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The impact of digital transformation on the operational efficiency of commercial banks: Empirical evidence from Vietnam

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Abstract

In recent years, the rapid development of digital transformation has reshaped the landscape of the banking sector, particularly in emerging economies like Vietnam. This study examines the impact of digital transformation on the operational efficiency of commercial banks in Vietnam, analyzing how digitalization initiatives such as mobile banking, artificial intelligence, data analytics, and automation contribute to improved service quality, cost reduction, and overall productivity. Using a combination of quantitative and qualitative data, the study evaluates key performance indicators (KPIs) from a range of commercial banks in Vietnam to identify significant patterns and outcomes related to digital innovation. Findings reveal that digital transformation has led to notable increases in customer satisfaction, operational speed, and cost efficiency, though challenges remain in areas such as cybersecurity and the adaptation of legacy systems. The study offers insights and strategic recommendations for Vietnamese banks to optimize digital solutions and achieve sustainable growth in a competitive market environment.

Keywords: Bank performance, Digital banking, Digital transformation.

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1. Introduction

Digital transformation in banking is not simply the application of technology, but also a revolution that completely changes the way of operation. The adoption of digital technologies has ushered in a new era of efficiency for the banking sector, transforming the ways financial processes are executed, monitored, and optimized [1]. Digital transformation has now become a strategic priority for many banks, with considerable investments made in research and development to leverage its potential benefits. In recent years, core banking activities, ranging from customer service to backend processes, have undergone substantial digital transformation by Naimi-Sadigh et al. [2]. This shift has not only enhanced the efficiency of

individual operations but has also created synergy across various banking activities, ultimately improving the sector's overall performance.

The Vietnamese government is actively driving digital transformation within the banking sector, positioning the country as a leading emerging nation in developing an index that evaluates the digital transformation of its commercial banks. The State Bank of Vietnam has taken proactive steps to encourage digital transformation in banking, notably through Decision No. 810/QD-NHNN issued on May 11, 2021, which outlines a comprehensive plan for digital transformation in the sector through 2025 with a vision toward 2030. Recognized as one of the fastest-growing sectors in digital transformation [3]. Vietnamese banking has seen notable advancements, yet questions remain regarding the tangible benefits of digital transformation. While some studies indicate improved business performance, the impact on overall operational efficiency is still debated. Lan et al. [3] highlight the need for context-specific research focused on Vietnamese banking to better understand and optimize these outcomes.

2. Literature Review

2.1. Digital Transformation in Commercial Banks

Scholars have yet to agree on a unified definition of digital transformation [4]. Generally, it refers to the adoption of new digital technologies to drive significant changes within organizations, impacting various aspects of users' lives. Vial [5] describes digital transformation as "a process aimed at enhancing an organization by making substantial changes to its core characteristics through the integration of information, computer, communication, and networking technologies." In the banking sector, digital transformation goes beyond basic automation, representing a profound shift in how financial institutions interact with customers, manage internal operations, and create value [2, 6].

Digital transformation in banking involves the continuous expansion and application of technologies like artificial intelligence and big data within commercial banks, enhancing business optimization, facilitating upgrades, and driving innovative change, thereby turning traditional operations into new sources of value [7]. These advancements have also spurred the creation of new business models and revenue streams [8]. Today, most banking and financial institutions leverage financial technologies to enable online banking, extensive automation, and AI-powered decision-making.

Vial [5] review of 282 studies concludes that digital transformation is a process through which organizations adapt their value creation methods in response to digital technology, while also managing structural changes and challenges that can yield both positive and negative impacts. Along with Verhoef et al. [9] describe digital transformation as the use of digital technology to analyze data, convert it into actionable insights, support decision-making, and develop new digital business models. This process ultimately enhances value creation, organizational performance, and influence. Digital transformation thus represents the convergence of "enterprise, technology, and data," marked by model innovation, value creation, and a transformative economic framework.

