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IMPACTS OF DIGITAL TRANSFORMATION ON THE COMPETITIVENESS OF VIETNAMESE COMMERCIAL BANKS

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Abstract

This study investigates the impact of digital transformation on the competitiveness of Vietnamese commercial banks. Given the rapid technological advancements of the Fourth Industrial Revolution and the increased competition from Fintech and Bigtech firms, Vietnamese commercial banks are compelled to adopt innovative financial technologies. Moreover, the COVID-19 pandemic has further accelerated digital transformation, necessitating widespread adoption of digital services. By analyzing panel data from 29 banks over 12 years, the study evaluates variables such as ICT Index, bank size, and financial ratios. Findings suggest a positive impact on bank competitiveness, with certain variables showing significance. This study is essential for understanding the current landscape and prospects of Vietnamese banking amidst ongoing digital transformation, providing actionable recommendations, and aiming to guide policymakers, regulatory bodies, and industry stakeholders in formulating policies to enhance the banking sector's competitive capacity.

Key Words: *Digital transformation, Digital banking, ICT Index, Lerner Index, Vietnam.*

1. Introduction

Digital transformation, driven by the Fourth Industrial Revolution (4.0) and intensified competition from Fintech and Bigtech companies, has accelerated in the banking sector globally. In Vietnam, international integration has deepened and broadened through the country's participation in international trade organizations and the signing of multilateral and bilateral trade agreements. This has provided opportunities for many foreign banks to enter the domestic market and engage in operations, heightening competition. Furthermore, the strong emergence of Fintech companies has also impacted the operations of traditional banks. With their technological prowess, Fintech companies have expanded beyond traditional activities such as lending and payment services, venturing into areas like peer-to-peer lending, international payments, and more. This wave of Fintech companies

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has compelled domestic banks to adopt advanced technologies in their financial services if they wish to survive and thrive in the market.

The year 2020 saw significant challenges for the global finance and banking industry due to the COVID-19 pandemic. However, it also accelerated digital transformation across all sectors, including finance and banking. Remote work became widespread, necessitating changes in work practices and driving the adoption of digital services. The financial industry rapidly transformed customer experiences through digitalization, leveraging technologies such as RPA, AML, KYC, and RegTech. Vietnamese banks are investing in technology to enhance operational efficiency and competitive capabilities.

This study aims to provide empirical evidence of the impact of digital transformation on the competitive capabilities of Vietnamese commercial banks. Using panel data from 29 joint-stock commercial banks from 2010 to 2022, the study will evaluate factors such as the ICT Index, bank size, equity-to-assets ratio, debt-to-assets ratio, and deposit-to-debt ratio, and provide recommendations for their digital transformation progress.

2. Literature Review

2.1. Digital Transformation

2.1.1. Overview of the Digital Transformation

Martin (2008) defines digital transformation as the application of information and communication technology and the automation process to enhance capabilities for businesses, governments, and individuals. According to Schwertner (2017), digital transformation involves leveraging technology to create new business models, processes, software, and systems, resulting in increased revenue, competitive advantage, and higher efficiency. Businesses achieve these outcomes by transforming processes and business models, empowering their workforce, and innovating to enhance personalized customer and citizen experiences.

Digital transformation in banking encompasses changes in culture, organization, and business operations through technology (Lugovsky, 2021). At its core, digital transformation involves transitioning to digital customer service online. It encompasses enhancements in service delivery, process automation, customer experience, data integration, organizational flexibility, and sales operations. Banks are adopting comprehensive digital services, reducing direct interactions, and introducing banking information technology products. This shift positions banks as technology companies, facilitated by close collaboration between marketing and information technology departments to deliver digital banking products. Using digital transformation to enhance operational efficiency, commercial banks have now aimed to transform their business models to optimize real-time, seamless multi-channel customer experiences. Successful digital transformation has contributed to increasing the competitive advantage of commercial banks over traditional financial institutions and Fintech companies.

Digital transformation in the banking industry yields multiple benefits, fostering growth and sustainable competitive advantages. Firstly, it streamlines operations and boosts efficiency by automating internal processes and enhancing transaction processing capabilities. Secondly, it improves customer experience through innovative digital channels like mobile apps and websites, enabling 24/7 access to account monitoring and transactions without physical visits. Moreover, online interaction platforms facilitate efficient customer communication, nurturing enduring relationships and trust. Thirdly, digitalization enhances transparency and compliance, aiding in accurate transaction tracking and regulatory adherence, mitigating risks. Lastly, leveraging digital technology enables banks to offer innovative services, competitive pricing, and flexible strategies, bolstering customer engagement and market position.

