. At the heart of this redefinition, two aspects emerge as essential pillars: financial performance and environmental performance. Financial performance, as a vital indicator of a bank's economic health, is directly affected by digitalization. Strategic decision-making has been transformed with the advent of advanced data analytics and predictive algorithms, influencing the profitability of organizations in an increasingly dynamic and complex economic environment. According to Fan et al., (2022), financial technology has facilitated the digital evolution of banks by fostering financial innovation and technological spillover effects. This transformation has led to acceleration in lending efficiency and an improvement in the financing efficiency of small and medium-sized enterprises, as noted by Zhao et al., (2022). Shou (2021) highlighted the role of financial technology in driving the digital transformation of banks and enhancing their efficiency through streamlined risk

management and control. Furthermore, Hoehle et al., (2012) emphasized that the digitalization of banks has the potential to improve the service model of traditional commercial banks, fostering the transformation and modernization of the industry. Considering the diversity within the sector, commercial banks may undergo mergers and acquisitions as a result of the impact of digital transformation, potentially leading to an improvement in the total factor productivity of restructured banks. In a study conducted by Chen (2020), a sample of 20 Chinese commercial banks was examined to analyze the changes in profit efficiency following the establishment of WeBank. The study discovered that subsequent to the founding of China's innovative online business bank, the profitability of the banks increased significantly. While much attention has been focused on the financial implications of digitalization, there is growing recognition of its potential impact on environmental performance, particularly in emerging economies where sustainability concerns are gaining importance. Recent research conducted by Feng et al., (2022) has analyzed the transition from digitalization to green innovation, suggesting that when indirect effects surpass direct effects, digitalization has the potential to reduce pollutant emissions and advance sustainability goals. The adoption of digitalization fosters an advanced and efficient production strategy that reduces pollution-intensive operations. Drawing from Wang et al., (2023), financial institutions can optimize their production processes and mitigate avoidable environmental harm by leveraging real-time emissions data. Furthermore, digital innovations have facilitated the transition of polluting industries toward environmentally friendly production methods (Zhang et al., 2022a, b).

Indeed, previous studies have not provided a conclusive answer to the question of whether digitalization enhances or deteriorates banks' performance. This study aims to empirically investigate the interaction between banks' financial performance and their environmental sustainability efforts in the context of digitalization, with a particular focus on Tunisian banks. The Tunisian banking sector, like many others globally, has embraced digitalization as a way to adapt to changing market dynamics and improve its competitiveness. Nevertheless, the impact of digitalization on financial indicators and environmental outcomes in this context has been relatively underexplored. This investigation aims to enhance our understanding of how digitalization shapes the dual goals of financial profitability and environmental responsibility within the banking industry. Through an investigation of the experiences of Tunisian banks, this study seeks to offer insights that can guide strategic decision-making and policy formulation, not only limited within the Tunisian context but also for banking sectors in other emerging economies facing similar challenges and opportunities. The structure of the paper is as follows: Section 2 presents the theoretical underpinnings and hypotheses development. Section 3 describes the data and methodology adopted in this research. Section 4 discusses the results of the empirical investigation. Finally, the last section highlights the main findings, implications and limitations and suggests potential avenues for future research.

2. Literature Review and Hypotheses

The onset of digitalization marks the integration of digital technologies into various aspects of business and society. It represents the transition towards digital tools and processes for improved efficiency, innovation, and connectivity. In fact, digitalization stands out as a significant trend in the financial sector, as emphasized by Yadgarov et al., (2019). As countries transition to digital economies, it's crucial for both financial institutions and governments to establish resilient digital identification systems and cybersecurity strategies (Artemenko and Zenchenko, 2021). The digitalization of the banking sector also contributes to broader societal digitalization efforts by increasing the adoption of digital channels for financial transactions (Carbó-Valverde et al., 2020). Recognized as vital indicators of competitiveness, digital skills are emphasized (Zhao et al., 2019; Georgescu and Kinnunen, 2021), with the financial sector's digitalization playing a pivotal role in advancing sustainable development goals (Úbeda et al., 2022). Moreover, digitalization is a prominent trend shaping the evolution of the financial industry (Yadgarov et al., 2019). Thus, prioritizing the development of digital identification systems, cybersecurity protocols, and robust data protection measures is essential for both financial institutions and governments as they embrace digital economies (Artemenko and Zenchenko, 2021). By strengthening overall business strategy, banking institutions enhance their implementation of digital transformation. Integrating digital technology into operations and processes aims to boost corporate value (Zhai et al., 2022). This adoption is anticipated to enhance reputation, expand the customer base, and bolster competitive positioning (Ardito et al., 2021). Furthermore, employing argument passing facilitates enhanced communication among leaders, employees, and customers.

