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INNOVATION AND BANK PERFORMANCE IN THE DIGITAL TRANSFORMATION ERA: EVIDENCE FROM VIETNAM

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ARTICLE INFO	ABSTRACT
	The number of smartphone users in Vietnam ranked 10th globally in 2020, and Vietnam is considered a high-growth digital economy market in Southeast Asia. Thus, this study examines the impacts of innovations in mobile banking applications (MBA) and research and development (R&D) costs on bank performance. We employ the dynamic system Generalized Method of Moments (GMM) to analyze 35 commercial banks in Vietnam from 2009 to 2020. Our findings show that innovations and application software positively impact banks' net interest margin (NIM). Applied mobile banking increased by 0.012% in NIM, and R&D costs empowered 0.011% of the bank's performance in Vietnam. The robustness test confirms that our main findings are persistent. The result highlights a new perspective on innovation that can help banks seize business opportunities more effectively. Our findings also offer practical implications for promoting a sustainable banking sector.

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1. Introduction

Investors and managers primarily focus on analyzing ROA and ROE to assess the performance of commercial banks. In the past decade, Sujud Hiyam (2017), Rahman et al. (2015), and Isshaq et al. (2019) state that NIM has been considered a measure that reflects banks' nature and operating status. Researchers have extensively studied the factors that influence the performance of commercial banks in the digital age. Technological advancements have intensified competition within the banking industry, particularly in digital banking. Although digital banking is used across all product services, it significantly impacts the customer interface. Abualloush et al. (2017) and Mbama and Ezepue (2018) understand that digital banking impacts financial performance, especially for customer segments. Saad and El-Moussawi (2012) pointed out that seven factors affect NIM, and this study explores the profound impact of innovation on banks.

Innovation propels a nation's development, particularly when fostering the transformation and growth of emerging economies (Brown et al. (2009). Since banks have traditionally dominated the contemporary economic and financial system, encouraging vitality and enhancing innovation effectiveness is crucial for fostering high-quality economic growth (Liang et al., 2013). The primary elements influencing bank innovation were examined from a variety of angles. Innovation can empower commercial banks to expand service alternatives, meet the different needs of consumers, and expand their growing space, enhancing their profitability (Gomber et al., 2017). Regarding risk management, innovation can utilize modern technology, like biometrics and speech recognition, to minimize labor, capital, and time expenses to increase data accuracy, hence reducing internal fraud risk and systemic risk (Berg et al., 2022).

Additionally, innovation can be combined with banks' loan services to reduce information asymmetry between banks and borrowers, making institutions safer and more flexible (Gomber et al., 2017) and lowering the likelihood of borrowers defaulting. Thus, innovation may reduce the risk-taking of commercial banks and increase their profits. Existing research must provide a definitive solution to how innovation affects a bank's performance.

Applying digital technology can significantly enhance personal, business, and operational behaviors, leading to a digital transformation of individuals and enterprises (Abdulquadri et al., 2021). Specifically, digital transformation is a process that improves an entity by modifying its attributes significantly using a combination of information, computation, communication, and networking technologies (Vial, 2019). This concept demonstrates that the application of current technology can drastically alter the business activities of organizations undergoing digital transformation. Since the idea of digital transformation has been introduced, it makes sense for organizations to modify and diversify their operational techniques. Larger banks quickly adopt new technology since they have the requisite resources, skills, dedication, and knowledge of digital opportunities (Dimelis et al., 2017). Do et al. (2022) suggest that the larger the scale of commercial banks in Vietnam, the more digital transformation will positively impact the performance. The digital transformation of retail banking has encountered numerous obstacles. The expansion of infrastructure, technology, and workflow in the direction that everything goes towards online and industrialized models is necessary for digital transformation.

Vial (2019) explains that digital transformation uses information, computer, communication, and networking technologies to enhance an entity's qualities. This definition

clarifies how digital transformation may revolutionize businesses using modern technological advances. When digital transformation is advocated, corporate operations may change and diversify. Do et al. (2022) emphasize the importance of digital transformation in improving commercial bank performance and discuss the aspects that make it effective. Digital transformation enhances productivity, innovation, customer satisfaction, and cost savings, improving profitability and market share.

Previous research has established a clear correlation between the employment of mobile banking and a bank's net interest margin. Mutua (2013), Evian et al. (2021), and Njiru (2014) confirm a significant connection between the financial success of commercial banks and the revenue generated through Internet and mobile banking. Vanderpal (2015) indicates that investment in research and software development can also positively impact a bank's net interest margin (Vanderpal, 2015). Therefore, Li et al. (2019) study that government support for research and development (R&D) in innovation has a positive effect on banks' performance in the Chinese market Li et al. (2019).

In a highly dynamic and risk-laden industry, a successful innovation can give a bank a distinctive competitive edge, leading to superior financial performance. Given the apparent importance of financial innovation in shaping banking outcomes, there are two compelling reasons to investigate the impact of innovation on financial performance. First, several things need to be clarified about the factors that drive innovation and how it affects financial performance. Many studies on innovation performance only take a simplistic approach and fail to consider the factors contributing to innovation both within and outside the banking institution. Kamau and Oluoch (2016) show that ATMs, credit cards, and debit cards issued by the bank or the agents banks

affect bank performance. Akhisar et al. (2015) explain that electronic banking services affect bank performance. This research explores how investments in digital products and software and research on mobile banking through MBA. Most previous studies have not considered the possibility of a reverse causal relationship between innovation and financial performance. We include innovation homogeneity as a predictor of financial performance.

The motivation for this study is predicated upon the dynamic and burgeoning landscape of technology and mobile device adoption in Vietnam, an emergent Asian nation. With technology ubiquity on a trajectory parallel to global trends, Vietnam distinguishes itself as a significant player within Southeast Asia, particularly in the mobile technology sphere. It ranks among the top three countries in the region for the fastest-growing smartphone market, boasting a smartphone penetration rate of 40% as of 2015. The rapid integration of smartphones into daily life presents an unparalleled opportunity for the banking sector to innovate and expand its services through mobile banking platforms. Furthermore, data from the World Bank (2019) underscores a substantial disparity in the accessibility of banking services, with a ratio of 25.904 ATMs to 3.983 bank branches per 100.000 individuals. This imbalance further highlights the potential for mobile banking to bridge the gap in banking access. Additionally, Dinh et al. (2015) corroborate the significant influence of innovation on the efficiency of banking services in Vietnam. Our study seeks to explore the implications of these developments on mobile banking adoption, aiming to contribute to the understanding of technological adaptation in the banking sector within rapidly evolving markets like Vietnam.

