ISA Journal of Business, Economics and Management (ISAJBEM)

Homepage: https://isapublisher.com/isajbem/
Email: office.isapublisher@gmail.com

Volume 2, Issue 4, July-August 2025 ISSN: 3049-1835

The Impact of Digital Transformation on the Operational Efficency of Commercial Banks in Vietnam

Le Duc Minh, Pham Thu Trang, Pham Thi Hong Ngoc, Luu Gia Linh, Pham Tuan Minh

Banking Academy of Vietnam

Received: *25.06.2025* | ***Accepted:*** *25.07.2025* | ***Published:*** *31.07.2025*

***Corresponding Author:** Le Duc Minh

DOI: *10.5281/zenodo.16645863*

Abstract **Original Research Article**

Digital transformation in the banking industry is changing the way banks do business, compete, and create value. This study examines how digital transformation influences the operational efficiency of commercial banks in Vietnam from 2018–2024. A combination of qualitative and panel data regression analysis (OLS, FEM, REM, and GLS) demonstrates how new technological advances, including the use of advanced AI, big data, and digital platforms, impact banking performance measures such as ROA and ROE. It is clear that digital transformation has a positive impact on banking efficiency in general but it depends on each bank's size, governance and implementation capabilities. The study also identifies some challenges that banks will need to address, such as infrastructure and digital workforce readiness. The findings of this study will provide valuable evidence to the academic literature as well as to policy makers, as the examination of digital transformation from an emerging market experience offers practical suggestions for banks and regulators to leverage experience to enhance speed and quality of their digital implementation.

Keywords: Digital Transformation, Commercial Banks, Operational Efficiency, Vietnam Banking Sector, ROA, ROE, Fintech, Panel Data Analysis, GLS Model, Digital Banking.

Citation: Le, D. M., Pham, T. T., Pham, T. H. N., Luu, G. L., & Pham, T. M. (2025). The impact of digital transformation on the operational efficiency of commercial banks in Vietnam. *ISA Journal of Business, Economics and Management (ISAJBEM)*, *2*(4), 409-419, July–August.

1. INTRODUCTION

Amid the rapidly escalating Fourth Industrial Revolution, digital transformation is undeniably the new trend and central focus of change across the board, and is transforming the operations of many industries with banking being one of them. The use of new digital technologies, such as the Internet of Things (IoT), artificial intelligence (AI), cloud computing and blockchain, has transformed and will change business models and create a need for total digitalisation in operation, governance and services (Tan et al., 2021; Zhang et al., 2023). Through the National Digital Transformation Strategy (Decision No. 749/QĐ-TTg and 221/QĐ-TTg), the Vietnamese Government has prioritized the finance and banking sector to accelerate digital transformation. The COVID-19 pandemic has accelerated digital transformation through increased use of digital solutions for transactions, risk management, identity verification and customer data analytics (Schueffel, 2017; Nguyễn & Lê, 2023). Many Vietnamese banks are now gradually adopting AI and big data and RPA at a faster pace to achieve lower costs and improved labour productivity.

Nevertheless, investment in digital transformation does not always create an immediate and obvious impact. A number of international and domestic studies have established that the impact of digital transformation on banking performance differs based on factors such as the business scale, the capability to manage technology governance, the implementation strategy, and the time taken for adaptation (Putra et al., 2022; Giotopoulos et al., 2017). Also, smaller banks or those undergoing the transitional phase will encounter barriers in both capital and human and technological resources.

In view of this, the present study therefore will focus on analyzing and quantifying the impact of digital transformation on the operational efficiency of commercial banks in Vietnam in the period of 2018 to 2024. The study hopes to clarify the relationship between the level of digitalization and banking performance, as well as present solutions to strengthen the capacity for digital transformation in the current digital economy.

This study consists of five parts; Introduction, Literature Review, Research Methodology, Results and Discussion, and

Conclusions and Recommendations. Methodologically, the study uses quantitative models regarding panel data of commercial banks in Vietnam and combines it with theoretical analysis to provide evidence of the impact of digital transformation on operational efficiency. The results are expected to provide empirical evidence to provide the foundation for the development of policies and strategies for digital transformation in banking.

