**DIGITAL TRANSFORMATION AND BANK PERFORMANCE – A STUDY OF VIETNAMESE LISTED COMMERCIAL BANKS**

*Nguyen Hoang Anh\*, National Economics University*

*Trinh Chau Anh\*, National Economics University*

*Luong Thai Bao\*a, National Economics University*

*Ngo Thuy Dieu\*, National Economics University*

*Tran Duc Thai\*, National Economics University*

*Hoang Lang Minh Thao\*, National Economics University*

**Abstract**

**Introduction**

Since the first banks were born, their business model has always been associated with the use of technology. The latest waves of technological development allow banks to continuously employ more technological resources in their quest for profit. On the other hand, competition has been a key driving force to make banks relentlessly find new ways to produce higher performance. Over the past few years, banks have been extensively engaged with ICT technologies in different forms as a strategic journey to transform themself into more agile and service-oriented organizations to better serve their diverse customers. Traditional research on bank performance has been taking technology into account as a source of efficiency. Berger and Mester (1997) used three methods to assess banks’ efficiency including cost, profit and alternative profit efficiency. However, their treatment of technology was somewhat exogenous as three measures of bank efficiency were tested in accordance with changes in environment including technology, regulation and market condition. Large number of studies on bank performance have been employed various data envelopment analysis (DEA) methods but the results were often different and difficult to make meaningful managerial decisions as well as conclusive policy suggestions (Eskelinen, 2017). The reasons for this were either that technology innovation was considered exogenously Paradi and Zhu (2013) or that unspecified technology that shape banks’ production possibility frontier was assumed to apply to all banks (Yue, 1992) or that the method of DEA was only able to assess linear relationships between banks’ inputs and outputs of homogenous branch units (Thanassoulis,1999).

Since banks have been ever willing to adopt financial technologies to either improve or innovate their core business activities including payment services, fund mobilizations, credit and lending as well as cross-industry services such as insurance services and investment management (Barroso and Laborda, 2022).The adoption of financial technologies by banks, however, must go through a process called digital transformation. It is necessary to distinguish digital transformation from two related terms which are digitization and digitalization. In many cases of both academic research and industry practice, they are used interchangeably to present a process in which banks implement at different levels and scopes digital related projects. For a business organization, digitization is a process covert data from analog to digital form, and digitalization is the one that partly changes an existing business model to provide more and enhanced business value, while digital transformation is the process that wholly creates a new digital business model from traditional one (O'Leary, 2022).

There is a growing number of studies that have focused on the relationship between digital transformation and organization performance. Bumann and Peter (2016) undertook a comparative analysis of several digital transformation models and frameworks and found that the most common dimensions that digital transformation brings in an organization are strategy, organization, corporate culture, technology and people (customers/employees). Xuanli and Wang (2023) decomposed digital transformation into three dimensions which are strategy transformation, business transformation and management transformation. As for banks, empirical analysis on the impact of digital transformation on bank’s performance of Xiang and Jiang (2023) is typically interesting. They specifically focused on digitalization (or digitization as interchangeable term) as an important source of improvement in the bank’s performance. Of a sample size of 117 Chinese commercial banks for the period from 2014 to 2021, they found the non-linear dynamic relationship between digitization and bank performance in which the former not only inhibits but also facilitates the latter.

The purpose of this paper is to investigate non-linear relationships between digital transformation and bank performance with Vietnamese listed commercial banks. ECB (2010) pointed out that the traditional bank’s performance measurement might not be providing a complete picture of bank. Instead, they argued that a bank’s performance should be defined as “*the capacity to generate sustainable proﬁtability*”. The paper argues that while digitization and digitalization only help the banks at operational and management level digital transformation is the process taking place at all levels of the society and organization and having impact on not only the on technology and business aspects of the organization but also on culture. To achieve sustainable profitability banks might consider the fact that financial technologies that they want to employ are embodied with innovation. At a strategic level a bank must work to bring innovation to its organizational culture, which is largely involved in its human resources, it can experience exponential growth through higher competitive capacities.

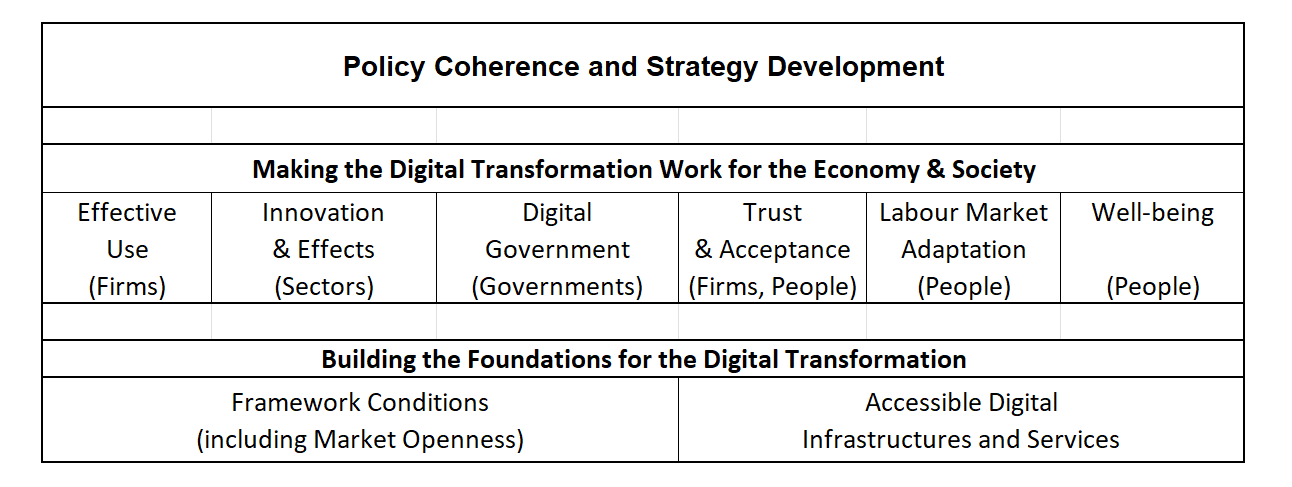
The paper is organized as follows. The next part is to explain a digital transformation framework from national to bank level in which Vietnam and Vietnamese banking sector might partly or fully follow. Come next is presentation of regression model with testing methods. Empirical results and management and policy implications