2.1.2. Measurements of Digital Transformation

The "E-readiness" index or "ICT Index" is a tool for evaluating the state of ICT readiness in Vietnam and globally. The ICT Index encompasses all technical means for communication, information generation, dissemination, storage, management, and processing (Binsfeld, 2018). To construct the Vietnam ICT Index, the Vietnam Computer Association collaborates with the National Steering Committee for ICT and the Enterprise Informatics Institute, using the evaluation methodology of ITU and Harvard University. The index aims to provide information about the current status and readiness level of ICT development and application in Vietnam.

The objectives of the Vietnam ICT Index are to assess organizations' readiness for ICT development and application, provide insights into ICT development, and help organizations enhance the effectiveness of their ICT applications. In the banking sector, the ICT Index measures four categories of indicators: ICT technical infrastructure, ICT human resource infrastructure, ICT applications, and organizational environment and policies for ICT (Kashorda and Waema, 2011). These indicators are sourced from reports provided by financial institutions based on templates from the Vietnam Computer Association. With the rise of online payment services and Fintech companies, this research focuses on ICT application indicators, particularly in the section on "Online Services for Customer Service".

2.2. Bank Competitiveness

2.2.1. Overview of the Bank's competitive

Numerous articles discuss competitive advantage, yet consensus remains elusive. OECD (1993) stated that "Competition is a situation in a market where independent companies or sellers strive to elicit the response of buyers to achieve a certain business goal such as profit, sales, or market share". Competition serves as a crucial process that compels companies to continually innovate and enhance operational efficiency to offer customers a range of product and service alternatives at more affordable prices. As a result, consumer welfare is heightened, and the efficiency of resource allocation improves. At the micro level, firm-level competitiveness is closely related to long-term operational efficiency and higher returns on investment for owners (Yap, 2004). At the macro level, Garelli (2002) defines national competitive advantage as a field of economic theory and analysis that examines the current situation and policies to establish the ability of a nation to sustain and build a sustainable environment, creating greater value for individuals and entities within the country. In Mehra (1998) research, firm-level competitive advantage refers to the ability to maintain and expand market share and profitability. Currently, competitive advantage is seen as the ability of businesses and other organizations to sustain, create, and develop existing advantages (in terms of consumption of goods and services compared to competitors) to increase market share and generate value for owners.

Besides, Lerner (1934) shown that "market power reflects the ability of a seller to set prices higher than marginal cost." Lerner expounded on this concept based on the disparities in the slope and elasticity of the demand curve that a seller faces in competitive and

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monopolistic markets. The demand curve confronting a seller in a monopolistic market is steeper, and its elasticity is not infinite as in a perfectly competitive market, leading to the seller being able to price at a level that maximizes their profit or "monopoly revenue." Church and Ware (2000) also identified that firms operating in a perfectly competitive market lack market power, whereas the greatest market power resides in monopolistic markets. This implies an inverse relationship between market power and competition, where a high level of competition corresponds to low market power of businesses, and vice versa.

2.2.2. Measurements of the bank's competitiveness

In general, there are two primary approaches considered when defining and assessing banking competition: the structural approach based on the Industrial Organization (IO) economic theory, and the non-structural approach developed based on empirical evidence from the New Empirical Industrial Organization (NEIO).

The structural approach provides measures of competition based on market structure characteristics. This approach assesses market power from the perspective of the traditional IO framework, following Bain's (1951) Structure-Conduct-Performance paradigm (SCP) (Boru and Kuhil, 2018). In general, the SCP model argues that market concentration reduces competitive behavior. Furthermore, the model assumes that market structure is related to competitive behavior, and competition can be measured through market structure metrics, primarily those related to concentration levels such as the number of banks, Concentration Ratio, and the Herfindahl-Hirschman Index (HHI) – inverted indices of competition intensity.

In recent years, non-structural approaches to represent market concentration measures have gained popularity because concentration measures have proven inadequate in assessing competition in contestable markets, where producers can enter and exit without incurring significant losses. With increasingly comprehensive and publicly available banking data, new methods for measuring competition based on the behavior of banks have emerged and been applied in many countries. Typical competition measures include the Lerner index (Lerner, 1995) and the H-statistic (Panzar and Rosse, 1987).