2. LITERATURE REVIEW

2.1. Overview of Studies on the Impact of Digital Transformation on Costs

As stated in the transaction cost theory of Coase (1933) and Williamson (1975), there are costs for businesses to convert transactions and therefore incur costs for organizing those transactions in terms of information search costs, negotiation, monitoring, and enforcement of contracts. The banking industry typically incurs costs of organizing transactions in terms of forming and managing transactions relating to transaction processing, credit appraisal, and customer management.

Digital transformation allows banks to cut these costs through automation of processes and quality of information. As new technologies such as Business Process Management (BPM) systems, electronic Know Your Customer (e-KYC), and smart contracts decrease processing time, minimize errors, and reduce reliance on human capital, banks can significantly reduce and with these costs. Deloitte (2020) states that banks implementing BPM can see a reduction of operational costs by up to 50% with increases in transaction efficiency by nearly 40%.

Moreover, digital technologies such as AI and Big Data improve the accuracy of customer data analysis through automation, thus decreasing credit risk, as well as costs incurred through non-performing loans. Many intelligent chatbots such as Erica (Bank of America) and Digibank (DBS) have significantly replaced some over-the-counter transaction functions with no personnel costs and client-facing improved service delivery. Juniper Research (2022) estimates chatbots will realise savings of more than USD 7 billion per year for the Global Banking industry.

In summary, digital transformation contributes to optimizing the cost structure of banks by reducing transaction costs—a core factor in determining operational efficiency and long-term competitive advantage.

2.2. Overview of Studies on the Impact of Digital Transformation on Human Resources

As defined by the Resource-Based View (RBV), a firm's competitive advantage comes from using consuming goods that are valuable, rare, inimitable, and non-substitutable (Barney, 1991). In the case of digital transformation, of all the possible resources available, the availability of human resources—notably with technology capabilities and flexibility—became the core resource in determining operational efficiency of commercial banks.

Digital transformation requires banks to invest in technological infrastructure, but that also concerned new approaches to processes, organizational models, and—most certainly—the competencies of their workforce. The competencies of the workforce include the capacity to embed technology into day-to-day workings, the propensity to make data-driven decisions, as well as show flexibility in collaboration in the digital space. Banks with well-established internal capabilities—features including functioning robust internal training systems, strong internal information sharing facilities, and alignment at the board or executive level—are demonstrably capable to adapt and improve operational performance (Teece et al., 1997).

The capacity to work with external stakeholders—this includes coordinating with staff at corporate and retail banks, customers, technology providers, and partners to render services—was also an important factor of the ability to move assistively throughout digital transformation. The ability to orchestrate and pool competencies created a conducive and sustainable digital ecosystem; an ecosystem that allowed banks and the banks' service delivery systems to carry on the process of growing and extending services, and improve customer experience, enhanced competitive positioning.

In summary, within the RBV framework, digital transformation introduces new requirements for human resources while also offering opportunities to optimize performance by strengthening internal capabilities and external collaboration. This is a central factor in realizing the long-term benefits of digital transformation in the banking sector.

2.3. Overview of Studies on the Impact of Digital Transformation on Bank Performance

As commercial banks undergo transitions in their operations and business models, digital transformation (DT) is quickly emerging as the key catalyst for restructuring. Not only do customer-facing digital technologies empower and boost customer experiences, they also optimize their internal processes and boost operational efficiency. Taiminen and Karjaluoto (2015) note that DT will provide banks access to more digital touchpoints and thus create opportunities for proactiveness and flexibility in customers. Similarly, Verhoef et al. (2021) highlight the role of digital platforms in amplifying online customer care and developing user loyalty.

In terms of operational change, DT shrinks manual workloads, adds opportunities for automation, enhances management systems which leads to labor productivity enhancement, without even going to headcount relative adjustments (Zhai et al., 2022). Moreover, by combining enhanced process efficiencies and digital innovation, banks can reduce operating costs, and maximize business profit, and ultimately, long-term margins.

Varied types of empirical studies have substantiated the positive contributions of DT to bank performance. Chen and Xu (2007), Guo and Xu (2021), and Zhang et al. (2021), all report that when banks invest in their digital infrastructure, it decreases transaction processing timeliness, reduced processing errors, and even positively affects risk management. In Vietnam, Đỗ et al. (2022), also suggested that utilizing virtual banking systems, incorporating artificial intelligence technology, and supporting electronic payment methods had contributed to improved labor productivity and subsequently the overall performance of credit institutions.

