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UNIVERSITY OF FINANCE – MARKETING

NGUYEN THANH QUANG

IMPACT OF INFORMATION TECHNOLOGY APPLICATION ON THE PERFORMANCE OF VIETNAMESE COMMERCIAL BANKS

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Supervisor 1: Assoc. Prof. Dr. Ho Thuy Tien
Supervisor 2: Dr. Dang Thi Ngoc Lan

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LIST OF PUBLISHED SCIENTIFIC RESEARCH WORKS RELATED TO THE DISSERTATION

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2. Hồ Thủy Tiên và Nguyễn Thanh Quang (2023). Tác động của ứng dụng công nghệ thông tin đến hiệu quả hoạt động của các ngân hàng thương mại Việt Nam. *Tạp chí Công Thương*, Số 26, Tháng 12/2023,Trang 216-223.

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1. Ho Thuy Tien & Nguyen Thanh Quang (2024). The application of Information Technology in minimizing risks in the bank operations: practices in Vietnam. *International Conference on Finance and Accounting for the promotion of sustainable Development in the private sector (FASPS6)*, ISBN: 978-604-79-4639-6, 11/2024, 773-784.
2. Nguyen Thanh Quang (2024). A review of banking operations on Digital Technology Platforms in developing countries. *International Conference on Finance and Accounting for the promotion of sustainable Development in the private sector (FASPS6)*, ISBN: 978-604-79-4639-6, 11/2024, 795-803.

CHAPTER 1. RESEARCH INTRODUCTION

1.1. Rationale for the Research Topic

Research on the impact of IT investment and application on bank performance has been conducted globally for a long time. Studies by Ken and Magdi (2004) in the UK and Eyadat and Kozak (2005) in the US show that IT investment helps banks reduce operational costs and enhance business efficiency. Similar findings were recorded in later studies, such as those by Casolaro and Gobbi (2007), Abdulrahman and Altmimi (2015), and Ebenezer (2019).

Regarding IT application, electronic banking (E-banking) services have become a key research focus. Studies like those by Alam et al. (2016), Maseko and Kalama (2022), and Abhay et al. (2023) show that E-banking helps banks enhance performance by improving service quality and reducing transaction costs. However, some studies, such as those by Amos et al. (2020) and Okolie et al. (2023), argue that the effectiveness of E-banking is unclear in the short term due to high initial investment costs and customer readiness.

In Vietnam, studies on the impact of IT on bank performance have also been conducted. Research by Trầm Thị Xuân Hương and Nguyễn Từ Nhu (2018), Phan Thị Hằng Nga and Trần Thị Phương Thanh (2019) confirms that IT application has improved operational efficiency in Vietnamese commercial banks. At the same time, studies by Nguyễn Thị Hằng Nga and Cao Thị Châu

Thoa (2022), and Vũ Thị Huyền Trang et al. (2022) emphasize the positive relationship between IT investment and bank performance. In the context of the Fourth Industrial Revolution, IT has become central to the digital transformation of economic sectors, particularly in banking. IT investment and application are not only inevitable trends but also key factors for commercial banks to enhance their competitiveness, optimize operations, and improve customer service. Globally, banks have implemented IT solutions such as Core Banking systems, E-banking services, and advanced risk management tools to reduce operating costs, expand market share, and improve performance. In Vietnam, in the context of the economy shifting towards cashless payments, the State Bank of Vietnam issued Decision 2655/QD-NHNN (2019) on the strategy for IT development in the banking sector, highlighting the role of technology in improving competitiveness and modernizing operations.

Between 2013 and 2023, Vietnamese commercial banks invested heavily in IT infrastructure, including hardware and software, to implement technology solutions supporting business operations. Concurrently, the application of IT in banking services such as ATM transactions, POS, credit cards, Mobile Banking, and Internet Banking grew significantly, contributing to a noticeable improvement in performance indicators like Return on Assets (ROA) and Return on Equity (ROE). However, the specific impact

of IT investment and application on bank performance has yet to be comprehensively studied in Vietnam.

Although numerous studies have been conducted globally and in Vietnam on the impact of IT investment and application on bank performance, there is still a lack of empirical studies using panel data and advanced quantitative methods to assess this relationship in the Vietnamese context. Particularly, few studies have applied the System GMM regression method using data from 24 Vietnamese commercial banks between 2013 and 2023 to comprehensively analyze the impact of IT investment and application on bank performance.

With the goal of filling this research gap and providing scientific and practical recommendations to improve the performance of Vietnamese commercial banks, the author has chosen to conduct the dissertation: "*The Impact of Information Technology Application on the Performance of Vietnamese Commercial Banks*".

1.2 Research Objectives and Research Questions

1.2.1 General Research Objective

The primary research objective of this dissertation is to evaluate the impact of IT investment and application on the performance of 24 Vietnamese commercial banks.

1.2.2 Specific Research Objectives

- Examining the impact of IT investment, including hardware investment, software investment, IT human resource infrastructure,

and IT technical infrastructure, on the performance of Vietnamese commercial banks.