Our study is unique because of the following ways. We similarly employ Return on Assets (ROA) and Return on Equity (ROE) as

performance metrics following to Akhisar et al. (2015). However, we contribute novel insights by integrating Net Interest Margin (NIM) into our analytical framework, providing a more comprehensive assessment of banking operations' outcomes. Our research endeavors to extend beyond the unidimensional analysis of previous studies by exploring the multidimensional and heterogeneous effects of MBA and R&D expenditures across various banking power proxies. Specifically, we add the interaction variable between Debt credit, Debt ratio, Loan, Capitalization, and Operating cost to evaluate the moderating effect of MBA and R&D costs on the financial performance of banks. This allows us to investigate whether and how the strategic allocation of resources to MBA and R&D initiatives can influence banking efficiency and profitability. Our study aims to elucidate the complex relationships between investment in technological advancements and financial performance metrics. The anticipated outcome of this research is to demonstrate that investments in MBA and R&D are not only associated with enhanced performance but are indeed critical levers for the improvement and competitiveness of banks in the fast-evolving financial landscape of Vietnam.

We collect data from 35 commercial banks in Vietnam from 2009 to 2020. To estimate the impacts of innovations on bank performance, we employ estimation methods of the Ordinary Least squares (OLS) and the dynamic system Generalized Method of Moments (GMM). We further test whether our findings are robust across the bank's performance determinants. The robustness test confirms that our main findings are persistent in all subsamples.

Our research findings highlight the significant benefits of progressively adopting mobile banking applications and replacing traditional banking operations with advanced software systems. A key outcome revealed in our study is the reduction of marginal operating costs, which maximizes revenues for banks. Banks can streamline their processes by leveraging sophisticated software solutions, automating routine tasks, improving operational efficiency, and reducing expenses associated with manual labor and outdated systems. Moreover, our research demonstrates that investments in software technologies have a dual effect on bank performance. While they may initially entail upfront costs, the subsequent outcomes are highly favorable. By embracing innovative software solutions, banks can increase their income through improved customer experiences, enhanced product offerings, and expanded market reach. Simultaneously, these investments enable banks to optimize their internal operations, leading to cost savings in various areas, such as personnel, infrastructure, and maintenance. A key aspect emphasized in our research is the importance of effectively managing MBA and R&D costs to align resources with efficiency objectives. By strategically controlling these expenses, banks can balance innovation and operational effectiveness. Banks entail adopting cost-effective approaches to MBA implementation, optimizing research and development activities, and continually assessing the return on investment generated by these initiatives.

Our research underscores the value of embracing technological advancements, mainly through the progressive adoption of MBA and robust software systems. Banks can experience a notable boost in their performance metrics, including increased revenues, reduced costs, improved efficiency, and enhanced competitiveness in the dynamic banking landscape. Our research is divided into the following sections. Section 2 covers the literature review, section 3 explains the data and methodology, section 4 presents the empirical results and discussions, and section 5 concludes the research.

2. Literature reviews

2.1. Theoretical framework

Porter (1996) places productivity enhancement as the central goal of a nation's strategy. Competitive advantage theory emphasizes that innovation, while often considered revolutionary breakthroughs, primarily comprises incremental and continuous improvements rooted in accumulating small discoveries and technological advancements over time. Through these ongoing acts of innovation, companies can attain a competitive advantage in the market. Building upon Porter's ideas, our research delves into the realm of bank performance and aims to examine the profound influence of innovation on this crucial aspect of the financial sector. By conducting a comprehensive analysis, we seek to validate and further elucidate the competitive theory of the banking industry. Through this study, we aim to shed light on how different types and levels of innovation impact a bank's performance, thereby providing valuable insights for practitioners and policymakers in shaping effective strategies for sustained success in the banking sector.

Recent research in the field has provided additional insights into the relationship between innovation and bank performance, further bolstering the importance of this topic. Several notable studies have emerged, shedding light on various aspects of innovation within the banking industry. Adopting digital technologies significantly improved efficiency, satisfaction, and financial performance for banks (Smith & Beretta, 2021). The finding highlights technological advancements' growing significance and transformative potential within the banking sector. Lin et al. (2022) indicated that product innovation (such as developing new financial products or services) and process innovation (such as improved operational procedures) positively influenced

bank performance. The study emphasized the importance of adopting a comprehensive approach to innovation, considering multiple dimensions to maximize the benefits for banks.

The resource-based view theory posits that a company's resources and abilities are fundamental for achieving exceptional performance. Santos and Winton (2019) confirm the innovation profile of sustainable firms and its impact on economic performance, affirming that innovation indeed contributes to performance. However, the assertion that innovation inherently creates a competitive advantage needs empirical validation. These collective studies underscore the critical role of resources and capabilities, particularly innovation, in steering the performance trajectory of banks.

The theory of diversification proposes that expanding income sources can mitigate income volatility and enhance the overall performance of banks (Vyadrova & Severina, 2022). Similarly, Adesina (2021) highlighted income diversification's positive and substantial influence on bank performance, advocating that branching into non-lending activities could bolster financial outcomes. Furthermore, exploring the role of human capital efficiency in moderating the relationship between diversification and bank performance, Li and Song (2021) found that higher human capital efficiency positively correlates with bank performance and helps counterbalance the performance-reducing effects of diversification. While diversification emerges as a potentially effective strategy for improving bank performance, its specific impacts may vary based on contextual factors like human capital efficiency.

Collectively, these recent studies reinforce the notion that innovation plays a pivotal role in shaping bank performance. From adopting digital technologies to embracing diverse

innovation types and fostering an innovative culture, banks can gain substantial competitive advantages by prioritizing and effectively implementing innovative practices. Our research aims to contribute to this growing body of knowledge by providing further insights and empirical evidence on the impact of innovation on bank performance, adding to the richness of contemporary research in this area.