However, the impact of digital transformation (DT) is not always immediate or uniformly positive. For instance, Beccalli (2007) and Martín-Oliver & Salas-Fumás (2008) argued that investing in technology does not always lead to better financial performance, especially if it is not aligned with strategy and organization. The challenges of limited resources, technology-specific capability, and change management capability may diminish the impact of DT implementation (Giotopoulos et al., 2021; Gebauer et al., 2020). In addition, it takes time for the benefits of DT to appear and that those benefits accrue steadily and necessitate adaptation to and re-alignment of the business model (Guo et al., 2023). Consequently, achieving successful digital transformation requires a combination of technology investment, human capital development, aligned strategy, and organizational agility.

3. RESEARCH METHODOLOGY

3.1. Research model

This research is to examine the effect of digital transformation on the operational performance of commercial banks in Vietnam. More specifically, the scope of the study is to measure the relationship between the degree of digital transformation and bank profitability using financial performance measures. In addition, the study attempts to account for the role of a number of micro- and macro-level control variables that affect performance, in order to make clear what is the actual effect of digital transformation, given the significant transformation of the banking industry in Vietnam due to digital technologies and changes in consumer financial behavior.

In conducting the research, the research objectives will involve a quantitative strategy utilizing panel-data regression models to assess the relationship between digital transformation and bank performance. The models used in the research included the Pooled Ordinary Least Squares (Pooled OLS), Fixed Effects Model (FEM), Random Effects Model (REM), and Generalized Least Squares (GLS) model, in order to account for heteroskedasticity and autocorrelation, The estimations were performed using Stata version 17. The ultimate models were selected using a number of statistical tests including the Hausman Test and Breusch–Pagan test, to ensure the highest degree of validity and reliability were realized.

3.2. Data

The research is based on panel data from audited financial statements of commercial banks in Vietnam, covering the period from 2018-2024. The data was compiled from a range of reliable public information sources including the official websites of banks, the State Bank of Vietnam's official information portal and financial information databases of Vietstock and FiinGroup. Of particular relevance, certain macroeconomic indicators were obtained from the General Statistics Office of Vietnam and the World Bank.

In order to reduce inaccuracies within the data, it will follow appropriate processing procedures. Overall, missing values, extreme outliers and inconsistent observations were removed and some extreme large value variables were natural log transformed to prevent any variance instability. Overall, the final dataset consisted of 24 banks over a 7-year time series which should provide an adequate number of observations for panel regression methods.

3.3. Variables

To analyze the impact of digital transformation on the operational performance of commercial banks, the author employs the following regression model:

$$PT_{i,t} = \beta_0 + \beta_1 \times DT_{i,t} + \beta_2 \times COST_{i,t} + \beta_3 \times INCDIV_{i,t} + \beta_4 \times NPL_{i,t} + \beta_5 \times CIR_{i,t} + \beta_6 \times SIZE_{i,t} + +\beta_7 \times INF_{i,t} + \beta_8 \times GDP_{i,t} + \upsilon_i + \varepsilon_{i,t}$$

Where:

Symbols	Variable	Hypothesis	References
PT	Dependent variable		Yin et al. (2022), Guo & Xu (2021), Boachie & Mensah (2022)
DT	Digital transformation	+	Zhao và Yang (2020), Zhang et al. (2021), Ni & Liu (2021), Wu et al. (2021), Verhoef et al. (2021)
COST	Non-interest expense to total assets ratio	-	Goddard et al. (2004)
INCDIV	Non-interest income to total assets ratio	+	Stiroh (2004)
NPL	Non-performing loan	-	Berger & DeYoung (1997)

SIZE	Bank size	+	Nizam et al. (2019),Platonova et al. (2018),Velte (2017) Mashayekhi, Bazaz (2008), Azeez (2015), Olokoyo (2013)
CAP	Equity to total assets ratio	+	Athanasoglou et al. (2008), Demirgüç-Kunt & Huizinga (1999)
INF	Inflation	+/-	Pasiouras & Kosmidou (2007), Claeys & Vander Vennet (2008), García-Herrero et al. (2009), Kasman et al. (2010), Trujillo-Ponce (2013), Boyd et al. (2001)
GDP	Gross Domestic Product	+	Demirgüç-Kunt & Huizinga (1999); Bikker & Hu (2002); Dietrich &Wanzenried (2011); Albertazzi &Gambacorta (2009)

4. RESULT

4.1. Descriptive Statistics

First, the author evaluates and checks the input data to eliminate and filter out potential errors that may affect the regression results. The linear regression process begins with a preliminary assessment of the collected dataset through descriptive statistics, including the mean, median, standard deviation, minimum value, and maximum value. The evaluation results are presented in detail in Table 1 below.