- Analyzing the impact of IT application, including internal IT application within banks, online banking services application, and the transaction value of credit and debit cards, on the performance of Vietnamese commercial banks.

1.2.3. Research Questions

To achieve the specific research objectives outlined above, this study seeks to answer the following questions:

- First, how does IT investment, including hardware investment, software investment, IT human resource infrastructure, and IT technical infrastructure, impact the performance of Vietnamese commercial banks?
- Second, how does IT application, including internal IT application within banks, online banking services application, and the transaction value of credit and debit cards, affect the performance of Vietnamese commercial banks?

1.3. Research Subjects and Scope

1.3.1. Research Subjects

The primary research subjects of this dissertation are IT investment, IT application, the performance of Vietnamese commercial banks, the impact of IT investment on the performance of Vietnamese commercial banks, and the impact of IT application on the performance of Vietnamese commercial banks.

1.3.2. Research Scope

The author analyzes the impact of IT investment and IT application in 24 Vietnamese commercial banks from 2013 to 2023.

- These 24 Vietnamese commercial banks include 23 domestic joint-stock commercial banks and 1 state-owned commercial bank. The study does not consider joint-venture commercial banks or foreign commercial banks operating in Vietnam due to their heterogeneity in characteristics and organizational structures.
- The author selects these 24 Vietnamese commercial banks for analysis because they have complete data on IT investment and IT application for the research period 2013–2023. The list of these 24 banks represents approximately 77% of the 31 joint-stock commercial banks in Vietnam as of December 31, 2023 (State Bank of Vietnam, 2023). Notably, Vietcombank (VCB) is excluded from this list because its software investment data is not fully disclosed in its annual reports and consolidated financial statements for the period 2013–2023.
- The research period from 2013 to 2023 is chosen because, starting in 2013, Vietnamese commercial banks began incorporating IT application data into their annual reports.

Scope of IT Investment:

- The author analyzes the impact of banks' hardware investment to examine how it influences the performance of Vietnamese commercial banks. Hardware serves as the essential foundation for software. Therefore, investing in hardware plays a crucial role in building the infrastructure necessary for operating software solutions. It provides the groundwork for banks to enhance operational capabilities, improve customer experience, and increase overall performance.

- The author examines the impact of banks' software investment to assess its effect on the performance of Vietnamese commercial banks. The development of technology in the banking sector is inherently linked to the interdependence and synergy between hardware (physical infrastructure) and software (technological solutions). This interdependence is inseparable—hardware investment provides the foundation, while software generates value and maximizes the utilization of hardware. Moreover, software cannot function effectively without a compatible hardware infrastructure. Complex software systems require robust hardware to ensure smooth, stable, and secure operations. Thus, investing in software is essential for banks to improve customer experience, optimize operational processes, and enhance competitiveness.
- The author analyzes the impact of banks' IT human resource infrastructure, including: (i) IT specialists, (ii) Information security specialists, (iii) IT personnel with internationally recognized IT certifications, to evaluate its influence on the performance of Vietnamese commercial banks.
- The author examines the impact of banks' IT technical infrastructure, which includes: (i) Server and workstation infrastructure, (ii) Communication infrastructure, (iii) ATM/POS infrastructure, (iv) Infrastructure for implementing information security and data protection solutions, (v) Infrastructure for establishing data centers and disaster recovery centers, to assess how these factors affect the performance of Vietnamese commercial banks.

Scope of IT Application:

- The author analyzes the impact of internal IT application within banks to assess how it influences the performance of Vietnamese commercial banks. Internal IT application refers to the use of systems, software, and advanced technologies to support operational processes, management, and internal transactions within the organization. It involves the deployment of technological systems and solutions aimed at automating, integrating, and optimizing management and operational activities within banks. This is a crucial factor in modernizing the banking sector, improving performance, and enhancing competitiveness. Internal IT applications in banks includes the following components: (i) Core Banking, (ii) Basic applications, (iii) Electronic payments.
- The author examines the impact of online banking service applications to evaluate their effect on the performance of Vietnamese commercial banks. Online banking services refer to the provision of financial products and services through digital channels (such as Internet Banking, Mobile Banking, or other electronic platforms) to meet the needs of individual and corporate customers in a fast, convenient, and secure manner. This is also a key component of banks' digital transformation strategies, focusing on optimizing customer experience and improving operational efficiency.
- The author analyzes the impact of transaction value using credit and debit cards to assess its effect on the performance of Vietnamese commercial banks. Credit and debit cards are essential payment tools that not only provide convenience to customers but also contribute to revenue growth and overall banking performance.

1.4. Research Methodology

The research data on IT investment, IT application, and the performance of 24 Vietnamese commercial banks used in this dissertation is panel data, collected from audited financial statements, annual reports of the 24 Vietnamese commercial banks, the IT Development and Application Readiness Index reports by the Ministry of Information and Communications, and statistical reports from the International Monetary Fund (IMF) during the period 2013–2023

- To answer the first research question, *'How does IT investment impact the performance of Vietnamese commercial banks?'* the author employs the Pooled OLS, REM, FEM, FGLS, and SGMM methods. Specifically:

  - The dependent variable, representing the performance of 24 Vietnamese commercial banks, is measured using two indicators: ROA and ROE.