2.2. The relationship between digital transformation and bank performance

Currently, numerous studies investigate whether digital transformation enhances business performance, though findings remain inconsistent. Some research suggests that digital transformation can improve operational performance by reducing costs, increasing efficiency, and fostering innovation. The core attributes of digital technology—such as connectivity, information sharing, and openness enable businesses to bypass intermediaries, which helps mitigate the negative effects of information asymmetry between trade partners and lowers costs associated with information searches and negotiations [10, 11]. Digital transformation also supports operational efficiency by providing both structured and unstructured data, enhancing data mining opportunities [12]. This facilitates meeting customers' long-term needs, supports industry specialization and collaboration, and ultimately boosts organizational performance.

Chen and Kim [13] found that digital finance advancements improve the efficiency of traditional banking operations by lowering banks' sales costs, highlighting the financial advantages of digital transformation for commercial banks. The shift toward digital operations increases efficiency, reduces operating expenses, boosts non-interest income, and drives financial growth in the banking sector [14]. Furthermore, digital platforms enable banks to gather, process, and analyze large amounts of data, which provides insights for better decision-making in resource allocation, risk management, and service improvement [15, 16].

Research by Al Busaidi and Al-Busaidi [17] also confirms that investments in IT and digital transformation significantly enhance financial performance. Provide additional evidence that adopting innovative technologies plays a critical role in improving financial outcomes. However, some studies argue that traditional digital technologies may not always have a significant impact on overall business performance. Although digital transformation in banking does not universally improve all performance metrics, it often has notable effects on profitability and operational efficiency.

Investing in digital transformation requires substantial resources and technological infrastructure. Not all banks achieve immediate success with their technology investments, as highlighted by Cao et al. [18], with some improvements in efficiency only emerging after several years. Studies by Kriebel and Debener [19] and Lan et al. [3] suggest that the benefits of digital transformation may take time to materialize, with potential setbacks in the process reducing efficiency and profitability. Banks implementing digital transformation allocate significant financial, human, and time resources and must manage the risks and errors that arise, Lan et al. [3]. Researchers examining digital transformation often focus on direct outcomes from financial technology but recognize potential long-term gains and inherent risks, such as technological vulnerabilities.

In addition to these factors, the process of digital transformation and the deployment of financial technology pose risks for banks. For instance, customer errors may lead to unsuccessful transactions, and privacy concerns could compromise customer trust, negatively affecting the customer experience and ultimately impacting profitability. These mixed findings

prompt further investigation into the relationship between digital transformation and the operational efficiency of commercial banks.

3. Hypothesis Development

Based on the literature, we propose the following hypotheses:

Hypothesis: Digital transformation has an impact on bank performance

Based on research objectives and referring to previous research by Zhu and Jin [20] and Chao et al. [21], the relationship between digital transformation and bank performance can be modeled in the form:

$$Bank\ performance_{it} = \alpha_i + \beta_1 Digital\_Transformation_{it} + \beta_1 Controlvariables_{it} + \varepsilon_{it}$$

4. Research Design

4.1. Data

Bank-level data were collected from banks' financial and annual reports, while macroeconomic data were obtained from the IMF e-library. the Information and Communication Technology (ICT) Readiness Index for Vietnamese banks has been officially reported since 2013 [22]. The ICT Index values were sourced from the Vietnamese Ministry of Information and Communications' ICT Index reports. This study's sample begins in 2013, covering the period from 2013 to 2022. Based on data availability, 26 commercial banks in Vietnam were selected. The dataset consists of 260 observations.

Besides, we divided the sample by type of commercial bank. Specifically, two groups are classified: one group consists of the top ten biggest banks, while the other group includes small and medium-sized banks.

