“Impact of IT investments on bank profitability: Empirical evidence from Vietnam”

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IMPACT OF IT INVESTMENTS ON BANK PROFITABILITY: EMPIRICAL EVIDENCE FROM VIETNAM

Abstract

The increasing role of digitalization in the banking sector necessitates an in-depth analysis of the impact of information technology (IT) investments on bank profitability. The paper analyzes the influence of IT investments on the profitability of Vietnamese commercial banks. The data were collected from 27 commercial banks in Vietnam between 2010 and 2022. The methodology used in this paper is the Feasible Generalised Least Squares (FGLS) regression. The key results indicate that investment in IT has improved the overall performance of banks, as evidenced by an average increase of 1.8% in Return on Assets (ROA) and 15.3% in Return on Equity (ROE). In addition, the Equity-to-Asset ratio exerts a favorable influence on bank performance, increasing ROA by 15.7% and ROE by 40.9%. Furthermore, bank size also demonstrates a positive correlation with both ROA and ROE, raising it by 0.3% and 2.3%, respectively. Based on these findings, more efficient investment in digital transformation, collaboration with Fintech firms, IT competence enhancement for staff, and communication promotion for Vietnamese commercial banks are recommended. Enabling environments for bank digital transformation should be provided by the Government in building a centralized database and electronic systems, introducing fintech regulations, establishing digital ecosystems, and implementing security solutions.

Keywords investment, profitability, technology, digitalization, performance, banking, regression

JEL Classification G21, O16, O33, C33

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INTRODUCTION

Over the past few years, digital transformation has spread rapidly across all aspects of life thanks to the success of the 4.0 Industrial Revolution. From politics and transportation to economics, digital transformation is gradually becoming a driver for all organizations and businesses to improve competitiveness and profitability. Keeping up with that trend, the banking industry also participated in digital transformation and quickly became one of the leading industries, leading to the progressively prominent footprints of digitalization in the service menus of many banks. This may be attributed to its capacity to integrate financial models with information technology to provide financial services at a reduced cost and in shorter times (Meyer & Okoli, 2023). On the one hand, the payment statistics of Bulgaria indicate a substantial increase in the volume of non-cash transactions over the recent years (Silvia, 2020), while the closure of physical branches has been observed as a consequence of the growing trend of online banking, leading to a decline in the frequency of the bank staff's presence, on the other hand. According to Kitsios et al. (2021), the percentage of bank workers who work remotely (from home) is 40%, and many tasks at branches are handled electronically.

Implementing digital technologies promises gains in operating efficiency, cost reduction, and customer satisfaction. However, banks face considerable financial hurdles, including software licenses, deployment, maintenance, infrastructure, and staff training. Ultimately, bank managers are tasked with a crucial cost-benefit analysis, as their mandate is to optimize profits by increasing revenues and decreasing costs. To answer the question of whether it is worth deploying edge-cutting information technology (IT), there is a wide range of studies on the impact of IT investment on bank profitability, such as Beccalli (2007), Mashal (2006), and Chhaidar et al. (2022).

Currently, the Vietnamese financial market is experiencing a significant surge in the development and proliferation of financial technology (Nguyen & Nguyen, 2024). Though Vietnam's national digital transformation program was officially launched in 2021, many banks had heavily invested in digitalization since 2010 and achieved impressive results. Thanks to these substantial investments, customers are now able to experience a variety of digital banking services offered in mobile applications, such as VCB Digibank, Vietinbank Ipay, and Agribank E-Mobile Banking (Do, 2023). Some other banks, such as VPBank, Sacombank, and TPBank, have adopted eKYC (electronic Know Your Customer), which is a digital solution, to verify a client's identity remotely without the need for paper documents (Vu, 2020). These significant advancements not only enhance customer experience but also improve the competitiveness of the Vietnamese banking sector, facilitating broader access to financial services, especially for individuals in rural and remote areas where traditional banking infrastructure remains limited (Trinh, 2024).

Despite the pervasive integration of new technologies within the Vietnamese banking landscape, a comprehensive understanding of the link between IT investment and profitability during the 2010-2022 timeframe remains elusive. This is highlighted by conflicting research findings, with Nguyen (2021) reporting a positive correlation between these two factors, while Vo et al. (2019) identified a negative relationship within larger, IT-heavy banks. Further research into this area is crucial for banks to optimize their IT infrastructure, bolster fintech activities, and cultivate a stronger competitive edge (Alzghoul & Al-kasasbeh, 2024). Therefore, this study focuses on examining the efficiency of investment in technology and digital transformation in the banking sector of Vietnam, which has emerged as one of the most dynamic financial markets in the region.

