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Evaluating the Nexus Between Foreign Ownership, Digital Transformation and Bank Performance: Evidence from Vietnam

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Abstract: In the context of global integration and rapid digital transformation, enhancing the long-term sustainability, resilience, and governance quality of the banking sector has become a critical priority for emerging economies such as Vietnam. This study investigates how foreign ownership and digital transformation contribute not only to bank performance but also to the broader sustainability of Vietnamese joint-stock commercial banks. Using a balanced panel dataset of 25 banks over the period 2013–2022, the study applies panel data regression with fixed effects to control for unobservable bank-specific characteristics. The empirical results indicate that foreign ownership plays a significant role in strengthening bank sustainability by improving operational efficiency. Regarding digital transformation, the findings reveal a nuanced impact of Information and Communication Technology (ICT). While the composite ICT index does not consistently show significant effects, specific ICT components—namely technical infrastructure and online banking services—emerge as key drivers of efficiency and institutional resilience. In contrast, other dimensions such as human resource infrastructure and internal ICT applications exhibit no significant contribution. These findings suggest that sustainable banking development depends not only on expanding foreign capital participation but also on prioritizing targeted digital investments that enhance operational robustness and service delivery capacity. The study provides policy implications for promoting responsible foreign ownership structures and strategic ICT development to support a more resilient, efficient, and sustainable banking system in Vietnam.

Keywords: Bank sustainability, digital transformation, fixed effects model, foreign ownership, ICT.

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INTRODUCTION

In the context of deepening global integration and the accelerating pace of the Fourth Industrial Revolution, the banking sector is undergoing a profound structural transformation. Beyond traditional objectives of profitability and growth, banks are increasingly expected to ensure long-term sustainability, institutional resilience, and responsible governance. These dimensions are particularly critical in emerging economies such as Vietnam, where the banking system plays a central role in financial stability and sustainable economic development. One of the key drivers shaping this transformation is the growing presence of foreign ownership in domestic banks. The inflow of foreign capital is not only a source of financial resources but also a channel through which advanced governance standards, risk management practices, and technological capabilities are transferred (Pham, Le, Pham, & Nguyen, 2025). From a sustainability perspective, foreign participation can enhance transparency, strengthen internal controls, and promote more disciplined strategic decision-making, thereby improving the resilience of banks against economic shocks. However, the implications of foreign ownership remain debated, particularly regarding its long-term contribution to sustainable banking development in emerging markets. At the same time, digital transformation, driven by the rapid advancement of Information and Communication Technology (ICT), is reshaping banking operations and service delivery. The adoption of digital technologies enables banks to improve operational efficiency, expand financial inclusion, and enhance customer experience (Yuen, Ngo, Le, & Ho, 2022). More importantly, ICT development contributes to sustainability by supporting better risk monitoring, reducing operational vulnerabilities, and facilitating more transparent and accountable banking practices. Nevertheless, the impact of digital transformation is not uniform across its components, and its role in strengthening resilience and sustainable performance requires further empirical clarification. In recent years, Vietnamese joint-stock commercial banks have experienced significant changes in ownership structure alongside an increasing emphasis on digital transformation strategies. The participation of foreign investors in governance and management, combined with investments in ICT infrastructure and digital services, has created new opportunities for enhancing not only performance but also the sustainability of banking operations. However, existing studies largely examine the effects of foreign ownership and digital transformation in isolation and primarily focus on short-term financial outcomes such as profitability indicators (e.g., ROA and ROE). This study addresses this gap by jointly analyzing the roles of foreign ownership and ICT development in shaping the sustainable performance of Vietnamese commercial banks. Specifically, it emphasizes how these factors contribute to long-term efficiency, resilience, and governance quality rather than merely short-term profitability. By employing a panel data regression approach with fixed effects on a dataset of Vietnamese joint-stock commercial banks over the period 2013–2022, the study provides empirical evidence on the mechanisms through which foreign ownership and digital transformation influence the sustainability of the banking sector. The findings of this study are expected to contribute to the growing literature on sustainable banking and to offer policy-relevant insights for regulators and bank managers in promoting a more resilient, responsible, and future-ready financial system in Vietnam.

LITERATURE REVIEW

The Impact of Foreign Ownership on Bank Efficiency

Practical observations of Vietnamese joint-stock commercial banks in recent years indicate that the involvement of foreign investors and shareholders has introduced both positive and negative impacts on various banking operations. Notably, positive effects are more prominently highlighted in academic studies and corporate reports. Specifically, foreign participation enhances customer competitiveness, capital capacity, technological prowess, and corporate governance, thereby enabling banks to improve efficiency and strengthen risk management. A majority of global empirical studies demonstrate that foreign ownership in banks within developing countries positively influences the operational efficiency of commercial banks. Panizza (2024) investigated ownership structures across over 6,500 banks in 181 countries from 1995 to 2020;