4.2. Variables

4.2.1. Dependent variables

This study examines how digital transformation in banking influences the business performance of banks. In order to conform to the research of this study, Return on Assets (ROA) is commonly used as a key metric to evaluate bank performance [21]. ROA measures how efficiently a bank utilizes its assets to generate profit. This makes it a comprehensive metric, capturing the performance of both revenue generation and cost management, which is crucial when evaluating the impact of digital transformation, which often aims at improving both efficiency and profitability. ROA offers an effective way to compare banks of different sizes. Unlike metrics such as Return on Equity (ROE), which can be influenced by capital structure, ROA is less affected by leverage and provides a clearer picture of operational efficiency. Digital transformation in banks typically leads to improvements in operational efficiency, such as reduced transaction costs and enhanced customer service. ROA directly reflects these improvements by evaluating how well the bank uses its assets to generate profits. Banking is an asset-intensive industry, with substantial investments in technology, infrastructure, and human capital. ROA is particularly suitable because it incorporates these asset-related investments and evaluates their contribution to profitability. Banks face diverse risks related to asset management, including credit, market, and operational risks. ROA helps assess the risk-adjusted performance by considering how well a bank is managing and deploying its assets to generate returns, providing valuable insights into its overall performance under digital transformations.

4.2.2. Independent Variables

In this study, the ICT index is identified as the primary independent variable. Currently, the use of a standardized digital transformation index within the banking sector is inconsistent, primarily due to the lack of a unified concept of Fintech. This absence of consensus has led to variations in the indicators or data used to measure digital transformation in banking.

Currently, three common methods for evaluating the digital transformation of organizations are: The first is the quantitative description approach, which measures digital transformation by analyzing associated costs, such as IT spending on hardware and software, as recorded in corporate balance sheets. Additionally, some studies have used survey results to evaluate investments in financial technology. However, this method has been criticized as subjective, as respondents may interpret survey questions differently. The second approach, text analysis, evaluates digital transformation by counting the frequency of relevant keywords in corporate reports, such as annual reports. The third, a dummy variable method, assigns a value of 1 if a bank has adopted online channels and 0 otherwise. However, this method has the drawback of only indicating whether digital transformation has been implemented, without distinguishing between high or low levels of digital transformation outcomes.

To overcome the limitations of the aforementioned methods for determining the level of digital transformation, the Ministry of Information and Communications of Vietnam, in collaboration with the Vietnam Information Technology Association, developed the ICT for Vietnamese Banks. The Vietnam ICT Index comprises four standardized components: (1) technology infrastructure, (2) human resource infrastructure, (3) internal banking applications, and (4) online banking services. The Vietnam ICT Index applies the Z-Score normalization method when calculating the component indicators.

Table 1.
Standards for evaluating the Vietnam ICT Index.

(1)	Technology Infrastructure (ITI)	Server and station infrastructure Communication infrastructure ATM/ POS infrastructure Solutions for information and data security Datacenter and disaster recovery center
(2)	Human Resource Infrastructure (IHI)	Percentage of specialized staff in technology and information. Percentage of specialized staff in information security Percentage of specialized staff in technology and information holding international certificates
(3)	Internal Bank's Application of Technology and Information (IIBA)	Core banking implementation Basic application implementation Electronic payment
(4)	Online Banking Services (IOBS) Banks' website	Internet banking for individual clients Internet banking for corporate clients Electronic banking activities Other electronic banking activities

Source: Ministry of Information and Communications, Vietnam.

The Vietnam ICT Index is evaluated by taking the average value of these four standardized indices using the formula below:

$$Vietnam\ ICT\ Index = \frac{1}{4}(I_{TI} + I_{HI} + I_{IBA} + I_{OBS})$$

The Vietnam ICT Index provides a comprehensive assessment of the digital transformation level of commercial banks. Vietnam ICT Index values range from 0 to 1, with higher values indicating a greater level of digital transformation within the bank. This result is very useful as it clearly distinguishes the minimum and maximum levels of digital transformation.

4.2.3. Control Variables

In addition to the primary independent variable, other factors may affect the operational efficiency of commercial banks. Based on previous research, the selected control variables include bank size (SIZE), bank age (AGE), solvency (LEV), capital intensity (CI), state ownership ratio (GOVS), profit growth rate (GROWTH), GDP growth rate (GDP), and inflation rate (INF).