**A digital transformation framework for banks in Vietnam**

Since digital transformation is posing challenges to nearly every aspect of the economy and society, a comprehensive response from the government must take into account a wide range of policy agenda. To develop a whole-of-government approach to policymaking, governments must reach across traditional policy silos and different levels of government. While many policies must be considered, the figure below helps to distinguish some key building blocks.

**Figure 1:** *OECD’s proposal of preliminary an integrated policy framework*

*for making the digital transformation work for growth and well-being*



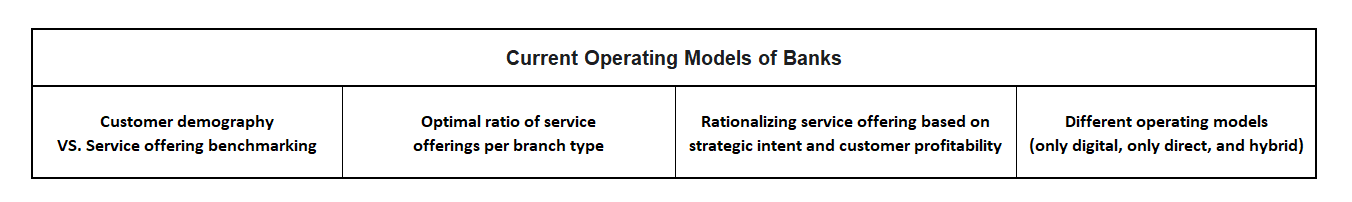
Source: Reproduced from OECD (2017)

According to the OECD, a nation can establish the three key building blocks including: “*First*, building the foundations for the digital transformation, including policies that impact the overall enabling environment (including market openness) for digital transformation as well as policies that promote grassroots access to digital infrastructure and services. *Second*, making the digital transformation work for the economy and society: This content focuses on policies that enable people, businesses, and governments to effectively use digital technology, as well as policies that promote the activity of digital technology in specific conditioning and policy areas. Additionally, it comprises measures that utilize digital tools to enhance wellbeing, such as granting more equitable access to public services. It also carries policies that promote trust and acceptance, as well as policies that can help all parties, including citizens, workers, and consumers, adapt to digital transformation. And *third*, policy coherence and strategic development, including coordination between ministries and other agencies at all levels of government, as well as the active participation of all key stakeholders in the process of policy development to ensure that all policies are mutually corroborate and aligned with a coherent and unified strategy. In addition, collective action will be needed in several sectors to seize opportunities and meet the changing challenges of the digital economy.”

As pointed out in the above preliminary policy framework for the digital transformation elements, it is important to note that the specific implications of the digital transformation may vary across sectors withing one country. Influenced by factors such as economic development, technological progress, trade specialization, and institutional characteristics, each country, including Vietnam, should tailor its policy responses to its unique circumstances and capabilities. In June 2020, Vietnamese government announced Decision No. 749/QĐ-TTg to approve *The National Agenda for Digital Transformation until 2025 with Orientation until 2030*. The agenda directs Vietnamese banks to embrace financial technologies to build digital and innovative banking business models, enriching financial ecosystem and meeting requirements of *The National Strategy for Financial Inclusion until 2025 with Orientation until 2030*. Although digital transformation had been envisaged by numerous commercial banks, implementation of it among banks at the strategic level has not been always obvious. Vietnamese commercial banks undertook a long and painful restructuring program directed by the State Bank of Vietnam in early 2010s after which universal banking models and customer-centric approaches have gradually emerged. The banks therefore would strategically shift to a new banking business model that relies on innovative measures as well as digital means to compete in the marketplace. And working with business consulting firms, big technology companies, and fintech firms through either buy or build models is the ways to achieve objectives.

At the sectorial level, Vietnamese commercial banks have been undertaking a transition from traditional banking business models to digital one which in turns helps them to realized shifts to more retail banking services as well as to more sources of income from services as compared to traditional interest rate one.

Picture 2 illustrates the current operating model of banks, which is the traditional model.