Table 1. Descriptive Statistics

Variables	Obs	Mean	Std. Dev	Min	Max
ROA	342	0.015641	0.0760724	-0.0045948	0.0128238
ROE	342	0.0437177	0.0285932	-0.0602418	0.1187620
DT	342	35.961607	30.051375	0	88.67660
COST	342	0.006702	0.0007358	-0.0001304	0.003403
INCDIV	342	0.018743	0.0141172	0	0.008893
NPL	342	0.01385253	0.0123533	0.0036576	0.098798
SIZE	342	0.467536	0.1766897	0.0000747	1.816585
CAP	342	0.082513	0.0251988	0.0409679	0.165878
INF	342	0.012084	0.0095143	-0.0043135	0.0232
GDP	342	0.06519	0.0182542	0.00298000	0.1438670

Source: Authors's calculation

The results from this table show that the mean value of the dependent variable (ROA) is 0.015641. This figure exhibits relatively low variation compared to other indicators and is fairly consistent with several previous studies.

When considering the standard deviation, the value associated with ROA is 7.6%, indicating a relatively stable performance of this indicator during the study period. Among the independent variables, the average operating expense to operating income ratio recorded a relatively high level of approximately 46.75%, with a deviation among banks of about 17.67%. For the remaining variables, the average values range from 0.01 to 0.08, suggesting a certain level of homogeneity across banks. Furthermore, the standard deviations of these variables are relatively low—around 1%—indicating data stability throughout the study period.

Regarding macroeconomic factors, the average GDP growth rate is 6.53%, with a maximum and minimum value of 14.39% and 0.3%, respectively. The inflation indicator (INF) has an average value of 0.12%, with the highest and lowest values being 2.32 and -0.43, respectively.

4.2. Model Diagnostic Test Results:

Table 2. Autocorrelation Matrix

	COST	INCDIV	NPL	SIZE	CAP	INF	GDP	DT
COST	1	0.5353	0.2188	0.311	-0.1561	0.189	0.0536	-0.0128
INCDIV		1	0.006	-0.2033	0.3659	-0.1584	-0.023	0.4825
NPL			1	-0.1502	-0.2496	-0.516	0.0578	-0.026
SIZE				1	-0.012	-0.105	-0.021	-0.117
CAP					1	0.0781	0.0763	0.731
INF						1	0.312	-0.211
GDP							1	0.6381
DT								1

Source: Authors's calculation

Before conducting the regression analysis, the study performs a multicollinearity test by examining the correlation matrix among the independent variables. According to Kennedy (2008), an absolute correlation coefficient exceeding the threshold of 0.8 may indicate serious multicollinearity issues in the model. The results show that no variable pairs exceed this threshold, with the highest observed correlation being –0.516 between the inflation rate and the non-performing loan ratio. This provides a preliminary indication that the selected variables are appropriate and do not need to be excluded.

Regarding the analytical approach, the study utilizes panel data to take advantage of a larger number of observations, control for unobserved heterogeneity among banks, and improve estimation accuracy. The models employed include Pooled OLS, Fixed Effects Model (FEM), Random Effects Model (REM), and Generalized Least Squares (GLS). Model selection is based on the Hausman and Breusch–Pagan tests to ensure consistency and reiability of the conclusions drawn from the regression analysis.

