

THE IMPACT OF DIGITAL TRANSFORMATION ON THE PERFORMANCE OF COMMERCIAL BANKS IN VIETNAM

**Bui Le Uyen Nhi, Tran Thi Yen Duyen, Nguyen Thanh Do,
Nguyen Minh Tai, Tran Thanh Hung, Bui Hong Diep***

Ho Chi Minh City University of Industry and Trade

*Email: diepbh@huit.edu.vn

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ABSTRACT

This research examines how digital transformation influences the performance of commercial banks in Vietnam. The analysis is based on panel data obtained from the financial reports of 25 banks over the period from 2018 to 2023. To investigate the relationships among variables, the study applies several econometric approaches, including pooled Ordinary Least Squares (OLS), the Fixed Effects Model (FEM), and the Random Effects Model (REM). The selection of the appropriate estimation technique is determined through statistical procedures such as the F-test, Breusch–Pagan Lagrange Multiplier test, and Hausman test, with results indicating that the pooled OLS model provides the best fit for the dataset. The empirical findings demonstrate that digital transformation exerts a positive and statistically significant influence on bank performance, measured through Return on Assets (ROA) and Return on Equity (ROE). Furthermore, internal factors such as bank size, liquidity level, and growth prospects contribute positively to performance outcomes, whereas financial leverage is found to have a detrimental effect. The results confirm all proposed hypotheses. This study enriches the existing literature by offering empirical evidence on the importance of digital transformation as a strategic asset in improving banking performance, particularly within the context of an emerging economy. From a practical standpoint, the findings highlight the need for banks to intensify digitalization efforts, allocate technological resources more efficiently, and maintain an appropriate financial structure in order to strengthen operational effectiveness and sustain competitiveness in an increasingly digital environment.

Keywords: Digital transformation, bank performance, ROA, ROE, commercial banks.

1. INTRODUCTION

In recent years, digital transformation has become one of the most significant trends shaping the global economy, particularly within the banking and financial services sector. Driven by the rapid development of the Fourth Industrial Revolution (Industry 4.0), technologies such as artificial intelligence (AI), cloud computing, big data analytics, and blockchain have substantially altered traditional banking operations, customer interactions, and service delivery systems [1], [2]. Consequently, digital transformation is increasingly viewed as a strategic necessity for improving operational efficiency, strengthening competitiveness, and enhancing long-term organizational performance.

Within the banking industry, digital transformation extends beyond technological adoption and involves broader changes in business models, operational processes, and customer service strategies. Existing studies suggest that digital technologies contribute positively to banking efficiency by reducing operational costs, improving transaction speed,

and enhancing service quality, thereby supporting profitability indicators such as ROA and ROE [3], [4]. In addition, digital transformation promotes financial inclusion and improves the allocation of financial resources by expanding access to banking services [5].

In Vietnam, digital transformation has been strongly encouraged through national digitalization strategies, particularly the “National Digital Transformation Program to 2025, with orientation toward 2030.” Vietnamese commercial banks have actively expanded digital banking platforms, upgraded technological infrastructure, and introduced innovative financial services to improve operational effectiveness and customer experience. Nevertheless, the digitalization process also presents several challenges, including substantial technology investment costs, cybersecurity concerns, technological uncertainty, and increasing pressure for organizational and human resource adaptation [6], [7].

Given these developments, examining the relationship between digital transformation and bank performance has become increasingly important for both researchers and practitioners. This study therefore investigates the impact of digital transformation on the performance of commercial banks in Vietnam using panel data from 25 banks during the period 2018–2023. By applying panel regression techniques and incorporating important bank-specific factors such as bank size, financial leverage, liquidity, and growth opportunities, the study aims to provide updated empirical evidence regarding the role of digital transformation in the Vietnamese banking sector.

This study contributes to the literature in several respects. First, it provides additional empirical evidence on digital transformation and bank performance in the context of an emerging economy undergoing rapid digitalization. Second, the use of panel data allows the analysis to capture both cross-sectional and time-series variations, thereby improving the robustness of the empirical findings. Third, the study offers practical implications for bank managers and policymakers in formulating strategies to improve banking efficiency and competitiveness in the digital era.

2. LITERATURE REVIEW

2.1. Digital transformation in the banking sector

Digital transformation has become an increasingly significant topic in contemporary banking research due to the growing impact of technological innovation on financial services. Vial [8] defines digital transformation as a process in which organizations employ digital technologies to fundamentally transform business models, operational activities, and value creation mechanisms. In the banking industry, this transformation involves the integration of advanced technologies such as AI, big data analytics, cloud computing, and blockchain into core banking operations [2].

Nicoletti [9] argues that digital transformation in banking goes beyond simple process automation and also includes the redesign of customer experience, organizational structures, and service delivery channels. Similarly, Verhoef et al. [10] suggest that digital transformation comprises three key dimensions, namely customer experience transformation, operational process transformation, and business model innovation. These perspectives demonstrate the multidimensional nature of digital transformation and emphasize its strategic role in improving bank competitiveness and operational performance.