To examine the factors influencing the Return on Assets (ROA) of Vietnamese commercial banks, a panel data regression model is applied. In order to support the hypothesis of this study, this model is specifically represented as follows:

ROA = β0 + β1*ICT + β2*SIZE + β3*AGE + β4*LEV + β5*CI + β6*GOVS + β7*GROW + β8 *GDP + β9*INF + ε

β represents the coefficient of each variable and ε is the random disturbance term.

Table 2 provides more detailed information about the variables in the research model.

Table 2.
The main variables.

Variable	Coding	Measurement
Dependent Variable		
Bank performance	ROA	Profit after tax/Total asset
Independent variable		
Digital transformation	ICT	The Vietnam Information and Communication Technologies Index is the composite of standardized component indices, with values ranging from 0 to 1, as provided by the Ministry of Information and Communications, Vietnam.
Control variable		
Size of bank	SIZE	Logarithm of total assets
Foundation year	AGE	Number of years since the bank was established
Leverage	LEV	The natural logarithm of assets
Capital Intensity	CI	Total assets/operating income
State ownership ratio	GOVS	The shareholding ratio of the state
Profit growth rate	GROW	(Net profit for the current period − Net profit for the previous year)/Net profit for the previous year
GDP growth rate	GDP	The annual GDP growth of Vietnam
Inflation rate	INF	The annual inflation rate of Vietnam

5. Research Results

5.1. Descriptive statistics

In this part, this study summarizes several statistical criteria related to mean, standard deviation, minimum, and maximum. These are presented in Table 3.

Table 3.
Descriptive statistics

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
ROA	260	0.009	0.007	0	0.037
ICT	260	0.512	0.106	0.253	0.811
SIZE	260	18.924	1.222	16.502	21.475
AGE	260	3.17	0.413	1.609	4.174
LEV	260	0.915	0.035	0.761	1.03
CI	260	0.01	0.008	0	0.041
GOVS	260	0.183	0.309	0	1
GROW	260	0.797	3.626	-0.951	51.48
GDP	260	0.061	0.018	0.026	0.08
INF	260	0.032	0.015	0.006	0.066

Our sample consists of 260 observations for the 2013–2022 period. Regarding business efficiency, the bank's return on assets (ROA) reached only 0.009 (0.9%) with a standard deviation of 0.007, with a peak value of 3.7%.

On average, the bank's digital transformation level is approximately 0.512, with a standard deviation of 0.106. The highest value recorded is 0.811, and the lowest is 0.253, indicating that all Vietnamese banks have deployed digital transformation.

5.2. Correlation Matrix

The correlation matrix coefficients reveal the relationships among these variables. It is essential to examine the pairwise correlation coefficients, particularly the correlation between the dependent and independent variables in the model.

Table 4.
The correlation matrix between variables.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1) ROA	1.000									
(2) ICT new	0.220***	1.000								
(3) SIZE	0.319***	0.151**	1.000							
(4) AGE	0.126**	-0.066	0.600***	1.000						
(5) LEV	-0.316***	-0.065	0.494***	0.218***	1.000					
(6) CI	0.988***	0.222***	0.344***	0.168***	-0.328***	1.000				
(7) GOVS	-0.098	-0.071	0.509***	0.394***	0.235***	-0.075	1.000			
(8) GROW	-0.027	-0.058	0.041	0.117*	0.072	-0.031	0.076	1.000		
(9) GDP	-0.111*	0.004	-0.074	-0.067	0.027	-0.092	-0.002	-0.032	1.000	
(10) INF	-0.059	-0.078	-0.134**	-0.138**	-0.133**	-0.045	0.001	0.130**	0.037	1.000

Note: *** p<0.01, ** p<0.05, * p<0.1.

As can be seen from Table 3, almost all independent variables correlate with ROA at different significance levels (90%, 95%, 99%). The coefficient of the correlation matrix is smaller than 0.9, so there is no multicollinearity in the model.

5.3. Panel Data Regression Estimation

By using xttest0, we tested the hypothesis between the POLS model and REM. As a result, REM is selected because the p-value in the test is smaller than 0.05 (P-value = 0.0205 < 0.05); therefore, REM is more efficient than OLS.