1. LITERATURE REVIEW

Profitability not only reflects a firm's financial health but also serves as a key driver of growth, competitiveness, and strategic decision-making in the banking sector. It is firms' financial gains resulting from its revenue after subtracting all expenses accrued within a specific timeframe. By gauging a company's capacity to produce profit from its business operations through the efficient deployment of its resources (Geamanu, 2011; Alarussi & Alhaderi, 2018), profitability serves as a fundamental metric of success. It plays a pivotal role in validating management performance, ensuring shareholder contentment, attracting investment, and securing the long-term sustainability of the institution (Bekmezci, 2015). Profitability is an indispensable element within the workings of a market economy.

The measurement of bank profitability is essential for assessing financial performance, stability, and efficiency within the banking sector. While diverse financial indicators exist to measure bank profitability, Return on Equity (ROE) and Return on Assets (ROA) are the most commonly used due to their effectiveness (Ozili, 2015; Jigger & Koroleva, 2023). ROA, calculated as Net Income divided by Total Assets (Holden & El-Bannany, 2007; Klaassen & Eeghen, 2015; Jigger & Koroleva, 2023), reflects a bank's ability to generate profit from its assets and serves as a measure of management performance (Goddard et al., 2004). ROE, defined as Net Income divided by Total Equity (Gul et al., 2011; Klaassen & Eeghen, 2015), indicates how efficiently a bank manages shareholder capital. A high ROA generally translates to favorable returns for shareholders.

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IT investment is a crucial factor to enhance operational efficiency, innovation, and competitiveness within the banking sector. It refers to the allocation of financial resources to tackle mission delivery and provide support for management functions. This may involve a vast array of projects aimed at the advancement, modernization, improvement, or preservation of a singular or a collection of IT assets with related features, followed by the ongoing functioning of these assets. In particular, these IT assets, or IT infrastructure, comprise a collection of joint IT resources that serve as the basis for facilitating current and forthcoming business applications (Xianfeng et al., 2008), for instance, Point of sale (POS) devices, Automatic teller machine (ATM), Local area network (LAN), online banking and other applications (Muhammad et al., 2013; Del Gaudio et al., 2021). In today's world, IT investments occupy a substantial and growing proportion of the capital expenditures of numerous businesses, with the forecast that these investments will continue to consume a significant share of future cash allocated to support new business activities (Berghout & Renkema, 2001). As stated by Dos Santos and Sussman (2000), IT has significantly impacted the US economy, leading to a transition from a manufacturing-based economy to one centered around the exchange and utilization of information. IT investment expenditures in US organizations have reached a level where they constitute a significant portion of capital expenditure (Ballantine & Stray, 1998).

IT infrastructure is defined as tangible technological resources like hardware, software, and networks (Beccalli, 2007). While Beccalli (2007) studied overall IT investment impact on banks, other methods exist. Ross & Beath (2002) suggest categorizing investments by business goals, and Hu and Plant (2001) prefer annual IT spending per employee. Despite these variations, the technology component approach is most common. The relationship between IT investment and bank profitability remains a key research area.

Therefore, this study aims to provide a comprehensive empirical investigation into the impact of IT investments on the profitability of Vietnamese joint-stock commercial banks during the period from 2010 to 2022. Specifically, it examines how digital infrastructure investments, measured through the ICT index, affect key performance indicators such as ROA and ROE. The findings contribute to the literature by offering new evidence from a rapidly evolving emerging market context and inform practical strategies for enhancing bank profitability through IT investments.

The impacts could be summarized as follows:

- *First*, numerous studies have demonstrated the positive impact of IT investment on bank profitability. Mai (2017), using panel data from five Vietnamese commercial banks (2010-2014), found a direct correlation between increased IT investment and higher ROA and ROE. Likewise, Mashal (2006), analyzing data from the Arab Bank in Jordan (1985-2004), concluded that increased IT investment leads to significant positive returns.

- *Second*, alongside studies highlighting positive correlations, research has also identified negative impacts of IT investments. Vo et al. (2019), examining financial data from 13 commercial banks during 2009–2018, discovered that technology investments adversely affected bank performance metrics such as ROA, ROE, and ROL (Return on Lending). Furthermore, Willy and Obinne (2013), utilizing a non-probabilistic sampling technique on four banks from 2005 to 2011, found evidence of a negative correlation between IT spending and bank profitability, implying that such expenditures reduce bank returns.