The H-statistic approach is employed to assess competitiveness within an industry across various competitive scenarios, including perfect competition, monopolistic competition, and monopoly. However, within the contemporary context of the digital economy, traditional methods for gauging and evaluating the competitiveness of commercial banks, such as the H-statistic approach, have become less precise. The H-statistics method carries two major shortcomings. Firstly, it was developed based on a static model and lacks specific boundaries (Leuvensteijn *et al.*, 2011). Moreover, the assumption made by the H-statistics index regarding a market equilibrium is unrealistic due to the entry and exit of firms in the industry (Claessens and Laeven, 2004). These limitations constrain the explanatory power of H-statistics results.

Conversely, the Lerner index has been demonstrated to offer advantages over H-statistics. The Lerner index, widely employed as a measure of competition among banks, represents market power. It determines the degree to which a firm adjusts prices in a given market period compared to prices under conditions of perfect competition, calculated using the formula:

$$\boldsymbol{Lerner}_{i,t} = \frac{(\boldsymbol{P_{i,t}} - \boldsymbol{MC_{i,t}})}{\boldsymbol{P_{i,t}}}$$

In which: i represents banks, t represents time, P represents output price calculated as total revenue/total assets, MC represents the bank's marginal cost (Lerner, 1995). The Lerner index value ranges from 0 to 1. Under standard assumptions, the Lerner index decreases as competition intensifies and equals 0 under conditions of perfect competition. In contrast, it increases when the price-cost margin of the bank is higher, implying greater market power. To compute the Lerner index, one must first construct a cost function dependent on output and various types of input costs. In the banking sector, studies typically incorporate three types of costs: management costs, employee costs, and capital costs. Consequently, the total cost function is determined as follows:

$$\boldsymbol{TC}_{i,t} = \boldsymbol{f}\,(\boldsymbol{Q_{i,t}}, \boldsymbol{W_{1i,t}}, \boldsymbol{W_{2i,t}}, \boldsymbol{W_{3i,t}}, \ldots.)$$

In which, $TC_{i,t}$ is total cost, $Q_{i,t}$ is the total output of bank i in year t. Marginal cost is calculated as the derivative of total cost, with the formula as follows:

$$\boldsymbol{MC_{i,t}} = \frac{\boldsymbol{\partial TC_{i,t}}}{\boldsymbol{\partial Q_{i,t}}}$$

According to Demirguc-Kunt and Peria (2010), the Lerner index is not a long-term measure of competition; instead, it can be computed at various points in time. The Lerner index represents a bank's pricing power in the market. This index is allowed to vary flexibly at the bank level and over time, thus, it can capture market power and competition dynamics more effectively. Furthermore, most approaches determine overall competition for the entire industry, whereas the Lerner index, belonging to the minority of approaches, can be measured at each bank level, within the industry, and over time, thereby identifying different behavioral patterns in the same market and across years (Berger *et al.*, 2004). Despite its numerous advantages, the Lerner index also has weaknesses. It cannot adequately capture the degree of product substitution (Vives, 2008), while Fernández de Guevara, Maudos and Pérez (2005) emphasizing that the Lerner index may overestimate market power as banks allocate relatively more resources to fund activities with higher profit margins.

Therefore, with the numerous superior advantages that have been analyzed, this study will use the Lerner index to represent the competition of Vietnamese commercial banks.

2.3. The Impacts of Digital Transformation on Bank Competitiveness

The 4.0 Revolution has driven digital transformation as a critical trend for banks to gain competitive advantages, adapt proactively, and achieve sustainable growth. Studies have found that digital transformation positively impacts customer experience, customer connectivity, bank efficiency, and productivity in the banking industry.

Yang *et al.*, (2018) found that digital transformation, particularly through E-banking services, improves the profitability of commercial banks. Similarly, Siddik *et al.*, (2016) examined the relationship between E-banking services and the operational efficiency of the banking sector in Bangladesh, showing a positive impact on bank profitability with a two-year lag. Additionally, Paisal, Afrizawati and Sabli (2023) investigated the impact of digital banking systems on customer service effectiveness in bank operations, using primary data collected through questionnaires,

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interviews, and observations involving 54 individuals in the customer service area of Bank Negara in Indonesia. The results revealed a positive effect of digitization on customer service effectiveness, as digital services provide essential features for customers to conduct simple banking transactions without requiring in-person visits. El-Chaarani and El-Abiad (2018) also demonstrated, based on data from Lebanon, that technological innovations such as E-banking services and ATMs play a positive role in enhancing the operational efficiency of commercial banks.