Indeed, enhancing the technological efficiency of banking processes can streamline and optimize traditional operations, prevent fraud, introduce new, customized offerings to cater to customer requirements, extend services to remote areas, and minimize operating expenses. Moreover, this will lead to a reduction in operating costs. Embracing digital transformation enables time saving, streamlines operational processes, and enhances risk management. Consequently, banks can elevate service standards for their customers (Boufounou et al., 2022). The decrease in operational costs and the improvement in work efficiency also boost the bank's overall performance.

Moreover, digitalization helps in enhancing the transparency of banking operations, which is crucial for refining management practices and fostering a positive corporate culture. The introduction of novel products and services, along with the transition of certain operations to a remote format, empowers banks to align their commercial strategies with the evolving demands of contemporary society. Therefore, digitalization is a central topic in the banking sector, and its influence on various aspects of banking performance is of particular interest.

2.1 Banking Digitalization and Financial Performance

The digitalization of banking services can have a favorable effect on the financial performance of banks. Several empirical studies and concrete examples support this idea. For instance, the findings of Mbama and Ezepeue (2018) highlight the potential for banks to enhance their financial performance through the implementation of digital banking services. Moreover, banks that integrate digital technologies manage to increase their operational efficiency, reduce expenses, and improve monitoring, risk management, and control mechanisms, which allows for the provision of high-quality products and services to the market. Forcadell et al., (2020) argue that integrating investments in technology with other intangible resources, like CSR, can provide banks with a competitive edge, ultimately leading to improved performance. Furthermore, the adoption of digitalization can strengthen the competitiveness of banks and help preserve their financial performance, even when consumer consumption slows during a pandemic, as stated by Carletti et al., (2020). Regarding the characteristics of digital transformation, as outlined by Nambisan et al., (2019), it notably involves the application of technological methods to improve business and production operations within enterprises. Additionally, Nambisan et al., (2019) demonstrate that digital transformation enhances company efficiency by reducing costs and boosting profits through process improvements. Concurrently, Verhoef et al., (2021) indicate that digital transformation facilitates the development of business models and fosters the creation of greater value for companies.

More precisely, numerous studies indicate that digital transformation positively influences performance (Zhai et al., 2022; Soltani and Abida, 2025). However, some research suggests that this impact may unfold relatively slowly for firms. According to Kriebel and Debener (2019), it typically takes about five years post-digital transformation to fully grasp the implications for firm performance. While many studies suggest a direct link between digital transformation and business outcomes, some propose a U-shaped relation (Guo and Xu, 2021). The assessment of digital transformation's influence on firm performance remains a subject of ongoing discussion, showcasing varied findings across distinct contexts. Therefore, tailored research is essential for understanding the implications of digital transformation in the banking sector in Tunisia. Based on these studies, the following hypothesis can be put forward:

“H1: The adoption of digitalization has a positive impact on financial performance”.

2.2 Banking Digitalization and Environmental Performance

The continued rise of banking digitalization is generating growing interest in its implications for environmental sustainability. This digital transition has profoundly transformed the way banks interact with their customers, manage their internal operations and provide financial services. At the heart of this development is the idea that digitalization can significantly contribute to improving the environmental performance of financial institutions. This idea raises key questions about the potential benefits of digitalization in reducing environmental impact while maintaining or improving bank profitability. To further explore this hypothesis, we will examine multiple studies and research endeavors exploring the correlation between banking digitalization and environmental performance. Abdul et al., (2021) asserted that the implementation of digitalization can serve as an efficient strategy to address dynamic environmental challenges, including air pollution, carbon emissions, wastewater treatment, and climate change. This viewpoint is corroborated by other scholars such as Chen et al., (2017) and Honarvar and Sami (2019). Moreover, concerning sustainable production, digitalization's support can bring about numerous favorable environmental impacts for a company. In a recent investigation by Ha et al., (2022), the relationship between digitalization and environmental performance was thoroughly analyzed using data from 25 European countries spanning the period from 2015 to 2020. Their findings indicate that digital transformation has a positive impact on environmental performance. This conclusion aligns with the notion that digitalization optimizes production processes and decreases resource consumption. Notably, advanced technologies such as Artificial Intelligence (AI), Internet of Things (IoT), and data analytics play a crucial role in promoting sustainability efforts by mitigating waste generation and reducing carbon emissions, as highlighted by Birat (2020). Digitalization assists banks in diminishing their direct environmental impact. Notably, banks reduce paper usage and minimize transportation needs by conducting certain operations remotely. Studies indicate that the rise in energy consumption resulting from modern technological advancements can enhance overall energy efficiency (Zakari et al., 2021). Moreover, Khan et al., (2021) propose that boosting investments in environmental technologies could enhance environmental quality.

