International Journal of Multiphysics
Volume 18, No. 4, 2024
ISSN: 1750-9548

# Digital Transformation in Vietnam Commerical Banks: Moderating effect of COVID-19 Pandemic

**Do Hoai Linh[1*], Le Phong Chau[1], Nguyen Mai Huong[1], Pham Thi Ngoc Huyen[1], Tran Minh Khue[1], Nguyen Thi Tuyet Mai[1], Nguyen Thi Hai Yen[1]**

[1]National Economics University, Vietnam.
*Corresponding author

**Abstract**

Digital Transformation has attracted the attention of researchers and managers for a long time. The study aims to investigate the impact of digital transformation on bank performance in emerging countries such as Vietnam. The Feasible Generalized Least Square (FGLS) regression method was employed to test the research hypotheses and determine variables relationships in the proposed model. A panel data collected from 17 joint-stock commercial banks in Vietnam in the period between 2013 and 2022. The empirical results show that Digital Transformation has a significant and positive impact on the profitability of commercial banks while having a significant but negative effect on operational costs. However, the moderating variable, COVID-19 pandemic, is not statistically significant, showing that COVID-19 pandemic does not stimulate the positive outcomes of Digital Transformation regarding profit-making capability and cost efficiency within commercial banks in the data sample. Control variables such as Credit Risk, Solvency, and GDP exert certain significant influences on bank performance. Therefore, these findings provide new insights that help financial institutions compete and adapt to continuously changing conditions resulting in competitive advantages and success of Vietnam commercial banks in modern days.

**Keywords**: Digital Transformation, Bank Performance, Commerical Banks, COVID-19, Vietnam

## 1. Introduction

The Fourth Industrial Revolution has proven to be highly successful, leading to the emergence of Digital Transformation as an unavoidable global trend. It has become a critical factor in the survival of countries, organizations, corporations, and consumers worldwide. The significant increase in labor productivity, the fundamental changes in user experience, and the creation of new and innovative business models underscore the evident importance and impact of Digital Transformation in society. There is a progressive shift observed in firms transitioning from conventional to online businesses.

Digital Transformation refers to changing individuals' and enterprises' operations by utilizing digital technology to generate significant enhancements in doing business, personal experiences, and novel business models (Abdulquadri et al., 2021). This concept elucidates that implementing contemporary technologies in a business setting might bring about considerable alterations to its operational processes, leading to Digital Transformation. It is evident that changes in business activities caused by Digital Transformation are extremely evident and tend to explode in any industry, especially in the Finance and Banking sector of Vietnam. Vietnam chose May 11 as Digital Transformation Day for the banking industry. This is the milestone that marks the awareness of the importance of Digital Transformation in economic development as well as the banking industry. In addition, by October 2022, the State Bank of Vietnam reported that the banking industry had invested up to VND 15,000 billion in digital transformation activities, which turned Vietnam into one of the leading digital banking application countries, with a 40%/year growth rate in digital payments over the past 3 to 4 years.

However, Digital Transformation in the banking industry not only encompasses the integration of digital technologies into financial services and the adoption of innovation strategies to enhance operational efficiency and customer experience but also effectively responds and adjusts to uncertain social and market conditions, for instance, the COVID-19 pandemic. Emerging at the end of 2019, the COVID-19 pandemic rapidly spread,

resulting in devastating effects on the economy of Vietnam as well as the world. The coronavirus disease has been acknowledged as an essential driver for the robust implementation of Digital Transformation in the finance and banking sector (An, 2021). During the outbreaks, social distancing measures, such as quarantine, containment, and restrictions on travel, mass gatherings, and commercial activities, forced businesses to incorporate a greater degree of digital technology into their operational processes to align with the prevailing circumstances and uphold optimal levels of production efficiency.

With the mentioned benefits, Digital Transformation is believed to be a proper driver of bank performance. According to research that surveyed the efficiency of banking services via different channels in the period 2012-2015, the number of customers engaging in face-to-face transactions at bank branches in the UK dropped by 30%. As reported by the Banking Review Journal (2023), most Vietnamese credit institutions have completed the digitization of various vital operations. A variety of banks have recorded more than 90% of transactions conducted via digital channels. Generally, studies confirm that technological innovation contributes to the growth and viability of banks.

The impact of Digital Transformation on bank performance has been widely studied in recent years and always classified as one of the most urgent topics, which requires new research both domestically and internationally. There has been a wide range of studies by foreign scholars on this topic conducted in different contexts, scopes, and sectors. However, there are only a few studies on this topic in Vietnam from 2013 to 2022 with inconsistent findings. There is research conducted by Chien (2022) to evaluate the influence of technological development on the business performance of IT enterprises. The data was collected from 26 IT businesses on the stock exchange in Vietnam from 2010 to 2020. The results showed that science and technology have no impact on business performance in the short term but positive impacts in the long term. In another study examining the impact of financial technology (Fintech) on commercial banks' performance in Vietnam, Huy et al. (2023) used a fixed effects model based on quarterly panel data of 12 Vietnamese commercial banks between 2010 and 2021. They found positive impacts of Fintech applications on the performance of commercial banks. In addition, previous works on business performance assessment mainly employed profitability indicators such as ROA and ROE rather than cost-related measures. In particular, the number of studies on this topic in the context of COVID-19 in Vietnam is still limited.