2.2. Mobile banking affects the net interest margin

This study examines how mobile banking affects bank performance, specifically in net interest margin. Recent mobile hacking incidents call for Vietnamese banks to adopt mobile banking applications for better business prospects. Evian et al. (2021) find that MBA positively impacts the NIM of banks. Banks can improve their financial performance by implementing focused marketing campaigns that track customer preferences

and investing in mobile banking. MBA can help achieve this by increasing operational efficiency. With a better understanding of customer needs, banks can reduce marketing costs and increase their net interest margin. Mobile banking can also reduce face-to-face transactions, which can lead to lower employee costs. Bagudu et al. (2017) confirm that mobile banking can increase customer loyalty and market share and reduce operating costs. Mobile banking positively affects financial performance by enabling banks to serve more customers in less time (Chalabi, 2020). Multiple studies support this positive relationship.

The goal of employing an MBA with ROA will have the reverse impact of making clients feel uneasy, uncomfortable, and in danger due to lax security Rubin and Smith (2009). The COVID-19 epidemic is complex; the government has strict regulations, and users have fewer options for accessing bank services. MBA is a common way to maintain

the relationship between customers and banks. The effect of MBA increases pressure on banks' net interest margins (NIM) and operational methods. The hypothesis develops.

Hypothesis 1 (H1): MBA negatively affects bank performance in Vietnam.

Hypothesis 2 (H2): MBA positively affects bank performance in Vietnam.

2.3. The R&D affects NIM

Financial institutions are using agile practices to improve their software development processes. Technology is transforming the finance industry, and adopting agile methodologies is one way financial institutions keep up. Vanderpal (2015) concludes that investing in R&D can significantly improve the performance of businesses, especially those in the financial industry. Khan et al. (2020) suggest commercial banks should introduce online banking services. Banks can benefit from investing more in software R&D, improving their understanding of market trends and enhancing operational performance. However, Molla and Rahaman (2022) find that high R&D costs may negatively impact net income and profit, leading to lower bank performance.

Hypothesis 3 (H4): R&D negatively affects bank performance in Vietnam.

Hypothesis 4 (H5): R&D positively affects bank performance in Vietnam.

3. Data and methodology

3.1. Data collection

The research collected financial and business information from 35 commercial banks in Vietnam, including details on MBA launches. The sources were verified and screened, guaranteeing a high level of precision.

Data presents the costs, including intangible fixed assets, cost application, equity, total assets, operating expenses, liabilities, loans,

and inflation. The debt ratio, debt credit, capitalization rate, and OC are calculated using the following formula in Appendix A. Because the MBA variable is a dummy variable, it will depend on how banks behave starting with the year they provide mobile banking apps. The application will have a value of 1 when it launches in 2020. However, 0 will be present the year prior if no mobile banking application exists.

3.2. Variable definitions

Table 1. Variable definition

Variables	Notation	Variable descriptions	Reference
Dependent variable			
Net interest margin	NIM	$\dfrac{\text{Net return on investment – Interest paid}}{\text{Average Assets}}$	Eng (2013)
Return on Asset	ROA	$\dfrac{\text{Net Income}}{\text{Average Assets}}$	Bagudu et al. (2017)
Return on Equity	ROE	$\dfrac{\text{Net Income}}{\text{Average Equity}}$	Bagudu et al. (2017)
Independence variables			
Mobile banking app	MBA	Has MBA =1 and no has= 0	Bagudu et al. (2017);
R&D software	COST_APP	Cost for intangible assets	Vanderpal (2015)
Control variables			
Debt credit	Debt_credit	$\dfrac{\text{Doubtful debts}}{\text{Total loans issued}}$	Hamadi and Awdeh (2012)
Debt ratio	Debt_ratio	$\dfrac{\text{Total debts}}{\text{Total equity}}$	Pradhan et al. (2017)
Loan	Loan	$\dfrac{\text{Loans}}{\text{Deposit}}$	Hamadi and Awdeh (2012)
Capitalization	CAP	$\dfrac{\text{Equity}}{\text{Total asset}}$	Doyran (2013)
Operating cost	OC	$\dfrac{\text{Operating expenses}}{\text{Net revenue}}$	Hamadi and Awdeh (2012)

Note: *Appendix A defines in-use dependent, independent, and control variables.*

The study hypothesizes that innovation using MBA and investment in research and software development will positively impact bank performance (Sujud Hiyam, 2017). Research and decisions in banking innovations positively affect commercial banks' profitability (NIM) because they think that when innovating with technology will reduce operating costs, product scale can be easily expanded by advertising on social networks. In addition, customers can quickly access products at the highest security level (Oyewole et al., 2013). In contrast, Gaudio et al. (2021) argue that extraordinary returns decrease when innovations are widely adopted. In the 1970s, when banks and non-financial corporations appeared in many regions, most relied on operating goals related to earnings per share (EPS) to evaluate the performance of the business. Investors seem aware of the change in ROA because ROA growth better explains the stock market value of (non-financial) banks (Sujud Hiyam, 2017). Over the decades in recent centuries, Eng (2013) indicated NIM and NON_NIM, which are also indicators that fully represent the performance of banks. Methodologically, some of the above measures are disproportionate across banks. ROA and ROE ratios all show a percentage of total assets, while NIM is the percentage difference between interest income and interest expense payable to a bank. It clearly shows the bank's characteristics and operations and whether its business is doing well. We sum up all of the costs associated with creating bank software, including designing, coding, testing, and upgrades, to calculate the R&D software costs, following Vanderpal (2015). We collect in the annual financial reports of Vietnamese banks under the section detailing intangible assets.