Thus, based on transaction cost economics, information processing theory, or the dynamic capabilities perspective, prior studies have largely suggested a positive association between digitalization and environmental performance (Schniederjans and Hales, 2016; Li et al., 2020). Consequently, the following hypothesis can be proposed:

“H2: The adoption of digitalization has a positive impact on environmental performance”.

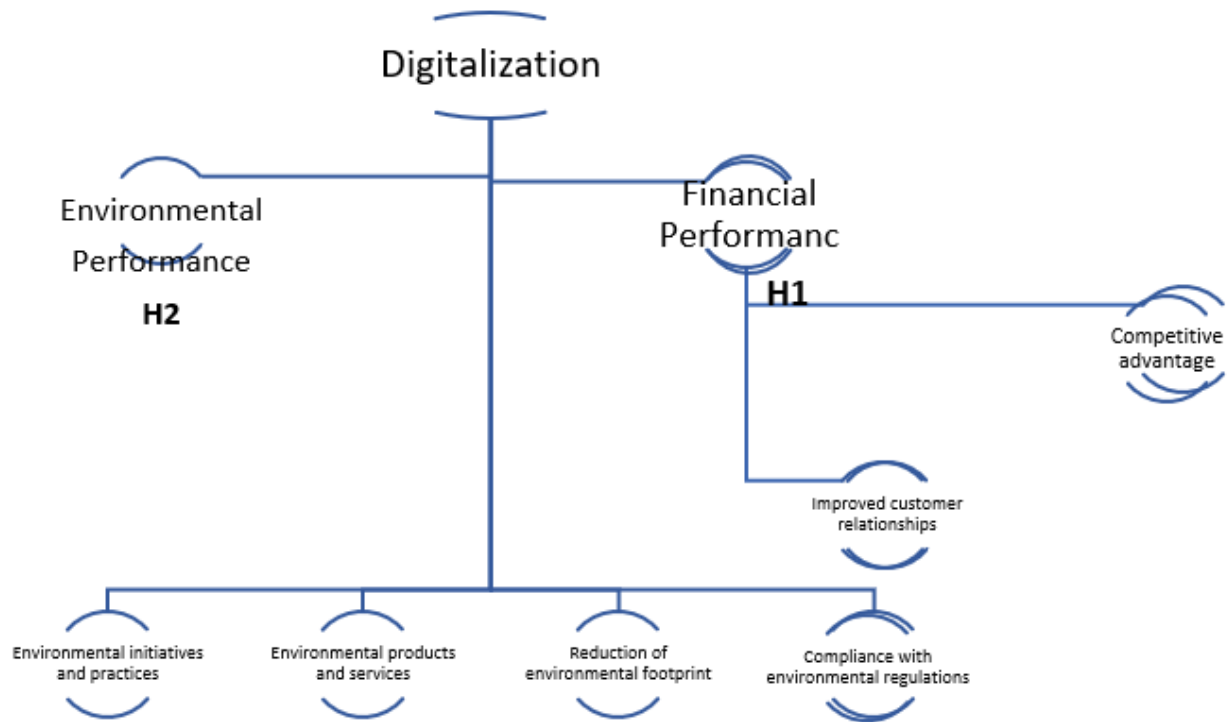


Fig. 1 Conceptual framework

3. Research Methodology

Our study investigates the impact of banking digitalization strategies on both the financial and environmental performance of Tunisian banks. Specifically, we aim to answer the central question: How does the adoption of digitalization influence the performance of Tunisian banks? Our methodology consists of two components. The first involves defining the criteria for selecting the data sample, while the second focuses on analyzing and interpreting the results. To ensure the robustness of our findings, respondents were required to answer all questions comprehensively. We employed SPSS for data recording, statistical analysis, and linear regression was used to test the proposed model.