Being aware of these limitations, the footprints of Digital Transformation on the performance of joint-stock commercial banks between 2013 and 2022 are analyzed in this paper, which seeks answers to the following questions: What are the impacts of digital transformation on the performance of Vietnam's listed commercial banks from 2013 to 2022? What impact does COVID-19 disease have on the relationship between digital transformation and the performance of Vietnamese-listed commercial banks? What recommendations are put forward to boost the performance driven by digital transformation, thereby improving the profitability of commercial banks in Vietnam?

The authors aim to elucidate the correlation between business performance and digital transformation. It also examines the impact of control variables such as Credit Risk, Solvency, and macroeconomic factors - GDP, on the bank performance. Additionally, the moderating impact of COVID-19 on the relationship between Digital Transformation and bank performance is investigated.

## 2. Literature Review

### *2.1. Theoretical framework*

*Resource-based Theory*

The main premise of Resourced-based theory is that firms cumulatively use and allocate resources in different ways to create sustainable competitive advantages and achieve higher performance (Conner, 1991; Peteraf, 1993). Several notable studies reflect this theory, including Penrose (1959), who identified organizational resources as having an essential role in an organization; Wernerfelt (1984), who emphasized the value of concentrating on a firm's resources rather than on its products, and Barney (1991) presented the core tenets of the Resource-based View help demonstrate that resources are controlled by the company, allowing the company to develop and

implement strategies that enhance its effectiveness and efficiency. In particular, the study of Barney (1991) laid the foundation for the Resource-based Theory.

Digital transformation is considered a resource revolutionizing companies' relationships with customers, how companies operate, how companies shape their business models, and how they structure themselves (Westerman & Bonnet, 2015). This could be explained by ways digital technologies, involving cloud computing, data analytics, social networks, and mobile, are used in coordination to enhance the operations of businesses (Kane et al., 2015). Thus, businesses can gather consumer data better and enhance their business procedures by organizing and integrating digital transformation resources (Karimi et al., 2001; Mithas et al., 2011).

*Signaling Theory*

According to Spence (2002), this theory originates from information asymmetry between inside and outside (the organization), meaning access to information is different between insiders and outsiders of an organization. This happens because individuals such as managers, directors, or departments within the company can have more access to internal information than investors or shareholders (Ross, 1977).

According to this theory, digital transformation is associated with uncertainty because investment in digital transformation can take a lot of time and cost, requiring a long-term strategy (Sebastian et al., 2017; Chanias et al., 2019), so stakeholders such as investors want to find ways to minimize that risk by reducing information asymmetry. Specifically, investors analyze specific actions and signals, such as from annual reports, to evaluate a company's digital transformation strategy and digital transformation outcomes (Bergh et al., 2014). Thus, investors will perceive a major firm as having a higher likelihood of successfully executing digital transformation if it places a high value on its digital transformation strategy (Fitzgerald et al., 2013). From here, investors who are wondering about buying shares of that large company will be willing to pay a high price, leading to an increase in the company's stock price and market capitalization, positively affecting its operations business (Dehning, Richardson, & Zmud, 2003; Kohli, Devaraj & Ow, 2012; Nicoară ND, 2023).

*Innovation theory*

Schumpeter's Theory of Innovation (1934) assumes that entrepreneurs seeking profits must innovate. Innovation is a response to the competition between businesses, to attain a competitive/monopoly advantage. In today’s markets, organizations engage in competition not solely through pricing tactics but also by innovation tools and advances in science and technology. This dynamic and transformative process of innovation remains central to business competition and economic development.

Yao et al., 2021 state that commercial banks possess the ability to foster and provide a more diverse range of new products and services within the Fintech innovation landscape. Furthermore, during the technology innovation process, they can broaden their business scope and increase the channels for obtaining funds. Fintech improves lending efficiency and increases the revenue of commercial banks (Gu & Zhang, 2018). In general, Innovation in technology/digital transformation significantly reduces costs, improves profitability, elevates the efficiency of data acquisition, and decision-making support, and enhances operational management. Moreover, these advancements can also boost productivity and improve the ability to attract investment capital, among other benefits for commercial banks.

*Transaction cost economics theory*

The concept of transaction costs was first mentioned in the classic paper "The Nature of the Firm" (1937) by Ronald Coase. Transaction costs refer to the expenses associated with the buying and selling process in the market, thereby potentially affecting the price of the product or service. In the banking sector, transaction costs are typically considered as financial costs that transaction participants must pay to carry out a financial or business transaction. Such costs commonly include brokerage fees, bank charges, processing fees, and custodial fees.