3.3. Empirical Models Construction

We use models to examine the relationship between independent variables and bank performance by employing standard regression such as Pooled Ordinary Least Square (OLS), Random Effects Model (REM), Fixed Effects Model (FEM), and Generalized Least Square (GLS). Model (1) is the Generalized Method of Moments (GMM) specification, including MBA and Cost app for Net Interest Margin.

$$\begin{aligned} NIM_{it} = & \beta_0 + \beta_1 MBA_{it} + \beta_2 DEBTCREDIT_{it} \\ & + \beta_3 DEBTRATIO_{it} + \beta_4 CAP_{it} + \beta_5 OC_{it} + \\ & \beta_6 LOAN_{it} + \beta_7 INF_{it} + \alpha_i + \alpha_t + \varepsilon_{i,t} \end{aligned} \quad (1)$$

Then we test on COST_APP in model (2), which stands for research and development of the application.

$$\begin{aligned} NIM_{it} = & \beta_0 + \beta_1 COSTAPP_{it} + \\ & \beta_2 DEBTCREDIT_{it} + \beta_3 DEBTRATIO_{it} + \\ & \beta_4 CAP_{it} + \beta_5 OC_{it} + \beta_6 LOAN_{it} + \beta_7 INF_{it} + \\ & \alpha_i + \alpha_t + \varepsilon_{i,t} \end{aligned} \quad (2)$$

In model (3), we put MBA and COSTAPP in the model.

$$\begin{aligned} NIM_{it} = & \beta_0 + \beta_1 MBA_{it} + \beta_2 COSTAPP_{it} \\ & + \beta_3 DEBTCREDIT_{it} + \beta_4 DEBTRATIO_{it} \\ & + \beta_5 CAP_{it} + \beta_6 OC_{it} + \beta_7 LOAN_{it} + \beta_8 INF_{it} \\ & + \alpha_i + \alpha_t + \varepsilon_{i,t} \end{aligned} \quad (3)$$

We test the robustness of model (1) by using alternative risk indicators with ROA and ROE.

The methodology is based on Maudos and De Guevara (2004) model and Claeys and Vander Vennet (2008). The model comprises factors that theoretically affect the net interest margin, consisting of operating cost (OC), cost for software and app (COST_ APP), the birth time of the mobile banking app (MBA), capitalization (Cap), debt credit, debt ratio, inflation, loan. The model also incorporates the macroscopic variables of economics.

3.4. Estimation methods

Our study uses the standard estimation method of Pooled Ordinary Least Square (OLS), Fixed Effects Model (FEM), and Random Effects Model (REM). We also apply the Hausman, Breusch-Pagan, and

Redundant Test to select the most appropriate analysis estimation. However, Greene (2005) has proven that standard estimations such as OLS, FEM, and REM carry asymptotic inefficiency and heterogeneity, significantly affecting the results. Hence, we are replacing these estimation methods with Generalized Least squares (GLS) to ensure our results are consistent. However, Lahouel et al. (2019) document that Generalized Least squares (GLS) still carry endogeneity biases, and this can be addressed by using the Generalized Method of Moments (GMM). Recent studies suggest using the GMM framework in the banking industry, including Hamdi et al. (2017) and Vo (2018). Therefore, we can control endogeneity and unobserved heterogeneity by applying GMM to our study. GMM can also reduce omitted bias problems and eliminate autocorrelation issues. In addition, GMM is distinctive in controlling measurement error issues. Hence, we employ the two-stage system GMM to examine the influence of management competence risk.

4. Empirical Results

4.1. Descriptive statistics

The descriptive statistics of the research sample (*see Appendix 1 online*). The average NIM of the banking industry in the sample is 1.6%, indicating that banks have an average spread of the cost of funding, and borrowers' charge is 1.6% over the total assets. The highest value is 7.4%, and the lowest is 0.1%, with a standard deviation of 1.1%. This finding is similar to Nguyen (2020). The cost for software and application (COST_APP) ranges from 9.323 to 12.027, with an average value of 10.813 and a standard deviation of around 0.653. The mobile banking application (MBA) is a binary dummy variable, which indicates the chairholders' birth time of the app (Yes for 1; No for 0).

The sample covers 35 commercial banks for the period 2009 – 2020. The data consists of 297 bank-year observations. The dependent variable is the net interest margin (NIM). The independent variables are mobile banking app (MBA), cost for software and app (COST_APP), capitalization (CAP), debt credit, debt ratio, inflation (INF), and loan.

4.2. Pearson Correlation matrix

All the correlation coefficients are less than 0.6, indicating weak correlations between independent variables. The lowest correlation is approximately 0.01. The highest correlation between MBA and COSTAPP is 0.57, indicating a relatively strong positive relationship.

We conduct the VIF test to check for multicollinearity. VIF test confirms no multicollinearity with all values below five. Hence, we examine the variance inflation factor (VIF) to test the robustness of the correlation matrix. As shown in Appendix 2 online, the maximum value of VIF is 2.14, with an average value of 1.514. Therefore, collinearity is not a significant matter in our results because the VIF of all variables is less than five (Salihu et al., 2019).

4.3. Estimation Results from Fixed Effect Models

The estimation results of determining Vietnamese commercial banks' credit risk after employing required tests such as the Hausman, Breusch-Pagan, and Redundant Test (*see Appendix 3 online*). We are using the Fixed Effects Model (FEM). In this table, MBA positively impacts the bank's performance. This result is consistent with Mutua (2013) and Evian et al. (2021). Model 2 states a positive relationship between COST_APP and bank ROA. When applying more cost in developing software, it helps bank performance become better. The results from model 3 show that both MBA and COSTAPP support the operation of commercial banks in Vietnam. Finally, table 3 reports that R-squared ranges from

21.0% to 24.7%. It implied that the variation of independent factors explains up to 24.7% of variations of the dependent variable.

4.4. Estimation results from GMM

Finally, we employ several robustness checks to confirm that our baseline findings remain valid. Specifically, we use a two-stage system GMM to examine the determinants of other performance indicators. Based on Oginni et al. (2017), we use ROA and ROE to remeasure the impact of a bank's performance determinants. In Appendix 4 online, we assemble three models for each dependent variable.