  - The independent variables, reflecting IT investment in commercial banks, are measured by four indicators: (i) Hardware investment, (ii) Software investment, (iii) IT human resource infrastructure, (iv) IT technical infrastructure.

  - Control variables include:

  + A group of variables representing the characteristics of commercial banks, such as: (i) Loan-to-total-assets ratio, (ii) Operating expenses-to-total-assets ratio, (iii) Bank size.

  + A group of variables representing macroeconomic factors, such as: (i) Inflation rate, (ii) Economic growth rate.

- To answer the second research question, *'How does IT application impact the performance of Vietnamese commercial banks?'* the

author employs the Pooled OLS, REM, FEM, FGLS, and SGMM methods. Specifically:

- The dependent variable, representing the performance of 24 Vietnamese commercial banks, is measured using two indicators: ROA and ROE.

- The independent variables, reflecting IT application in commercial banks, are measured by three indicators: (i) Internal IT application within banks, (ii) Online banking service application, (iii) Transaction value of credit and debit cards.

- Control variables include:

+ A group of variables representing IT infrastructure, such as: (i) IT human resource infrastructure, (ii) IT technical infrastructure.

+ A group of variables representing the characteristics of commercial banks, such as: (i) Loan-to-total-assets ratio, (ii) Operating expenses-to-total-assets ratio, (iii) Bank size.

+ A group of variables representing macroeconomic factors, such as: (i) Inflation rate, (ii) Economic growth rate.

1.5. New Contributions of the Dissertation

1.5.1. New Scientific Contributions

❖ *Contribution to Research Methodology*: This study addresses the research gap regarding the impact of IT investment on bank performance by separating hardware and software investment costs into two distinct independent variables within the research model. The results indicate that both hardware and software investments have an inverse effect on ROA and ROE, but their effects may not be immediate and require a certain period (lag) to take effect, once the systems are deployed and operate stably. This is a novel contribution regarding the time factor in IT

investment effectiveness, helping Vietnamese commercial banks adjust their IT investment strategies effectively.

❖ *Assessment of the role of IT human resource infrastructure and IT technical infrastructure:* This study has addressed the research gap by analyzing the impact of IT human resource infrastructure and IT technical infrastructure on bank performance. The results show that both of these factors have a significant impact on the bank's performance, but their effects may require some time to materialize, especially in the context of IT systems being deployed and operated.

❖ *Identifying the differences between short-term and long-term impacts of IT*: The research findings reveal that IT investments (hardware, software, human resources, and technical infrastructure) generally have a negative impact in the short term due to high initial costs and extended integration periods but yield positive effects in the long term when systems are synchronized and operate efficiently. This is a new scientific contribution regarding the temporal dimension of IT investment effectiveness, enhancing the understanding of this relationship.

❖ *Analyzing the role of IT applications in improving banking performance*: The study confirms that IT applications, particularly internal IT application within banks, online services and cashless payments, have a significantly positive impact on banking performance. This underscores the critical role of digital transformation in enhancing the competitiveness of banks. The findings provide new scientific evidence on the impact of IT application factors in the Vietnamese context.

❖ *Integrating theoretical frameworks in analyzing IT impacts*: The dissertation integrates various theoretical frameworks, including: the

Technology Acceptance Theory, Innovation Theory, Resource-Based Theory, Transaction Cost Theory, Agency Cost Theory, and the Efficient-Structure Theory, to analyze the impact of IT investment and application on performance. This integration enriches the theoretical foundation and opens up new research directions on IT and performance in the banking sector.

1.5.2. New practical contributions

❖ *Supporting IT application strategies in Vietnamese commercial banks (CBs):* The study demonstrates that IT application factors, including internal IT systems, online services, and cashless payments, have a significantly positive impact on the banking performance. This provides practical insights for Vietnamese CBs to prioritize investments in IT applications to enhance operational efficiency, improve customer experiences, and meet the demands of digital transformation.

❖ *Orienting the development of online services and digital payments*: The findings reveal that online banking services (Internet Banking, Mobile Banking) and payments via credit and debit cards play a crucial role in improving banking performance. This emphasizes the need for Vietnamese CBs to accelerate the development of cashless payment systems and online applications to meet customer needs and enhance competitiveness.

❖ *Strengthening IT system security and integration capabilities*: The application of internal IT systems and online services requires banks to ensure the security and stability of their IT infrastructure. This suggests that banks should invest in advanced security solutions and build robust IT infrastructures to address potential risks in the digital environment.

❖ *Developing a synchronized technology investment strategy*: The study highlights that the effectiveness of IT investments (hardware, software, human resources, and technical infrastructure) can only be achieved when these components are implemented in a coordinated manner. This serves as a basis for banks to develop long-term investment strategies, ensuring the integration of technology with business operations.