Table 5.
REM estimation results.

ROA	Coef.	St. Err.	t-value	p-value	[95% Conf	Interval]	Sig
ICT new	0	.001	-0.59	**.552**	-.002	.001	
AGE	-.001	0	-4.14	0	-.001	0	***
LEV	.005	.002	2.14	.032	0	.01	**
CI	.858	.01	89.32	0	.84	.877	***
GOVS	0	0	-0.71	.478	-.001	0	
GROW	0	0	0.92	.357	0	0	
GDP	-.009	.003	-2.63	.008	-.016	-.002	***
INF	-.009	.004	-2.06	.039	-.018	0	**
Constant	-.001	.002	-0.35	.724	-.005	.003	
Mean dependent var	0.009		SD dependent var		0.007		
Overall r-squared	0.980		Number of obs		260		
Chi-square	10330.131		Prob > chi2		0.000		
R-squared within	0.963		R-squared between		0.995		

Note: *** p<.01, ** p<.05, * p<.1.

Breusch and Pagan Lagrangian multiplier
chibar2(01) = 4.18
Prob > chibar2 = 0.0205

Besides, the results showed that the effect of the ICT variable on ROA is not significant at any confidence level (p-value = 0.552 > 0.05).

5.3.1. Econometric Model in Big Banks

According to Table 5, the result of the Hausman test in the panel regression model shows that Chi2(4) = 15.287 and Prob > Chi2 = 0.083 < 0.1. Therefore, the fixed effects model is suitable. The following table presents the regression results of the fixed effects model.

Table 6.
Regression results for the sample of large banks.

ROA	Coef.	St. Err.	t-value	p-value	[95% Conf.	Interval]	Sig
ICT1	0.012	0.003	3.96	0	0.006	0.018	***
SIZE	0.002	0.001	2.09	0.039	0	0.003	**
AGE	-0.006	0.002	-3.05	0.003	-0.011	-0.002	***
CI	0.687	0.041	16.65	0	0.605	0.769	***
GOVS	0.008	0.004	2.23	0.029	0.001	0.016	**
GDP	-0.021	0.006	-3.53	0.001	-0.033	-0.009	***
INF	-0.015	0.008	-1.88	0.064	-0.032	0.001	*
Constant	-0.015	0.01	-1.49	0.139	-0.034	0.005	
Mean dependent var	0.013		SD dependent var		0.008		
R-squared	0.973		Number of obs		100		
F-test	420.465		Prob > F		0.000		
Akaike crit. (AIC)	-1089.006		Bayesian crit. (BIC)		-1068.165		

Note: *** p<.01, ** p<.05, * p<.1

It can be seen from the table that ICT1 impacts positively on ROA at a 99% confidence level (P-value < 0.01). The coefficient of regression is 0.012, which means that when the level of digital transformation increases by 1 point, ROA also goes up by 1.2%, assuming other factors are constant. Besides, CI and GOVS also positively influence ROA, whereas the age of the bank, GDP, and INF negatively affect ROA.

Table 7.
Heteroskedasticity and serial autocorrelation diagnostics in the model.

	Heteroskedasticity	Autocorrelation
Hypothesis testing	H_0: Heteroskedasticity existence H_1: No Heteroskedasticity	H_0: No autocorrelation H_1: Autocorrelation
Statistics (Chi-square, Fisher)	Chi2(10) = 213.63	F (1,9) = 2.668
P-value	Prob > Chi2 = 0.0000	Prob > F = 0.1368
Diagnostics	Not rejected H_1, No Heteroskedasticity	Not rejected H_0, No autocorrelation

The results from the table above indicate that there is no evidence of heteroskedasticity or autocorrelation.

5.3.2. Econometric Model in Small and Medium Banks

Table 8.
specification test.

	Coef.
Chi-square test value	26.415
P-value	0.002

Source: Hausman [23]

The result of the Hausman test in the panel regression model shows that Chi2(4) = 26.415 and Prob > Chi2 = 0.002 < 0.05. Therefore, the fixed effects model is suitable. The following table presents the regression results of the fixed effects model.