However, conflicting results are also found in other studies. For instance, Phan *et al.*, (2020) explored the impact of Fintech companies on the efficiency of the banking sector, revealing a strong negative influence of Fintech companies on the business performance of commercial banks in the Indonesian market.

The competitiveness of banks is a research topic that has attracted significant attention from scholars. Hac, Khai and Anh (2019) identified factors influencing bank competitiveness, including previous-year bank competition, operating cost-to-income ratio, capital-to-total assets ratio, return on equity (ROE), loan-to-total assets ratio, bank size, inflation, and GDP growth. Vo and Duong (2017) studied the factors impacting the competitiveness of commercial banks in Vietnam, found that internal factors such as non-interest income ratio, provision for credit risk ratio, capital size, number of banks, ownership ratio, and state ownership, along with macroeconomic factors such as GDP growth rate and inflation, significantly influence the competitiveness of commercial banks.

Fungáčová, Pessarossi and Weill (2012) used the Lerner index to assess the competitiveness of 76 Chinese commercial banks from 2002 to 2011. The study revealed that the average Lerner index for Chinese banks was very high at 37.8% and ranged from 27.7% to 42.1%. Furthermore, a study was conducted by Thuy and Duong (2021) on the macro and micro factors influencing the competitiveness of Vietnamese commercial banks using the Lerner ratio. Applying the SGMM method by Arellano & Bond (1991) to panel data from 30 Vietnamese commercial banks from 2007 to 2018, the results showed that factors such as the equity-to-total-assets ratio, credit risk provisioning ratio, inflation rate, and bank size had a negative impact on competitiveness.

In summary, while research on bank competitiveness and digital transformation is extensive, the relationship between digital transformation and the competitiveness of commercial banks has received less attention globally, including in Vietnam. Existing studies primarily focus on the role and benefits of digital transformation in bank operations. Therefore, there is a need for investigation into the impact of digital transformation on the competitiveness of commercial banks to fill this research gap and provide recommendations for enhancing the competitiveness of Vietnamese commercial banks through digital transformation.

2.4. Conceptual Framework

Based on the theories and relevant research literature regarding the impact of digital transformation on the competitive capacity of banks, in this study, the inheritance of determinant factors influencing a bank's competitive capacity will be synthesized and conceptualized as depicted in Figure 1. Within this framework, these factors will be used as the primary determining elements in this article.

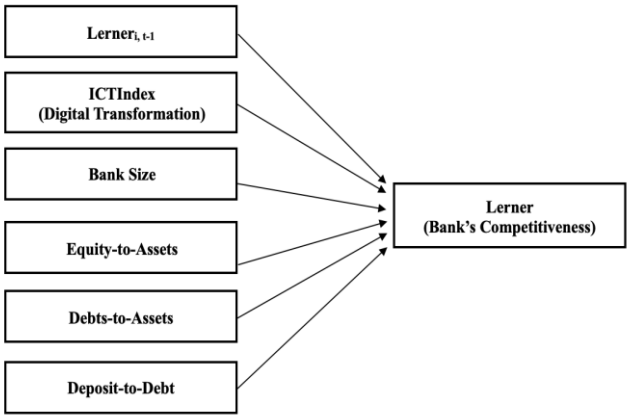

Figure 1. Conceptual Framework

3. Data and Methodology

3.1. Data Sources

The research data is panel data and is compiled from various datasets, as detailed below:

- Digital transformation data of commercial banks: The ICTIndex dataset from the Ministry of Information and Communications has been collected since 2006 to assess the development of information and communication technology, as well as the readiness and adoption of information and communication technology in commercial banks. This dataset provides measurements for relevant indicators related to technical infrastructure, human resources, internal information technology applications, and online services in Vietnamese commercial banks. The ICTIndex provides fundamental information about the digital transformation process of commercial banks.
- Data on competitiveness and other variables (Size, ETA, DTA, DTD): sourced from the annual audited consolidated financial reports of 29 Vietnamese joint-stock commercial banks from 2010 to 2022, obtained from VietStock. Appendix 1 contains the list of the selected banks.

In summary, the research sample comprises 29 banks with 375 observations from 2010 to 2022. Consequently, the panel data used in this study is strongly balanced.

3.2. Research Methods

To understand how digital transformation impacts a bank's competitive capacity along with other relevant factors, this study employs a quantitative research method with the support of Microsoft Excel and STATA 14. Specifically, a multivariate regression model will be applied for analysis. The data processing sequence is as follows: univariate analysis, including descriptive statistics, correlation matrix analysis, and multivariate analysis, encompassing model selection, assessment of regression process suitability, and explanatory variable selection.