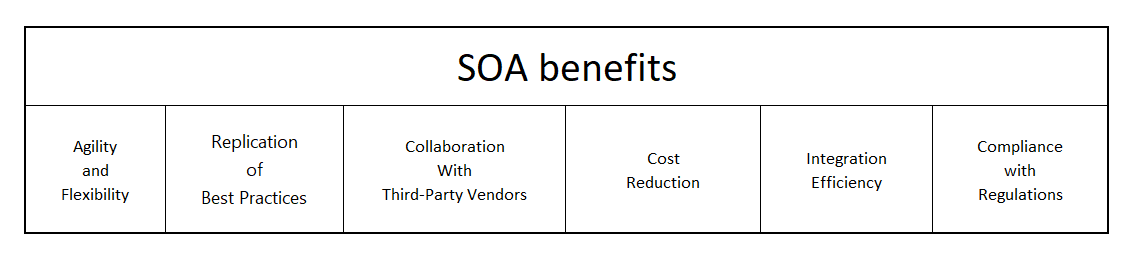


The current operating model of banks faces several limitations. Firstly, traditional banks often struggle with outdated legacy systems and technology infrastructure, hindering their ability to provide seamless digital banking experiences. Secondly, the branch-centric model may lead to higher operational costs and inefficiencies, as physical branches require significant investment and maintenance. Thirdly, the lack of personalized customer experiences and tailored offerings can lead to decreased customer satisfaction and reduced loyalty. Additionally, the regulatory environment poses challenges, as banks need to navigate complex compliance requirements that can slow down innovation and hinder flexibility. Lastly, the emergence of fintech startups and digital disruptors has increased competition, requiring banks to adapt quickly to stay relevant in the market.

From the traditional model, through digitalization and digitization, banks can transfer to the service model (Service-Oriented Architecture - SOA).

Service-oriented architecture (SOA) is a design framework for integrating applications that connects business objectives to the IT infrastructure. It aligns IT capabilities with organizational goals and provides a technically adaptable infrastructure to swiftly respond to necessary changes.

SOA offers flexibility through automation of infrastructure and essential tools, resulting in reduced integration costs and efficient coordination.



Service-Oriented Architecture (SOA) guarantees the seamless integration of various IT systems within a bank without incurring additional time or cost requirements. A well-crafted and executed SOA allows banks to undertake multiple smaller integration projects with less capital investment, as opposed to the high investment associated with the traditional legacy overhaul of IT architecture.

* SOA gives banks the capacity to respond swiftly and effectively to shifting market circumstances in constantly changing sectors.
* Core banking systems with standardized SOA directly address banks' concerns about compliance and regulation.
* The highest level of efficiency is guaranteed by the use of widely accepted standards for interoperability between IT systems.
* Banks can improve their back-office performance while reducing IT maintenance costs by switching to a common standard.
* Collaboration with third-party vendors will be facilitated by standardized application programming interfaces
* Replication of best practices and enhancement of development processes are made possible by the creation of standardized services.

**Literature review**

Cần có 1 phần nói về phát triển gần đây của hệ thống ngân hàng việt nam gồm: I) xu hướng phát triển mảng dịch vụ từ thiên về bán buôn (doanh nghiệp) sang bán lẻ (cá nhân, hộ gia đình, doanh nghiệp SMB) và ii) thay đổi cấu trúc thu nhập cho ngân hàng từ interest sang non-interest. (thày Bảo)

**Methodology (Model and Data)**

# **III, Methodology:**

## **1, Data and sample:**

In pursuit of our research objectives, we diligently collected secondary data from a diverse array of sources. The data sources encompassed the following:

***ICT Index****:* We accessed the ICT index data through comprehensive reports issued by the Vietnamese Ministry of Information and Communication.

***GDP Information****:* For the Gross Domestic Product (GDP) data, we meticulously retrieved it from the National Accounts, which are meticulously maintained by the General Statistics Office of Vietnam.

***ECT Data****:* The data related to the Electronic Communication Technology (ECT) aspect was meticulously compiled from various exchanges, including the Hanoi Stock Exchange, Ho Chi Minh Stock Exchange, and the Unlisted Public Company Market.

***Other Datas (ROA NIM LDR TA CIR NPL IS):*** To ensure a robust dataset, we also sourced a plethora of supplementary information from the annual reports and financial statements of the commercial banks under our study.

Turning our attention to the sample utilized in our research, our rigorous selection process initially identified 23 Vietnamese listed commercial banks as potential candidates from the broader population. It's noteworthy that we excluded several banks due to missing data during the stipulated research period, which spanned from 2017 to 2022. Consequently, our final dataset consisted of 22 out of the original 30 Vietnamese listed commercial banks, yielding a total of 138 bank-year observations for our analysis. This meticulous selection process ensured the integrity and reliability of our research findings.

## **2, Variables and measurements:**

**2.1. Dependent Variable:**

1. The Return on Assets (ROA) metric indicates the percentage of a company's assets that contribute to generating revenue. This figure essentially reveals how efficiently a company utilizes its assets to generate earnings; in other words, it reflects the number of dollars in earnings derived from each dollar of assets controlled by the company. ROA is a valuable measure for comparing companies within the same industry. In our study, we focused on the dependent variable, which is the return on assets (ROA).