- *Third*, certain studies have presented evidence of no discernible relationship between IT investment and bank profitability. Giordani and Floros (2015), in their analysis of Greek commercial banks, found that while IT investment and ATM deployment positively influenced fee and commission revenue, they did not correlate with ROA or ROE. Likewise, Beccalli (2007), examining a large sample of European banks, concluded that despite significant IT expenditure, there was no observed correlation with enhanced bank profitability or efficiency. These findings contribute to the overall picture of IT investment's impact on bank profitability as inconsistent, with research demonstrating positive, negative, and null relationships.

In this study, IT investment is believed to have a negative impact on bank profitability in the Vietnamese context. Commercial banks in Vietnam display a reluctance to make significant investments in information technology, as such investments can diminish the appeal of traditional banking products while simultaneously exposing banks to greater risks due to the pressure of adopting emerging technologies (Tran, 2024). Further, these technologies often entail high implementation costs and are prone to rapid obsolescence. Consequently, bank managers ought to deliberate on the optimal approach to technology investment to achieve steady progress in their banking operations (Pham et al., 2021).

Beyond IT investment, bank performance is influenced by various internal factors, including bank size, equity-to-asset ratio, and loan-to-deposit ratio. External factors like GDP growth and inflation are excluded due to the focus on Vietnamese banks. Bank size, measured by Total Assets or their logarithm (Laeven et al., 2014), reflects the aggregate value of a bank's assets (Mkhaiber & Werner, 2021). While many studies suggest larger banks are more profitable (Halkos & Salamouris, 2004; Regehr & Sengupta, 2016), others argue that size negatively impacts or has no effect on profitability (Petria et al., 2015). This may be attributed to the rigidities, inertia, and bureaucracy often associated with larger organizations, which can hinder performance.

In this study, bank size is hypothesized to positively influence profitability, which aligns with the Vietnamese context. Most Vietnamese commercial banks are relatively small, with some barely exceeding the minimum charter capital of VND 3,000 billion. These banks struggle to provide adequate financial services and maintain business sustainability. Their limited branch networks and physical facilities further hinder their ability to expand service coverage nationwide (Huynh, 2021). Conversely, larger banks like BIDV, Vietcombank, and VPBank have experienced rapid growth, possess substantial capital, extensive branch networks, and diverse services, resulting in significantly higher profits than their smaller counterparts.

The equity-to-assets ratio (ETA) reflects the proportion of assets funded by equity. A higher ETA signifies greater financial independence, reducing risk for shareholders and the bank itself. Specifically, increased ETA leads to lower bad debts, minimizing loss provisions and enhancing profitability (Dietrich & Wanzenried, 2011; Lee and Hsiesh, 2013). Conversely, a low ETA can lead to moral hazard, encouraging high-risk investments that negatively impact profits and liquidity (Goddard et al., 2004). This study predicts a positive correlation between ETA and profitability, consistent with Phan et al. (2022), who found that higher ETA in Vietnamese banks (2010-2021) reduces reliance on liabilities, thus decreasing interest expenses and increasing profits.

The loan-to-deposit ratio (LDR) measures the proportion of loans to deposits. Maintaining a healthy LDR allows banks to meet obligations, manage liquidity risk, and operate profitably (Anggari & Dana, 2020). Research presents mixed results: Chou and Buchdadi (2016) found a strong positive LDR-ROA relationship, Hantono (2017) found a positive but weak effect, and Pinasti and Mustikawati (2018) found a negative but insignificant effect. This variance reflects that not all banks rely solely on credit for profits; some rely on fee-based revenue (Steven & Toni, 2020). This study predicts a positive LDR-profitability correlation, consistent with Lai et al. (2022), who found LDR crucial for Vietnamese bank operational performance and safety, suggesting higher LDR enhances efficiency.

Hence, the hypotheses developed in this study are:

H1: IT investments have a negative impact on ROA of Vietnamese banks.

H2: IT investments have a negative impact on ROE of Vietnamese banks.

H3: Bank size has a positive impact on ROA of Vietnamese banks.

H4: Bank size has a positive impact on ROE of Vietnamese banks.

H5: ETA has a positive impact on ROA of Vietnamese banks.

H6: ETA has a positive impact on ROE of Vietnamese banks.

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H7: LDR has a positive impact on ROA of Vietnamese banks.

H8: LDR has a positive impact on ROE of Vietnamese banks.