the results revealed that state-owned banks generally underperform in terms of profitability and face higher credit risks compared to private counterparts. Similarly, Bouzgarrou, Jouida, and Louhichi (2018), utilizing a sample of 170 commercial banks in the French market (2000 - 2012), found that foreign-owned banks achieved higher profitability than domestic ones, particularly during economic crises. While lagged profits did not help domestic banks withstand crisis shocks, instead exacerbating performance decline, pre-crisis profits served as a financial buffer for foreign banks. Other studies suggest that private banks generally suffer from lower levels of risk than domestic banks due to their robust risk management systems. According to Locke (2025), Canadian banks with higher foreign equity ratios exhibited lower risk levels, as measured by standard financial stability indicators. Aldousari, Mohammed, and Lindop (2025) also concluded that within the GCC bloc, foreign-owned commercial banks outperformed domestic ones both before and after the Covid-19 period. State ownership often undermines profitability due to political interference, which diverts management incentives and results in laxer monitoring mechanisms compared to the private sector (Davydov, 2018). Consequently, state-owned banks often trade off operational performance to prioritize social objectives (Rosalina & Nugraha, 2019).

However, the impact of foreign ownership on profitability may vary across different economies. Yuan (2024) indicated that the overall presence of foreign banks could diminish the output performance of domestic banks in less developed economies. Mateev, Sahyouni, and Tariq (2023) also observed that in the MENA region, foreign-owned banks yielded lower profit margins than domestic ones. Domestic banks tend to be more cautious in credit risk management, whereas foreign-capitalized banks are more vulnerable to credit shocks, particularly in countries with low institutional quality. Conversely, in many other developing nations, foreign commercial banks tend to be more profitable than their domestic counterparts.

Domestic research in Vietnam also presents mixed findings. Hang, Nguyen, Pham, Nguyen, and Ho (2025) examined the impact of ownership structure on the profitability of 29 Vietnamese commercial banks from 2012 to 2023. The authors identified that internal governance, equity concentration, and private ownership ratios are critical factors positively affecting profitability. Dung and Trinh (2023) utilized an unbalanced panel data set of 26 Vietnamese commercial banks (2007–2021), finding that higher foreign ownership ratios correlate with increased profitability and reduced risk. In contrast, these authors also pointed out the positive impact of state ownership on Return on Assets (ROA) and Return on Equity (ROE), despite the higher risk. However, Nam, Nhung, and Nhat (2025) studied 27 banks (2012–2021) and found that both private and foreign ownership negatively impacted bank performance. Furthermore, some studies highlight adverse effects in the relationship between foreign ownership and efficiency. Empirical evidence from Mamatzakis, Zhang, and Wang (2017) in China suggested that foreign ownership did not lead to significant improvements and was, in some cases, associated with lower efficiency, reflecting barriers in transferring governance advantages to emerging markets. Similarly, Angkinand and Wihlborg (2010) found that foreign ownership is frequently associated with elevated credit risk. According to the "Home Field Advantage" hypothesis, the presence of foreign banks may not contribute additional benefits to industry stability due to their higher risk appetite (Haque, 2019). Additionally, foreign banks may amplify international or domestic shocks (Adams-Kane, Caballero, & Lim, 2017). When a bank underperforms, the presence of foreign shareholders can lead to a more severe decline in profits compared to purely domestic banks (Endrajati & Anggraeni, 2025). Moreover, Bouzidi and Nefzi (2024) suggested that increased competition from foreign banks could reduce the operational efficiency of domestic institutions. Foreign ownership has also been associated with decreased credit growth in Vietnamese commercial banks; the relationship between market competition and credit growth follows an inverted U-shape, where moderate competition stimulates growth, but excessive competition stifles it (Duong, Nguyen, Tran, & Pham, 2023). Despite these challenges, foreign-owned banks maintain advantages in risk management expertise, access to modern technology, and high-quality human resources (Ambarwati, 2021).

In summary, the literature regarding the impact of foreign ownership on bank performance remains a subject of ongoing debate and requires clarification within specific national and temporal contexts. Therefore, this study provides empirical evidence on how foreign ownership influences the efficiency of joint-stock commercial banks in the Vietnamese market.

The Impact of the ICT Index on Bank Efficiency

The rapid advancement of Information and Communication Technology (ICT) has fundamentally transformed banking operations, with a large body of literature documenting its positive effects on efficiency and competitiveness. ICT adoption enables banks to reduce transaction costs, enhance service quality, and improve decision-making through better data processing (Chen, You, & Chang, 2021; Hoque, Le, & Le, 2024). From a sustainability perspective, digital transformation also contributes to resilience by strengthening risk monitoring systems, improving operational continuity, and facilitating financial inclusion. However, the evolution of ICT applications inevitably introduces risks concerning information security and system safety, which are often associated with heightened credit risk (Sulong, Fuszder, Abdullah, & Abakah, 2025).