Developing transaction costs theory, Foss, 1996 asserts that investing in technology can lower production costs, resulting in decreased selling prices. This, in turn, leads to a decrease in transaction costs, enabling customers to purchase high-quality products at affordable prices. Following that, Chen, 2004 studying technology and

productivity, shows that using technology will increase productivity and reduce transaction costs. This is primarily attributed to the advancements in technology, particularly the emergence of the Internet, which allows businesses to connect with cost-effective suppliers worldwide. Therefore, information technology promotes profit improvement without increasing or even shrinking the size of the organization (Kenneth & Jane, 2009).

*2.2. Literature review*

*2.2.1. Digital Transformation and Bank Performance*

The essence of any business activity is profit. This is also the basic goal of bank administrators (Bobáková, 2003). Nambisan et al. (2019) argue that digital transformation brings greater efficiency to businesses by increasing profits when business processes are improved. Therefore, when evaluating business performance, the two most commonly used indicators are Return on Assets (ROA) and Return on Equity (ROE) to measure profit efficiency because these indicators reflect bank profitability and show whether commercial banks are using their resources effectively or not. Moreover, Return on Assets is defined as the percentage for determining the profitable nature of the company, related to the total assets while Return on Equity is the proportion of return on shareholders' equity. Besides, ROA includes both debt and equity, ROE only considers shareholder's equity. This will lead to the different purposes of using the two metrics, specifically, investors will be more interested in the ROE index because it demonstrates, on average, how much profit a company generates with the money shareholders have invested and how successful the firm's management team converts the capital into increased profits and growth for both the company and investors (Dietrich and Wanzenried 2011). Thus, it is necessary to take into account the two profit indexes ROA combined with ROE to have a comprehensive view of the financial performance of commercial banks.

Current literature presents some different relationships between digital transformation and bank performance. Some researchers suggest that digital transformation has an insignificant and negative relationship with Return on Assets due to the large initial investment cost that offset the benefits that digital transformation brought about, and it takes time to witness the positive effect of digital transformation (Kriebel & Debener, 2019; Jardak & Hamad, 2022; Lan Nguyen-Thi-Huong et al., 2023, Nhi et al., 2023). In contrast, the study of Chhaidar et al. (2022) found a strong positive effect of digital transformation on improving firm performance measured by ROA and ROE, similar to Zhai et al. (2022); Huy et al. (2023) and Azmi et al. (2020). The applications of digital technology also help banks enhance their value and attract customers, thus increasing the competitiveness of banks and strengthening their operations (Lin & Kunnathur, 2019; Ardito et al., 2021). Besides, digital transformation also boosts the bank's capabilities and risk resistance (Du et al., 2016; Jiao et al., 2021). Therefore, digital transformation is expected to support banks with positive outcomes due to operating process optimization, operational efficiency, and bank-customer relationship enhancement, resulting in increasing revenues and higher profit. Thus, we put forth the following hypotheses:

***Hypothesis 1 (H1): Digital Transformation has a positive impact on Return on Assets.***

***Hypothesis 2 (H2): Digital Transformation has a positive impact on Return on Equity.***

According to Mahendru & Bhatia (2017), bank efficiency is associated with the ability to simultaneously minimize costs and maximize revenue at its current level of production. Therefore, banks must take into account both input and output aspects to improve their efficiency performance, meaning that they not only have to focus on increasing revenue growth. improving profit efficiency, but also reducing costs, improving cost efficiency. Therefore, in this study, we measure cost-effectiveness using the Cost-to-Income Ratio.

The integration of technology into products and services yields a multitude of benefits for banks, including the attraction of a large customer base and the enhancement of operational management. Firstly, the implementation of digital banking platforms not only fulfills the customer's demand but also improves their overall experience, thus contributing to a significant growth in income for commercial banks. Secondly, the process of digital transformation enables synchronized and efficient processing of procedures and transactions, resulting in cost savings and improved labor productivity. This, in turn, enhances operational information and processes, as well as ensures prompt, clear, and transparent professional progress. Consequently, with the advancement of the digital

ecosystem, digital banks have witnessed a substantial increase in income while a decrease in operating costs, highlighting the effective utilization of resources and operational efficiency.

This is in line with Kriebel & Debener (2019), showing that digital transformation hurts personnel expenses in cost structure, thereby reducing the Cost-to-Income ratio. Similarly, Xie & Wang (2023) argue that digital transformation significantly decreases the cost-income ratio of banks and enhances bank efficiency. Therefore, we propose hypothesis 4.

***Hypothesis 3 (H3): Digital Transformation hurts the Cost-to-Income ratio.***

*2.2.2. The moderating role of Covid 19*

In addition to the aforementioned main hypotheses evaluating the influence of digital transformation on bank performance, this study incorporates the moderating variable of COVID-19 to examine the effect of the independent variable on the dependent variable within the context of the COVID-19 pandemic.