### **2.2. Independent Variables.**

### ***3 Main Groups of Independent Variables: 2 Digital Transformation Variables, 3 Control Variables, and 6 Traditional Variables***

**Traditional Variables:**

1. ***logTA***: The variable "logTA" typically represents the natural logarithm of the total assets of a commercial bank. It is often used in financial analysis and research to transform the total asset values into a logarithmic scale, which can make it easier to analyze and compare the bank's financial performance and growth trends over time.
2. ***LDR****:* The Loan-Deposit Ratio, often abbreviated as LDR, is a vital financial metric used in the banking industry. It quantifies the relationship between a bank's total loans and its total deposits. This ratio is typically expressed as a percentage, providing insights into how much of the bank's assets are deployed as loans in relation to the funds it holds in customer deposits.
3. ***NIM****:* Net interest margin is a measure of the difference between the interest income generated by banks or other financial institutions and the amount of interest paid out to their lenders (for example, deposits), relative to the amount of their (interest-earning) assets. It is similar to the gross margin (or gross profit margin) of non-financial companies
4. ***CIR:*** The Cost-to-Income Ratio is a key metric used to assess the operational efficiency of a business or organization. This ratio provides valuable insights into whether a company is effectively managing its costs relative to its income. Operating expenses encompass the essential expenditures that a business must incur to maintain its operations. While the specific nature of these expenses may vary from one company to another, they typically encompass various categories such as interest expenses, professional support services, taxes, employee wages and salaries, sales and marketing expenses, utility costs, telecommunications expenses, and expenditures on office supplies. By analyzing the CIR, stakeholders can evaluate the efficiency of cost management and determine whether the company is generating profits or incurring losses.
5. ***IS:*** The "IS" variable signifies the proportion of income structure that relates to service-based income over traditional income sources for financial institutions, predominantly stemming from interest on loans. Its purpose is to highlight and elucidate the differences in the influence of digital transformation on the overall performance of banks.
6. ***NPL***: A non-performing loan is a loan provided by a bank that faces issues with late repayments or is not expected to be fully paid back by the borrower. NPLs pose a significant obstacle for the banking industry, as they have a negative impact on profitability. These loans are frequently cited as a hindrance to banks in terms of extending more credit to businesses and individuals, potentially stalling economic growth. However, it's important to note that there is some disagreement about the validity of this theory.

**Control Variables:**

1. ***GDP****:* Gross domestic product (GDP) is the total monetary or market value of all the finished goods and services produced within a country's borders in a specific time period. As a broad measure of overall domestic production, it functions as a comprehensive scorecard of a given country's economic health.
2. ***INF:*** Consumer Price Index is a crucial measure of price increases and fluctuations in the costs of goods and services that consumers have to pay within a specific timeframe. This index tracks price changes and can indicate the presence of inflation or economic growth. The inflation index is widely used to assess the impact of price fluctuations on consumers and the overall economy.
3. ***ECI****:* Or Exchange Capitalization Index, serves as a comprehensive indicator summarizing the logarithmic representation of exchange capitalization in Vietnam. To construct this index, we systematically gather data from multiple sources, including the Hanoi Stock Exchange, Ho Chi Minh Stock Exchange, and the Unlisted Public Company Market. This allows us to encapsulate a holistic view of the capitalization trends across various segments of the Vietnamese financial market.

**Digital Transformation Variables:**

1. ***ICT Index:*** as presented in the "Report on Readiness Index for Vietnam's ICT Application and Development," is a critical annual publication by the National Steering Committee for Information Technology and the Ministry of Information and Communications. This index serves as a pivotal indicator, offering insights into the technological readiness and infrastructure in Vietnam with regard to the processes of digitization and digitalization. The ICT Index comprises four sub-categories: Technical Infrastructure Index, Human Resources Infrastructure Index, Internal Banking Applications Index, and Online Banking Services Index. These sub-indices collectively evaluate and reflect Vietnam's state of readiness and development in the field of information and communication technology.
2. ***Digital Transformation Index:*** DT, which stands for "Digital Transformation," is the sole binary variable considered in our analysis. It is assessed in accordance with the presence or absence of a strategic plan related to digital transformation within the joint-stock commercial bank. A value of 1 indicates the existence of a specific plan, whereas a value of 0 signifies the absence of such a plan.

## **3. Method:**

Our team will utilize panel data analysis in their study because the datasets at their disposal encompass both cross-sectional and time-series dimensions. To select the most appropriate model for their analysis, we will employ estimation techniques that include Pooled Ordinary Least Squares (OLS), the Fixed Effects Model (FEM), and the Random Effects Model (REM). Furthermore, we will conduct rigorous tests to assess the potential presence of multicollinearity and heteroscedasticity within the dataset. This comprehensive approach to data analysis will ensure a robust and thorough examination of the research variables and their relationships.

## **4. Model:**

***To investigate the influence of fintech on bank performance, the researchers formulated the following empirical model for estimation:***

ROAit=0+1logTAit+2LDRit+3NIMit+4CIRit+5ISit+6NPL

7GDPit+8ECIit+9ICTit+10DTit

Variables and Indices:

* *"i" represents an individual bank.*
* *"t" represents the time period (year).*
* *"β0" is the constant intercept.*
* *"ROA" is a measure of the bank's performance (Return on Assets).*
* *"GDP" and "ECI" are controlling variables, likely related to the economy.*
* *"DT" and "ICT" are technology-related factors.*
* *"β1–β10" are coefficients that are part of the equation.*
* *The rest variables or indices encompass a wide range of financial metrics and indicators that are relevant to understanding a bank's operations, risk profile, and profitability.*