4.3. Regression Results

Table 3: Regression Results with ROA as the Dependent Variable

	Pooled OLS	**FEM**	**REM**
COST	-0.855*** [-5.28]	-0.694*** [-3.70]	-0.698*** [-3.80]
INCDIV	0.959*** [10.86]	0.782*** [7.82]	0.797*** [8.17]
NPL	-0.0259*** [-3.88]	0.000466*** [0.07]	-0.00188*** [-0.29]
SIZE	0.00627*** [-13.50]	-0.0529*** [-11.33]	-0.0537*** [-10.60]
CAP	0.0288*** [9.29]	0.0395*** [9.94]	0.0385*** [10.01]
INF	-0.00396 [-0.42]	-0.0119 [-1.41]	-0.0112 [-1.32]
GDP	0.00630 [1.84]	0.00847** [2.78]	0.00822** [2.70]

DT	0.00133*** [4.23]	0.0000215*** [6.86]	0.0000207*** [6.68]
_cons	0.00406*** [6.09]	0.00229*** [3.76]	0.00242*** [3.50]
N	342	342	342
R-sq	0.745	0.664	

Source: Authors's calculation

The regression results from the three models - Pooled OLS, Fixed Effects Model (FEM), and Random Effects Model (REM) - demonstrate that the majority of independent variables play an important role in the return on assets (ROA) of commercial banks. The operating cost variable (COST) exhibits a negative coefficient and is statistically significant across all models, which supports the notion that an increase in operating costs will likely lead to a decline in a bank's financial performance.

In contrast, the non-interest income variable (INCDIV), in these models indicate a positive coefficient that is significant at the 1% level, which illustrates the positive role of non-interest income in support of profitability.

The non-performing loan ratio (NPL) shows a negative effect in the OLS model at the 1% significance level. In the FEM and REM models, statistical significance is lacking in the results for NPL which suggests that the conflicting nature of how credit risk will affect profitability may depend on how unobserved heterogeneity among banks is adjusted.

The variable bank size (SIZE) has a positive coefficient in the OLS model, suggesting that larger banks may be able to capture better economies of scale thereby converting that economies of scale to higher ROA. However, in the FEM and REM estimations the SIZE coefficient becomes negative while still having significance indicating that when controlling for bank-specific effects at the bank size index level, larger size does not necessarily lead to better performance and this is an important consideration when making decisions related to expansion strategies related to scale.

The equity ratio (CAP) is positive and significant in ROA in all three models meaning that capital strength is important in supporting profit success. The inflation rate (INF) did not obtain any level of statistical significance in any of the models indicating inflation's effect on ROA was not clearly seen during the study period.

The variable of GDP growth (GDP) presents a positive and statistically significant relationship with ROA at the .05 level in the REM and FEM, which highlights the pro-cyclical characteristics of bank performance and economic growth. The variable of digital transformation (DT), capturing the extent of fintech adoption, only has a positive and strongly significant affect at the .01 level in all three models. Which further indicates the consistent and positive impact of digital transformation on enhancing ROA for Vietnamese commercial banks throughout the research period.

The regression results are consistent throughout and identify operating costs, variable of non-interest income, capital strength and digital transformation as significant determinants of profitability for commercial banks. This research can provide strong evidence base implications for regulatory frameworks and strategic directions for the development of the banking sector during this period of rapid digital transformation.

Table 4: Regression Results with ROE as the Dependent Variable

	Pooled OLS	**FEM**	**REM**
COST	-8.542*** [-4.43]	-7.326*** [-3.33]	-7.299*** [-3.38]
INCDIV	9.344*** [8.87]	8.295*** [7.05]	8.385*** [7.24]
NPL	-0.294*** [-3.72]	-0.00250*** [-0.02]	-0.0178*** [-0.23]
SIZE	0.0752*** [-13.59]	-0.0709*** [-12.90]	-0.0712*** [-11.08]
CAP	-0.213***	-0.142***	-0.245**

	[-5.84]	[-3.03]	[-3.18]
INF	-0.0664 [-0.59]	-0.153 [-1.55]	-0.148 [-1.50]
GDP	0.0664 [1.65]	0.0962** [2.67]	0.0940** [2.65]
DT	0.0158*** [4.22]	0.000238*** [6.41]	0.000232*** [6.35]
_cons	0.0960*** [12.08]	0.0792*** [10.94]	0.0798*** [9.37]
N	342	342	342
R-sq	0.624	0.590	

Source: Authors's calculation

The regression results for ROA with ROE as a dependent variable (an indicator of effective utilization of equity) provide considerable distinctions when viewed against ROA molecularly showing the working of ROE is sensitive democracy of financial factors capital structure. In each of the three models (OLS, FEM, REM), the operating cost variable (COST) recorded a significant positive coefficient confirming high-cost operating not only reduces efficiency but affordability in shareholders equity. This means that it's important to maintain working with high-cost operating and cost management to further explore shareholder value.