Regression models employing POLS, FEM, and REM will be estimated. Subsequent tests will be conducted to determine the most suitable model and expound on the research findings. The selection between models will involve examining F-tests and Hausman tests. Additionally, Variance Inflation Factor (VIF) coefficients will be computed to detect multicollinearity among variables. Moreover, in panel data regression models, autocorrelation and heteroskedasticity can introduce bias in

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estimates. To address this, the Woolridge test will be used to detect autocorrelation, while the Wald test will identify heteroskedasticity. If violations are detected, the Feasible Generalized Least Squares (FGLS) method will be employed to rectify the issue due to its superior advantages over the conventional OLS method.

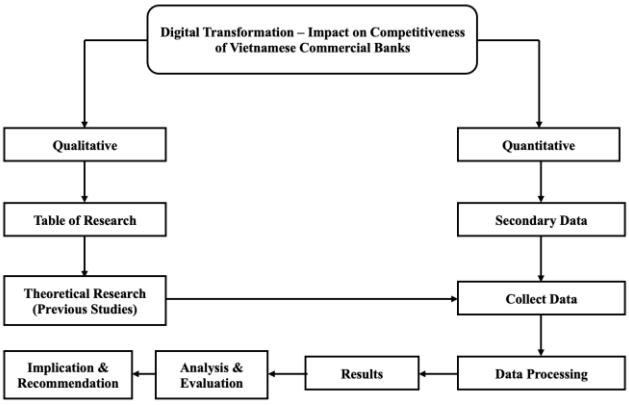

Figure 2. The Research Model Framework

3.3. Model Specification

3.3.1. Research Variables

Drawing from the model presented in Pham and Dao (2021) study, the competitiveness of Vietnamese commercial banks is influenced by factors such as bank size, credit scale, equity-to-assets ratio, and deposit-to-loan ratio. The proposed research model aims to verify the relationship between digital transformation and bank competitiveness. Upon selecting variables as referenced, a summary of the independent variables used in this model is presented in Figure 3. Expected signs are synthesized from previous research.

The study also introduces six hypotheses for the independent variables.

3.3.1.1. Lagged Lerner Index

The Lerner Index is a quantitative measure of market power for a company, indicating its ability to set prices above marginal cost (Grandi and Bozou, 2018). When considering the Lagged Lerner Index, it signifies evaluating the market power of a bank in the preceding period and assessing its impact on the bank's competitiveness in the subsequent period. The historical market power of banks, as measured by the Lagged Lerner Index, could influence their current competitive capabilities. Banks with a higher historical market power might have a more secure position within the industry, potentially affecting their current effective competitive abilities. On the other hand, banks with lower-lagged Lerner Index values might exhibit weaker competitive positions due to their historical pricing behaviour.

Utilizing the Lagged Lerner Index to explore its correlation with the Lerner Index provides insights into how the presence of market power influences the competitive landscape of the banking industry. This approach has the potential to offer a deeper understanding of strategic decisions and market behaviour of banks. So, the first hypothesis is:

H1: The lagged Lerner Index has a statistically significant impact on the Lerner Index of the banking industry.

3.3.1.2. ICTIndex

The hypothesis concerning the “ICTIndex” and “Lerner Index” is built upon the recognition that the application and integration of ICT can hold significant relevance to both competitive behavior and market power within the banking sector (Nassar and TVARONAVIČIENĖ, 2021). The implementation of advanced technological solutions can potentially exert influence over various facets of a bank's operations, customer engagement, service provisioning, and overall efficiency. As banks adopt more advanced technological solutions, they are likely to streamline their services, enhance customer engagement, and optimize overall efficiency. This heightened technological capability can empower banks to shape their pricing strategies better and effectively utilize their market power. Consequently, higher ICTIndex values should align with higher Lerner Index values, signifying increased competitive strength in the banking sector.

However, the intricacies and varying degrees of complexity inherent in this relationship must be considered, as the ramifications of technology on market power may diverge across distinct banking environments and disparate temporal contexts. The hypothesized positive correlation underscores the potential trade-off between technological advancement and the preservation of competitive advantage within the banking industry. Thus, the second hypothesis will be:

H2: ICTIndex has a statistically significant impact on the Lerner Index of the banking industry.