❖ *Supporting operational cost management*: The findings indicate that operating costs (OER) have a positive impact on banking performance when managed efficiently and allocated effectively. This suggests that banks should focus on optimizing operating costs through automation, process digitization, and technology applications to increase productivity and reduce unnecessary expenses.

❖ *Enhancing credit risk management*: The negative impact of the loan-to-total-assets ratio (TLTA) on banking performance highlights that credit expansion is not effective unless accompanied by robust credit risk management. Banks should adopt advanced credit management systems, such as internal credit rating systems, to improve credit quality and minimize non-performing loans.

❖ *Adapting flexibly to macroeconomic fluctuations*: The study shows that inflation (INF) and economic growth (GDP) negatively affect banking performance, suggesting that banks need to develop flexible business strategies to respond to macroeconomic changes. Strategies may include adjusting interest rates or diversifying asset portfolios.

❖ *Supporting policy formulation by the State Bank of Vietnam (SBV):* The research provides practical evidence for the SBV to implement clear policy guidelines, focusing on technology standardization, promoting

digital payments, and enhancing credit management. These measures aim to ensure the sustainable and secure development of the banking system.

1.6. Dissertation layout

The structure of the dissertation includes 05 chapters as follows:

Chapter 1: Research introduction

Chapter 2: Theoretical basis and research overview

Chapter 3: Research methodology

Chapter 4: Research results and discussion

Chapter 5: Conclusion and policy implications

CHAPTER 2. THEORETICAL BASIS AND RESEARCH OVERVIEW

2.1. Foundational Theoretical Framework

2.1.1. Technology Acceptance Theory

The Technology Acceptance Model (TAM) was proposed by Davis et al. (1989). This is a theoretical model that explains user behavior regarding technology adoption, and TAM has been widely applied in studies on technology usage, including research on software adoption, online shopping website usage, and mobile applications. In this dissertation, the TAM theory serves as a theoretical foundation to explain why IT investment and IT applications in banks can impact their performance.

2.1.2. Innovation Diffusion Theory

According to Schumpeter (1934), innovation refers to the introduction of a new product, a new process, a new production method, or a new system by companies. In this dissertation, the innovation theory helps explain IT investment and IT application in banks as a form of innovation aimed at enhancing performance

2.1.3. Resource-Based Theory

Penrose (1959) provided the initial foundation for the study of firm resources. Building on Penrose's (1959) research on resources, Wernerfelt (1984) introduced the resource-based view (RBV), which became the first and most fundamental branch of the resource-based theory. Wernerfelt (1984) laid the groundwork for the resource-based theory of firms. In this dissertation, the resource-based theory serves as the theoretical foundation for analyzing the role of IT resources in enhancing the performance of banks.

2.1.4. Transaction Cost Theory

The concept of transaction costs was first introduced by Coase in 1937. Coase's (1937) research laid the foundation for transaction cost theory. Building on Coase's (1937) work, Williamson (1975) further developed the concept of transaction costs and established transaction cost theory to explain the existence of firms in a market economy. In this dissertation, transaction cost theory helps explain the relationship between IT investment, IT application, and the performance of banks.

2.1.5. Agency Cost Theory

Fama and Miller (1972) studied capital structure based on agency costs. Later, Jensen and Meckling (1976) built upon the work of Fama and Miller (1972) and further developed agency cost theory at a deeper level. In this dissertation, agency cost theory plays a crucial role in explaining the relationship between IT investment, IT applications, and the performance of banks.

2.2. Theoretical Framework of Information Technology

In this dissertation, the theoretical framework of IT helps explain two key aspects of IT:

- IT Investment: Examines the role of allocating financial and non-financial resources to develop IT infrastructure.
- IT Application: Evaluates how IT solutions are implemented to enhance performance and improve customer service

2.3. Theoretical Framework of Performance

In this dissertation, the theoretical framework of performance, including the profit maximization theory, the Structure-Conduct-Performance (SCP) model, and the Efficient-Structure theory, plays a crucial role in understanding and analyzing the impact of IT investment and IT application on the performance of Vietnamese commercial banks

2.4. Concepts of Information Technology and Performance

- Information Technology (IT) refers to computer technology (including hardware and software) that processes and stores the necessary information for data transmission (Daniel et al., 1999). In the research context of this dissertation, IT in the banking sector is considered a core element, playing a crucial role in implementing data management systems, automating processes, and providing modern digital banking services. The key IT components utilized in commercial banks include hardware, software, communication technology, and IT services.

- Performance is the operationalized concept of efficiency within an organization, reflecting its ability to utilize available resources (such as financial, human, and physical assets) to achieve its objectives optimally. Performance is a multidimensional concept that has been studied from various perspectives. According to microeconomic theory, performance is defined as the degree of success in resource allocation to optimize outcomes, with a primary focus on profitability (Bikker & Bos, 2008; Daft, 2008).