Table 2. Robustness test results after employing alternative proxies of bank performance

VARIABLES	ROA	ROE	NIM
Variable	0.067***	0.176***	0.855***
Lag Dependent Variable (-1)	(0.0050)	(0.0067)	(0.0857)
MBA	0.007***	-0.016*	0.012***
	(0.0006)	(0.0086)	(0.0017)
COSTAPP	0.011***	0.045***	0.011***
	(0.0003)	(0.0077)	(0.0018)
Debtcredit	-0.243***	-2.230***	-0.223***
	(0.0179)	(0.2694)	(0.0283)
Debtratio	0.001	0.168***	0.014
	(0.0032)	(0.0415)	(0.0155)
CAP	0.001	0.357***	0.210***
	(0.0096)	(0.0540)	(0.0507)
OC	0.801***	2.620***	-0.867***
	(0.0510)	(0.6813)	(0.2745)
LOAN	-0.017***	0.186***	-0.001
	(0.0016)	(0.0285)	(0.0122)
INF	0.054***	0.278***	0.085***
	(0.0036)	(0.0437)	(0.0113)
Constant	-0.116***	-0.697***	-0.137***
	(0.0054)	(0.1037)	(0.0207)

Note: Table 2 presents the robustness test, which studied 35 Vietnamese commercial banks from 2009 to 2020. The alternative proxies of the dependent variable are ROA and ROE. The symbol ***, **, and * represents the significant level at 1%, 5%, and 10% respectively.

4.5. Discussion

Table 4 shows that mobile banking app has a positive impact on the net interest margin of banks in Vietnam, with a correlation coefficient of 1.3% and statistical significance of about 0%, which is consistent with the results of Evian et al.

(2021), Bagudu et al. (2017). The following three main reasons can solve it. Firstly, operating costs were almost done by transmitting much money, and there was no high efficiency when using MBA products encapsulated in client software that can be used for various experiences and

services simultaneously, saving staff costs. It can serve many customers at a time Chalabi (2020). The second is implementing targeted marketing campaigns based on tracking customer preferences. As a result, the bank's marketing costs will be reduced. Finally, when the MBA is expanded and at a high-quality level, customer loyalty can be enhanced, market share will be high, and operating costs will be reduced. This result does not match El-Chaarani and El-Abiad (2018). Because of some limitations, the bank needs a high level of human and financial investment and offers a low rate of return. While the acquisition of mobile banks reflects a high degree of modernization, the low level of security and high perceived risk on the part of the bank's customers lead to a reduction in its impact on the bank.

Model 3 documents that the investment in computer software (COST_APP) significantly impacts the net interest margin. Our finding suggests that a 1% increase in research and development costs leads to a 0.011% increase in NIM. This result shows that when banks invest in research and software development, they maximize profits while minimizing operating costs. Investing in software research helps banks understand customer preferences, have more opportunities, and better grasp market trends, thereby helping to have a good development orientation and improve operational efficiency Khan et al. (2020). This result is inconsistent with El-Chaarani and El-Abiad (2018) because they argue that investing in computer software can improve control systems and employee productivity without directly affecting banks' productivity, competitive advantage, and operational efficiency. More research and development in the products improve the service and workforce quality of the entire banking system. They indicated that the employee improves their understanding of the product and provides better consulting and customer service. Then, customers will

use more bank products, increasing the bank's performance. Our findings support hypothesis 4 and competitive advance theory, indicating a positive relationship between R&D Cost and bank performance in Vietnam.

The test results show a relationship between debt credit and net interest margin with the corresponding system of 22.3%. These results contradict those of Carbo-Valverde et al. (2009) because they argue that debt credit positively affects lending. The results agree with Hamadi and Awdeh (2012). This result can be explained by the main reasons that the bank lends easily and does not care about anticipating the bad debt risk that brings the risk of continuous increase to the projects.

The correlation coefficient between inflation and net interest margin is 8.5%, with a statistical significance of 0%. When savings deposits in banks at the beginning of the year are affected by inflation, the value of profits increases (Abaidoo & Anyigba, 2020). In addition, when banks lend back from that savings, it will be adjusted rapidly for inflation.

The relationship between net profit margin and capitalization (CAP) is positive and statistically significant, with a correlation coefficient of 21.0%, a relatively high correlation. Saad and El-Moussawi (2012) and El-Chaarani and El-Abiad (2018) also give test results showing the above positive relationship because, with high capitalization, banks can let more flexible activities in loans while allocating provision expenses appropriately. In addition, the high capitalization makes banks confident in high-interest loans containing many risks, thereby increasing the net profit margin.

The loan negatively correlates with the net interest margin, with a relatively small correlation coefficient of 0.1%. This result is consistent with Hamadi and Awdeh (2012). We find that credit risk is negatively related to bank profitability. Banks with high credit risk tend to

offer higher interest rates, encouraging people to deposit money in the bank so the interest earned is reduced. The finding contradicts the results of other studies, Carbo-Valverde et al. (2009) and Maudos and De Guevara (2004).

Marginal interest income is influenced by operating costs (OC). This conclusion is in line with Maudos and De Guevara (2004), Maudos and Solís (2009), Hamadi and Awdeh (2012), and Nguyen (2020). This result indicates that lending rates will likely rise if banks are not running efficiently due to high operational expenses. When banks increase operational costs by opening branches and hiring more workers, they take on additional risks, which they pass on to their clients through higher loan rates. Because of Vietnam's relatively new commercial banking system, operational expenses are essential in fostering development.

Debt ratio negatively correlates with net interest margin at a relatively small 0.1% level, consistent with Pradhan et al. (2017). The relationship can explain that when debt is too high, the interest from those debts will cause the interest earned to decrease, leading to a decrease in the net interest margin index.

The robustness test results in Table 5 show reliable results on the influence of the launch time of mobile banking apps on the determination of banks' net interest margins. Inconsistent results can be seen between all three models. The introduction of MBA mobile banks to supplement and gradually replace basic banking operations will reduce marginal operating costs, leading to maximizing profits. Evian et al. (2021), Bagudu et al. (2017), and Chalabi (2020) agree that the introduction of mobile banking apps will help improve the operational efficiency of banks according to model (3). The correlation coefficient is minimal in models (1) and (2), showing a negative effect. This result is consistent with El-Chaarani and El-Abiad (2018) because the bank needs a high

level of investment, human and financial, and offers low rates of return.