2.2. Digital Transformation and Bank Performance

An increasing number of empirical studies have explored the relationship between digital transformation and bank performance. Prior research generally suggests that the adoption of digital technologies contributes positively to banking efficiency and profitability. For example,

Beccalli [11] finds that investment in information technology is positively associated with bank performance in European banking systems. Similarly, DeYoung et al. [12] demonstrate that the adoption of online banking services improves cost efficiency and enhances bank profitability.

More recent evidence also supports the positive role of digital transformation in improving banking performance. Dadoukis et al. [13] report that digitalization enhances bank efficiency through the optimization of internal processes and improved customer engagement. Likewise, Alam et al. [14] indicate that electronic banking services positively affect financial performance indicators such as Return on Assets (ROA), Return on Equity (ROE), and net interest margin (NIM).

Despite these positive findings, the literature also presents mixed and sometimes contradictory results. Stiroh [15] argues that technological investment may increase operational costs in the short run, thereby negatively affecting bank performance if such investments are not managed effectively. In a similar vein, Brynjolfsson and Hitt [16] suggest that the benefits derived from information technology may only materialize after a certain time lag and depend heavily on organizational capabilities and management practices. These differing findings imply that the impact of digital transformation on bank performance may vary across contexts and institutional environments, highlighting the need for further empirical investigation.

2.3. Evidence from Vietnam

In Vietnam, studies on digital transformation in the banking sector have attracted growing scholarly attention in recent years due to the rapid digitalization of financial services. Several empirical studies provide initial evidence regarding the role of digital technologies in improving banking performance. For instance, Do et al. [17] indicate that digital transformation contributes positively to the operational efficiency and profitability of Vietnamese commercial banks. Similarly, Nguyen Thi Huong et al. [18] find that digital transformation improves bank performance through enhanced service quality, cost reduction, and increased operational efficiency.

In addition, Nguyen et al. [19] emphasize that digitalization positively affects the profitability of commercial banks in Vietnam by supporting service innovation and expanding digital banking activities. Other studies also suggest that technological innovation enhances competitiveness and promotes financial inclusion within the Vietnamese banking sector [5]. However, some researchers argue that digital transformation may also create challenges and financial risks, particularly when banks lack adequate technological capabilities and effective risk management systems [6].

Overall, although previous studies provide important insights into digital transformation in Vietnamese banking, empirical findings remain relatively fragmented and sometimes inconsistent. Moreover, differences in measurement approaches, sample periods, and estimation methods continue to create variations in research outcomes, indicating the need for further empirical investigation in the Vietnamese context.

2.4. Theoretical foundations and research gaps

This study is primarily grounded in the Resource-Based View (RBV) and Organizational Performance Theory. These theoretical perspectives provide an appropriate foundation for explaining how digital transformation influences banking performance.

According to the Resource-Based View, organizations achieve sustainable competitive advantage through the effective utilization of valuable, rare, inimitable, and non-substitutable resources [20]. In the banking industry, digital technologies and digital capabilities can be regarded as strategic resources that improve operational efficiency, support innovation, and

strengthen competitiveness [2], [16]. Therefore, banks with stronger digital transformation capabilities are expected to achieve superior performance outcomes.

Organizational Performance Theory further emphasizes the importance of aligning organizational resources, strategic orientation, and environmental conditions in enhancing performance [21]. From this perspective, digital transformation enables banks to optimize operational processes, improve coordination, reduce transaction costs, and enhance service quality, thereby contributing positively to profitability and operational efficiency [9], [16].

Although the relationship between digital transformation and bank performance has attracted increasing scholarly attention, several important research gaps remain. First, many prior studies focus primarily on developed economies, while empirical evidence from emerging markets such as Vietnam remains relatively limited [6]. In the Vietnamese context, several recent studies have examined the impact of digital transformation or digitalization on banking profitability and performance. However, these studies often employ different proxies for digital transformation and produce inconsistent findings regarding its effects on bank performance [17], [18], [19].

Second, a large proportion of previous studies rely on cross-sectional data or relatively short observation periods, which may not adequately capture the dynamic effects of digital transformation over time. The application of panel data approaches in the Vietnamese banking context therefore remains relatively limited.

Third, there is still no widely accepted measurement for digital transformation in banking research. Existing studies use various indicators, including ICT investment, digital banking adoption, fintech integration, or technology expenditure, leading to differences in empirical results and limiting comparability across studies [13], [17].

Finally, previous studies often focus mainly on the direct relationship between digital transformation and bank performance while paying insufficient attention to internal bank-specific characteristics such as size, leverage, liquidity, and growth opportunities, despite their important influence on profitability and operational efficiency [3], [4].

Based on these gaps, this study seeks to provide updated empirical evidence on the impact of digital transformation on the performance of Vietnamese commercial banks by employing panel data over the 2018–2023 period and incorporating important bank-specific control variables into the empirical model.

2.5. Hypothesis development

Building upon the theoretical foundations and prior empirical evidence, this study develops hypotheses to examine the impact of digital transformation on bank performance. In addition to the main explanatory variable, several bank-specific variables, including bank size, leverage, liquidity, and growth opportunities, are incorporated as control factors to account for differences in operational and financial characteristics across banks.

2.5.1. Digital transformation and bank performance

Digital transformation is considered a strategic resource that enhances operational efficiency and strengthens competitiveness in the banking sector. From the perspective of the Resource-Based View (RBV), digital technologies such as artificial intelligence, cloud computing, and big data analytics enable banks to improve information processing, optimize internal operations, and reduce transaction costs [20]. Through the automation of banking activities and the expansion of digital financial services, digital transformation also improves customer experience and supports revenue diversification [5], [10].