Commencing in late 2019, the COVID-19 pandemic broke out suddenly and rapidly spread to numerous nations globally. Not only does it cause the loss of human lives but also severely hinders diverse sectors and industries. Specifically, in Vietnam, the Gross Domestic Product (GDP) witnessed a growth of 2.91% in 2020 and 2.58% in 2021, marking the lowest increase in the past three decades. At the same time, the global supply chain disruption results in business hardships, numerous bankruptcies, supply and demand" workforce scarcity, as well an increasing unemployment rate.

Regarding financial markets, the COVID-19 outbreak affects stock market volatility (Narayan & Phan, 2020; Iyke, 2020), liquidity (Just & Exhaust, 2020; Karim et al. al., 2021), risk (Zhang et al., 2020), solvency (Mirza et al., 2020) and profitability (Al-Awadhi et al., 2020; Anh & Gan, 2020). Before and after the COVID-19 outbreak, the operational capacity and profitability of commercial banks were significantly different.

However, viewed from another aspect, the COVID-19 pandemic is not only considered a challenging crisis but also a positive factor for the acceleration of digital transformation in the financial and banking sectors. (Lyons et al., 2017) identified digitalization of the financial sector as an improvement in providing financial services effectively while ensuring banks' profitability. Particularly during the pandemic, the advancement of digital technology has played a crucial role in meeting the demand for contactless transactions and sustaining customers' shopping, consumption, and financial activities. In Vietnam, the digital platform has facilitated the growth of digital banking services, from conventional direct transfer transactions to e-wallet payment systems. This development not only stimulates economic recovery but also provides a solution for financial risk management during the pandemic (Arner et al., 2020).

Overall, the emergence of COVID-19 has presented numerous investment opportunities for digital transformation in the banking industry. So, in the context of the epidemic in Vietnam, how does digital transformation impact commercial banks' performance? In other words, does the COVID-19 pandemic moderate the relationship between digital transformation and Vietnamese commercial banks' performance? Zhu & Jin (2023) show that COVID-19 hurts the relationship between Digital Transformation and Bank Performance, while (Abidi et al. 2023) found no interaction effect between digital transformation and COVID-19 of digitally-enabled firms and digitally-constrained firms in the Middle East and Central Asia region. These contrasting findings can be attributed to the limited use of the moderating variable "COVID-19" in related studies, as well as the differences in contexts and research subjects across previous studies. Therefore, further research is needed to contribute to the existing literature review on this topic.

In addition, we found that the influence of COVID-19 on the relationship between Digital Transformation and Bank Performance is mainly measured by profit index without mentioning costs, while cost efficiency is also one of the crucial goals of achieving business performance. Therefore, this paper proposes hypotheses considering the moderate impact of COVID-19 as follows:

***Hypothesis 4 (H4): COVID-19 moderates the relationship between Digital transformation and Return on Assets.***

***Hypothesis 5 (H5): COVID-19 moderates the relationship between Digital transformation and Return on Equity.***

***Hypothesis 6 (H6): COVID-19 moderates the relationship between Digital transformation and Cost to Cost-to-Income ratio.***

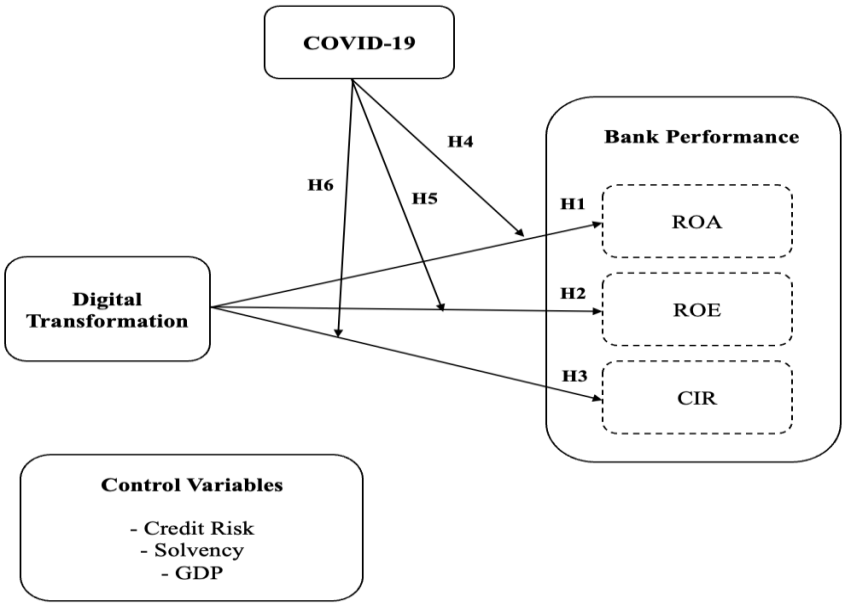


**Figure 1. The research model**

## 3. Methodology

*3.1. Research design*

Based on research model in Figure 1, the research team used multiple regression analysis methods for panel data. Therefore, we propose a research model as follows:

- **Regression model:**

$$ROA_{i,t} = \alpha_0 + \alpha_1 C\text{Đ}S_{i,t} + \alpha_2 C\text{Đ}S_{i,t} * COVID-19_{i,t} + \alpha_3 CREDIT\ RISK_{i,t} + \alpha_4 SOLVENCY_{i,t} + \alpha_5 GDP_{i,t} + \varepsilon_{i,t}$$

$$ROE_{i,t} = \beta_0 + \beta_1 C\text{Đ}S_{i,t} + \beta_2 C\text{Đ}S_{i,t} * COVID-19_{i,t} + \beta_3 CREDIT\ RISK_{i,t} + \beta_4 SOLVENCY_{i,t} + \beta_5 GDP_{i,t} + \mu_{i,t}$$

$$CIR_{i,t} = \gamma_0 + \gamma_1 C\text{Đ}S_{i,t} + \gamma_2 C\text{Đ}S_{i,t} * COVID-19_{i,t} + \gamma_3 CREDIT\ RISK_{i,t} + \gamma_4 SOLVENCY_{i,t} + \gamma_5 GDP_{i,t} + \nu_{i,t}$$

**In which, $ROA_{i,t}$:** *return on total assets of bank i in year t;*

$ROE_{i,t}$*: return on total equity of bank i in year t;*

$CIR_{i,t}$*: cost-to-income structure of bank i in year t;*

$C\text{Đ}S_{i,t}$*: the level of technology investment of bank i in year t*

$COVID-19_{i,t}$*: dummy variable representing the COVID-19 pandemic*

*$CREDIT\ RISK_{i,t}$: ratio of bad debt to total outstanding loans (representing credit risk) of bank i in year t*

*$SOLVENCY_{i,t}$: ratio of total equity to total assets (representing solvency) of bank i in year t*

*$\alpha_0, \alpha_1, \alpha_2, \alpha_3, \alpha_4, \alpha_5, \alpha_6\ \beta_0, \beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6, \gamma_0, \gamma_1, \gamma_2, \gamma_3, \gamma_4$: coefficients of the regression equations*

$\varepsilon_{i,t}, \mu_{i,t}, \nu_{i,t}$: error of the corresponding regression equations.

*3.2. Samples & Data Source*

The research used secondary data collected from the annual reports and audited financial statements of 17 Joint Stock Commercial Banks in the period from 2013 to 2022. After the process of screening and eliminating observations that lack information and reliability, do not guarantee the listing time, or have outliers that affect the calculation results, the research team synthesized the data. Data in panel data form of 17 banks over 10 years (2013-2022), equivalent to 170 observations. The number of observed Joint Stock Commercial Banks is listed in the following table.

**Table 1. List of Joint Stock Commercial Banks in Vietnam**

| No. | Name | Abbr. |
|---|---|---|
| 1 | Asia Commercial Joint Stock Bank | ACB |
| 2 | BAC A Commercial Joint Stock Bank | BAB |
| 3 | Joint Stock Commercial Bank for Investment and Development of Vietnam | BID |
| 4 | Vietnam Joint Stock Commercial Bank of Industry and Trade | CTG |
| 5 | Viet nam Export Import Commercial Joint Stock Bank | EIB |
| 6 | Military Commercial Joint Stock Bank | MB |
| 7 | The Maritime Commercial Joint Stock Bank | MSB |
| 8 | National Citizen bank | NCB |
| 9 | Orient Commercial Joint Stock Bank | OCB |
| 10 | Saigon-Hanoi Commercial Joint Stock Bank | SHB |
| 11 | Southeast Asia Commercial Joint Stock Bank | SSB |
| 12 | Saigon Thuong TinCommercial Joint Stock Bank | STB |
| 13 | Viet Nam Technological and Commercial Joint Stock Bank | TCB |
| 14 | TienPhong Commercial Joint Stock Bank | TPB |
| 15 | Joint Stock Commercial Bank for Foreign Trade of Vietnam | VCB |
| 16 | Vietnam International Commercial Joint Stock Bank | VIB |
| 17 | Vietnam Commercial Joint Stock Bank for Private Enterprise | VPB |

The common characteristic of these banks is that they are all joint stock commercial banks in Vietnam. The total assets of the 17 banks considered in this study will reach 11.1 million billion VND in 2022, accounting for 87.4% of the total asset size of the entire banking industry. This shows that the selected research sample can generalize and represent the entire banking industry.

After collecting, calculating, cleaning, and eliminating missing data on the Excel spreadsheet, the team brought the data into STATA17 software to conduct data analysis. In this study, the secondary data set is implemented in panel data, so regression analysis will be conducted using the Panel Data Regression method with the approach of all four models, including Pooled OLS model (pooled OLS model), fixed effect model (FEM), random effect model (REM). Then, the research team conducts testing to select the most suitable research model and finally corrects the model using the FGLS model to overcome model defects.

*3.3. Digital Transformation Measurement*

Digital transformation is the process of deeply and rapidly transforming operations, processes, capabilities, and business models to fully take advantage of changes and opportunities created by digital technology and its impact on society optimally and strategically (Demirkan et al., 2016; Gong and Ribiere, 2021).