In the Vietnamese context, many joint-stock commercial banks affirm that technological development and digital transformation are vital to their business survival; notably, 96% of these banks have been formulating development strategies centered on Industry 4.0 technologies. Accordingly, several recent studies have explored the efficiency of joint-stock commercial banks within this new paradigm. Specifically, Tuấn (2024) demonstrated that digital transformation enhances the quality of customer experience and engagement, thereby boosting overall efficiency and productivity. The author also emphasized that under the global pressure of digitalization across all sectors, it is imperative and urgent for banks to implement digital transformation strategies and envision the utilization of Big Data, Artificial Intelligence (AI), and Machine Learning in bank governance. Furthermore, banks with a high level of ICT readiness are more highly valued by the market, reflecting expectations of future profitability and technological competitiveness (Nguyen, 2025). Research by Manh and Vuong (2022) also indicated that the ICT index, along with its sub-indices, including infrastructure investment, human resource investment, and information services, has a significantly positive impact on profitability and mitigates operational risks for Vietnamese commercial banks. In contrast, the internal core technology application index was found to have an inverse effect. Some other studies conclude that the impact of digital transformation on bank performance varies by bank size (Do, Pham, Thalassinos, & Le, 2022), with stronger effects observed in small-sized and low-profit banks, while the effects are weaker among medium-profit banks (Phan, Vu, & Nguyen, 2025). This indicates heterogeneity in the level of digital transformation adoption across different groups of banks. In summary, while a substantial body of domestic and international literature has examined the individual impacts of foreign ownership, technological innovation, ICT development, and digital transformation on the efficiency of Vietnamese joint-stock commercial banks, most existing studies analyze these factors in isolation. There remains a significant gap in the literature regarding the simultaneous analysis of these impacts, particularly when considering the diverse contexts of shifting foreign ownership structures within the Vietnamese commercial banking sector.

RESEARCH METHODS AND DATA

Research Model

Based on the literature review regarding the determinants of bank performance, the authors proposed the research framework as shown in Figure 1. Figure 1 depicts the conceptual model where bank performance is determined by internal characteristics, foreign ownership, technological advancement, and external macroeconomic factors:

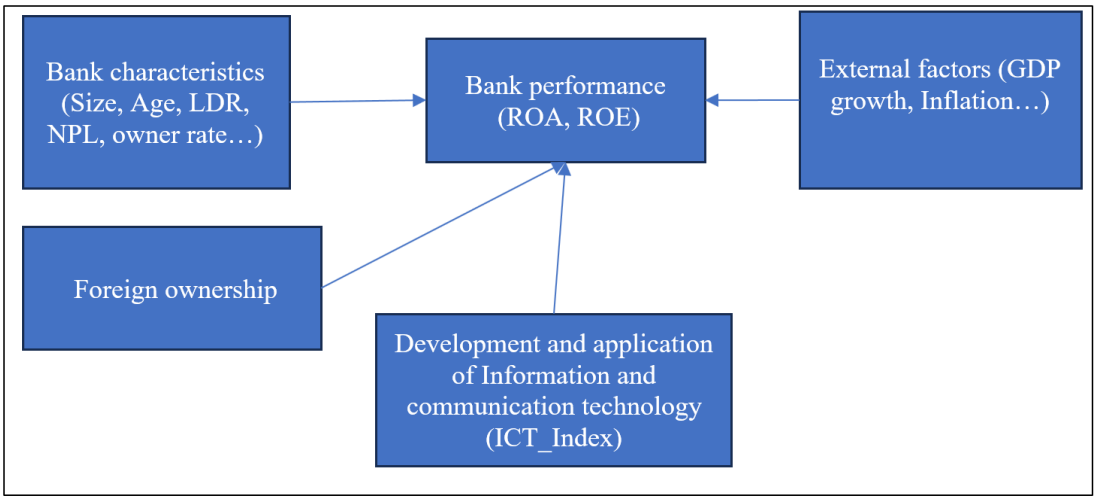

Figure 1: Conceptual framework of ICT application and foreign ownership on bank performance

Main research hypotheses:

H_1: Foreign ownership has a positive impact on bank performance.

H_2: The level of digital transformation (ICT index) has a positive impact on bank performance.

H_{2a}: Developing technical infrastructure for the application of information and communication technology (ICT_TI) has a positive effect on bank performance.

H_{2b}: The level of human resource infrastructure development for IT and communication applications (ICT_HR) has a positive impact on bank performance.

H_{2c}: The level of internal application (ICT_IA) has a positive impact on bank performance.

H_{2d}: The level of development of online banking services (ICT_OB) has a positive impact on bank performance.

To test these hypotheses, the following generalized panel data regression model is constructed.

$$Performance_{it} = \beta_0 + \beta_1 * ICT\_Index + \beta_1 * Foreign\_Ownership + \sum \gamma_j * X_{it} + c_i + \varepsilon_{it} \quad (1)$$

Where:

$Performance_{it}$ is the performance of bank *i* in the year *t*. The bank's performance includes many aspects such as business activities, business strategy, growth, and profit (Bonin, Hasan, & Wachtel, 2005). There are some approaches to evaluate the efficiency and profitability of banks, which are traditional methods, market-based, and economic measurement methods (Khandker, Khalily, & Khan, 1997). However, the most popular performance measurements are return on assets (ROA) and return on equity (ROE).

The factor of readiness to develop information and communication technology (ICT) applications is specified through five measures, including the general ICT index (ICT_index), ICT technical infrastructure index (ICT_TI), the IT human resources index (ICT_HR), the bank internal application index (ICT_IA), and the development of online banking services (ICT_OB). The independent variable representing the foreign ownership factor is measured by the foreign ownership ratio (FOR).