North and south were constructed with variables but income and other no interest income variable (INCDIV) all three models had an included positive and statistically significant results which suggested the revenue diversification (and income) especially from individual credit services has been an increasingly important result in the discussion to consider improved ROE. This result is converging with a time of increasing digitalization of banking that increase non-credit service fees income, digital banking, and expense to input the fintech; digitalization makes more income matter as relevant to total income.

Bank size (SIZE) has a positive coefficient in the OLS model, but its coefficient is negative and statistically significant in the FEM and REM models. This indicates that larger bank size improves performance without controlling for the bank-specific characteristics. However, measuring the effect of bank size on performance under fixed costs, bureaucratic structures, or weaker governance in large banks discouraging the efficient utilization of equity capital.

The equity ratio (CAP) is inconsistent with expectations as it has a negative and statistically significant coefficient in the FEM and REM models. This indicates that bank performance will decrease with increases in the proportion of equity capital, which can also be attributed to lower reliance on financial leverage that would allow a bank to produce a higher return during leverage. In this specific situation, ROE will decrease if banks do not efficiently mobilize capital as it returns will decrease according to level of equity.

With respect to macroeconomic indicators, GDP growth (GDP) has a significant and positive coefficient in both FEM and REM models indicating that steady economic growth enables banks to enhance equity efficiency through credit expansion and better management of non-performing loans. In contrast, inflation variable (INF) shows no statistically significant effect in any of the models suggesting an inconsistent impact of price levels on equity returns in Vietnam's capital markets.

Importantly, the digital transformation variable (DT) has a positive and statistically significant coefficient at the 1% level in all three models, demonstrating a robust and positive impact of digitalization on ROE. Investment in technology, automation and digital banking platforms have streamlined operations by improving customer outreach and value per unit of equity capital. This finding further strengthens the notion that digital transformation not only positively affects the overall efficiency of the operations of an organization, but it improves shareholder financial returns directly.

In summary, cost factors, income structure, size, capital composition, and especially digital transformation significantly influence ROE. The in-depth analysis across three quantitative models highlights the importance of internal control and strategic direction in improving equity efficiency among Vietnamese commercial banks.

4.4. Model Reliability Test

Table 5: GLS Estimation Results with ROA and ROE

	ROA	ROE
COST	-0.810*** [-5.91]	-8.498*** [-5.68]
INCDIV	0.944*** [10.93]	9.351*** [9.38]
NPL	-0.0297*** [-4.36]	-0.292*** [-3.52]
SIZE	0.00548*** [11.59]	0.0732*** [13.34]
CAP	0.0303*** [9.74]	-0.245*** [-6.85]
INF	-0.00955 [-1.17]	-0.120 [-1.09]
GDP	0.00639** [2.18]	0.0667** [1.82]
DT	0.0524*** [5.62]	0.1521*** [5.27]
_cons	0.00371*** [6.32]	0.0971*** [12.90]
N	342	342
R-sq	0.7447	0.6237

Source: Author's calculation

To verify the stability and reliability of the regression results, the Generalized Least Squares (GLS) method was applied to address potential issues of autocorrelation and heteroskedasticity inherent in panel data. The GLS estimation—conducted without the inclusion of lagged variables—produced coefficient signs and significance levels that are consistent with those obtained from the original models (OLS, FEM, REM), thereby reinforcing the robustness of the findings.

For the ROA model, the variables operating cost (COST) and non-performing loans (NPL) exhibit negative and statistically significant effects at the 1% level, highlighting the adverse impact of operational expenses and credit risk on asset profitability. Conversely, variables such as non-interest income (INCDIV), bank size (SIZE), capital adequacy (CAP), GDP growth (GDP), and particularly digital transformation (DT) have positive and highly significant coefficients. Notably, the coefficient for DT is 0.0524, significant at the 1% level, underscoring the clearly positive role of digitalization in enhancing banks' financial performance.

Similarly, in the ROE model, the variables COST and NPL continue to exert negative influences, while INCDIV, SIZE, GDP, and DT show positive and statistically significant effects. Interestingly, the CAP variable displays a negative relationship with ROE, supporting the notion that an excessively high equity ratio may reduce return on equity by limiting financial leverage. The coefficient of DT in the ROE model is 0.1521, also significant at the 1% level, indicating that digital transformation not only improves ROA but also significantly enhances the efficiency of equity utilization.