3.1 Research Sample and Data

Our empirical investigation adopts a quantitative research approach, using a questionnaire as the primary method for data collection. The questionnaire consists of two main sections, which align with the thematic areas discussed in the existing literature. The first section aims to gather information from the banks regarding their digitalization processes, while the second part is focused on assessing both financial and environmental performance.

In order to maximize response rates, we administered the questionnaire as follows: the first was distributed online to around ten agencies, each comprising different staff members, while the second was allocated directly to staff from various Tunisian banks. The selection of the Tunisian context is justified by the growing interest of households and firms in banking services, particularly following the Revolution of 2011. Therefore, studying the dynamics of Tunisian banks provides valuable insights into the current landscape.

In this context, it is important to clear distinguish between the dependent, independent and control variables. The following table presents our related variables.

Table 1 Summary of variables used in the empirical analysis

Dependent variables		
Variable Name	Items	Source
Financial Performance (FP)	Improved customer relationships.	Vanheems (2013).
	Competitive advantage.	Rosenberg, (1982); Penrose (1959).
Environmental Performance (EP)	Environmental initiatives and practices.	Risal and Joshi (2018); Zhang et al., (2022); Zhang et al., (2022) ; Chen et al., (2022).
	Environmental products and services.	Sen and Bhattacharya (2001); Wijesiri, M., et al., (2020).
	Reduction of environmental footprint.	Siddique, A. N., et al., (2020) ; Chen, Y., et al., (2021).
	Compliance with environmental regulations.	Schiavone, F., and Pellicano, M., (2017) ; Bairwa, S. L., et al., (2021).
Independent variables		
Digitalization (Dig)	Degree of knowledge and use of digital channels	Daniel (1999); Karjaluoto et al., (2002)

Control variables		
Customer satisfaction (CS)	The adoption of technology in digital banking enhances customer satisfaction, improves operational efficiency, and boosts financial performance.	Stief et al., (2016); Mbama and Ezepue, (2018).
Existence (Ex)	Are FinTechs offering innovative solutions?	Llorca, (2017) ; Châlons et Dufft, (2017) ; Christensen et Raynor, (2013).
Barries (Br)	Presence of barriers and challenges associated with digital transformation.	David Fayon (2018).
Risk (Risk)	Presence of risks associated with digital transformation.	Olanrewaju (2014); Botta et al.,(2016).
Bank Size (Size)	The size of the bank influences both return on assets (ROA) and return on equity (ROE).	Gupta and Mahakud, (2020); Nyabaga and Matanda, (2020).

Source: Authors' Elaboration

3.2 Research Models

To assess the impact of digitalization on both the financial and environmental performance of banks and to test the initial hypothesis suggesting that the adoption of digitalization improves financial performance, we constructed a regression model (Equation (1)).

$$FP_t = \beta_0 + \beta_1 Dig + \beta_2 Cs + \beta_3 Ex + \beta_4 Br + \beta_5 Risk + \beta_6 Size + \varepsilon \quad (1)$$

In addition, to examine Hypothesis 2, which posits that the adoption of digitalization in banks enhances their environmental performance, we developed a regression model (Equation (2)) to capture this effect.

$$EP_t = \beta_0 + \beta_1 Dig + \beta_2 Cs + \beta_3 Ex + \beta_4 Br + \beta_5 Risk + \beta_6 Size + \varepsilon \quad (2)$$

Where:

- *FP* depicts the dependent variable, namely financial bank performance,
- *EP* represents the dependent variable of environmental banks performance,
- *Dig* represents the independent variable of digital bank, and
- *Cs*, *Ex*, *Br*, *Risk* and *Size* represent the control variables.

4. Analyses and Discussions

4.1 Principal Component Analysis (PCA)

To perform a Principal Component Analysis, it is crucial to ensure that certain conditions are met. Firstly, it is necessary to verify that the variables are minimally correlated with each other. Secondly, the Kaiser-Meyer-Olkin (KMO) index should exceed 0.5, and the Bartlett's Test of Sphericity should approach 0, as confirmed by the results in Table 2. In this case, the KMO index is 0.650 and 0.619, both exceeding the threshold of 0.6, and the Bartlett's test result is 0.000.