2. METHODOLOGY

The sample of this study contains 27 Vietnamese commercial joint-stock banks, which are listed in the Vietnam ICT Index report (MIC, 2010–2022), a measure of Information & Communications Technologies (ICT) application. Data were collected from annual reports, which include Consolidated Financial Statements, posted to their official websites. Therefore, Consolidated Financial Statements are used to collect research data such as total assets, total liabilities, total equity, net interest income, etc. At the same time, IT investment is measured by the IT infrastructure index. The data are taken from the secondary data source in the Vietnam ICT Index report owing to its suitability for the context in Vietnam. GDP and inflation are derived from the General Statistics Office's Socio-economic Situation reports, which provide economic growth and inflation rate data.

This study employs a panel dataset comprising 27 Vietnamese joint stock commercial banks over the period 2010-2022. These banks were selected from a total of 35 commercial banks operating in Vietnam during the study period, including 31 joint-stock commercial banks and 4 state-owned commercial banks. The selection was guided by three main criteria: (i) data availability and completeness, (ii) institutional diversity, and (iii) alignment with the study's objective of assessing the impact of IT investment on bank performance. The sample includes a balanced mix of large state-owned commercial banks (e.g., BIDV, VietinBank, Vietcombank), medium-sized joint stock banks (e.g., MB, ACB, SHB), & small private banks (e.g., KienlongBank, PGBank, Bac A Bank). This ensures representation across ownership types, operational scales, and strategic orientations, allowing for a comprehensive examination of heterogeneous IT investment effects. All selected banks publicly disclose consistent and audited financial statements, annual reports, and information on IT-related expenditures and profitability indicators, ensuring data continuity and reliability. Collectively, these 27 institutions account for the majority of the banking sector's total assets, deposits, and lending, thereby enhancing the generalisability and policy relevance of the study's findings.

The cleaned panel data are processed with STATA 15 software. Descriptive statistics, Pearson correlation coefficient, and VIF tests are applied to examine the correlation between independent and dependent variables. Multiple regression analysis approach involving Pooled Ordinary Least Squares (Pooled OLS), Fixed Effect Model (FEM), and Random Effect Model (REM) are performed to determine the relationship and its strength of IT investments with bank profitability during the research period. To choose the most appropriate model, several tests are conducted, including F-test for FEM and Pooled OLS, Breusch-Pagan Lagrange Multiplier for REM and Pooled OLS, and Hausman for both FEM and REM. Once the most suitable model has been chosen, model limitations tests are conducted. These evaluations augment the dependability of the results. These tests include the Wooldridge test for autocorrelation and the Modified Wald test for heteroskedasticity. When errors such as autocorrelation and heteroscedasticity are present, correction with the FGLS (Feasible Generalised Least Squares) model is required to ensure accurate and unbiased estimation results.

Based on past research models, the study performed multiple regression analysis using panel data to estimate the trend and level of the influence of IT investment on bank profitability over time. The following research model is developed:

$$Bank\ profitability_{i,t} = {}_0 + {}_1 ICT_{i,t} + {}_2 Banksize1_{i,t} + {}_3 ETA_{i,t} + {}_4 LDR_{i,t} + {}_{i,t} \quad (1)$$

where *Bank profitability* is the dependent variable, being represented by ROA and ROE of commercial banks.

The independent variable is ICT value as an indicator representing IT investments.

Three control variables are:

$Banksize1_{i,t}$ is the natural logarithm of bank *i* in year *t*, $ETA_{i,t}$ is the equity-to-assets ratio of bank *i* in year *t*, $LDR_{i,t}$ is the loan-to-deposit ratio of bank *i* in year *t*, $\varepsilon_{i,t}$ – errors in the regression.

3. RESULTS

The descriptive statistics of the variables from the model are summarized in Table 1.

Table 1. Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
ROA	345	0.0123022	0.01848	–0.0551	0.198
ROE	345	0.1120696	0.1021202	–0.82	0.747
ICT	239	0.4871958	0.1267098	0.1535	0.8561
Banksize1	346	18.61777	1.195963	15.92274	21.47497
ETA	346	0.0949398	0.0559348	0.0049854	0.8029387
LDR	345	0.6633066	0.1857531	0.0342	2.2823

The average ROA of banks is 1.23%, with the greatest value being 19.8% and the lowest value being –5.51%. Meanwhile, the average ROE stands at 11.21%, while the individual values range from –82% to 74.7%. Although ROA and ROE had negative values (–5.51% and –82%) throughout the research period, this is common in the banking sector, particularly during economic recessions such as the 2012–2015 period. Thus, it can be said that the study sample has no outliers. Regarding the IT investment, the average ICT index is 0.4872, demonstrating that banks have seriously considered this matter due to the widespread and unavoidable trends of IT investments and digital transformation in the global banking business.