Regarding control variables, the authors use two groups: a group of control variables from within the bank, including Asset size (SIZE), number of years of operation (Age), shareholders' equity to total assets (Owner_rate), Loan to Deposit Ratio (LDR), and non-performing loans (NPL); and control variables outside the bank, including Economic growth (GDP_g) and INF rate (INF).

Research Data

In this study, the authors collected data and information for control variables inside the bank, including Assets (SIZE), years of operation (Age), equity ratio (Owner_rate), non-performing loans (NPL), and Loan to Deposit Ratio (LDR) from annual reports and financial statements of commercial joint-stock banks. Data for control variables outside the bank, including GDP growth (GDP_g) and INF rate (INF), were collected from the General

Statistics Office. All data were collected from 2013 to 2022. Data on the readiness index for the development and application of information and communication technology (ICT) of banks were obtained from the Department of Information and Communication Technology Industry - Ministry of Information and Communication and the Vietnam Informatics Association (website: http://vaip.org.vn/) from 2013 to 2022.

The ICT readiness and development report is a complete and comprehensive ranking report of companies, industries, localities, organizations, and businesses in general, including commercial banks in particular. Data on component ICT focuses on evaluating four aspects: the level of development of information and communication technology infrastructure, the level of human resource infrastructure for IT development, the level of internal application of banking, and online services. Technical infrastructure standards (ICT _TI) include: server infrastructure, workstations, communication infrastructure, ATM, POS infrastructure, implementation of information security and data safety solutions, data centers, and disaster contingency centers. Human resource infrastructure indicators (ICT _HR) include: the proportion of staff specializing in information technology, the proportion of personnel specializing in information security, and the proportion of personnel with international certificates majoring in information technology in the total number of staff specializing in information technology. Bank internal information technology application criteria (ICT _IA) include: deploying core banking, deploying basic applications, and implementing electronic payments. Online service criteria (ICT _OB) include: bank website, internet banking for individual customers, internet banking for business customers, and other electronic banking services. Finally, the general ICT index is calculated based on the four component indices (ICT _TI, ICT _HR, ICT _IA, and ICT _OB) according to the weight ratio of each component indicator.

Data on the foreign ownership rate (FOR) is collected and compiled from sources: annual reports of commercial banks and websites: https://finance.vietstock.vn/.

After data collection, 25 banks met sufficient data criteria for econometric model analysis. Consequently, the database for this study comprises 250 observations, covering 25 banks over 10 consecutive years from 2013 to 2022.

Model Estimation Method

To examine the impact of foreign ownership and ICT development on bank performance, this study employs panel data regression techniques. Specifically, three estimation approaches are considered, including Pooled Ordinary Least Squares (Pooled OLS), Random Effects Model (REM), and Fixed Effects Model (FEM). Given the panel structure of the dataset (25 banks observed over the period 2013–2022), it is necessary to account for unobserved heterogeneity across banks that may influence performance outcomes. Ignoring such heterogeneity may lead to biased and inconsistent estimates. Therefore, a series of specification tests is conducted to determine the most appropriate estimation method. First, the F-test for individual effects is performed to assess whether pooled OLS is an adequate specification. The test strongly rejects the null hypothesis of no individual effects ($F(24, 217) = 18.47$, Prob > F = 0.0000), indicating the presence of significant bank-specific heterogeneity. This result confirms that pooled OLS is not appropriate for the dataset. Second, the Hausman test is employed to compare the consistency of the Random Effects and Fixed Effects estimators. The test results reject the null hypothesis that the Random Effects estimator is both consistent and efficient ($chi2(9) = 26.35$, Prob > chi2 = 0.0018), suggesting that unobserved bank-specific effects are correlated with the explanatory variables. Under such conditions, the Fixed Effects Model provides consistent and unbiased estimates, whereas the Random Effects Model becomes inappropriate. The FEM has the following general form:

$$Y_{it} = c_i + X'_{it}\beta + \varepsilon_{it} \ (*) \quad (2)$$

In which, ε_{it} is the error term, c_i is a random variable that shows the unobservable properties of each bank.

$$E[\varepsilon_{it} / c_i, x_{it}] = 0 \text{ with } t = 1,...T \quad (3)$$

Here, the error term is assumed to have a conditional expectation, given the variables, equal to zero. A form of model (*) is considered an unobservable random variable and is likely to correlate with observed variables. Approaching the model in this form is the fixed impact model. If the fixed effect exists and correlates

with Xit, the pooled OLS equation will no longer be accurate. Instead, it is necessary to use a suitable estimation method to eliminate this effect and ensure accurate estimation.

When estimating a fixed effects model (FEM) with panel data, the authors also perform defect tests to detect potential violations related to variable and self-correlation error variance. The fixed impact model with robust standard errors is used to correct the standard errors of regression coefficients from the FEM, ensuring reliable conclusions about the impact of independent variables in the model.

RESEARCH RESULTS AND IMPLICATIONS

Descriptive Statistics

Prior to conducting correlation and regression analyses, the study computes fundamental statistical parameters to evaluate the data distribution and identify and address any potential outliers within the observed dataset.

The summary of these descriptive statistics is presented in the tables below. Table 1 presents the descriptive statistics for all variables included in the study, covering 250 observations.