## **5. Hypothesis.**

### **Table: The variables defined**

|  |  |  |  |
| --- | --- | --- | --- |
| Variable name | Code | Measurement | Hypothesis |
| ***Dependent variable*** | | | |
| Bank performance | ***ROA*** | = return on asset |  |
| ***Independent variable*** | | | |
| **Traditional Variables** | | | |
| Logarithm of Total asset | ***logTA*** | = Logarithm (TA) | *H1: logTA has a positive impact with bank performance* |
| Loan to deposit ratio | ***LDR*** | = Total loans/ Total deposit | *H2: LDR has a positive impact with bank performance* |
| Net interest margin | ***NIM*** | =(Interest Received – Interest Paid) / Average Invested Assets | *H3: NIM has a positive impact with bank performance* |
| Cost to income ratio | ***CIR*** | = Total operating cost/ Total operating income | *H4: CIR has a negative impact with bank performance* |
| Income structure | ***IS*** | = Income from service activities/ loan interest income | *H5: IS has a positive impact with bank performance* |
| Non performing loan | ***NPL*** | = Total bad debt/Total outstanding debt | *H6: NPL has a negative impact with bank performance* |
| **Control variable** | | | |
| Gross domestic product | ***GDP*** | = GDP growth (annual%) | *H7: GDP growth has a positive impact with bank performance* |
| Exchange Capitalization Index | ***ECI*** | = Logarithm (Market cap) | *H8: ECI has a positive impact with bank performance* |
| **Digital Transformation Variables** | | | |
| ICT Index | ***ICT*** | = information and communication technologies index published annually by the Ministry of Information and Communications | *H9: ICT has a positive impact with bank performance* |
| Digital transformation | ***DT*** | =0 if year do not have phrase “digital transformation” (in annual report)  =1 if year have phrase “digital transformation” (in annual report) | *H10: DT has a positive impact with bank performance* |

# **IV, Result and discussion:**

## **Descriptive statistics:**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | ROA | logTA | LDR | NIM | CIR | IS | NPL | GDP | ECI | ICT | DT |
| Mean | .01228 | 5.2905 | .73751 | .03351 | .47232 | .08620 | .01620 | .05737 | 11.526 | .51816 | .49275 |
| Meadian | 0.0095 | 5.253 | 0.7448 | 0.0303 | 0.4594 | 0.0748 | 0.0154 | 0.0692 | 15.27 | 0.5167 | 0 |
| Min | .0008 | 4.3091 | .4441 | .0060 | .2271 | .0029 | .0050 | .02580 | 0 | .25270 | 0 |
| Max | .0370 | 6.3264 | 1.1233 | .0930 | .8745 | .3200 | .0459 | .0802 | 15.763 | .77620 | 1 |

**Dependent Variable:**

The descriptive statistics presented in Table 2 provide an overview of key measures for the variables under investigation in this research. Specifically, let's focus on the Return on Assets (ROA) variable, which is a crucial metric in our study.

* The ROA values exhibit a considerable range, spanning from a minimum of 0.08% to a maximum of 3.7%. This wide range indicates substantial variability in the performance of the entities or observations included in the study concerning their ability to generate returns from their assets.

The mean ROA, calculated across all the entities or observations, is 1.228%. This mean value serves as a central point of reference, representing the average return on assets within the dataset. It provides insight into the typical performance level of the entities under scrutiny.

**Independent variables:**

***Traditional Variables:***

***logTA****:* Mean (5.29): Indicates the average level of total assets across the dataset, reflecting the typical scale of commercial bank operations. Max (6.326): Suggests the presence of banks with significantly larger total assets, potentially representing major players in the banking industry. Min (4.309): Represents banks with smaller total assets, possibly indicating smaller or newer financial institutions.

***NIM:*** (Net Interest Margin): Mean (3.351%): This represents the average net interest margin for banks in the dataset, indicating their typical profitability from interest-related activities. Max (9.300%): Indicates that certain banks achieved higher profitability, possibly through more favorable interest rate spreads. Min (0.600%): Shows banks with lower profitability, potentially due to narrower interest rate spreads or other factors affecting interest income.

***LDR:*** (Loan-Deposit Ratio): Mean (73.75%): Reflects the average proportion of loans relative to total deposits for banks in the dataset, indicating a typical lending strategy. Max (112.33%): Suggests banks that have a more aggressive lending approach, potentially with higher loan portfolios compared to deposits. Min (44.41%): Represents banks with a more conservative lending strategy, maintaining lower loan portfolios relative to deposits.

***CIR:*** (Cost-to-Income Ratio): Mean (0.4723): Indicates the average cost-to-income ratio, offering insights into cost management efficiency for banks. Max (0.8745): Suggests some banks with higher operational costs relative to income, potentially indicating less efficiency. Min (0.2271): Represents banks with lower operational costs relative to income, implying higher efficiency in cost management.

***NPL:*** (Non-Performing Loan Ratio): Mean (0.0162): Represents the average proportion of non-performing loans in banks' portfolios, indicating typical credit risk levels. Max (0.0459): Indicates that some banks may have experienced higher credit risk or non-performing loan issues during the examined period. Min (0.005): Represents banks with lower credit risk and fewer non-performing loans on their books.

***IS:*** (Income Structure): Mean (.0862): Reflects the average proportion of income derived from service-based sources relative to traditional income within financial institutions. Max (0.32): Suggests some banks have significantly diversified their income sources towards services, possibly due to digital transformation initiatives. Min (0.0029): Represents banks with a smaller portion of income from service-related activities in comparison to traditional sources.