Up to the present time, worldwide scholars have used various methods to measure digital transformation variables. In this study, the Bank Digital Transformation Index developed by the Digital Finance Research Center of Peking University in 2022 is selected as a proxy variable for the bank's digital transformation process. product due to its comprehensiveness and reasonableness. The Bank's Digital Transformation Index is divided into three dimensions: strategy, business, and management (Qi and Cai, 2019; Yang et al., 2021; Xie & Wang, 2023). Among them, the digitalization strategy focuses on the bank's attention to digital technology. Business transformation focuses on the extent to which digital technology is integrated into a bank's financial services. Management transformation focuses on the level of integration of digital technology into the bank's governance structure and management organization. Table 2 below presents the measurement method.

**Table 2. Descriptions of indicators of digital transformation of commercial banks.**

| First-level indicators | Second-level indicators | Type | Measurements |
|---|---|---|---|
| Strategy transformation | Frequency of digital technology keywords in annual report | Continuous variable | Several keywords related to digital technology appear in the annual report (Xie & Wang, 2023). |
| Business transformation | Digital project | Categorical variable | IT projects that have been implemented during the research period. |
| | Digital channel | Categorical variable | Channels of e-banking and e-wallet are linked in one year |
| | Digital products | Categorical variable | Products and services of digital banking: Internet wealth management, internet credit, e-commerce, e-payment,... |
| | Digital awards | Categorical variable | Awards related to digital achievements. |
| | Digital architecture | Categorical variable | Digital-finance-related departments and fintech subsidiaries. |
| Management Transformation | Digital talents | Categorical variable | Number of directors with IT background on the board of directors |
| | | Categorical variable | Number of executives with IT backgrounds in the management team |
| | Digital cooperation | Categorical variable | Collaborations with technology companies |

*3.4. Control variables*

Besides, the study has control variables on business characteristics and macro factors.

**Credit risk:** Credit risk is defined as the possibility of losing part or all of the loan balance due to credit events (default risk), determined by the ratio of Bad Debt to Total Outstanding Debt. Credit risk is an internal factor that determines a bank's operational efficiency.

**Solvency ratio:** The solvency ratio, which is the ratio between equity and total assets, measures the risk level of a business (Chhaidar et al., 2022). The equity-to-assets ratio shows how much of a bank's money is raised from equity instead of debt. So, this ratio also reflects a bank's ability to pay all short-term and long-term debts.

**GDP:** The growth rate of any country's gross domestic product reflects that country's economic growth rate. The banking system has long played a vital role in the economy, being the main channel for capital to participate in the production and business process. Therefore, the development of an economy is reflected in the banks' performance.

**4. Results**

**4.1. Descriptive Statistics**

**Table 3. Descriptive statistics of variables**

```
. sum ROA ROE CIR CreditRisk Solvency GDP CDS COVIDCDS
```

| Variable | Obs | Mean | Std. dev. | Min | Max |
|---|---|---|---|---|---|
| ROA | 170 | .0104319 | .0076838 | 0 | .0361 |
| ROE | 170 | .1214109 | .0712097 | 0 | .2807927 |
| CIR | 170 | .4908408 | .1569015 | .2271 | 1.2543 |
| CreditRisk | 170 | .018435 | .0156214 | .0035 | .179 |
| Solvency | 170 | .0819998 | .0271113 | .04 | .1697 |
| GDP | 170 | .05871 | .0170398 | .0258 | .0802 |
| CDS | 170 | .4777165 | .2964934 | .0614446 | 1.968077 |
| COVIDCDS | 170 | .2188033 | .3879634 | 0 | 1.968077 |

As can be seen from Table 3, the average ROA of banks is 1.04%, the lowest is 0.000009%, the highest is 3.61%, and the standard deviation is 0.77%, showing that there is not a big difference in operating efficiency. of commercial banks in Vietnam. Meanwhile, the average ROE of banks is 12.14%, the lowest is 0.00014%, the highest is 28.08%, and the standard deviation is 7.1%, showing that, in general, there is not too much fluctuation during the period. research section. In addition, Table 3 also shows that the Cost-to-Income ratio of banks is, on average, 49.08%, with amplitude ranging from 22.71% to 125.43% and a standard deviation of 15.69%, showing that there is a clear difference in the performance of commercial banks. The average level of digital transformation of banks is 47.77 %, the lowest value is 6.14%, the highest value is 196.8%, and the standard deviation is 29.65%, showing the level of digital transformation between banks. Commercial banks vary widely, and the data is relatively scattered. Because data has been collected since 2013, businesses in general and banks specifically have made some progress in digital transformation. However, it is essential to note that the level of implementation varies among different banks.