Previous empirical studies generally indicate that digitalization positively affects bank performance. Dadoukis et al. [13] show that digital technologies improve banking efficiency

by streamlining operational processes, while Ozili [3] emphasizes the positive effect of digital finance on profitability indicators such as ROA and ROE. Similarly, recent studies in Vietnam also suggest that digital transformation contributes positively to banking profitability and operational efficiency [17], [18].

Although technological investment may generate substantial short-term implementation costs and adjustment challenges [16], the long-term benefits of digital transformation are expected to outweigh these costs through efficiency gains, innovation capability, and economies of scale. Therefore, the following hypothesis is proposed:

H1: Digital transformation (DIG) positively affects bank performance.

2.5.2. Bank size and performance

Bank size is included in this study as a control variable representing differences in operational scale and resource capacity among banks. Previous studies suggest that larger banks often benefit from economies of scale, stronger financial capacity, and greater ability to invest in technological infrastructure and innovation initiatives [3], [4]. Larger institutions may also possess superior risk management systems and broader service diversification, which can positively influence profitability.

Athanasoglou et al. [22] indicate that bank size is positively associated with profitability due to improved operational efficiency and resource utilization. In the context of digital transformation, larger banks are generally more capable of implementing complex digital systems and adapting to technological change [2].

Based on these arguments, the following hypothesis is proposed as a control relationship within the research model:

H2: Bank size (SIZE) positively affects bank performance.

2.5.3. Financial leverage and bank performance

Financial leverage is incorporated in the model as a control variable representing the extent to which banks rely on debt financing in their operations. Although leverage may enhance returns through greater capital utilization, excessive dependence on debt can increase financial risk, funding costs, and vulnerability to financial instability.

Previous studies generally report a negative relationship between leverage and bank profitability. Demirgüç-Kunt and Huizinga [4] argue that high leverage increases risk exposure and financing costs, thereby reducing banking performance. Similarly, Athanasoglou et al. [22] find that leverage negatively affects profitability indicators such as ROA and ROE.

In the context of digital transformation, banks may increase borrowing to finance technological investment and digital infrastructure. However, if debt levels become excessive, the resulting financial burden may offset the operational benefits generated by digitalization. Therefore, leverage is expected to negatively affect bank performance and is included in the model as a control factor.

Accordingly, the following hypothesis is proposed:

H3: Financial leverage (LEV) negatively affects bank performance.

2.5.4. Liquidity and bank performance

Liquidity is included as a control variable reflecting a bank's ability to meet short-term financial obligations and maintain operational stability. Adequate liquidity enables banks to reduce financial uncertainty, strengthen customer confidence, and support continuous banking operations.

Berger and Bouwman [23] suggest that higher liquidity improves banking resilience and contributes positively to operational performance. Likewise, Athanasoglou et al. [22] indicate that sufficient liquidity enhances profitability by supporting smoother financial operations and reducing financial risk.

Within the digital banking environment, liquidity management becomes increasingly important because digital transactions and online banking services require continuous operational capability and real-time financial processing. Banks with stronger liquidity positions are therefore better prepared to maintain operational continuity and support digital banking activities.

Although excessive liquidity may reduce profitability due to lower returns on liquid assets, the overall relationship between liquidity and bank performance is generally expected to be positive. Thus, the following hypothesis is proposed:

H4: Liquidity (LIQ) positively affects bank performance.

2.5.5. Growth opportunities and performance

Growth opportunities are incorporated into the model as a control variable representing a bank's potential for future expansion and profitability. Banks with stronger growth prospects are generally more capable of expanding financial services, investing in innovation, and entering new market segments.

Previous studies suggest that firms with high growth potential are more likely to achieve superior financial performance. Fama and French [24] argue that growth opportunities positively influence profitability and firm value. In the banking sector, Demirgüç-Kunt and Huizinga [4] also indicate that growth opportunities contribute positively to bank performance through revenue expansion and broader market penetration.

In the context of digital transformation, banks with stronger growth opportunities are more likely to adopt advanced technologies, develop innovative digital financial products, and improve customer engagement through digital platforms [2], [16]. These advantages may strengthen operational efficiency and support long-term profitability.

Accordingly, growth opportunities are expected to positively influence bank performance and are included in the model as a control factor. Therefore, the following hypothesis is proposed:

H5: Growth opportunities (MB) positively affect bank performance.