Regarding the COST_APP variable, the test results show statistical significance with the performance of banks according to models (1) and (3). The results are consistent with all three models and Vanderpal (2015). Investment in software increases a bank's business's price while maximizing revenue and minimizing costs.

5. Conclusions and implications

This study examined the effects of MBA and software R&D on Vietnamese banks' net return (NIM). The research used empirical methods and public data to achieve this. GMM and robustness tests uncover significant correlations and differences across variables and bank segments. The investigation yielded numerous noteworthy conclusions. Firstly, variables such as MBA, investment in software research and development, inflation, and capitalization positively impacted banks' net return (NIM). On the other hand, variables such as credit risk, debt ratio, operating cost, and loans hurt NIM.

This study examines bank profitability ratios more thoroughly than earlier Vietnamese studies. It validates prior results and finds noteworthy variances in effect levels when mixing factors within various bank segments. MBA and cost applications improve business margins, distinguishing this research from others.

The empirical data obtained from our research shed light on the pressing need for a clear strategy and direction for mobile banking in Vietnam. The findings reveal valuable insights into the key elements that significantly influence bank profitability, offering valuable guidance to policymakers and bank management to enhance bank performance and competitiveness within the Vietnamese market. One crucial aspect highlighted by our research is the transformative impact of innovation on bank management. The results demonstrate that embracing innovative

practices within mobile banking can lead to a rise in interest rates, effectively reducing capital expenses for commercial banks. This finding holds significant implications for bank management, providing a concrete avenue for optimizing financial resources and improving overall profitability.

Moreover, our study serves as a valuable resource for bank planners and managers, providing a comprehensive understanding of the factors that shape bank performance in the context of mobile banking in Vietnam. With this knowledge, managers can develop targeted and tailored solutions that align with their specific bank's objectives, needs, and customer base. While each bank may have unique characteristics, our research identifies the solid aspects of net interest margin, which can positively impact bank management and performance. By paying close attention to these factors, managers can proactively implement measures to enhance profitability and efficiency within their respective banks. Overall, the factors identified in our study serve as a roadmap for bank managers to bolster profitability, improve operational efficiency, and effectively navigate the competitive landscape of mobile banking in Vietnam. By leveraging these insights and tailoring strategies to their specific circumstances, managers can drive sustainable growth, capitalize on emerging opportunities, and ultimately secure a stronger foothold in the dynamic Vietnamese banking sector. According to the findings, Vietnamese banks' NIM ratios rise with software and MNA investment expenses. Policymakers should push banks to build mobile banking systems to ease the transition to digital models. Policymakers and bank management must track mobile banking in Vietnam because it offers a new platform for competition and changes in the banking sector. Central and state banks should help commercial banks adapt to technology, encouraging banking sector stability and economic progress in Vietnam.

This study carries significant implications for academics, as it delves into the relationship between MBA training, software research and development (R&D), and their impact on Vietnamese banks. By examining these factors, the research offers valuable insights that can contribute to advancing academic knowledge in the field. One notable implication of this study is the recognition that innovation plays a crucial role in facilitating knowledge acquisition and advancement for both banks and their employees. The findings underscore the importance of embracing innovative practices and technologies as they create opportunities for continuous learning and professional growth. In a competitive job market, the insights provided by this research can be instrumental in helping individuals gain a competitive edge by acquiring the necessary skills and knowledge to thrive in the banking sector.

Moreover, this study offers an in-depth investigation of the subject matter, providing a comprehensive understanding of how MBA training and software R&D influence bank performance. This depth of analysis can serve as a valuable resource for academics, enabling them to explore further the intricacies of these factors and their interplay within the banking industry. By building upon these findings, researchers can uncover new avenues for inquiry and expand the knowledge surrounding bank performance and innovation. Lastly, this study equips workers in the banking sector with industry-specific expertise. The research illuminates the impact of MBA training and software R&D on bank performance, providing employees with valuable insights into how these factors can be leveraged to their advantage. By understanding the dynamics between innovation, training, and performance, workers can enhance their skill sets and contribute effectively to their organizations.

In summary, this study offers significant implications for academics, guiding further research, aiding individuals in the competitive job market, informing decision-making processes for directors and management boards, and equipping workers with valuable banking sector expertise. The research advances knowledge and practice in banking and innovation through these various avenues.

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References

Abaidoo, R., & Anyigba, H. (2020). Bank performance variability and strands of inflationary conditions. *European Journal of Management and Business Economics*, *29*(3), 235-253. https://doi.org/10.1108/EJMBE-09-2018-0100

Abdulquadri, A., Mogaji, E., Kieu, T. A., & Nguyen, N. P. (2021). Digital transformation in financial services provision: A Nigerian perspective to the adoption of chatbot. *Journal of Enterprising Communities: People and Places in the Global Economy*, *15*(2), 258-281. https://doi.org/10.1108/JEC-06-2020-0126

Abualloush, S., Bataineh, K., & Aladwan, A. S. (2017). Impact of information systems on innovation (product innovation, process innovation)-field study on the housing bank in Jordon. *International Journal of Business Administration*, *8*(1), 95-105. http://dx.doi.org/10.5430/ijba.v8n1p95

Adesina, K. S. (2021). How diversification affects bank performance: The role of human capital. *Economic Modelling*, *94*, 303-319. https://doi.org/10.1016/j.econmod.2020.10.016

Akhisar, I., Tunay, K. B., & Tunay, N. (2015). The effects of innovations on bank performance: The case of electronic banking services. *Procedia-Social and Behavioral Sciences, 195*, 369-375. https://doi.org/10.1016/j.sbspro.2015.06.336

Bagudu, H. D., Mohd Khan, S. J., & Roslan, A.-H. (2017). The effect of mobile banking on the performance of commercial banks in Nigeria. I*nternational Research Journal of Management, IT & Social Sciences, 4*(2), 71-76. http://dx.doi.org/10.21744/irjmis.v4i2.392

Berg, T., Fuster, A., & Puri, M. (2022). Fintech lending. *Annual Review of Financial Economics, 14*, 187-207. https://doi.org/10.1146/annurev-financial-101521-112042