2.5. Overview of Relevant Research

Empirical studies on the impact of IT on bank performance focus on two main areas:

- The impact of IT investment on bank performance: Ken & Magdi (2004), Eyadat & Kozak (2005), Casolaro & Gobbi (2007), Leckson et al. (2011), Smita et al. (2013), Abdulrahman & Altmimi (2015), Bilkisu & Kabiru (2015), Hendra & Serlyna (2018), Rakhi & Ajit (2018), Ebenezer (2019), Wiredu et al. (2020), Mohammad et al. (2021), Syrine (2021), Asma et al. (2023).

- The impact of IT application on bank performance: Abaenewe et al. (2013), Van et al. (2015), Alam et al. (2016), Mahboub (2018), Hani & Zouhour (2018), Amos et al. (2020), Demaki et al. (2021), Maseko & Kalama (2022), Raymond et al. (2022), Prabodhi & Buddhika (2022), Mamun et al. (2023), Abhay et al. (2023), Okolie & Eze (2023), Enoruwa et al. (2023).

2.6. Research Gaps

Through a review of previous studies, the dissertation identifies the following research gaps:

(1) Research gap on the impact of IT investment on the performance of commercial banks.

-First, previous studies often aggregate hardware and software investment costs into a single IT expenditure variable. This makes it difficult to separate and specifically assess the impact of each type of investment on the performance of commercial banks

-Second, no study has clearly explained why IT investment (including both hardware and software) may not yield the desired performance outcomes for commercial banks.

-Third, existing research has not considered the role of IT human resource infrastructure and IT technical infrastructure in influencing bank performance.

(2) Research gap on the impact of IT application on the performance of commercial banks.

-First, existing studies have not considered the internal IT application within banks (Core Banking, basic applications, and electronic payments), despite its crucial role in optimizing operational processes and enhancing performance.

-Second, no research has evaluated the impact of IT human resource infrastructure and IT technical infrastructure on the performance of commercial banks when implementing IT applications.

-Third, many studies rely on primary data from user surveys and dummy variables (0-1) to measure the impact of E-banking. This approach fails to accurately reflect the specific impact of each E-banking service on bank performance.

CHAPTER 3. RESEARCH METHODS

3.1. Research Hypotheses

Research hypotheses proposed for Model 1:

H1-1: Hardware investment has a positive impact on ROA.

H1-2: Software investment has a positive impact on ROA.

H1-3: IT human resource infrastructure has a positive impact on ROA.

H1-4: IT technical infrastructure has a positive impact on ROA.

H1-5: Hardware investment has a positive impact on ROE.

H1-6: Software investment has a positive impact on ROE.

H1-7: IT human resource infrastructure has a positive impact on ROE.

H1-8: IT technical infrastructure has a positive impact on ROE.

Research hypotheses proposed for Model 2:

H2-1: Internal IT application within banks has a positive impact on ROA.

H2-2: Online banking service application has a positive impact on ROA.

H2-3: The transaction value of credit and debit cards has a positive impact on ROA.

H2-4: Internal IT application within banks has a positive impact on ROE.

H2-5: Online banking service application has a positive impact on ROE.

H2-6: The transaction value of credit and debit cards has a positive impact on ROE.

3.2. Research Model

Model 1: This model is used to evaluate the impact of IT investment on the performance of Vietnamese commercial banks

$$Y_{it} = \alpha + \beta_1 Y_{it-1} + \beta_2 \mathrm{HITA}_{it} + \beta_3 \mathrm{SITA}_{it} + \beta_4 \mathrm{HTNL} + \beta_5 \mathrm{HTKT} + \beta_6 \mathrm{TLTA}_{it} + \beta_7 \mathrm{OER}_{it} + \beta_8 \mathrm{SIZE}_{it} + \beta_9 \mathrm{INF}_t + \beta_{10} \mathrm{GDP}_t + \mu_{it}$$

Model 2: This model is used to evaluate the impact of IT application on the performance of Vietnamese commercial banks

$$Y_{it} = \alpha + \beta_1 Y_{it-1} + \beta_2 \text{UDCNTTNB}_{it} + \beta_3 \text{DVTT}_{it} + \beta_4 \text{Card\_Trans\_Val} + \beta_5 \text{HTNL} + +\beta_6 \text{HTKT}_{it} + \beta_7 \text{TLTA}_{it} + \beta_8 \text{OER}_{it} + \beta_9 \text{SIZE}_{it} + \beta_{10} \text{INF}_t + \beta_{11} \text{GDP}_t + \mu_{it}$$

Variable	Meaning	Data Source
ROA	Return on Assets	Audited Financial statements of Vietnamese commercial banks
ROE	Return on Equity	Audited Financial statements of Vietnamese commercial banks
HITA	Hardware Investment	Audited Financial statements of Vietnamese commercial banks
SITA	Software Investment	Audited financial statements of Vietnamese commercial banks
HTNL	Information Technology Human Resource Infrastructure	ICT Readiness Index Report for Development and Application
HTKT	Information Technology Technical Infrastructure	ICT Readiness Index Report for Development and Application