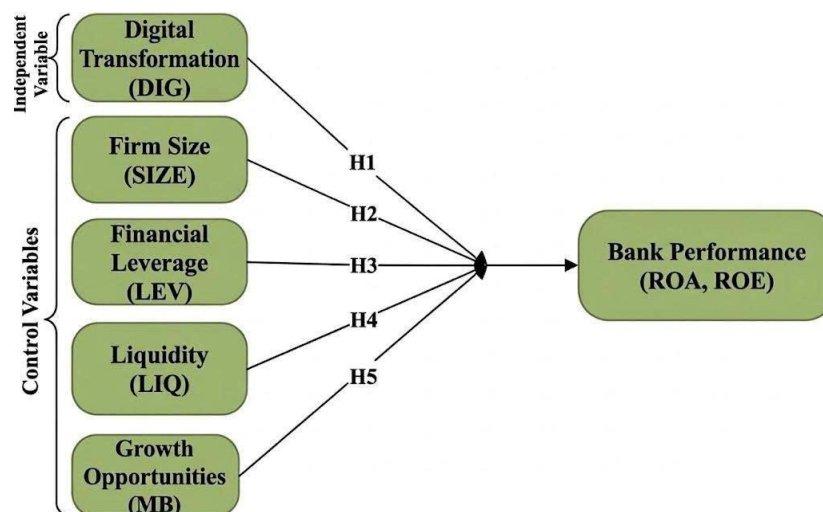


Figure 1. Proposed research model (Source: Proposed by the author)

3. METHODOLOGY

3.1. Research design and data collection

This research employs a quantitative approach to analyze the influence of digital transformation on the performance of commercial banks in Vietnam. A panel data framework is utilized, allowing the study to capture both cross-sectional differences among banks as well as changes over time. Such an approach is appropriate for examining the dynamic relationship between digital transformation and banking performance.

The dataset is compiled from secondary sources, including audited financial statements and annual reports of Vietnamese commercial banks. These data sources are considered reliable and consistent, ensuring the validity of the variables used in the empirical analysis.

The sample includes 25 commercial banks, comprising both state-owned and joint-stock institutions, covering the period from 2018 to 2023. This timeframe is selected to reflect the recent surge in digital transformation within the Vietnamese banking sector. After removing incomplete entries and conducting data screening, the final sample consists of 150 balanced panel observations.

Panel data offers several methodological advantages. It increases the total number of observations, thereby enhancing estimation efficiency. It also enables the control of unobserved heterogeneity across individual banks. In addition, it provides deeper insights into how digital transformation affects bank performance over time.

3.2. Data analysis method

To analyze the relationship between digital transformation and bank performance, this study applies panel regression methods. In particular, three estimation approaches are utilized, namely Pooled Ordinary Least Squares (OLS), the Fixed Effects Model (FEM), and the Random Effects Model (REM). These techniques are commonly adopted in empirical banking research to handle panel data structures, as they allow for the examination of both cross-sectional differences and time-related dynamics [3], [4].

The Pooled OLS approach assumes that all banks share similar characteristics and does not account for unobserved heterogeneity across individual entities. In contrast, the FEM captures bank-specific factors that remain constant over time by allowing each entity to have its own intercept. Meanwhile, the REM treats these individual effects as random variables that are not correlated with the explanatory variables.

To identify the most suitable estimation method, a series of statistical tests are performed. The F-test is employed to assess whether the FEM provides a better fit than the Pooled OLS model. The Breusch–Pagan Lagrange Multiplier (LM) test is used to determine whether the REM is more appropriate than the pooled specification. Furthermore, the Hausman test is conducted to select between FEM and REM by evaluating the presence of correlation between individual effects and the regressors.

The empirical findings suggest that the Pooled OLS model is the most appropriate for this dataset, as no significant individual effects are detected from the statistical tests. Consequently, the final regression is estimated using the OLS method with robust standard errors to correct for potential heteroskedasticity and to ensure the validity of statistical inference.

In addition, diagnostic tests are performed to validate the model assumptions. Multicollinearity is examined using the Variance Inflation Factor (VIF), while heteroskedasticity and autocorrelation are tested using standard econometric procedures. Appropriate corrections are applied to ensure consistent and unbiased estimation results..

4. RESULTS AND DISCUSSION

4.1. Model Selection Results

To determine the appropriate estimation method, this study conducts a series of model selection tests, including the F-test, Breusch–Pagan Lagrange Multiplier (LM) test, and Hausman test for both ROA and ROE models.

The results indicate that the Pooled OLS model is more suitable than both the FEM and REM, as no significant individual effects are detected. Therefore, the OLS model is selected as the primary estimation method for subsequent analysis .

This finding suggests that differences across banks are not sufficiently large to require fixed or random effects, and the pooled regression approach is appropriate for capturing the relationship between digital transformation and bank performance.

4.2. Regression Results

4.2.1. Regression Results for ROA

Before interpreting the regression results, this study first conducts model selection tests to determine the most appropriate estimation method for the ROA model.

The results of the F-test (Table 1) show that the null hypothesis $H_0: u_i = 0$ cannot be rejected, with a p-value greater than the conventional significance levels (Prob > F = 0.0915). This indicates that individual-specific effects are not statistically significant, and therefore, the Fixed Effects Model (FEM) is not superior to the Pooled OLS model.

Table 1. Regression Results for Fixed Effects Model

Variables	Coefficient	Std. Error	t-statistic	p-value
SIZE	0.0020***	(0.0003)	6.53	0.000
LEV	-0.0710***	(0.0151)	-4.70	0.000
DIG	0.3034**	(0.1353)	2.24	0.027
LIQ	0.0220***	(0.0050)	4.43	0.000
MB	0.0196***	(0.0017)	11.47	0.000
_cons	0.0161	(0.0172)	0.94	0.351
Dependent Variable: ROAR-squared (overall): 0.7069 R-squared (within): 0.6509 F-statistic (5, 119): 44.38 Prob > F: 0.0000 F-test for $u_i=0$: 1.47 (p = 0.0915)				

*Notes: Standard errors are reported in parentheses. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.*

(Source: Data analysis results from STATA 17)

In addition, the Breusch–Pagan Lagrange Multiplier (LM) test (Table 2) is conducted to compare the REM with the Pooled OLS model. The results reveal that the null hypothesis H_0 cannot be rejected (Prob > $\chi^2_{19} = 0.2109$), suggesting that there is no significant panel effect. Therefore, the REM model is also not preferred over the Pooled OLS model.