Table 2 Summary of Principal Component Analysis

Variables	KMO and Bartlett's teest	Vp	σ^2 (En%)	Items	R
Financial Performance (FP)	0,650 (0,001)***	1,419	70,971	<i>Item 1:</i> Improved customer relationships	0,842
				<i>Item 2:</i> Competitive advantage	0,842
Environnemental Performance (EP)	0,619 (0,000)***	2,364	59,104	<i>Item 1:</i> Environmental initiatives and practices	0,796
				<i>Item 2:</i> Reduction of environmental footprint	0,861
				<i>Item 3:</i> Compliance with environmental regulations	0,782
				<i>Item 4:</i> Environmental products and services	0,615

Notes: Values in parentheses indicate statistical significance. *, **, *** denote significance at the 10%, 5%, 1%, respectively

Source: Authors' Elaboration

4.1.1 Total Variance Explained

Referring to Table 3, we observe the "total" column, which indicates the initial eigenvalues. Only eigenvalues exceeding 1 (according to the Kaiser criterion) are considered (for the first dependent variable, 1.419; 0.581 and for the second 2.364; 0.581; 0.927; 0.480; 0.230). As a result, components 1, 2, 3, 4, 5, and 6 are retained, as they capture more variance than the original variables. These six components account for the maximum information, representing approximately 70.971% and 59.104% of the total variance across all initial items for the two variables, respectively.

Table 3 Total variance explained

Financial Performance						
Component	Initial Eigen values			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	1,419	70,971	70,971	1,419	70,971	70,971
2	,581	29,029	100,000			
Environmental Performance						
3	2,364	59,104	59,104	2,364	59,104	59,104
4	,927	23,165	82,268			
5	,480	11,994	94,262			
6	,230	5,738	100,000			

Source: Authors' Elaboration

4.1.2 Rotated Matrix Component and Reliability Statistics

The correlation between the items and the factor axis, as shown in Table 4, is greater than 0.5. Additionally, the reliability test gives a Cronbach's α greater than 0.5 (0,783 and 0.755). Therefore, we can confirm that the reliability condition is satisfied.

Table 4 Rotated matrix component and Reliability statistics

Financial Performance	
Component Matrix^a	
	Component
	2
Improved customer relationships	0,842
Competitive advantage	0,842
Reliability Statistics	
Cronbach's Alpha	No. of Items
0,783	2
Environmental Performance	
Environmental initiatives and practices	0,796
Reduction of environmental footprint	0,861
Compliance with environmental regulations	0,782
Environmental products and services	0,615
Reliability Statistics	
Cronbach's Alpha	No. of Items
0,755	4

Source: Authors' Elaboration

4.2 Multiple linear regression

Table 5 presents the regression results. Model 1 examines the influence of control variables on financial performance. Model 2 analyzes the direct impact of digitalization on environmental performance in the banking sector. This separation allows a detailed understanding of traditional financial determinants and the evolving relationship between digitalization and environmental sustainability.

Table 5 The results of regression analysis

Variable	Model.1			Model.2		
	Beta	Sig	Conclusion	Beta	Sig	Conclusion
Constant	-0,47	0,237	-----	0,571	0,269	-----
Dig	0,759	0,00***	(+)	0,572	0,001***	(+)
Cs	0,128	0,017**	(+)	0,103	0,443	N.S
Ex	0,274	0,287	N.S	-0,486	0,149	N.S
Br	-0,015	0,9	N.S	-0,003	0,966	N.S
Risk	-0,018	0,042**	(-)	-0,163	0,05**	(-)
Size	0,031	0,541	N.S	0,017	0,909	N.S

Notes: *, **, ***, significance at the 10%, 5% and 1%, respectively. (+) and (-): positive and negative effects, respectively. N.S: Non-significant. Source: Authors' Elaboration