***Control Variables:***

***GDP:*** The median GDP value of 0.06915 aligns with the concept of the median, which is a statistical measure used to represent the middle value within this dataset. In this context: The median GDP value indicates that half of the time periods considered in the analysis had GDP values below 0.06915, while the other half had GDP values above this level. This suggests that the median serves as a useful reference point for understanding the central tendency of the GDP data. It is not affected by extreme values and provides insight into the typical level of economic production during the specified time frame. In other words, it reflects the GDP value that separates the data into two equal halves, offering a balanced perspective on VietNam’s economic performance.

***ECI:*** Min value equal to 0 represents at that specific time the bank has not been listed on any stock exchange. The close proximity between the mean ECI value of 15.27 and the maximum ECI value of 15.76 suggests that, on average, the capitalization trends in Vietnam's financial markets are relatively consistent and stable. The maximum value, which is only slightly higher than the mean, indicates that there have been specific years with notable surges in capitalization, signifying periods of significant market activity and growth. However, the fact that the maximum value is not significantly higher than the mean implies that these periods of peak activity are relatively infrequent compared to the overall trend of moderate and steady capitalization. In essence, while there are occasional spikes in market activity, the financial markets in Vietnam generally maintain a moderate and stable level of capitalization over time.

***Digital Transformation Variables:***

***DT:*** The mean value of DT is 0.4928, and it falls within the binary range of 0 and 1. This mean value suggests that, on average, approximately half of the joint-stock commercial banks in our study have implemented a strategic plan for digital transformation, while the other half have not.

***ICT:*** The ICT Index's minimum value of 0.2527 signifies the lowest technological readiness level in Vietnam, highlighting areas with limited ICT infrastructure development. At a median value of 0.498, it represents the midpoint, with half of the surveyed regions falling below and half above this level in terms of technological preparedness. The ICT Index's mean value of 0.5167 reflects the average technological readiness across Vietnam, providing an overview of the nation's overall digital infrastructure and development status.

## **Correlation matrix**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | ROA | logTA | LDR | NIM | CIR | IS | NPL | GDP | ECI | ICT | DT |
| ROA | 1.000 |  |  |  |  |  |  |  |  |  |  |
| logTA | 0.469 | 1.000 |  |  |  |  |  |  |  |  |  |
| LDR | 0.087 | 0.206 | 1.000 |  |  |  |  |  |  |  |  |
| NIM | 0.730 | 0.324 | 0.066 | 1.000 |  |  |  |  |  |  |  |
| CIR | -0.690 | -0.632 | -0.201 | -0.534 | 1.000 |  |  |  |  |  |  |
| IS | 0.638 | 0.584 | 0.132 | 0.438 | -0.450 | 1.000 |  |  |  |  |  |
| NPL | -0.299 | -0.274 | -0.093 | -0.031 | 0.294 | -0.216 | 1.000 |  |  |  |  |
| GDP | -0.056 | -0.071 | 0.061 | 0.043 | 0.126 | -0.096 | 0.067 | 1.000 |  |  |  |
| ECI | 0.314 | 0.488 | 0.311 | 0.209 | -0.290 | 0.385 | -0.121 | -0.184 | 1.000 |  |  |
| ICT | 0.237 | 0.363 | 0.089 | 0.090 | -0.319 | 0.257 | -0.155 | -0.073 | 0.154 | 1.000 |  |
| DT | 0.255 | 0.201 | 0.219 | 0.174 | -0.281 | 0.236 | -0.015 | -0.415 | 0.383 | 0.225 | 1.000 |

In the correlation matrix of variables provided, we can observe the relationships between various financial and economic indicators. Let's discuss the correlation between the dependent variable, ROA (Return on Assets), and other independent variables, considering both positive and negative correlations.

**Positive Correlations with ROA:**

**logTA** (Natural Log of Total Assets) demonstrates a positive correlation of 0.47 with ROA. This suggests that larger total assets are associated with higher ROA. It could imply that banks with more substantial asset bases tend to generate better returns on those assets.

**LDR** has a positive correlation of 0.09 with ROA. This suggests that there is a slight positive relationship between a bank's loan-deposit ratio and its return on assets. Banks with a higher loan-deposit ratio may experience marginally better ROA.

**NIM** (Net Interest Margin) has a positive correlation of 0.73 with ROA. This suggests that as the net interest margin increases, the return on assets tends to increase as well. This makes sense since a higher net interest margin signifies better profitability from interest-related activities, which can positively impact ROA.

**IS** (Income Structure) shows a positive correlation of 0.64 with ROA. This indicates that a higher proportion of income from service-based sources in comparison to traditional income is associated with higher ROA. This may suggest that diversifying income sources through service-related activities can contribute to better returns on assets.

**ICT** exhibits a positive correlation of 0.24 with ROA. While the correlation is positive, it is relatively weak, indicating a limited relationship between a bank's use of information and communication technology and its return on assets.

**DT** has a positive correlation of 0.26 with ROA. This suggests that there is a moderate positive relationship between a bank's digital transformation efforts (the presence of a digital transformation plan) and its return on assets. Banks with digital transformation plans may experience slightly better ROA.

**Negative Correlations with ROA:**

**CIR** (Cost-to-Income Ratio) exhibits a negative correlation of -0.69 with ROA. This implies that as the cost-to-income ratio increases, ROA tends to decrease. A higher cost-to-income ratio indicates less efficient cost management, which can negatively impact profitability and ROA.

**NPL** (Non-Performing Loan Ratio) has a negative correlation of -0.30 with ROA. As the non-performing loan ratio increases, ROA tends to decrease. This suggests that a higher level of non-performing loans can have an adverse effect on a bank's profitability and ROA.