The Pearson correlation is used to assess the linkages between variables in the model prior to running their regression. Table 2 displays the findings of Pearson's correlation analysis among the variables.

Table 2. Correlation matrix

	ROA	ROE	ICT	Banksize1	ETA	LDR
ROA	1.0000					
ROE	0.4167	1.0000				
ICT	0.1659	0.3451	1.0000			
Banksize1	0.0807	0.2705	0.3071	1.0000		
ETA	0.1414	–0.0025	–0.0672	–0.3776	1.0000	
LDR	0.0167	0.1912	0.2008	0.2122	0.0903	1.0000

It is evident that there is no correlation coefficient over 0.8 between the variables (Gujarati, 2012). This reveals the absence of any multicollinearity phenomena in the model.

With the ROA variable, the F-test is first utilized to assess and choose between Pooled OLS and FEM (Javed et al., 2016). The findings suggest that Prob > F = 0.0000, confirming that the FEM is appropriate for comparing Pooled OLS with FEM. The Breusch-Pagan test is thereafter conducted to assess and pick the optimal model between OLS and REM (Baltagi, 2008). The results indicate that Prob > chibar2 = 0.0000, meaning that the OLS model is not appropriate. Therefore, the REM model is selected. The Hausman test is used to evaluate and choose the appropriate model between FEM & REM (Deshmukh & Vogt, 2005). The test result shows that Prob > chi2 = 0.1902 > 0.05. This suggests that the REM is a better choice than the FEM. The model's compatibility is tested using the same stages as the ROA variable, with the variable ROE. After performing all three tests to determine the most suitable model, it is obvious that REM is chosen for both ROA & ROE. The test results for the two models are shown in Table 3.

Table 3. Tests for model selection

Model	Tests	
ROA	**F-test**	
	F(26, 207)	4.10
	Prob > F	0.0000
	Breusch & Pagan Lagrangian multiplier test	
	chibar2(01)	80.57
	Prob > chibar2	0.0000
	Hausman test	
	chi2(4)	6.12
	Prob > chi2	0.1902
ROE	**F-test**	
	F(26, 207)	9.00
	Prob > F	0.0000
	Breusch & Pagan Lagrangian multiplier test	
	chibar2(01)	178.54
	Prob > chibar2	0.0000
	Hausman test	
	chi2(4)	1.69
	Prob > chi2	0.7918

With the dependent variable ROA, the Wooldridge test is conducted for autocorrelation in panel data. The test provides a result of Prob > F = 0.0735 >

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0.05, indicating that there is no autocorrelation present in the model. Subsequently, the Modified Wald test is carried out to assess groupwise heteroskedasticity, giving a result of Prob > chi2 = 0.0000. This indicates that the REM of ROA exhibits the presence of heteroskedasticity phenomena. With the REM model of the variable ROE, the steps to verify the model's errors are also carried out similarly and are shown in Table 4.

Table 4. Tests for model limitations

Model	Tests	
ROA	**Wooldridge test**	
	F (1,25)	3.501
	Prob > F	0.0731
	Modified Wald test	
	chi2 (27)	72034.44
	Prob > chi2	0.0000
ROE	**Wooldridge test**	
	F (1,25)	158.858
	Prob > F	0.0000
	Modified Wald test	
	chi2 (27)	1837.85
	Prob > chi2	0.0000

In addition to the presence of heteroskedasticity in the REM of ROA, it is evident that both the models for the dependent variable ROE exhibit autocorrelation and heteroskedasticity. To address these two problems & enhance the model's reliability, the FLGS model is applied.

The initial regression analysis indicated that ICT, ETA, and bank size significantly influenced Vietnamese commercial bank performance, as measured by ROA, while LDR did not. To create the most effective model, only the statistically significant variables were retained for further regression analysis. The outcomes of this analysis are presented in Table 5.

The regression equation that represents the relationship between IT investment and the profitability of commercial banks in Vietnam, as measured by ROA, is:

$$ROA = -0.059373 + 0.0181853 \cdot ICT + 0.0026206 \cdot Banksize1 + 0.1574565 \cdot ETA + u. \quad (2)$$

First, the ICT variable has a strong positive effect on ROA, which is statistically significant at a confidence level of 95%. Similarly, the variables Banksize1 and ROA exhibit a positive correlation at the same confidence level. Nevertheless, the Banksize1 variable has a weaker impact on ROA than ICT because of its lower regression coefficient (0.0026206 < 0.0181853). *Second*, the variable ETA also has a positive and statistically significant influence on the ROA at the higher 1% significance level, with the coefficient being 0.1574565. *Third*, the intercept coefficient –0.059373 is statistically significant at 1% in explaining the unobserved components in the model, as shown by the P-value = 0.009 < 0.01.