UDCNTTNB	Internal Information Technology Applications in Banks	ICT Readiness Index Report for Development and Application
DVTT	Online Banking Services Applications	ICT Readiness Index Report for Development and Application
Card_Trans_Val	Transaction Value of Payments Made via Debit and Credit Cards	Annual Reports of Vietnamese Commercial Banks
TLTA	Loan-to-Total-Asset Ratio	Audited financial statements of Vietnamese commercial banks
OER	Operating Cost-to-Total-Asset Ratio	Audited financial statements of Vietnamese commercial banks
SIZE	Bank Size	Audited financial statements of Vietnamese commercial banks
INF	Annual Inflation Rate	IMF
GDP	Annual Economic Growth Rate	IMF

CHAPTER 4. RESEARCH RESULTS AND DISCUSSION

4.1. Discussion of Research Results - Model 1

- *Regression results with SGMM (ROA) - Model 1*

- The variable HITA, representing the ratio of hardware investment to total assets, has a negative regression coefficient (-3.265701) at a 5% significance level. This indicates that hardware investment has a negative impact on ROA of Vietnamese commercial banks during the period 2013–2023. However, the regression coefficient of the variable L.ROA (one-period lag of ROA) is positive (+0.8437413) and statistically significant at the 1% level, suggesting that the effectiveness of hardware investment may not be immediate but requires a certain time lag to take effect.

- The variable SITA, representing the ratio of software investment to total assets, has a negative regression coefficient (-0.9224415) at a 5% significance level. This implies that software investment negatively impacts ROA of Vietnamese commercial banks during the period 2013–2023. However, the regression coefficient of the variable L.ROA (one-period lag of ROA) is positive (+0.8437413) and statistically significant at the 1% level, indicating that the benefits of software investment may not be immediate but require a certain time lag to materialize.

- The variable HTNL, representing IT human resource infrastructure, has a negative regression coefficient (-0.009) at a 1% significance level. This indicates that IT human resource infrastructure negatively impacts ROA of Vietnamese commercial banks during the period 2013–2023. However, the regression coefficient of the variable L.ROA (one-period lag of ROA) is positive (+0.8437413) and statistically

significant at the 1% level, suggesting that the benefits of IT human resource infrastructure investment may not be immediate but require a certain time lag to take effect.

- The variable HTKT, representing IT technical infrastructure, has a negative regression coefficient (-0.6059735) at a 5% significance level. This implies that IT technical infrastructure negatively affects ROA of Vietnamese commercial banks during the period 2013–2023. However, the regression coefficient of the variable L.ROA (one-period lag of ROA) is positive (+0.8437413) and statistically significant at the 1% level, indicating that the effectiveness of IT technical infrastructure investment may not be realized immediately but requires a certain time lag to materialize.
- The variable OER, a control variable representing the operating expenses-to-total-assets ratio, has a positive regression coefficient (+37.51451) at a 1% significance level. This indicates that operating expenses relative to total assets have a positive impact on ROA of Vietnamese commercial banks during the period 2013–2023
- The variable TLTA is not statistically significant at the 1%, 5%, or 10% significance levels during the 2013–2023 period. This suggests that the loan-to-total-assets ratio does not have a significant impact on ROA of Vietnamese commercial banks.
- During the research period 2013–2023, the variable SIZE is not statistically significant at the 1%, 5%, or 10% significance levels. This suggests that bank size does not have a significant impact on the ROA of Vietnamese commercial banks.
- The variable INF, a control variable, has a negative regression coefficient (-0.0757215) at a 1% significance level. This indicates that

the inflation rate has a negative impact on ROA of Vietnamese commercial banks during the period 2013–2023

- The variable GDP, a control variable, has a negative regression coefficient (-0.0486357) at a 1% significance level**.** This suggests that economic growth has a negative impact on ROA of Vietnamese commercial banks during the period 2013–2023.

- *Regression results with SGMM (ROE) - Model 1*

- The variable HITA, representing the ratio of hardware investment to total assets, has a negative regression coefficient (-29.6784) at a 1% significance level. This indicates that hardware investment has a significantly negative impact on ROE of Vietnamese commercial banks during the period 2013–2023. However, the regression coefficient of the variable L.ROE (one-period lag of ROE) is positive (+0.530622) and statistically significant at the 1% level, suggesting that the benefits of hardware investment may not be realized immediately but require a certain time lag to take effect. This implies that in the long run, hardware investments can contribute positively to a bank's financial performance when effectively utilized and synchronized with other factors.

- The variable SITA, representing the ratio of software investment to total assets, has a negative regression coefficient (-15.46082) at a 1% significance level. This suggests that software investment has a significantly negative impact on ROE of Vietnamese commercial banks during the research period. However, the regression coefficient of the variable L.ROE (one-period lag of ROE) is positive (+0.530622) and statistically significant at the 1% level, indicating that the benefits of software investment may not be immediate but require a certain time

lag to materialize. This lag may be related to the time required for implementation, integration, and operation of software systems.