Overall, A value of 0.2 indicates a positive correlation, but it is weak and not statistically significant. Experts suggest that a correlation becomes meaningful when it reaches at least a value of 0.8. However, a correlation coefficient with an absolute value of 0.9 or higher signifies a very strong relationship. The correlation matrix provides valuable insights into the relationships between ROA and other financial variables. None of the correlations exceed the threshold of 0.8, indicating that multicollinearity is not a significant concern. These correlations are essential for confirming and selecting the most appropriate models in financial analysis and research.

## **Regression model.**

In order to select the most suitable regression model for our dataset, a series of tests were conducted to compare the effectiveness of three models: Pooled Ordinary Least Squares (OLS), Fixed Effect Model (FEM), and Random Effect Model (REM). When comparing OLS to FEM, we utilized an F test to determine that the FEM model was more appropriate. Similarly, when comparing OLS to REM, we employed the Breusch and Pagan Lagrangian multiplier test for random effects, yielding the result that the REM model was more efficient than OLS. Finally, to compare FEM and REM models, the Hausman test was applied, leading to the selection of the most suitable model, which was REM.

After selecting the most suitable model, it is necessary to examine whether that model exhibits any flaws or deficiencies through a series of tests, including the *Wooldridge test for autocorrelation in panel data* and *the Breusch and Pagan Lagrangian multiplier test for random effects.* The results show that there exists both autocorrelation and heteroscedasticity in the selected model.

In that case, it's advisable to address these issues using a method called Feasible Generalized Least Squares (FGLS) regression.

### **Final Model: Cross-sectional time-series FGLS regression:**

|  |  |
| --- | --- |
| Cross-sectional time-series FGLS regression | |
| Chi-square = | 1192.84 |
| Prob > chi-square = | 0.0000 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| ROA | Coefficient | Std. err. | z | P > |z| |
| logTA | .0004299 | .0006746 | 0.64 | 0.524 |
| LDR | .0070025 | .0018723 | 3.74 | 0.000 |
| NIM | .2352651 | .0218531 | 10.77 | 0.000 |
| CIR | -.0125442 | .0016352 | -7.67 | 0.000 |
| IS | .0250167 | .0041112 | 6.09 | 0.000 |
| NPL | -.0274415 | .0172627 | -1.59 | 0.112 |
| GDP | .0144281 | .0047599 | 3.03 | 0.002 |
| ECI | -.0000118 | .0000235 | -0.50 | 0.617 |
| ICT | .0041364 | .0015103 | 2.74 | 0.006 |
| DT | .0008428 | .0002587 | 3.26 | 0.001 |
| cons | -.0028606 | .0044921 | -0.64 | 0.524 |

From here, we have conclusions regarding the hypotheses set forth earlier as follows:

|  |  |  |  |
| --- | --- | --- | --- |
| ROA | Expected | Result | Significant level |
| logTA | + | Insignificant | Insignificant |
| LDR | + | + | 1% |
| NIM | + | + | 1% |
| CIR | - | - | 1% |
| IS | + | + | 1% |
| NPL | - | Insignificant | Insignificant |
| GDP | + | + | 1% |
| ECI | + | Insignificant | Insignificant |
| ICT | + | + | 1% |
| DT | + | + | 1% |

**Discussions:**

logTA's Insignificant Impact on ROA: logTA, which represents the natural logarithm of total assets, may not significantly impact ROA. The insignificance may arise from the fact that the size of a bank's assets (logTA) does not always directly correlate with its financial performance. Other factors such as risk management or specific business strategies may be more influential.

LDR's Positive Impact on Banking Efficiency: Increasing the Loan-to-Deposit Ratio (LDR) can create opportunities to profit from lending activities, ultimately raising ROA. When this ratio rises, a bank can utilize deposits to extend loans, generating profit from interest rates.The outcomes of this investigation align with the findings from studies carried out by Kurniawati (2017) and Suciaty (2019). Their research results similarly affirmed that the Loan To Deposit Ratio (LDR) exerts a significant and positive impact on Return On Assets (ROA).

NIM's Positive Impact on Banking Efficiency: Net Interest Margin (NIM), which measures profit from a bank's interest operations, shows a strong positive relationship with ROA. As per the findings reported by (N. V. Dewi, Mardani, and Salim 2017), it was observed that the NIM variables exert a significant positive influence on the ROA variables, although to a certain extent. The research of Hidayat Wastam. (2022) indicated that the positive impact of NIM on profitability is attributed to the fact that any rise in net interest income leads to an increase in pre-tax profit, consequently enhancing profitability (ROA).

CIR's Negative Impact on Banking Efficiency: The Cost-to-Income Ratio (CIR) negatively affects banking efficiency. When CIR increases, it signifies that a bank is managing its costs and operations less efficiently. This is in line with several previous studies, including those by Syfari et al. (2012), Antwi (2019), and Mamun et al. (2023). The results demonstrated that, when considering capital adequacy and bank size as control variables, the effect of the cost-to-income ratio on return on assets is consistently negative and statistically significant using various estimation methods. This suggests that a higher cost-to-income ratio has an adverse impact on the performance of Vietnamese banks.

IS's Impact on ROA: The "IS" variable may affect ROA by altering a bank's income structure. If "IS" increases, it implies that the bank is generating more income from service activities relative to interest income. This could potentially create pressure to reduce ROA if interest income is a significant revenue source and income from service activities has lower profitability.