Table 9.
Regression results for the sample of small and medium-sized banks.

ROA	Coef.	St. Err.	t-value	p-value	[95% Conf	Interval]	Sig
ICT2	-0.007	0.002	-4.00	0	-0.011	-0.004	***
SIZE	0.001	0	3.27	0.001	0	0.002	***
AGE	-0.002	0.001	-2.47	0.015	-0.004	0	**
CI	0.744	0.026	28.32	0	0.692	0.795	***
Constant	-0.007	0.004	-2.03	0.044	-0.015	0	**
Mean dependent var		0.006	SD dependent var			0.005	
R-squared		0.971	Number of obs			160	
F-test		1167.076	Prob > F			0.000	
Akaike crit. (AIC)		-1865.455	Bayesian crit. (BIC)			-1850.080	

Note: *** p<.01, ** p<.05, * p<.1.

As can be seen from the table, ICT2 impacts negatively on ROA at a 99% confidence level (P-value < 0.01). The coefficient of regression is -0.007, which means that when the level of digital transformation increases by 1 point, ROA decreases by 0.7% when other factors are constant. Additionally, the age of the bank also negatively influences ROA, whereas CI and SIZE affect ROA negatively.

Table 10.
Heteroskedasticity and serial autocorrelation diagnostics in Model 2.

	Heteroskedasticity	Autocorrelation
Hypothesis testing	H_0: Heteroskedasticity existence H_1: No Heteroskedasticity	H_0: No autocorrelation H_1: Autocorrelation
Statistics (Chi-square, Fisher)	Chi2(10) = 1781.59	F(1,15) = 0.336
P-value	Prob > Chi2 = 0.0000	Prob > F = 0.5709
Diagnostics	Not rejected H_1, No Heteroskedasticity	Not rejected H_0, No autocorrelation

The results from the Table 10 indicate that there is no evidence of heteroskedasticity or autocorrelation.

6. Discussion

The rise of artificial intelligence has accelerated digital transformation within the banking industry. To enhance competitiveness and operational efficiency, many commercial banks have embarked on digital transformation initiatives. This study contributes empirical evidence on the relationship between digital transformation and the financial performance of commercial banks. Drawing on data from 13 Vietnamese commercial banks, primarily large-scale institutions, it is confirmed that digital transformation effectiveness depends on bank size; specifically, larger banks experience a greater positive impact on operational efficiency from digital transformation. Using a larger sample, our results align with Do's findings. However, our analysis further clarifies that bank size moderates the relationship between digital transformation and performance. Digital transformation positively influences performance for large commercial banks, while for small and medium-sized banks, the effect tends toward a negative impact. Although studied in diverse regional contexts, our results support the argument regarding the cost and time required for technology investments in digital transformation.

In addition to ICT, variables such as SIZE and CI positively influence ROA, while bank AGE negatively affects ROA. Interestingly, the study also reveals that GOVS, GDP, and INF significantly impact large banks, while no statistical evidence supports similar effects for small and medium-sized banks.

7. Conclusion

This study utilizes data from Vietnamese commercial banks during the period 2013 to 2022 to explore the impact of digital transformation on financial performance. Empirical research findings indicate the following:

First, digital transformation significantly influences banks' financial performance. Therefore, managers of commercial banks should recognize the essential role of digital transformation in enhancing operational efficiency and profitability.

Second, commercial banks should develop a flexible digital transformation strategy tailored to the bank's specific characteristics. For small and medium-sized banks, digital transformation investments should prioritize long-term growth over short-term profitability.

8. Limitations and Future Prospects

This research has certain limitations. Firstly, it focuses exclusively on digital transformation within commercial banks. Future studies could expand to other financial intermediaries to examine the broader impact of digital transformation on financial institutions' performance. Such research would allow for a comparison of digital transformation's effects across various financial institutions. Additionally, calculating the digital transformation index follows widely accepted academic standards, which will be essential for expanding the sample and scope of international research.

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