Brown, J. R., Fazzari, S. M., & Petersen, B. C. (2009). Financing innovation and growth: Cash flow, external equity, and the 1990s R&D boom. *The Journal of Finance, 64*(1), 151-185. https://doi.org/10.1111/j.1540-6261.2008.01431.x

Carbo-Valverde, S., Rodriguez-Fernandez, F., & Udell, G. F. (2009). Bank market power and SME financing constraints. *Review of Finance, 13*(2), 309-340. https://doi.org/10.1093/rof/rfp003

Chalabi, F. (2020). The impact of innovation on banking performance: Evidence from Lebanese banking sector. *Journal of Applied Finance and Banking, 10*(6), 175-202. https://doi.org/10.47260/jafb/1069

Claeys, S., & Vander Vennet, R. (2008). Determinants of bank interest margins in Central and Eastern Europe: A comparison with the West. *Economic Systems, 32*(2), 197-216. https://doi.org/10.1016/j.ecosys.2007.04.001

Dimelis, S., Giotopoulos, I., & Louri, H. (2017). Can firms grow without credit? A quantile panel analysis in the euro area. *Journal of Industry, Competition and Trade, 17*, 153-183. https://doi.org/10.1007/s10842-016-0216-1

Dinh, V., Le, U., & Le, P. (2015). Measuring the impacts of internet banking to bank performance: Evidence from Vietnam. *The Journal of Internet Banking and Commerce, 20*(2). http://dx.doi.org/10.4172/1204-5357.1000103

Do, T. D., Pham, H. A. T., Thalassinos, E. I., & Le, H. A. (2022). The impact of digital transformation on performance: Evidence from Vietnamese commercial banks. *Journal of Risk and Financial Management, 15*(1), 21. https://doi.org/10.3390/jrfm15010021

Doyran, M. A. (2013). Net interest margins and firm performance in developing countries: Evidence from Argentine commercial banks. *Management Research Review, 36*(7), 720-742. https://doi.org/10.1108/MRR-05-2012-0100

El-Chaarani, H., & El-Abiad, Z. (2018). The impact of technological innovation on bank performance. *Journal of Internet Banking and Commerce, 23*(3). https://ssrn.com/abstract=3845169

Eng, T. S. (2013). Pengaruh NIM, BOPO, LDR, NPL & CAR Terhadap Roa Bank Internasional Dan Bank Nasional Go Public Periode 2007–2011. *Jurnal dinamika manajemen, 1*(3). https://doi.org/10.22437/jdm.v1i3.1473

Evian, M., Limijaya, A., & Hutagaol-Martowidjojo, Y. (2021, August). An analysis on the effect of e-banking on bank performance in Indonesia. In *2021 International Conference on Information Management and Technology (ICIMTech), 1,* 187-192. https://doi.org/10.1109/ICIMTech53080.2021.9535039

Fungáčová, Z., Shamshur, A., & Weill, L. (2017). Does bank competition reduce cost of credit? Cross-country evidence from Europe. *Journal of Banking & Finance, 83*, 104-120. https://doi.org/10.1016/j.jbankfin.2017.06.014

Gaudio, B. L. D., Porzio, C., Sampagnaro, G., & Verdoliva, V. (2021). How do mobile, internet and ICT diffusion affect the banking industry? An empirical analysis. *European Management Journal, 39*(3), 327-332. https://doi.org/10.1016/j.emj.2020.07.003

Gomber, P., Koch, J.-A., & Siering, M. (2017). Digital Finance and FinTech: current research and future research directions. *Journal of Business Economics, 87*, 537-580. https://doi.org/10.1007/s11573-017-0852-x

Greene, W. (2005). Fixed and random effects in stochastic frontier models. *Journal of Productivity Analysis, 23*, 7-32. https://doi.org/10.1007/s11123-004-8545-1

Hamadi, H., & Awdeh, A. (2012). The determinants of bank net interest margin: Evidence from the Lebanese banking sector. *Journal of Money, Investment and Banking, 23*(3), 86-98. https://mpra.ub.uni-muenchen.de/id/eprint/119121

Hamdi, H., Hakimi, A., & Zaghdoudi, K. (2017). Diversification, bank performance and risk: have Tunisian banks adopted the new business model? *Financial innovation, 3*(1), 1-25. https://doi.org/10.1186/s40854-017-0069-6

Isshaq, Z., Amoah, B., & Appiah-Gyamerah, I. (2019). Non-interest income, risk and bank performance. *Global Business Review, 20*(3), 595-612. https://doi.org/10.1177/0972150919837061

Kamau, D. M., & Oluoch, J. (2016). Relationship between financial innovation and commercial bank performance in Kenya. *International Journal of Social Sciences and Information Technology, 2*(4), 34-47. https://www.ijssit.com/main/wp-content/uploads/2016/06/RELATIONSHIP-BETWEEN-FINANCIAL-INNOVATION-AND-COMMERCIAL-BANK-PERFORMANCE-IN-KENYA.pdf

Khan, M. A., Siddique, A., & Sarwar, Z. (2020). Determinants of non-performing loans in the banking sector in developing state. *Asian Journal of Accounting Research, 5*(1), 135-145. https://doi.org/10.1108/AJAR-10-2019-0080

Lahouel, B. B., Gaies, B., Zaied, Y. B., & Jahmane, A. (2019). Accounting for endogeneity and the dynamics of corporate social–corporate financial performance relationship. *Journal of Cleaner Production, 230*, 352-364. https://doi.org/10.1016/j.jclepro.2019.04.377

Li, L., Chen, J., Gao, H., & Xie, L. (2019). The certification effect of government R&D subsidies on innovative entrepreneurial firms' access to bank finance: Evidence from China. *Small Business Economics, 52*, 241-259. https://doi.org/10.1007/s11187-018-0024-6

Li, X., & Song, C. (2021). Does the target market affect bank performance? Evidence from the geographic diversification of city commercial banks in China. *Frontiers of Business Research in China, 15*(1), 1-25. https://doi.org/10.1186/s11782-021-00104-x