- The variable HTNL, representing IT human resource infrastructure, has a negative regression coefficient (-9.94246) at a 1% significance level. This indicates that IT human resource infrastructure has a significantly negative impact on ROE of Vietnamese commercial banks during the research period. However, the regression coefficient of the variable L.ROE (one-period lag of ROE) is positive (+0.530622) and statistically significant at the 1% level, suggesting that the benefits of IT human resource infrastructure may not be realized immediately but require a certain time lag to take effect. This may reflect the time required for training and implementing IT human resource infrastructure, allowing personnel to familiarize themselves with and effectively operate technological systems.

- The variable HTKT, representing IT technical infrastructure, has a negative regression coefficient (-3.5245) but is not statistically significant. This indicates that IT technical infrastructure does not have a significant impact on the ROE of Vietnamese commercial banks during the period 2013–2023.

4.2. Discussion of Research Results - Model 2

- *Regression results with SGMM (ROA) - Model 2*

  - The variable UDCNTTNB, an independent variable representing the level of internal IT application within banks, has a positive regression coefficient (+0.8047162) at a 1% significance level. This indicates that internal IT application has a significant positive impact on performance, as measured by ROA, of Vietnamese commercial banks during the period 2013–2023.

- The variable DVTT, an independent variable representing the level of online banking service application, has a positive regression coefficient (+0.6128069) at a 1% significance level. This suggests that the implementation of online banking services, such as Internet Banking and Mobile Banking, has a significant positive impact on performance, as measured by ROA, of Vietnamese commercial banks during the period 2013–2023.

- The variable Card_Trans_Val, an independent variable representing the transaction value of credit and debit cards, has a positive regression coefficient (+2.277832) at a 1% significance level. This indicates that the transaction value of credit and debit cards has a significant positive impact on performance, as measured by ROA, of Vietnamese commercial banks during the period 2013–2023.

- The variable HTNL, a control variable representing IT human resource infrastructure, has a negative regression coefficient (-0.2932962) at a 1% significance level. This indicates that IT human resource infrastructure has a significant negative impact on performance, as measured by ROA, of Vietnamese commercial banks during the period 2013–2023. However, the regression coefficient of the lagged variable L.ROA (one-period lag of ROA) is positive (+0.8762423) and statistically significant at the 1% level, suggesting that the benefits of investing in IT human resource infrastructure may not be immediate but require a certain time lag to materialize.

- The variable HTKT, a control variable representing IT technical infrastructure, has a negative regression coefficient (-2.093434) at a 1% significance level. This suggests that IT technical infrastructure

has a significant negative impact on performance, as measured by ROA, of Vietnamese commercial banks during the period 2013–2023. However, the regression coefficient of the lagged variable L.ROA is positive (+0.8762423) and statistically significant at the 1% level, indicating that the benefits of IT technical infrastructure investment may require a certain time lag to take effect.

- The variable OER, a control variable representing the operating expenses-to-to-total-assets ratio, has a positive regression coefficient (+24.858) at a 1% significance level. This indicates that operating expenses relative to total assets have a significant positive impact on performance, as measured by ROA, of Vietnamese commercial banks during the period 2013–2023.

- The variable TLTA, a control variable representing the loan-to-total-assets ratio, has a negative regression coefficient (-0.3134467) at a 1% significance level. This suggests that the loan-to-total-assets ratio has a significant negative impact on performance, as measured by ROA, of Vietnamese commercial banks during the period 2013–2023.

- Bank size (SIZE) is an important variable in analyzing bank performance. Size can be measured by total assets. The variable SIZE, a control variable representing bank size, has a positive regression coefficient (+0.008332) but is not statistically significant at the 1%, 5%, or 10% significance levels. This indicates that bank size does not have a significant impact on performance, as measured by ROA, of Vietnamese commercial banks during the period 2013–2023.

- The variable INF, a control variable representing the inflation rate, has a negative regression coefficient (-0.0982447) at a 1% significance level. This suggests that inflation has a significant negative impact on performance, as measured by ROA, of Vietnamese commercial banks during the period 2013–2023.

- The variable GDP, a control variable representing economic growth, has a negative regression coefficient (-0.0586745) at a 1% significance level. This indicates that economic growth has a significant negative impact on performance, as measured by ROA, of Vietnamese commercial banks during the period 2013–2023. This result contradicts the expectation that economic growth would have a positive effect on performance.

- *Regression results with SGMM (ROE) - Model 2*

- The variable UDCNTTNB, an independent variable representing the level of internal IT application within banks, has a positive regression coefficient (+7.575567) at a 1% significance level. This indicates that internal IT application has a significant positive impact on performance, as measured by ROE, of Vietnamese commercial banks during the period 2013–2023. The result is consistent with the expectation that internal IT applications help optimize operational processes, improve internal management efficiency, and thereby enhance performance.