In summary, the GLS results confirm that internal factors such as cost management, credit risk, and capital structure, along with external drivers like economic growth and digital transformation, consistently and reliably influence the operational performance of Vietnamese commercial banks during the study period.

5. CONCLUSION AND RECOMMENDATION

5.1. Conclusion

This research investigates the effect of digital transformation on Vietnamese commercial banks' operational efficiency. The authors then based on a summary of the theoretical foundation and the empirical study created a quantitative model based on panel data from 2018 to 2024 to evaluate the relationship between the level of digital transformation and banks' financial performance. The regression results would reveal the positive impact of digital transformation on operational efficiency in circumstances in which the banks invested heavily in technology infrastructure, process improvement and enhanced personalisation of services. Additionally, the research indicated that banks will not benefit from their digital transformation initiatives in the immediate future but only through a stable, synchronised implementation road-map having the backing of a clear strategic vision. However, there are certain facets of banks that have been identified such as big data, artificial intelligence (AI), and digital platforms which will allow increasingly fierce competition with an improvement in operational efficiency and innovational capability.

With these findings in mind, the study offers a number of recommendations for the government and banking organizations to promote a more effective and sustainable digital transformation process. Although the study points to several challenges such as cybersecurity risks, investment in technology, and access to technology by users, it is crucial to develop an integrated digital transformation strategy that balances the opportunity of new technology with the risk of new technology to appropriately ensure the stable development of the banking industry in a digital world.

5.2 Recommendations for the Government and Regulatory Authorities

To achieve an effective digital transformation (DT) in the banking sector, the Government should continue to play the role of facilitating, coordinating, and providing policy direction. The Government should first give priority to strengthen the legal framework supporting the sharing of financial data for regulatory sandboxes in the banking sector and the issuance of specific guidelines on Open APIs. This still enables banks and Fintech companies to experiment with digitalization in ways that are flexible to engage in, but with some level of risk control. At the same time, the Government should accelerate the development of shared data infrastructure across different sectors touching on banking, insurance, taxation, and managing population data - specifically through the national population database for improved identity verification and personalising the customer experience of financial services.

In addition, a clear regulatory framework on the implementation of cloud computing technologies and solid information security standards is required to support banks in adopting new technologies in a safe way. The Cashless Payment Development Scheme and the amendment of the Law on Electronic Transactions should be expedited to meet the needs of the market. Due to the increasing threats posed by cybercrime, the Government should strengthen enforcement mechanisms, enhance supervisory capacity over Fintech firms and payment intermediaries and develop a standardised technology risk assessment framework aligned with international best practices.

Finally, promoting financial literacy is essential as a way to promote public awareness and capacity to safely use these services. The Government, in collaboration with banks and technology companies could undertake activities to educate the public, provide guidance on the use of digital services, and assist vulnerable customer groups through the digital transformation process.

5.3 Recommendations for Commercial Banks

Commercial banks require to view digital transformation (DT) as a holistic development strategy, which does not only imply an adoption of new technologies, but instead, a wholesale rethinking of their operating models, decision-making culture, and customer experience. An appropriate digital banking strategy should be developed in combination with internal capabilities, as well as important investments in core technology systems, data platforms, and analytics architecture to support decision-making, risk/operational management, and personalization of services. Examples from Vietcombank, BIDV, Techcombank, and TPBank illustrate how investments in digital ecosystems, big data and automation technologies is a great way to enhance competitive advantages.

Banks should also focus on designing a seamless, customer-centric, omnichannel experience while enhancing the integration between technology, operations, and business models. Upgrading cybersecurity systems, implementing multi-factor authentication, fraud prevention mechanisms, and data protection technologies are critical to ensuring continuity and safety in digital operations.

In addition, human capital plays a decisive role in digital transformation. Banks must adopt policies to attract and develop high-quality IT talent while organizing training programs on digital skills, data analytics, and agile working culture. A well-designed incentive structure will motivate and retain creative, proactive employees who can adapt to change.

Finally, banks should place greater emphasis on collaborating with financial technology (FinTech) companies to leverage external resources, deploy innovative solutions, and expand service delivery capacity. Such partnerships will help banks maintain their competitive edge and serve customers more effectively in the digital era.

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