NPL's Insignificant Impact on ROA: Non-performing loans (NPLs) represent the proportion of bad debts in an organization's or bank's assets, reflecting loans that are not repaid on time or as scheduled. The "Insignificant" result in the table implies that, in statistical analysis, there is no significant impact of NPL on ROA. The chart suggests that the actual outcome of NPL does not align with the expected result, indicating that NPL does not strongly influence ROA. The impact of NPL on ROA may not be substantial or may be obscured by other factors such as industry sector, time lag in impact, or other risk management factors, or simply due to insufficient sample size. Base on article ANALYSIS OF THE EFFECT OF CAR AND NPL ON PROFITABILITY WITH LDR AS VARIABLE INTERVENING (Case Study on Commercial Banks Listed on the IDX Period 2018- 2020). Based on the research obtained regarding the NPL on ROA the results of hypothesis testing it can be concluded that NPL has a negative and insignificant effect on ROA in banking companies listed on the Indonesia Stock Exchange. NPL shows that the ability of bank management in managing non- performing loans provided by banks. So that the higher this ratio, the worse the quality of bank credit,which causes the number of non-performing loans to be greater, the greater the possibility of a bank introubled conditions (Almilia and Herdanigtyas, 2005). So if the greater the NPL) will result in a decrease in ROA, which also means the bank's financial performance decreases.

GDP's Impact on ROA: Gross Domestic Product (GDP) can influence ROA through several mechanisms. The business and profit environment: GDP reflects a nation's economic health and a robust economy often creates a better business environment with more investment and consumption opportunities. A favorable business environment can provide financial institutions with more opportunities to generate higher profits, positively affecting ROA. Base on The impact of credit risk and macroeconomic factors on profitability: the case of the ASEAN banks, Interest rates: The correlation between GDP and ROA may also depend on the interest rate levels in the country. If GDP increases while interest rates also rise, financial institutions may have higher ROA due to the opportunity to earn more from higher interest rates. Credit demand: GDP growth typically leads to economic expansion, resulting in increased credit demand from businesses and individuals. Banks and financial institutions can capitalize on this opportunity to provide financial products, earning income from interest rates and service fees, potentially improving ROA. Credit risk: A weak economic environment may lead to a rise in non-performing loans. If GDP decreases, businesses and individuals may struggle to repay their debts, increasing credit risk for banks. This increased risk can impact ROA through costs related to bad debt management.

ECI's Impact on ROA: The Exchange Capitalization Index (ECI) may not have a significant impact on ROA due to several factors. Time lag in impact: Financial markets and market capitalization values may experience time lags in reflecting changes in ECI on the financial performance of financial institutions. While ECI may represent changes in financial market value at a specific point in time, its impact on ROA may take time to manifest. Short-term vs. long-term fluctuations: ECI may primarily represent short-term market fluctuations, while ROA is often evaluated based on the long-term financial performance of financial institutions. Short-term fluctuations may not necessarily reflect the extent of influence on an institution's long-term performance. Transaction costs and market fees: A portion of market value is derived from transaction costs and market fees, which can affect a financial institution's profitability. Thus, the impact of ECI may be mitigated by transaction costs and market fees. Base on The Effect of Profitability Ratios on Market Capitalization in Jordanian Insurance Companies Listed in Amman Stock Exchange [20] was analyzed the impact of the rates of return on the market capitalization for 25 insurance companies listed on the Amman Stock Exchange for the period of time 2010-2013 talk about Market capitalization can have an impact on a company's Return on Assets.

ICT's Positive Impact on Banking Efficiency: Information and Communication Technology (ICT) has a positive impact on a bank's efficiency. Having a well-prepared technical infrastructure, skilled workforce, and internal applications or online services can expedite the digital transformation process, thereby increasing ROA. In a study conducted by Thuy Nguyen in 2021, which utilized tabular data spanning from 2007 to 2019 for 20 commercial banks listed on the Vietnamese stock market, a comparable outcome was achieved. The research revealed that allocating resources to information technology investments can significantly transform a bank's operational model, leading to enhanced efficiency. Banks possessing substantial financial resources tend to take a proactive approach in intensifying their digital transformation efforts, consequently boosting their overall performance.

Digital Transformation Impact on Banking Efficiency: Digital transformation, which encompasses the use of digital technology, data, and digital processes to enhance operational efficiency, can positively influence a bank's performance. This result significantly diverges from the findings of Xuanli X. and S. Wang (2023). In their research, they found that the positive effect of digital transformation in banks on ROA in the following year is minor, indicating that the direct improvement of a bank's overall performance through digital transformation is limited. One potential reason for this variance may lie in the disparity in the measurement of the digital transformation variable. While Xuanli X. and S. Wang assessed digital transformation in banks across three dimensions, namely Strategy Transformation, Business Transformation, and Management Transformation, our study focuses on pinpointing the exact years in which banks have engaged in digital transformation within their strategic framework. Investing in and implementing digital transformation can yield benefits by optimizing production processes, effectively managing assets, improving customer experiences, and even creating new products and services. All of these factors can lead to an increase in Return on Assets (ROA) through enhanced productivity and business efficiency.

In summary, these variables have varying impacts on ROA based on theoretical concepts and empirical findings. The interplay of these factors within the specific context of the study can lead to different outcomes, highlighting the complexity of financial analysis.

**Results (Thầy Bảo)**

Discussion

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