Upon identifying the presence of autocorrelation and heteroskedasticity in the residual error of the ROE variable, the FGLS model is the optimal choice as it effectively addresses both issues. The findings indicate that the variables ICT, Banksize1, and ETA have a noteworthy influence on the profitability of banks as measured by the ROE, while the LDR variable does not. Hence, these significant variables are selected for the following regression to get a more appropriate model for ROE.

The regression equation representing the relationship between IT investments and the profitability of commercial banks in Vietnam is derived from this point:

$$ROE = -0.4317669 + 0.153014 \cdot ICT + 0.0231499 \cdot Banksize1 + 0.4089211 \cdot ETA + u. \quad (3)$$

First, the ICT and Banksize1 variables have a strongly positive effect on ROE at a 1% significance level, but the ICT with the coefficient 0.153014

Table 5. Adjusted FGLS model for ROA

ROA	Coef.	Std. Err.	z	P> | z |	[95% Conf. Interval]	
ICT	. 0181853	. 0088295	2 . 06	0 . 039	. 0008799	. 0354907
Banksize1	. 0026206	. 0011532	2 . 27	0 . 023	. 0003603	. 0048809
ETA	. 1574565	. 0339679	4 . 64	0 . 000	. 0908806	. 2240323
_cons	– . 059373	. 0226176	–2 . 63	0 . 009	– . 1037027	– . 0150433

Table 6. Adjusted FGLS model for ROE

ROE	Coef.	Std. Err.	z	P> | z |	[95% Conf. Interval]	
ICT	. 153014	. 0379169	4 . 04	0 . 000	. 0786983	. 2273297
Banksize1	. 0231499	. 0049524	4 . 67	0 . 000	. 0134434	. 0328564
ETA	. 4089211	. 1458705	2 . 80	0 . 005	. 1230201	. 6948221
_cons	– . 4317669	. 0971283	–4 . 45	0 . 000	– . 6221349	– . 241399

has a more significant effect on bank profitability (ROE) than the bank size with the coefficient of 0.0231499. *Second*, the variable ETA also significantly and positively affects the ROE at a significance level of 1%. Additionally, the equity-to-asset ratio and ROE also possess the strongest positive correlation in the model. *Third*, with the P-value = 0.000 < 0.01, the intercept value of –0.4317669 suggests that the presence of unobserved variables in the model will result in a decrease in a bank's performance (ROE).

Table 7 summarizes all findings.

As evidenced by Table 7, the only accurately predicted relationships are those between bank size and ROA, bank size and ROE, the equity-to-asset ratio and ROA, and the equity-to-asset ratio and ROE, meaning that the hypotheses *H3, H4, H5,* and *H6* are accepted. This indicates that banks with a higher equity-to-asset ratio tend to be more financially stable and profitable. This finding also suggests that larger banks have a better chance of achieving higher profitability, likely due to economies of scale, more robust risk management, or higher operational efficiency.

Hypotheses *H1* and *H2* are not supported by the empirical results and are therefore rejected. Contrary to initial expectations, IT investments appear to enhance bank profitability rather than impose a financial burden. Meanwhile, hypotheses *H7* and *H8* cannot be conclusively determined due to insufficient evidence, leading to their rejection.

4. DISCUSSIONS

First, a statistically significant positive correlation exists between IT investment and ROA. While not supported by some researchers (Mashal, 2006; Mai, 2017), this finding is consistent with others (Willy & Obinne, 2013; Vo et al., 2019). The conflicting results may arise from early IT investments increasing costs and assets while decreasing operational profits, impacting ROA negatively. However, Vietnamese banks, as later-stage IT adopters, have realized financial gains. This is because early IT adoption involves high, unpredictable risks and uncertain benefits. As technology costs decline (Dos Santos & Peffers, 1993), later adopters benefit from reduced expenses. Therefore, pioneer nations face higher IT investment costs compared to later adopters.