Based on the results of both the F-test and LM test, it can be concluded that the Pooled OLS model is the most appropriate estimation method for analyzing the relationship between digital transformation and bank performance measured by ROA. This result is consistent with

the model selection discussion presented earlier and reinforces the robustness of the chosen methodology.

After selecting the appropriate model, the regression results indicate that digital transformation (DIG) has a positive and statistically significant impact on ROA ($\beta = 0.3034$, $p < 0.05$). This finding suggests that increased investment in digital technologies enhances the efficiency of asset utilization and improves overall bank profitability. The result supports Hypothesis H1 and is consistent with prior studies emphasizing the role of digitalization in improving operational efficiency.

Regarding control variables, bank size (SIZE) exhibits a positive and highly significant effect on ROA ($\beta = 0.0020$, $p < 0.01$), indicating that larger banks benefit from economies of scale and more efficient resource allocation. This finding supports Hypothesis H2.

Liquidity (LIQ) also shows a positive and statistically significant relationship with ROA ($\beta = 0.0220$, $p < 0.01$), implying that banks with higher liquidity levels are better able to maintain stable operations and enhance profitability. This result is consistent with Hypothesis H4.

Similarly, growth opportunities (MB) have a strong positive effect on ROA ($\beta = 0.0196$, $p < 0.01$), suggesting that banks with higher growth potential are more capable of generating future income and improving performance. This finding supports Hypothesis H5.

In contrast, financial leverage (LEV) has a negative and statistically significant impact on ROA ($\beta = -0.0710$, $p < 0.01$), indicating that excessive reliance on debt financing increases financial risk and reduces profitability. This result confirms Hypothesis H3.

Overall, the model demonstrates strong explanatory power, with an overall R-squared of 0.7069, indicating that approximately 70.69% of the variation in ROA is explained by the independent and control variables. Furthermore, the F-statistic is statistically significant ($\text{Prob} > F = 0.0000$), confirming the overall validity of the regression model.

In summary, the empirical results for the ROA model provide strong evidence supporting all proposed hypotheses (H1–H5), highlighting the critical role of digital transformation and internal bank characteristics in enhancing bank performance.

Table 2. Breusch and Pagan Lagrangian Multiplier Test

Test Result	ROA	ROE
chibar2 (01)	0.65	0.00
Prob > chibar2	0.2109	1.0000

Notes: ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively. Figures for Breusch-Pagan test indicate whether a random effects model is appropriate over OLS.

(Source: Data analysis results from STATA 17)

4.2.2. Regression Results for ROE

Similar to the ROA model, this study first conducts model selection tests to determine the most appropriate estimation method for the ROE model.

The results of the F-test (Table 3) indicate that the null hypothesis H_0 cannot be rejected, with a high p-value ($\text{Prob} > F = 0.8173$). This suggests that individual-specific effects are not statistically significant, and therefore, the FEM is not more appropriate than the Pooled OLS model.

Table 3. Regression Results for Fixed Effects Model (Dependent Variable: ROE)

Variables	Coefficient	Std. Error	t-statistic	p-value
SIZE	0.0107***	(0.0008)	13.44	0.000
LEV	-0.1261***	(0.0387)	-3.26	0.001
DIG	0.9622***	(0.3460)	2.78	0.006
LIQ	0.0362***	(0.0127)	2.85	0.005
MB	0.0491***	(0.0044)	11.21	0.000
_cons	-0.0019	(0.0439)	-0.04	0.966
R-squared (overall): 0.7939 R-squared (within): 0.7127 F-statistic (5, 119): 59.04 Prob > F: 0.0000 F-test for u_i=0: 0.73 (p = 0.8173)				

(Source: Data analysis results from STATA 17)

In addition, the Breusch–Pagan LM test (Table 4) is conducted to assess the presence of random effects. The test results show that the null hypothesis H_0 cannot be rejected (Prob > chibar2 = 1.0000), indicating that there is no significant panel effect. Consequently, the REM is also not preferred.

Based on the results of both tests, it can be concluded that the Pooled OLS model is the most suitable estimation method for the ROE model. This finding is consistent with the ROA model and confirms that the panel structure does not exhibit significant individual effects in this study .

After selecting the appropriate model, the regression results reveal that digital transformation (DIG) has a positive and statistically significant impact on ROE ($\beta = 0.9622$, $p < 0.01$). This indicates that digital transformation not only improves operational efficiency but also significantly enhances returns to shareholders. The result strongly supports Hypothesis H1.

Regarding control variables, bank size (SIZE) shows a positive and highly significant effect on ROE ($\beta = 0.0107$, $p < 0.01$), suggesting that larger banks benefit from economies of scale and more effective resource utilization. This finding supports Hypothesis H2.