- The variable DVTT, representing the application of online banking services, has a positive regression coefficient (+6.233519) at a 1% significance level. This suggests that the application of online banking services has a significant positive impact on performance, as measured by ROE. The result aligns with the expectation that providing online

services, such as Internet Banking or Mobile Banking, enhances customer experience and improves operational efficiency.

- The variable Card_Trans_Val, representing the transaction value of credit and debit cards, has a positive regression coefficient (+57.5572) at a 1% significance level. This indicates that the transaction value through credit and debit cards has a significant positive impact on performance, as measured by ROE.

- The variable HTNL, a control variable representing IT human resource infrastructure, has a negative regression coefficient (-2.60128) at a 1% significance level. This indicates that IT human resource infrastructure has a significantly negative impact on performance, as measured by ROE, of Vietnamese commercial banks during the period 2013–2023.

- The variable HTKT, a control variable representing IT technical infrastructure, has a negative regression coefficient (-28.8139) at a 1% significance level. This suggests that IT technical infrastructure has a significantly negative impact on performance, as measured by ROE, of Vietnamese commercial banks during the period 2013–2023.

However, the regression coefficient of the lagged variable L.ROE (one-period lag of ROE) is positive (+0.6035932) and statistically significant at the 1% level, suggesting that the benefits from investing in IT human and technical infrastructure may not be immediate but require a certain time lag to materialize.

CHAPTER 5. CONCLUSION AND POLICY IMPLICATIONS

5.1. Conclusion

5.1.1. Model 1 - The Impact of IT Investment on the Performance of Vietnamese Commercial Banks

All IT investment factors (hardware, software, human resources, and technical infrastructure) have a negative impact on performance in the short term, primarily due to high initial investment costs and prolonged integration periods. However, with the support of the lagged variables L.ROA and L.ROE, the study confirms that these investments will yield positive results in the long term when systems are implemented in a coordinated manner and operated smoothly. At the same time, control factors such as operating expenses (OER), loan-to-total-assets ratio (TLTA), bank size (SIZE), inflation rate (INF), and economic growth (GDP) also play an important role in affecting performance. Properly managed operating expenses have a clear positive impact, optimizing the use of assets and equity. On the other hand, a high loan-to-asset ratio increases credit risk and reduces operational efficiency, while bank size only affects performance when measured by ROE, emphasizing the importance of effective asset and resource management. Macroeconomic variables such as inflation and economic growth have negative impacts, increasing operational costs and creating competitive pressure. This highlights that banks need not only a well-planned, long-term, and coordinated IT investment strategy, but also focus on cost management, credit risk control, effective utilization of economies of scale, and the development of flexible strategies to cope with macroeconomic fluctuations in order to optimize performance.

5.1.2. Model 2 - The Impact of IT Application on the Performance of Vietnamese Commercial Banks

The study indicates that IT application factors, including internal IT application within banks (UDCNTTNB), online banking services (DVTT), and the transaction value through credit and debit cards (Card_Trans_Val), all have a significant positive impact on performance, as measured by both ROA and ROE**.** These factors are crucial drivers for improving the performance of Vietnamese commercial banks, especially in the context of the accelerating digital transformation. However, control factors such as the loan-to-asset ratio, bank size, operating expenses, and the macroeconomic environment also play an important role, requiring banks to have appropriate management strategies

5.2. Policy implications

5.2.1. Policy implications for Vietnamese commercial banks

- Commercial banks need to develop a long-term IT investment strategy, focusing on ensuring coordination between hardware, software, and IT human resources. This includes clearly planning each investment phase and integrating technological elements to optimize value.

- Commercial banks need to increase investment in online services (Internet Banking, Mobile Banking) and cashless payments (credit cards, debit cards, e-wallets). This not only improves performance but also meets customer demands in the context of digital transformation.

5.2.2. Policy Implications for the State Bank of Vietnam

- The State Bank of Vietnam (SBV) needs to develop specific policy frameworks to guide and support banks in their digital transformation process, such as tax incentives for IT investment, providing financial or preferential credit support packages for technology implementation

- The SBV needs to establish technical and security standards for internal IT systems and online services, ensuring consistency, security, and efficiency across the entire banking system

5.3. Limitations of the study and future research directions

5.3.1. Limitations of the study

- The data used in this dissertation only includes Vietnamese commercial banks during the period 2013–2023, with a limited number of banks and a restricted study period. This may limit the generalizability of the research findings, especially when applied to banks in other countries or in different economic contexts.
- The study focuses on the direct impact of IT investment and application on performance but has not fully analyzed indirect impacts, such as the effect of IT on customer experience, service innovation, or risk management efficiency

5.3.2. Future research directions

- Future research should expand both spatially and temporally, including banks from other countries to compare the impact of IT in different contexts. Expanding the research period would also provide a more comprehensive assessment of the long-term effects of IT investment and application.
- The next research direction could focus on the indirect impacts of IT, such as how IT improves customer experience, reduces operational risks, and drives service innovation in banking.