Table 7. Hypotheses vs actual results on the impact of IT investment on bank profitability

Variables	Full name	Hypothesis	Actual result	Conclusion
Dependent variables				
ROA	Return on Assets			
ROE	Return on Equity			
Independent variable				
ICT	ICT Index	ROA: (–)	ROA: (+)	Not support
		ROE: (–)	ROE: (+)	Not support
Control variables				
Banksize1	Bank size	ROA: (+)	ROA: (+)	Support
		ROE: (+)	ROE: (+)	Support
ETA	Equity-to-Asset Ratio	ROA: (+)	ROA: (+)	Support
		ROE: (+)	ROE: (+)	Support
LDR	Loan-to-Deposit Ratio	ROA: (+)	ROA: None	No conclusion
		ROE: (+)	ROE: None	No conclusion

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Although Vietnam entered the 4.0 Industrial Revolution later than many industrialized nations, it has effectively utilized their experience to advance its banking technology. Despite not being a leader, Vietnam has seen considerable progress. IT investments in 2018 resulted in 255 million online transactions and VND 1.86 million billion in phone-based transactions (Thuy, 2019). Banks recover their investments through service fees, which are initially high. As technology costs fall, banks can increase profits and ROA. Future IT investments will further foster digital transformation, improve profitability, and expand financial access. Banks that strategically invest in IT will enhance operational efficiency, improve customer experience, and achieve sustained financial growth.

Second, IT investments show a positive effect on ROE, a finding that contrasts with Mahboub (2018), who argued that infrastructure costs negate benefits. However, this aligns with the situation in Vietnam. Despite revenue growth, many banks invest minimally in IT (Tue, 2022). The surge in digital payment accounts (104.2 million by 2020) indicates that IT investment attracts customers and generates fee revenue. Banks also benefit from non-traditional revenue streams (Ta, 2021), contributing to ROE growth. Future strategic IT investments will strengthen banks' competitive edge and ensure sustained financial performance.

Third, ETA is shown to positively influence ROA, supporting research by Dietrich and Wanzenried (2011) and Lee and Hsiesh (2013). This study finds that a higher ETA enhances operational efficiency within the Vietnamese banking sector. During the research period, Vietnamese banks competed fiercely to increase equity. Rapid credit expansion coupled with sluggish equity growth from the late 2000s to early 2010s led to decreased CAR. Following 2012, a surge in non-performing loans resulted in lower profits or losses. This prompted the restructuring of nine vulnerable banks and capital increases, especially for smaller banks (Van, 2014).

The Vietnamese banking sector adapted to meet capital adequacy and risk management requirements under Circular No. 41/2016/TT-NHNN and Basel II (Nguyen & Tran, 2021). From 2018, equity growth surpassed deposit growth, with a significant 17% increase in 2020 (Nguyen & Tran, 2021). Can (2021) reported consistent profit growth in Vietnamese banks from 2016 to 2020, likely due to successful bad debt resolution and restructuring.

Fourth, the ETA variable has a positive relationship with bank profitability measured by ROE, which supports the research of Dietrich and Wanzenried (2011) and Lee and Hsiesh (2013). This finding provides more evidence that increasing the equity capital of commercial banks in Vietnam throughout the period of 2010-2020 enhances operational efficiency, thereby leading to a rise in profits. The Prime Minister approved the Decision No. 1058/QD-TTg dated July 19, 2017, which outlines the Scheme «Restructuring the system of credit institutions associated with handling bad debts in the 2016-2020 period». This decision recognizes the significance of increasing charter capital as a strategic solution for commercial banks to restructure and develop. Thus, in 2017, 19 out of 35 banks declared their intentions to expand their charter capital, resulting in a collective increase of VND 37,135 billion (Long, 2017). This enabled them to grow business, boost profitability, and therefore increase ROE.

Fifth, the analysis indicates that bank size has a positive impact on ROA, suggesting that larger banks tend to be more profitable. This finding aligns with Regehr and Sengupta (2016), who argue that an increase in bank size can improve profitability through the realization of economies of scale. Larger banks are better positioned to diversify their operations, negotiate favorable terms with clients, and manage credit risk more effectively. Their access to broader investment opportunities, greater capital mobilization capacity, and stronger market presence enables them to optimize operations, enhance managerial efficiency, and reinforce customer confidence. Moreover, large banks often enjoy a superior reputation in interbank and international markets, allowing them to obtain funding at lower costs than smaller institutions. They are also more capable of spreading fixed costs – such as technological infrastructure, skilled labor, and regulatory compliance – across a wider operational base, thereby reducing average costs. Collectively, these advantages contribute to higher earnings per unit of assets, ultimately improving ROA. In the context of Vietnam, it may

be concluded that commercial banks, particularly larger institutions, benefit significantly from economies of scale and tend to exert greater market influence (Nguyen, 2024).