Liquidity (LIQ) also has a positive and statistically significant impact on ROE ($\beta = 0.0362$, $p < 0.01$), indicating that banks with stronger liquidity positions are better able to maintain stable operations and improve financial performance. This result is consistent with Hypothesis H4.

Growth opportunities (MB) exhibit a strong positive effect on ROE ($\beta = 0.0491$, $p < 0.01$), suggesting that banks with higher growth potential are more capable of generating returns and expanding their business activities. This finding supports Hypothesis H5.

In contrast, financial leverage (LEV) has a negative and statistically significant effect on ROE ($\beta = -0.1261$, $p < 0.01$), indicating that higher debt levels increase financial risk and reduce returns to equity holders. This result confirms Hypothesis H3.

The model demonstrates strong explanatory power, with an overall R-squared of 0.7939, indicating that approximately 79.39% of the variation in ROE is explained by the independent and control variables. Additionally, the F-statistic is statistically significant (Prob > F = 0.0000), confirming the overall validity of the regression model.

In summary, the empirical results for the ROE model are consistent with those of the ROA model and provide further evidence supporting all proposed hypotheses (H1–H5). These findings reinforce the critical role of digital transformation and internal bank characteristics in improving both operational efficiency and shareholder returns in the Vietnamese banking sector.

Table 4. Breusch and Pagan Lagrangian Multiplier Test for Random Effects

Variable	Variance (Var)	SD = sqrt(Var)
ROE	0.0001194	0.0109289
e	0.0000251	0.0050144
u	0	0
Dependent Variable: ROE Test: Var(u) = 0 chibar2 (01) = 0.00 Prob > chibar2 = 1.0000		

Note: The Breusch-Pagan LM test is used to decide between a random effects regression and a simple OLS regression. A p-value (Prob > chibar2) greater than 0.05 suggests that OLS is the more appropriate model.

(Source: Data analysis results from STATA 17)

4.3. Diagnostic Tests

To ensure the reliability of the regression results, several diagnostic tests are conducted. The Variance Inflation Factor (VIF) indicates that multicollinearity is not a serious concern in the model. However, the results reveal the presence of heteroskedasticity and autocorrelation. To address these issues, robust standard errors are employed, ensuring that the estimated coefficients remain consistent and statistically reliable . These adjustments enhance the validity of the empirical results and support the robustness of the conclusions.

4.4. Discussion of Findings and Hypothesis Testing

The empirical findings support all proposed hypotheses (H1–H5), suggesting that digital transformation and bank-specific financial characteristics jointly influence the performance of Vietnamese commercial banks during the 2018–2023 period. First, the positive and statistically significant impact of digital transformation supports H1 and indicates that digitalization contributes to improving banking efficiency and profitability. This finding is consistent with prior studies emphasizing the strategic role of digital technologies in enhancing operational performance and customer service quality [13], [17], [18]. The result also aligns with the Resource-Based View, which considers digital capability a valuable organizational resource that can strengthen competitive advantage. However, the findings differ from several earlier studies reporting mixed or negative short-term effects of digital transformation on bank profitability [15], [16]. One possible explanation is the specific institutional and operational context of Vietnamese banks during 2018–2023. Following the COVID-19 pandemic, Vietnamese commercial banks accelerated the adoption of digital banking platforms, online payment systems, and cashless transaction services in response to changing customer behavior and government digitalization policies. During this period, many banks increasingly benefited from digital service expansion, lower transaction costs, and improved operational efficiency. Consequently, the positive effects of

digital transformation may have become more visible compared with earlier periods when technology investment costs were still dominant.

Second, the positive relationship between bank size and performance confirms H2. This finding suggests that larger banks possess stronger financial capacity, broader customer networks, and greater ability to invest in digital infrastructure and innovation initiatives. In Vietnam, large commercial banks are generally more capable of implementing advanced technological systems and adapting to digital transformation requirements, thereby achieving better operational performance.

Third, the negative effect of financial leverage supports H3 and indicates that excessive dependence on debt financing increases financial risk and funding costs. This finding is consistent with previous banking studies suggesting that high leverage may weaken profitability due to higher financial burdens and risk exposure [3], [4]. In the context of digital transformation, banks often require substantial capital investment in technology infrastructure and cybersecurity systems. If these investments are financed primarily through excessive borrowing, the associated costs may offset part of the efficiency gains generated by digitalization.

Fourth, the positive impact of liquidity on bank performance confirms H4. Adequate liquidity enables banks to maintain operational stability, support real-time digital transactions, and respond effectively to financial uncertainties. This result is particularly relevant in the Vietnamese banking sector, where the rapid expansion of digital banking services requires continuous operational capability and strong liquidity management to ensure transaction efficiency and customer confidence.

Finally, the positive relationship between growth opportunities and bank performance supports H5. Banks with stronger growth potential are generally more capable of expanding digital financial services, developing innovative banking products, and attracting new customer segments. In the Vietnamese context, the rapid growth of fintech services, e-wallets, and online banking activities during 2018–2023 created favorable conditions for banks with strong growth orientation to enhance profitability and competitiveness through digital transformation.