Table 1: Descriptive statistics of variables

Variables	Obs.	Mean	Std. Dev.	Min.	Max.
ROA	250	0.8734	0.6773	0.0000	3.2380
ROE	250	10.3529	6.8474	0.0001	26.3876
NPL	250	1.9184	1.3999	0.5000	17.9298
LDR	250	73.2855	16.3848	31.0772	245.7070
SIZE	250	8.2037	0.4993	7.1669	10.2000
Age	250	3.1709	0.4213	1.6094	4.1744
Owner_rate	250	8.7046	3.2553	4.0618	23.8381
ICT_INDEX	250	0.5098	0.1174	0.2527	0.8114
ICT_TI	250	0.4677	0.1368	0.0795	0.8561
ICT_HR	250	0.4249	0.2247	0.0000	1.0000
ICT_IA	250	0.5291	0.2054	0.0000	1.0000
ICT_OB	250	0.6589	0.1981	0.0000	1.0000
GDP_g	250	5.8710	1.7024	2.5800	8.0200
INF	250	3.6060	1.7791	0.6300	6.6600
FOR	250	10.6784	11.4733	0.0000	30.0000

In general, there are no unusual values in the data, and most variables have an approximately normal distribution.

Table 2 presents a comparative analysis of descriptive statistics for ROA, ROE, and the ICT Index between foreign-owned and non-foreign-owned banks.

Table 2: Descriptive statistics for ROA, ROE, ICT Index for the two groups of foreign-owned and non-foreign-owned banks

Variables	Groups	Obs.	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
ROA	Non-foreign-owned banks	84	**0.492**	0.030	0.272	0.433	0.551
	Foreign-owned banks	166	**1.067**	0.057	0.737	0.954	1.180
ROE	Non-foreign-owned banks	84	**5.934**	0.420	3.852	5.099	6.770
	Foreign-owned banks	166	**12.589**	0.540	6.952	11.523	13.654
ICT_Index	Non-foreign-owned banks	84	**0.478**	0.010	0.096	0.457	0.499
	Foreign-owned banks	166	**0.526**	0.010	0.124	0.507	0.545

To describe the relationship between variables in the model, the authors use the following scatter plots, as shown in the Figure 2.

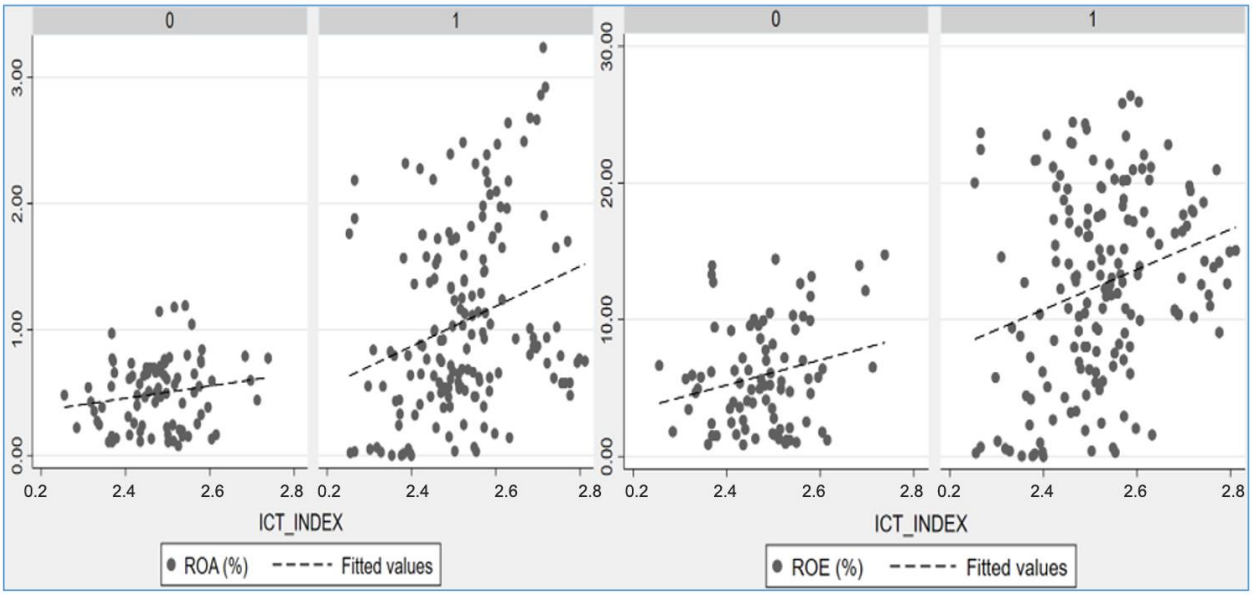

Figure 2: Scatter plots for the relationship between ICT and ROA, ROE by foreign ownership status (Group of banks with foreign ownership (On the right side) and group of banks without foreign ownership (On the left side)

To analyze the relationships between the variables, Table 3 presents the correlation matrix, confirming the independence of the explanatory variables. Following this, the main research findings are disclosed: Table 4 and Table 5 illustrate the estimated effects of bank-specific, technological, and macroeconomic factors on ROA and ROE, respectively.