The findings from Model 1 reveal a notable positive correlation between digitalization and financial performance, indicating a significant impact of digital strategies on the financial outcomes of banks. Therefore, hypothesis H1 is accepted. Additionally, we find that customer satisfaction (Cs) significantly and positively impacts the financial performance of the bank, highlighting the pivotal role of customer-centric strategies in improving financial outcomes, with a significance threshold of which is around 5%. Furthermore, the control variable, "brakes", is not significant and has a negative coefficient (-0.015), indicating an opposite effect on performance. This supports the argument of Akhisa et al., (2015), who argue that there is a positive correlation between technological innovations and the performance of banks

in both developed and developing countries. For instance, research conducted in various African countries, such as Zimbabwe (Mazana et al., 2016), Nigeria (Bagudu et al., 2017), Zambia (Lusaya and Kalumba, 2018), and South Africa (Maduku, 2014), has shown that banks embracing digitalization have experienced enhanced performance metrics, including increased productivity and efficiency. This positive relationship is explained by the shift in customer consumption habits, which encourages banks to redefine their operations by integrating new customer-oriented digital technologies into their business processes. These processes have become more receptive to the use of digital services. This trend is also driven by the advantages that online services provide, particularly in terms of information quality, real-time accessibility to information and products, ease of use of the channels, and the perceived usefulness of these digital services. Interestingly, new technologies serve as a real accelerator, not only in terms of efficiency but also in improving customer relations. Furthermore, the regression results consistently reveal a positive and statistically significant relationship between digitalization and environmental performance, ($\beta = 5.72$; $p = 0.001$). Thus, we can conclude that the digitalization variable has a positive and significant impact on environmental performance. Therefore, H2, also is accepted. This finding aligns with the perspective of Abdul et al., (2021), who argued that digitalization can effectively address ever-changing environmental challenges. Additionally, Ha et al., (2022) confirmed that digital transformation leads to an improvement in environmental performance.

5. Conclusion

This study delves into the effects of digitalization adoption, a profound and transformative force, on various facets of banking performance. Through our analysis, several notable conclusions emerge: Firstly, we have identified a positive correlation between the digitalization of banking services and improved financial performance. This positive influence can be attributed to the transformation in customers' consumption behaviors facilitated by digitalization. Moreover, it is crucial to highlight that the digitalization variable also exerts a positive and statistically significant impact on environmental performance. Hence, it is appropriate to assert that digitalization serves as a pivotal enabler for enhancing both financial and environmental dimensions of performance. Overall, our findings suggest that digitalization has a beneficial impact on various aspects of performance, whether financial or environmental, effectively stimulating or enhancing them.

This study is subject to several limitations. Firstly, the sample consists solely banks listed on the Tunisian stock market, which may limit the generalizability of the findings. Exploring this topic within small, non-listed firms could provide valuable comparisons. Secondly, the study focuses exclusively the effects of digitalization adoption on financial and environmental performance. Therefore, future research could explore the moderating role of digitalization in banks. Additionally, due to the broad scope and intricate nature of digitalization, our methodology might not fully capture the level of digitalization within a bank. Future investigation could use alternative approaches to obtain more comprehensive measurements.

6. Theoretical Implications

This research contributes to the existing literature by examining the outcomes of the digitalization and both financial and environmental performance relationship, with a particular emphasis on the Tunisian banking sector. It provides insights into strategies for enhancing both types of performance through digitalization. In contrast to previous findings, our results offer a new perspective, revealing a positive relationship and enhancing the understanding of the role digitalization plays in improving environmental performance within banks. Second, digital technology has catalyzed the digital transformation and green innovation within commercial banks. This has enabled them to streamline operations, reduce costs, conserve resources, and strengthen environmental conservation efforts as well as internal governance practices. Finally, the research findings reveal that executives with a background in innovation and technology significantly and positively influence the correlation between digital banking, financial performance, and environmental performance within banks.

7. Managerial Implications

The results of this research suggest that managers should prioritize the integration of technology and the advancement of digitalization within the banking sector. Moreover, the identified correlation between digitalization and both financial and environmental performance underscores the importance for banks to approach their digitalization initiatives with careful consideration and strategic foresight. Due to potential resource conflicts and the initial learning curve for employees with new technologies, banks may face challenges that could impact their financial and environmental performance in the short term. It is advisable that managers recognize the likelihood of obstacles in the adoption and implementation of new technologies. As banks gradually adjust and embrace these innovations, they can eventually reap the benefits of moderate to high levels of digitalization.

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