Liang, Q., Li, X., Yang, X., Lin, D., & Zheng, D. (2013). How does family involvement affect innovation in China? *Asia Pacific Journal of Management, 30*, 677-695. https://doi.org/10.1007/s10490-012-9320-x

Lin, X. Q., Chen, Y. C., Liu, C. H., & Li, Y. Q. (2023). Measuring creativity: role of service quality management, knowledge sharing and social interaction. *Total Quality Management & Business Excellence, 34*(1-2), 1-18. https://doi.org/10.1080/14783363.2021.2021800

Maudos, J., & Solís, L. (2009). The determinants of net interest income in the Mexican banking system: An integrated model. *Journal of Banking & Finance, 33*(10), 1920-1931. https://doi.org/10.1016/j.jbankfin.2009.04.012

Maudos, J., & De Guevara, J. F. (2004). Factors explaining the interest margin in the banking sectors of the European Union. *Journal of Banking & Finance, 28*(9), 2259-2281. https://doi.org/10.1016/j.jbankfin.2003.09.004

Mbama, C. I., & Ezepue, P. O. (2018). Digital banking, customer experience and bank financial performance: UK customers' perceptions. *International Journal of Bank Marketing, 36*(2), 230-255. https://doi.org/10.1108/IJBM-11-2016-0181

Molla, M. I., & Rahaman, M. K. B. (2022). Effect of advertising spending on operating and market performance of banks: empirical evidence from Bangladesh. *Asian Journal of Accounting Research, 7*(1), 97-110. https://doi.org/10.1108/AJAR-06-2021-0078

Mutua, R. W. (2013). *Effects of mobile banking on the financial performance of commercial banks in Kenya* (Doctoral dissertation, University of Nairobi). http://hdl.handle.net/11295/64340

Nguyen, O. T. (2020). Factors affecting the intention to use digital banking in Vietnam. *The Journal of Asian Finance, Economics and Business, 7*(3), 303-310. http://koreascience.or.kr/article/JAKO202014862061657.pdf

Njiru, C. W. (2014). *The effect of internet and mobile banking on financial performance of commercial banks in Kenya* (Doctoral dissertation, University of Nairobi). http://erepository.uonbi.ac.ke/bitstream/handle/11295/77583/Njiru_The%20effect%20of%20internet%20and%20mobile%20banking%20on%20financial%20performance%20of%20commercial%20banks%20in%20Kenya.pdf.pdf?sequence=3

Oyewole, O. S., Abba, M., Gambo, J., & Abam, I. (2013). E-banking and bank performance: Evidence from Nigeria. *International Journal of Scientific Engineering and Technology, 2*(8), 766-771. https://www.indianjournals.com/ijor.aspx?target=ijor:ijset1&volume=2&issue=8&article=004

Porter, M. E. (1996). Competitive advantage, agglomeration economies, and regional policy. *International Regional Science Review, 19*(1-2), 85-90. https://doi.org/10.1177/016001769601900208

Pradhan, P., Shyam, R., & Khadka, N. (2017). The effect of debt financing on profitability of Nepalese commercial banks. *Radhe Shyam and Pradhan, Prof. Dr. Radhe Shyam and Khadka, Nitesh, The Effect of Debt Financing on Profitability of Nepalese Commercial Banks (September 27, 2017).* http://dx.doi.org/10.2139/ssrn.3044107

Rahman, M. M., Hamid, M. K., & Khan, M. A. M. (2015). Determinants of bank profitability: Empirical evidence from Bangladesh. *International journal of business and management, 10*(8), 135. http://dx.doi.org/10.5539/ijbm.v10n8p135

Rubin, A., & Smith, D. R. (2009). Institutional ownership, volatility and dividends. *Journal of Banking & Finance, 33*(4), 627-639. https://doi.org/10.1016/j.jbankfin.2008.11.008

Saad, W., & El-Moussawi, C. (2012). The determinants of net interest margins of commercial banks in Lebanon. *Journal of Money, Investment and Banking*, 23, 118-132. https://www.researchgate.net/profile/Wadad-Saad/publication/266592438_The_Determinants_of_Net_Interest_Margins_of_Commercial_Banks_in_Lebanon/links/55bc71c208aed621de0dcbe2/The-Determinants-of-Net-Interest-Margins-of-Commercial-Banks-in-Lebanon.pdf

Salihu, A., Metin, H., Hajrizi, E., & Ahmeti, M. (2019). The effect of security and ease of use on reducing the problems/deficiencies of Electronic Banking Services. *IFAC-PapersOnLine*, *52*(25), 159-163. https://doi.org/10.1016/j.ifacol.2019.12.465

Santos, J. A., & Winton, A. (2019). Bank capital, borrower power, and loan rates. *The Review of Financial Studies, 32*(11), 4501-4541. https://doi.org/10.1093/rfs/hhz001

Smith, P., & Beretta, M. (2021). The gordian knot of practicing digital transformation: Coping with emergent paradoxes in ambidextrous organizing structures. *Journal of Product Innovation Management, 38*(1), 166-191. https://doi.org/10.1111/jpim.12548

Sujud, H., & Hashem, B. (2017). Effect of bank innovations on profitability and return on assets (ROA) of commercial banks in Lebanon. *International Journal of Economics and Finance, 9*(4), 35-50. https://doi.org/10.5539/IJEF.V9N4P35

Vanderpal, G. (2015). Impact of R&D expenses and corporate financial performance. *VanderPal, GA (2015). Impact of R&D expenses and corporate financial performance. Journal of Accounting and Finance*, *15*(7), 135-149. https://ssrn.com/abstract=2959290

Vial, G. (2019). Understanding digital transformation: A review and a research agenda. *The journal of strategic information systems*, *28*(2), 118-144. https://doi.org/10.1016/j.jsis.2019.01.003

Vo, X. V. (2018). Bank lending behavior in emerging markets. *Finance Research Letters, 27*, 129-134. https://doi.org/10.1016/j.frl.2018.02.011

Vyadrova, N., & Severina, K. (2022). Diversification of the bank's activity and the role of banking services in income formation. *Financial and Credit Systems: Prospects for Development, 1*(4), 19-27. https://doi.org/10.26565/2786-4995-2022-1-02