Table 3: Matrix of correlation coefficients between variables

	ROA	ROE	NPL	LDR	SIZE	Age	Owner_rate	ICT_index	ICT_TI	ICT_HR	ICT_IA	GDP_g	INF	FOR
ROA	1.000													
ROE	0.862	1.000												
	0.000													
NPL	-0.254	-0.341	1.000											
	0.000	0.000												
LDR	0.256	0.223	-0.106	1.000										
	0.000	0.000	0.096											
SIZE	0.442	0.632	-0.209	0.202	1.000									
	0.000	0.000	0.001	0.001										
Age	0.118	0.180	-0.024	0.263	0.451	1.000								
	0.064	0.004	0.707	0.000	0.000									
Owner_rate	0.298	-0.125	0.085	0.170	-0.406	-0.015	1.000							
	0.000	0.049	0.180	0.007	0.000	0.813								
ICT- index	0.301	0.311	-0.175	0.078	0.395	0.299	0.028	1.000						
	0.000	0.000	0.006	0.220	0.000	0.000	0.659							
ICT_TI	0.392	0.416	-0.151	0.079	0.387	0.368	-0.005	0.636	1.000					
	0.000	0.000	0.017	0.215	0.000	0.000	0.938	0.000						
ICT_HR	-0.077	-0.197	-0.040	-0.085	-0.256	-0.229	0.208	0.349	-0.076	1.000				
	0.223	0.002	0.531	0.178	0.000	0.000	0.001	0.000	0.231					
ICT_IA	0.194	0.259	-0.121	0.093	0.395	0.280	-0.109	0.644	0.332	-0.142	1.000			
	0.002	0.000	0.056	0.143	0.000	0.000	0.086	0.000	0.000	0.025				
GDP_g	-0.086	-0.083	0.096	0.005	-0.048	-0.049	-0.014	-0.155	-0.184	-0.006	-0.135	1.000		
	0.177	0.189	0.132	0.939	0.446	0.437	0.822	0.014	0.004	0.920	0.033			
INF	-0.161	-0.179	0.190	-0.102	-0.152	-0.143	0.032	-0.184	-0.223	-0.043	0.065	0.073	1.000	
	0.011	0.005	0.003	0.107	0.016	0.024	0.612	0.004	0.000	0.495	0.303	0.254		
FOR	0.549	0.555	-0.182	0.263	0.588	0.261	-0.018	0.251	0.338	-0.239	0.222	-0.079	-0.138	1.000
	0.000	0.000	0.004	0.000	0.000	0.000	0.774	0.000	0.000	0.000	0.000	0.215	0.029	

Table 4: Estimate of the effect of factors on ROA

Variables Modifications	**ROA** **(1)**	**ROA** **(2)**	**ROA** **(3)**	**ROA** **(4)**	**ROA** **(5)**	**ROA** **(6)**	**ROA** **(7)**	**ROA** **(8)**
SIZE	0.6499**	0.5790**	0.6221**	0.5747**	0.5991**	0.5258**	0.5974*	0.5105**
	(0.2891)	(0.2531)	(0.2536)	(0.2484)	(0.2885)	(0.2519)	(0.2935)	(0.2436)
Age	1.2417**	1.0826**	0.7565	0.7492	0.4079	0.3552	0.4856	0.3621
	(0.5323)	(0.4672)	(0.5775)	(0.5041)	(0.6108)	(0.5157)	(0.6106)	(0.5207)
owner_rate	0.1233***	0.1232***	0.1139***	0.1031***	0.1243***	0.1233***	0.1233***	0.1231**
	(0.0177)	(0.0196)	(0.0149)	(0.0180)	(0.0157)	(0.0176)	(0.0176)	(0.0196)
LDR	0.0007	0.0012	0.0003	-0.0001	0.0041	0.0029*	0.0038	0.0028
	(0.0018)	(0.0017)	(0.0014)	(0.0011)	(0.0024)	(0.0017)	(0.0025)	(0.0018)
NPL	-0.0639**	-0.0632**	-0.0634**	-0.0549**	-0.0521	-0.0421**	-0.0589*	-0.0475**
	(0.0273)	(0.0251)	(0.0294)	(0.0197)	(0.0319)	(0.0176)	(0.0326)	(0.0172)
GDP_g	-0.0032	-0.0002	0.0044	0.0010	0.0061	0.0026	0.0091	0.0059
	(0.0099)	(0.0102)	(0.0079)	(0.0088)	(0.0082)	(0.0099)	(0.0085)	(0.0102)
INF	0.0106	0.0108	0.0162	0.0151	0.0172	0.0171	0.0271**	0.0238*
	(0.0098)	(0.0096)	-0.0108	(0.0110)	(0.0108)	(0.0110)	(0.0118)	(0.0124)
ICT_TI		**0.4538****					**0.4849***	**0.4020****
		(0.1992)					**(0.2511)**	**(0.1903)**
ICT_HR		-0.2041					0.2009	0.0035
		(0.1426)					(0.2852)	(0.2390)
ICT_IA		-0.0896					-0.0118	0.0389
		(0.1555)					(0.1388)	(0.1416)
ICT_OB		-0.0058					**0.3121***	**0.3876****
		(0.1635)					**(0.1541)**	**(0.1473)**
ICT_INDEX	-0.0995				**0.7367****	**0.6372****		
	(0.3665)				**(0.3411)**	**(0.3083)**		
FOR			**0.3493****		**0.4601*****		**0.4552****	
			(0.1255)		**(0.1571)**		**(0.1727)**	
Constant	-9.3630***	-8.4606***	-7.7760***	-7.2262***	-6.3137***	-5.4247***	-6.6985***	-5.4834***
	(1.3649)	(1.4428)	(1.1976)	(1.4001)	(1.4942)	(1.4246)	(1.7535)	(1.6919)
Observations	250	250	250	250	250	250	250	250
R-squared	0.5987	0.6115	0.6326	0.6402	0.4735	0.5205	0.4859	0.5329
Number of banks	25	25	25	25	25	25	25	25
Bank FE	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES

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

Table 5: Estimate of the effect of factors on ROE

VARIABLES	**ROE**	**ROE**	**ROE**	**ROE**	**ROE**	**ROE**	**ROE**	**ROE**
Modifications	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
SIZE	**6.3306****	**6.0625****	**6.0932****	**5.7596****	**6.1004****	**5.7715****	**6.0194****	**5.5524****
	(2.5543)	(2.3613)	(2.2107)	(2.2742)	(2.3100)	(2.3768)	(2.4241)	(2.2731)
Age	**12.463****	**11.380****	8.0941	**8.4833***	8.4915	**8.8793***	9.2892	**9.1794***
	(4.5004)	(4.1169)	(5.1970)	(4.4533)	(5.2809)	(4.5170)	(5.7124)	(4.8014)
owner_rate	0.1921	0.1642	0.0754	0.0016	0.1257	0.0522	0.0865	0.0130
	(0.2287)	(0.2416)	(0.2200)	(0.2439)	(0.2415)	(0.2690)	(0.2495)	(0.2799)
LDR	0.0181	0.0215	0.0157	0.0138	0.0143	0.0124	0.0136	0.0123
	(0.0172)	(0.0169)	(0.0136)	(0.0125)	(0.0152)	(0.0140)	(0.0159)	(0.0146)
NPL	-0.6689	**-0.7023***	-0.6630	**-0.5965***	-0.6704	**-0.6045***	**-0.7458***	**-0.6786***
	(0.3921)	(0.3745)	(0.4021)	(0.3216)	(0.4131)	(0.3334)	(0.4242)	(0.3367)
GDP_g	-0.0775	-0.0520	0.0100	-0.0226	-0.0205	-0.0523	0.0093	-0.0129
	(0.1157)	(0.1173)	(0.1045)	(0.1114)	(0.1066)	(0.1160)	(0.1089)	(0.1223)
INF	0.0755	0.1578					0.1541	0.1442
	(0.1151)	(0.0981)					(0.1200)	(0.1131)
ICT_TI		2.7273					5.0798	5.4172
		(2.3706)					(6.1557)	(5.6810)
ICT_HR		-2.2579					1.1736	0.3603
		(1.4840)					(3.6679)	(3.7977)
ICT_IA		-2.5163					0.1982	0.8601
		(1.8057)					(4.2373)	(3.7956)
ICT_OB		1.3481					4.0948	4.9273
		(1.7100)					(3.8186)	(3.7238)
ICT_INDEX	-3.3594				-3.4104	-3.3484	-11.5805	-12.6141
	(4.4433)				(3.8746)	(4.0292)	(15.8727)	(14.7013)
FOR			**3.0023****		**2.9727****		**2.8003***	
			(1.3591)		(1.3588)		(1.5561)	
Constant	-80.918***	-77.259***	-67.889***	-65.172***	-67.588***	-64.946***	-71.043***	-66.004***
	(13.5340)	(15.1052)	(15.0874)	(16.8908)	(15.0290)	(16.9604)	(16.4239)	(17.6728)
Observations	250	250	250	250	250	250	250	250
R-squared	0.4609	0.4730	0.4833	0.4817	0.4864	0.4847	0.4984	0.5002
Number of banks	25	25	25	25	25	25	25	25
Bank FE	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES

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

Research Results

The results of correlation analysis show that foreign ownership rate and ICT index are both correlated at the 5% significance level with ROA and ROE. After performing descriptive statistical analyses and correlation analyses, the authors estimate panel data regression models with the fixed impact estimation (FE) method. The estimated results are summarized and presented in Tables 4 and 5.