### 4.2. Hypothesis Testings and Discussion

**Table 4.. Digital Transformation and Return on Asset**

| ROA | Coefficient | Std. err. | z | P>\|z\| | [95% conf. | interval] |
|---|---|---|---|---|---|---|
| CDS | .0038376 | .0013458 | 2.85 | 0.004 | .0011999 | .0064753 |
| COVIDCDS | .0007232 | .000838 | 0.86 | 0.388 | -.0009192 | .0023656 |
| CreditRisk | -.0446505 | .0166008 | -2.69 | 0.007 | -.0771874 | -.0121135 |
| Solvency | .1486933 | .0137799 | 10.79 | 0.000 | .1216853 | .1757014 |
| GDP | .0249952 | .0077218 | 3.24 | 0.001 | .0098607 | .0401297 |
| _cons | -.0047857 | .0012485 | -3.83 | 0.000 | -.0072328 | -.0023386 |

**Table 5. Digital Transformation and Return on Equity**

| ROE | Coefficient | Std. err. | z | P>\|z\| | [95% conf. | interval] |
|---|---|---|---|---|---|---|
| CDS | .0596399 | .018086 | 3.30 | 0.001 | .024192 | .0950879 |
| COVIDCDS | -.0017163 | .0124662 | -0.14 | 0.890 | -.0261497 | .022717 |
| CreditRisk | -.4229447 | .1969215 | -2.15 | 0.032 | -.8089039 | -.0369856 |
| Solvency | .2222699 | .1718804 | 1.29 | 0.196 | -.1146094 | .5591493 |
| GDP | .2577228 | .101206 | 2.55 | 0.011 | .0593626 | .4560829 |
| _cons | .0647915 | .0171733 | 3.77 | 0.000 | .0311325 | .0984506 |

**Table 6. Digital Transformation and Cost-to-Income Ratio**

| CIR | Coefficient | Std. err. | z | P>\|z\| | [95% conf. | interval] |
|---|---|---|---|---|---|---|
| CDS | -.1958275 | .0433515 | -4.52 | 0.000 | -.2807949 | -.1108601 |
| COVIDCDS | -.0093167 | .0349775 | -0.27 | 0.790 | -.0778714 | .059238 |
| CreditRisk | 3.419653 | .8165225 | 4.19 | 0.000 | 1.819298 | 5.020007 |
| Solvency | -.6192948 | .3135964 | -1.97 | 0.048 | -1.233933 | -.0046572 |
| GDP | .6701898 | .4596776 | 1.46 | 0.145 | -.2307617 | 1.571141 |
| _cons | .5208339 | .0411076 | 12.67 | 0.000 | .4402645 | .6014033 |

This study examines the effect of Digital Transformation on Bank Performance.

Table 4 shows that the dependent variable Digital Transformation is positively and significantly correlated with the independent variable Return on Asset (ROA), with a regression coefficient of 0.0038376 (1% significance level). It means that higher Digital Transformation is associated with a higher Return on Asset Index. The regression result for Return on Equity (ROE) is illustrated in Table 5 The estimated coefficient shows that other variables remain constant, an increase of 1 unit in digital transformation will result in a corresponding increase of 0.0596399 units in the Return on Equity and vice versa. The more a bank promotes digital transformation, the more its business performance (ROE) increases.

The result of digital transformation regarding bank profitability measured by ROA and ROE shows positive correlations. This can be explained that the benefits of digital transformation to the performance of commercial banks are apparent as digital transformation enables commercial banks to innovate new products, improve customer services, enhance business procedures, and increase competitiveness to operate more effectively, resulting in boosting revenue and higher profitability. However, the research results contradict the findings of Bughin and Zeebroeck., 2017; Jardak & Hamad., 2022; Lv et al., 2022, Nga et al., 2023, while supporting the findings of both Vietnamese authors (Nguyen and al., 2021; Trang et al., 2022; Huy et al., 2023) and foreign

authors (Becalli, 2007; Lin et al., 2020; Stefanovic et al., 2021; Zuo et al., 2021; Chhaidar et al., 2022). This discrepancy can be explained that the impact of digital transformation on ROA and ROE might experience lag effects and it takes time to display the beneficial effects of digital technology while investing in digital transformation might be costly; thus commercial banks must decide the appropriate digital transformation strategies that match its capabilities to reap positive benefits from digital transformation.

Table 6 demonstrates the Feasible Generalized Least Squares result for the Cost to Income ratio (CIR). The independent variable Digital Transformation has a regression coefficient of -0.1958275 at a 1% significance level. The signs of this regression coefficient are as expected. It illustrates that Digital Transformation is essential to reducing operational costs and achieving higher bank efficiency. In summary, Hypotheses 1, 2, and 3 are confirmed.

Theoretically, the result of this study are consistent with the transaction cost theory of Ronald Coase (1937) mentioned in the theoretical framework and is similar to the findings of previous studies (Beccalli, 2007; Xie & Wang, 2023; Ren Y, Li B & Liang D, 2023; Zhu & Jin, 2023). Practically, in technical terms, the advancement of information technology is the foundation for digital transformation in banking. Currently, artificial intelligence, big data, machine learning, and other modern technologies are being applied to improve customer service while also saving a significant amount of time and human resources in administrative duties. As a result, managerial responsibilities are more effectively carried out when innovative technology is applied. Therefore, applying digital transformation lowers expenses and enhances the effectiveness of information-gathering and decision-making processes as well as operations of commercial banks.