Overall, the findings not only support theoretical expectations and prior empirical evidence but also provide updated insights into the Vietnamese banking sector during a period of accelerated digitalization. The results suggest that the effectiveness of digital transformation depends not only on technological adoption itself but also on bank-specific financial conditions and the broader institutional environment in which banks operate.

5. CONCLUSION AND IMPLICATIONS

5.1. Conclusion

This research explores how digital transformation affects the performance of commercial banks in Vietnam, drawing on panel data from 25 institutions during the 2018–2023 period. By employing panel regression methods and identifying the most suitable estimation approach, the study offers reliable and rigorous empirical evidence on the linkage between digital transformation and banking performance.

The results reveal that digital transformation has a positive and statistically significant effect on both ROA and ROE, confirming its role as a key driver of operational efficiency and profitability. This finding supports the theoretical perspective of the Resource-Based View, which considers digital technology as a strategic resource that enhances competitive advantage.

In addition, the study finds that bank size, liquidity, and growth opportunities positively influence bank performance, while financial leverage has a negative impact. These results indicate that both technological and internal financial factors play crucial roles in determining bank performance.

Importantly, all proposed hypotheses (H1–H5) are supported, reinforcing the validity of the research model and contributing to the existing literature on digital transformation in the banking sector, particularly in the context of a developing economy like Vietnam.

5.2. Managerial and Policy Implications

Based on the empirical findings, several important implications can be drawn for bank managers and policymakers.

First, commercial banks should prioritize digital transformation as a core strategic initiative. Investment in digital technologies such as artificial intelligence, data analytics, and digital banking platforms can significantly enhance operational efficiency, reduce transaction costs, and improve customer experience. Banks should also develop long-term digital transformation roadmaps to ensure effective implementation and maximize returns.

Second, banks need to optimize their financial structure by maintaining a balanced level of leverage. While debt can support expansion and digital investment, excessive leverage may increase financial risk and negatively affect performance. Therefore, prudent capital management is essential to sustain long-term profitability.

Third, enhancing liquidity management is crucial in the digital banking environment. Adequate liquidity ensures operational stability, especially in the context of real-time digital transactions. Banks should adopt advanced liquidity risk management systems to support digital operations and maintain financial resilience.

Fourth, banks should actively exploit growth opportunities by expanding digital services and entering new market segments. Digital transformation enables banks to diversify their products, improve service accessibility, and enhance customer engagement, thereby creating additional revenue streams.

From a policy perspective, regulators should continue to promote digital transformation in the banking sector by developing supportive legal frameworks, encouraging innovation, and strengthening cybersecurity standards. In addition, policies that facilitate digital infrastructure development and financial inclusion will further enhance the effectiveness of digital transformation in the banking industry.

5.3. Limitations of the Study

Despite its contributions, this study has several limitations. First, the sample is limited to 25 commercial banks in Vietnam, which may restrict the generalizability of the findings to other countries or financial systems. Second, the measurement of digital transformation is based on a proxy variable, which may not fully capture the multidimensional nature of digital transformation. Third, the study focuses primarily on financial performance indicators and does not consider non-financial aspects such as customer satisfaction or service quality.

5.4. Directions for Future Research

Future studies may address these limitations by expanding the sample to include banks from other countries or conducting comparative analyses across regions. In addition, future research can employ more comprehensive measures of digital transformation, such as digital maturity indices or fintech adoption indicators.

Moreover, researchers may explore the mediating and moderating effects of factors such as corporate governance, innovation capability, or regulatory environment on the relationship

between digital transformation and bank performance. Longitudinal studies using extended time periods may also provide deeper insights into the long-term effects of digital transformation.