The estimation results from the empirical models indicate that the composite ICT index exerts a positive impact on the Return on Assets (ROA) of the surveyed banks. However, this effect is not statistically significant when efficiency is measured by Return on Equity (ROE), indicating that the same investments do not translate into improved returns for equity holders. This apparent inconsistency can be explained by several complementary mechanisms. First, ICT investments typically involve substantial upfront costs, including infrastructure development, system integration, and cybersecurity enhancements. These expenditures increase operating costs and may dilute short-term profitability attributable to equity, thereby exerting downward pressure on ROE despite improvements in operational efficiency reflected in ROA. Second, ICT development tends to enhance process efficiency, risk monitoring, and service delivery, which primarily improves the productivity of bank assets rather than directly boosting returns on equity. In other words, digital transformation may initially generate efficiency gains at the operational level without immediately translating into higher net income relative to equity capital. Third, the impact of ICT on ROE may be moderated by bank-specific characteristics such as capital structure and size. Banks with larger capital bases or more conservative leverage may experience a lag in translating efficiency gains into shareholder returns. In such cases, ICT-driven improvements in asset performance may be absorbed by higher capital buffers or reinvested into further technological upgrades, limiting short-term gains in ROE. Regarding the sub-components of the ICT index, the disaggregated results provide more nuanced insights into how different dimensions of digital transformation affect bank performance. The estimation results indicate that only technical infrastructure (ICT_TI) and online banking services (ICT_OB) have statistically significant and positive impacts on ROA, whereas human resource infrastructure (ICT_HR) and internal ICT applications (ICT_IA) do not exhibit significant effects. This pattern suggests that not all ICT investments contribute equally to operational efficiency. Investments in technical infrastructure, such as IT systems, data centers, and network capabilities, directly enhance the processing capacity, speed, and reliability of banking operations. Similarly, the development of online banking services improves customer accessibility, transaction efficiency, and service scalability, thereby generating immediate gains in asset utilization and operational productivity. These components are customer-facing and infrastructure-driven, allowing banks to quickly translate technological investment into measurable efficiency improvements. In contrast, investments in ICT-related human resources and internal applications tend to have more indirect and long-term effects. Enhancing IT human capital requires time for skill accumulation, organizational learning, and effective integration into business processes. Likewise, internal applications, such as core banking upgrades or internal digitalization, may improve internal coordination and control but often do not produce immediate efficiency gains that are captured in short-term performance indicators like ROA. In some cases, these investments may even temporarily increase operational complexity and adjustment costs, thereby diluting their short-term measurable impact. From a strategic perspective, these findings carry important implications for bank resource allocation and digital transformation priorities. First, banks should prioritize targeted investments in core technical infrastructure and customer-oriented digital services, as these areas demonstrate the most immediate and significant contribution to operational efficiency. Second, while investments in human capital and internal systems remain essential for long-term sustainability and governance quality, banks need to adopt a phased or balanced investment approach, recognizing that these components yield benefits over a longer horizon. Moreover, the results highlight the importance of strategic alignment between ICT investments and business objectives. Simply increasing overall ICT spending is insufficient; rather, banks must allocate resources toward the most impactful components and ensure that supporting elements, such as human resources and internal systems, are effectively integrated to maximize long-term value. Overall, the evidence suggests that digital transformation in the banking sector is not a uniform process but a multi-dimensional investment strategy, where infrastructure and service-oriented technologies drive short-term efficiency, while organizational and human capital investments underpin long-

term resilience, governance, and sustainable development. Concerning the impact of foreign ownership, the estimated coefficients demonstrate a positive and significant effect on the performance of Vietnamese joint-stock commercial banks across both ROA and ROE metrics. This consistency underscores foreign ownership as a pivotal factor driving the operational efficiency of the Vietnamese banking sector.

Regarding control variables, bank size (SIZE) and bank age (Age) are found to have positive impacts on efficiency, whereas the non-performing loan ratio exhibits a significant negative correlation with performance. These findings align with previous literature. However, the impacts of other control variables remain inconclusive within the scope of this study.

Conclusion and Policy Implications

This study provides empirical evidence on the roles of foreign ownership and digital transformation in shaping the performance and long-term sustainability of Vietnamese joint-stock commercial banks. The findings indicate that foreign ownership contributes positively to bank efficiency. At the same time, digital transformation, particularly through investments in technical infrastructure and online banking services, emerges as a key driver of improved operational effectiveness and service accessibility, which are essential components of a sustainable banking system.

Based on the empirical findings, the study proposes the following recommendations.

For Joint-Stock Commercial Banks:

- Banks should prioritize research and development (R&D) and the integration of ICT and digital transformation to bolster efficiency. Formulating long-term strategies for technological innovation is essential for sustainable performance.
- Within regulatory frameworks, banks should consider expanding foreign ownership "room" to attract capital. This allows domestic banks to leverage abundant financial resources, professional management expertise, advanced technology, and the global ecosystems of foreign investors. However, a rigorous selection process is necessary to partner with reputable investors who align with the bank's strategic goals for governance and innovation.

For the Government and Regulatory Authorities:

- The Government and the State Bank of Vietnam should refine legal frameworks to facilitate the attraction of strategic foreign investors. Simultaneously, robust monitoring and supervisory mechanisms are required during banking restructuring involving foreign shareholders to ensure stability, safety, and efficiency amidst international integration. It is essential to develop a supportive institutional and policy framework that encourages responsible foreign participation and promotes innovation in digital banking while safeguarding financial stability. Strengthening regulatory oversight, enhancing cybersecurity standards, and fostering a conducive environment for digital innovation will be critical to ensuring that technological advancements contribute to a resilient and sustainable banking system.
- Authorities should enhance policies and action programs regarding technological innovation and digitalization within the banking system. Creating a favorable environment will enable joint-stock commercial banks to continue advancing their ICT capabilities, leading to improved national banking efficiency.

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