**Moderator variable - Covid 19**

This paper also introduces COVID-19 as a moderator variable to examine the impact of digital transformation on commercial banks' performance. The research results show that Covid is not statistically significant as its p-value is higher than the 10% significance level in all three models which are ROA, ROE, and CIR respectively. This means that the COVID-19 pandemic does not moderate the relationship between digital transformation and Vietnamese commercial banks' performance. Therefore, Hypotheses 4, 5, and 6 are rejected.

These findings are in contrast to the study of Lutfi, Alshira'h et al. (2022); and Zhu & Jin (2023), however, in line with (Abidi et al., 2023). This suggests that the bank performance may be less affected in the short term by the joint effect of digital transformation and the pandemic, potentially due to significant policy support during and after the pandemic. Another possible explanation is that financial indexes namely Return on Assets (ROA), Return on Equity (ROE), and Cost-to-Income Ratio (CIR) may not be appropriate to measure the influence of digital transformation, instead, operating efficiency could be a more suitable measure. However, it should be noted that information on bank operational performance is not available.

**Control variables**

The control variables of this study are Credit Risk, Solvency, and GDP.

In the ROA model, these control variables are significant at 1%. Specifically, a negative and statistically significant correlation exists between Credit Risk and ROA, as indicated by a correlation coefficient of -0.0446505. Solvency and GDP have on average a significantly positive impact on Return on Asset (ROA), with correlation coefficients of 0.1486933 and 0.0249952, respectively.

In the ROE model, except for the Solvency variable, both Credit Risk and GDP demonstrate statistical significance at the 5% level. While Credit Risk has a negative effect, macroeconomic factors like GDP show a positive relationship towards dependent variable ROE. The regression coefficients are - 0.4229447 and 0.2577228, respectively. This means bank performance is also significantly controlled by both internal elements (Credit Risk) and external factors (GDP).

In the CIR model, it is evident that the macro variable GDP does not control the variation of the CIR variable. However, CreditRisk has a significant positive influence on CIR at a significance level of 1%, with a

correlation coefficient of 3.419653. Additionally, Solvency is found to have a significant negative impact on CIR at a significance level of 5%, with a regression coefficient of - 0.6192948.

## 5. Conclusions

According to the research findings, other stakeholders should cooperate in attaining numerous tasks. Firstly, the government is expected to enhance regulatory measures in the banking industry to establish an enabling environment for commercial banks to undertake their digital transformation endeavors. In addition, the Central bank needs to test several financial technology policies and remove difficulties in establishing a cross-sector digital ecosystem. Besides, the Ministry of Information and Communications should collaborate with the Central Bank and other relevant ministries and agencies to boost communication efforts aimed at the widespread adoption of technological innovations within the banking sector. Moreover, the Ministry of Public Security should quickly introduce solutions to provide citizen credit scoring services as a source of reference for commercial banks in their internal credit scoring system.

Secondly, commercial banks must raise the degree of consciousness among senior executives on the significance and immediacy of digital transformation while also fostering the active engagement of all staff. It is recommended to conduct surveys to assess the presence of any gaps in technological knowledge among employees, and the implementation of novel policies aimed at both retaining and attracting individuals possessing technological expertise should be considered. Furthermore, enhancing collaboration with IT enterprises to execute advanced technological initiatives is necessary as well as active engagement with Government agencies is crucial for the development of clearly defined strategies for digital transformation. Commercial banks should formulate a comprehensive communication strategy aimed at effectively introducing digital services to the general public. This will ensure that clients are well-informed and possess the necessary confidence to readily avail themselves of these new services. Commercial banks should establish a complete framework of rules and regulations about the sharing and security of information. This framework serves the purpose of safeguarding the personal data of consumers and ensuring compliance with the Law on Access to Information.

In summary, this paper sampled 17 Vietnamese joint-stock commercial banks from 2013 to 2022 to study the relationship between digital transformation and the performance of commercial banks. Besides, the moderator variable COVID-19 was introduced to test the impact of digital transformation on bank performance, and the following conclusions were drawn. Firstly, digital transformation enhances both the profitability and cost efficiency of commercial banks. Specifically, digital bank transformation improves efficiency, reduces operating costs, and promotes the growth of financial performance. Secondly, further examination the authors found that the influence of COVID-19 on the ability of the digital bank transformation to generate profit and cut down operating costs is statistically insignificant. This leads us to conclude that improving performance is a continuous process unaffected by disruptive factors such as crisis. Thirdly, the control variables Credit Risk, Solvency, and GDP have varying effects on bank performance.

**Acknowledgment:** The paper has been sponsored by National Economics University, Vietnam

**Conflict of interest:** None

Financial support: This paper has been funded by National Economics University, Vietnam

Ethics statement: None

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