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REFERENCES

- [1] J. Gomber, R. J. Kauffman, C. Parker, and B. W. Weber, "On the FinTech revolution: Interpreting the forces of innovation, disruption, and transformation in financial services," *Journal of Management Information Systems*, vol. 35, no. 1, pp. 220–265, 2018, doi: <https://doi.org/10.1080/07421222.2018.1440766>
- [2] P. C. Verhoef, T. Broekhuizen, Y. Bart, A. Bhattacharya, J. Q. Dong, N. Fabian, and M. Haenlein, "Digital transformation: A multidisciplinary reflection and research agenda," *Journal of Business Research*, vol. 122, pp. 889–901, 2021, doi: <https://doi.org/10.1016/j.jbusres.2019.09.022>
- [3] P. K. Ozili, "Impact of digital finance on financial inclusion and stability," *Borsa Istanbul Review*, vol. 18, no. 4, pp. 329–340, 2018, doi: <https://doi.org/10.1016/j.bir.2017.12.003>
- [4] A. Demirgüç-Kunt and H. Huizinga, "Determinants of commercial bank interest margins and profitability: Some international evidence," *The World Bank Economic Review*, vol. 13, no. 2, pp. 379–408, 1999, doi: <https://doi.org/10.1093/wber/13.2.379>
- [5] I. Mavlutova, L. Fomins, K. Spilbergs, and M. Atstaja, "Digital transformation as a driver of financial inclusion," *Sustainability*, vol. 15, no. 3, 2023, doi: <https://doi.org/10.3390/su15031842>
- [6] D. T. Hoang, H. T. Nguyen, and Q. T. Le, "Digital transformation in Vietnamese banking: Opportunities and challenges," *Journal of Asian Finance, Economics and Business*, vol. 10, no. 2, pp. 345–356, 2023, doi: <https://doi.org/10.13106/jafeb.2023.vol10.no2.0345>
- [7] T. T. Pham and H. T. Nguyen, "Digital banking risks and financial stability: Evidence from Vietnam," *Asian Economic and Financial Review*, vol. 14, no. 1, pp. 45–60, 2024, doi: <https://doi.org/10.55493/5002.v14i1.4978>
- [8] G. Vial, "Understanding digital transformation: A review and a research agenda," *The Journal of Strategic Information Systems*, vol. 28, no. 2, pp. 118–144, 2019, doi: <https://doi.org/10.1016/j.jsis.2019.01.003>
- [9] B. Nicoletti, *The Future of FinTech: Integrating Finance and Technology in Financial Services*. Cham, Switzerland: Springer, 2017, doi: <https://doi.org/10.1007/978-3-319-51415-4>
- [10] P. C. Verhoef, T. Broekhuizen, Y. Bart, A. Bhattacharya, J. Q. Dong, N. Fabian, and M. Haenlein, "Digital transformation: A multidisciplinary reflection and research agenda," *Journal of Business Research*, vol. 122, pp. 889–901, 2021, doi: <https://doi.org/10.1016/j.jbusres.2019.09.022>
- [11] E. Beccalli, "Does IT investment improve bank performance? Evidence from Europe," *Journal of Banking & Finance*, vol. 31, no. 7, pp. 2205–2230, 2007, doi: <https://doi.org/10.1016/j.jbankfin.2006.10.022>
- [12] R. DeYoung, W. Lang, and D. Nolle, "How the internet affects output and performance at community banks," *Journal of Banking & Finance*, vol. 31, no. 4, pp. 1033–1060, 2007, doi: <https://doi.org/10.1016/j.jbankfin.2006.10.003>

- [13] A. Dadoukis, A. Fiaschetti, and P. Fusi, "IT adoption and bank performance: Evidence from Europe," *Journal of Banking & Finance*, vol. 122, 2021, doi: <https://doi.org/10.1016/j.jbankfin.2020.105997>
- [14] M. M. Alam, S. Raza, and A. Akram, "The impact of e-banking on bank performance," *International Journal of Bank Marketing*, vol. 39, no. 1, pp. 45–67, 2021, doi: <https://doi.org/10.1108/IJBM-02-2020-0064>
- [15] K. J. Stiroh, "Information technology and the U.S. productivity revival: What do the industry data say?" *American Economic Review*, vol. 92, no. 5, pp. 1559–1576, 2002, doi: <https://doi.org/10.1257/000282802762024638>
- [16] E. Brynjolfsson and L. Hitt, "Beyond computation: Information technology, organizational transformation and business performance," *Journal of Economic Perspectives*, vol. 14, no. 4, pp. 23–48, 2000, doi: <https://doi.org/10.1257/jep.14.4.23>
- [17] T. D. Do, H. A. T. Pham, E. I. Thalassinou, and H. A. Le, "The impact of digital transformation on performance: Evidence from Vietnamese commercial banks," *Journal of Risk and Financial Management*, vol. 15, no. 1, p. 21, 2022, doi: <https://doi.org/10.3390/jrfm15010021>
- [18] L. Nguyen-Thi-Huong, H. Nguyen-Viet, A. Nguyen-Phuong, and D. Van Nguyen, "How does digital transformation impact bank performance?" *Cogent Economics & Finance*, vol. 11, no. 1, 2023, doi: <https://doi.org/10.1080/23322039.2023.2217582>
- [19] H. M. Nguyen, H. T. N. Pham, K. M. Tran, M. T. T. Nguyen, and Y. T. H. Nguyen, "Digitalization and its impact on commercial banks' profitability in Vietnam," *Ho Chi Minh City Open University Journal of Science – Economics and Business Administration*, vol. 15, no. 1, pp. 152–164, 2024.
- [20] J. Barney, "Firm resources and sustained competitive advantage," *Journal of Management*, vol. 17, no. 1, pp. 99–120, 1991, doi: <https://doi.org/10.1177/014920639101700108>
- [21] N. Venkatraman and V. Ramanujam, "Measurement of business performance in strategy research: A comparison of approaches," *Academy of Management Review*, vol. 11, no. 4, pp. 801–814, 1986, doi: <https://doi.org/10.5465/amr.1986.4283976>
- [22] M. Athanasoglou, S. Brissimis, and M. Delis, "Bank-specific, industry-specific and macroeconomic determinants of bank profitability," *Journal of International Financial Markets, Institutions and Money*, vol. 18, no. 2, pp. 121–136, 2008, doi: <https://doi.org/10.1016/j.intfin.2006.07.001>
- [23] A. N. Berger and C. H. S. Bouwman, "Bank liquidity creation," *Review of Financial Studies*, vol. 22, no. 9, pp. 3779–3837, 2009, doi: <https://doi.org/10.1093/rfs/hhn104>
- [24] E. F. Fama and K. R. French, "The cross-section of expected stock returns," *Journal of Finance*, vol. 47, no. 2, pp. 427–465, 1992, doi: <https://doi.org/10.1111/j.1540-6261.1992.tb04398.x>