Sixth, the variable representing bank size has a positive effect on ROE, unlike the conclusions of Rumaly (2023) who showed that the increase of asset size in commercial banks of Bangladesh may result in a decline in ROE due to its influence on leverage. Meanwhile, this finding aligns with the study conducted by Vu and Nahm (2013) on Vietnamese commercial banks.Indeed, large banks in Vietnam such as BIDV, Vietcombank, and VietinBank can mobilize substantial quantities of deposits at favorable interest rates. These banks benefit from economies of scale by allocating fixed expenses to a large number of transactions (Doan, 2018). In addition, banks may use existing IT infrastructure, human resources, and other resources to drive an expansion in their overall assets (Nguyen & Nguyen, 2016). Consequently, the drop in the average cost per unit of assets leads to a rise in their earnings.

CONCLUSIONS

This study examines the impact of IT investments on the profitability of Vietnamese joint-stock commercial banks, utilizing data from 27 banks over a 12-year period (2010–2022). The analysis employs the Feasible Generalized Least Squares (FGLS) regression method to explore this relationship and assess the influence of additional factors – equity-to-asset ratio, loan-to-deposit ratio, and bank size – on bank profitability. The results indicate that the profitability of banks during the study period is positively influenced by equity-to-asset ratio, bank size, and IT investments. Yet, this study did not find a correlation between the loan-to-deposit ratio and bank profitability. The findings reveal that IT investments contribute positively to bank performance, suggesting that digital transformation enhances operational efficiency and profitability. Additionally, the equity-to-asset ratio and bank size demonstrate a favorable effect on profitability, while the loan-to-deposit ratio has a negative impact, indicating potential liquidity risk concerns.

Based on these findings, several key conclusions can be drawn. Banks need to make substantial investments to build a robust IT infrastructure that facilitates competition and establishes a solid digital framework. First, allocate a significant portion of their resources toward the investment in digital transformation. Second, enhance collaboration with Fintech businesses to advance technological research and deployment. Third, improve IT competence of their employees. Fourth, promote communication to introduce innovative digital services to both existing and potential customers.

Moreover, an enabling environment should be built by introducing policies and regulations to assist commercial banks in enhancing business efficiency. First, establish a centralized database to consolidate all data from the whole banking system. Second, develop an electronic government system in SBV to manage business processes, deliver public services, and facilitate the exchange and dissemination of data between SBV and commercial banks. Third, conduct testing of various financial technology regulations and effectively address any challenges encountered in the establishment of digital ecosystems in collaboration with other businesses. Last but not least, enhance the administration and implementation of security solutions.

AUTHOR CONTRIBUTIONS

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest regarding the publication of this paper.

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APPENDIX A

Table A1. List of commercial banks in the study

No.	Bank name	Abbreviation
1	Joint Stock Commercial Bank for Investment and Development of Vietnam	BIDV
2	Vietnam Joint Stock Commercial Bank for Industry and Trade	VietinBank
3	Joint Stock Commercial Bank for Foreign Trade of Vietnam	VCB
4	Military Commercial Joint Stock Bank	MB
5	Saigon Thuong Tin Commercial Joint Stock Bank	STB
6	Asia Commercial Joint Stock Bank	ACB
7	Vietnam Technological and Commercial Joint Stock Bank	TCB
8	Vietnam Prosperity Joint Stock Commercial Bank	VP
9	Saigon-Hanoi Commercial Joint Stock Bank	SHB
10	Vietnam International Commercial Joint Stock Bank	VIB
11	Tien Phong Commercial Joint Stock Bank	TP
12	Southeast Asia Commercial Joint Stock Bank	SeaBank
13	Vietnam Maritime Commercial Joint Stock Bank	MSB
14	Vietnam Commercial Joint Stock Export Import Bank	Eximbank
15	Orient Commercial Joint Stock Bank	OCB
16	Bac A Commercial Joint Stock Bank	Bac A Bank
17	Saigon Bank for Industry and Trade	SGB
18	Sai Gon Joint Stock Commercial Bank	SCB
19	Ho Chi Minh City Development Joint Stock Commercial Bank	HD
20	Vietnam Public Joint Stock Commercial Bank	PVcomBank
21	Kien Long Commercial Joint Stock Bank	KienlongBank
22	Nam A Commercial Joint Stock Bank	Nam A Bank
23	An Binh Commercial Joint Stock Bank	ABBank
24	Vietnam - Asia Commercial Joint Stock Bank	VietABank
25	Bao Viet Joint Stock Commercial Bank	BVB
26	Viet Capital Commercial Joint Stock Bank	BVBank
27	Prosperity and Growth Commercial Joint Stock Bank	PGBank