3.3.1.3. Bank Size

The proposed hypothesis suggests the existence of a statistically significant correlation relationship between "Bank Size" and the "Lerner Index." This is similar to U-Din, Tripe and Kabir (2022) and Thuy (2021). This implies that the operational scale of a bank may influence its ability to shape pricing strategies and leverage market power. A positive correlation would indicate that larger banks are more likely to exert a higher influence on pricing, potentially due to advantages related to scale, enhanced resources, or a stronger market position. If larger banks possess a better position to independently set prices in response to market forces, they could achieve higher values of the Lerner Index, signifying greater market power.

H3: Bank size has a statistically significant impact on the Lerner Index of the banking industry.

3.3.1.4. Equity-to-Assets Ratio

The fourth hypothesis posits that there exists a statistically significant correlation between the "ETA" and the "Lerner Index." This ratio also known as the leverage ratio or capital adequacy ratio, reflects the proportion of a bank's total equity (shareholders' equity or capital) to its total assets (Motley Fool Staff, 2016). It provides insights into the financial health and risk-taking capacity of a bank. This ratio can play a pivotal role in influencing the market power and pricing behaviour of a bank. The expected relationship between these factors can be either negative or positive.

Anticipatedly, a positive signal will reflect an inverse relationship, as within the context of the banking industry, a higher owner's ETA ratio could indicate a conservative financial structure, where the bank relies more on its capital than external funding sources. Such a cautious approach may lead to constrained pricing capacity, as the bank might prioritize risk management and stability over implementing robust pricing strategies to gain a competitive advantage. Consequently, a higher owner's ETA ratio could be associated with a lower Lerner Index value, reflecting decreased market power due to a more conservative financial outlook.

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However, a positive signal can also be reflected through a positive relationship, indicating a direct connection between the owner's ETA ratio and the Lerner Index. In this scenario, a higher owner's ETA ratio could signify financial strength, as the bank possesses the capability to self-fund its operational activities (CFI Team, n.d.). This circumstance can create favorable conditions for implementing more flexible pricing strategies to achieve a strong competitive advantage. Consequently, a higher owner's ETA ratio could be linked to a higher Lerner Index value, highlighting increased market power due to a robust financial outlook.

H4: Equity-to-Assets Ratio has a statistically significant impact on the Lerner Index of the banking industry.

3.3.1.5. Debts-to-Assets Ratio

DTA ratio, also known as the Debt Ratio, is a financial metric that indicates the proportion of a company's total liabilities (debts) to its total assets. This ratio provides insights into the extent to which a company's operations are funded through debt financing (Peterdy, 2020). In the context of banks, it reflects the portion of a bank's assets that are financed by borrowing from various sources. DTA Ratio plays a significant role in shaping a bank's competitiveness by influencing its risk profile, stability, profitability, access to funding, and adherence to regulatory requirements.

The hypothesis suggests that there exists a significant correlation between the "DTA" and the "Lerner Index", where the negative sign is anticipated. This implies that higher levels of debt relative to assets may lead to reduced competitiveness for banks. A negative relationship could be attributed to the fact that higher debt levels increase financial risk and may constrain the bank's ability to invest in innovative and competitive strategies. Additionally, excessive debt can result in higher interest payments, potentially limiting the bank's ability to adjust pricing strategies in response to market changes. Thus, a negative impact on the Lerner Index is expected, reflecting the potential adverse influence of higher debt levels on the competitiveness of the banking industry.

H5: Debts-to-Assets Ratio has a statistically significant impact on the Lerner Index of the banking industry.

3.3.1.6. Deposit-to-Debt Ratio

The DTD is a financial metric that represents the proportion of a bank's total deposits to its total outstanding debts. This ratio provides insight into the extent to which a bank relies on customer deposits to fund its operations and investments as opposed to relying on external borrowing or debt financing.

The hypothesis shows that the "DTD ratio" significantly influences the "Lerner Index" within the banking industry. The expected sign for this hypothesis is positive. A higher DTD ratio will be positively associated with a higher Lerner Index. This implies that banks with a larger proportion of customer deposits relative to outstanding debts will likely exhibit a greater degree of market power and less competitive behavior. As the DTD ratio increases, the Lerner Index is expected to increase as well, indicating a stronger association between a higher ratio of customer deposits to outstanding debts and a higher level of market power in the banking industry.

H6: Deposit-to-Debt Ratio has a statistically significant impact on the Lerner Index of the banking industry.

Variables (Abbreviation)	**Formula/ Explanation**	**Expected Correlation with dependent variable**
Lerner	$Lerner_{i,t} = \frac{(P_{i,t} - MC_{i,t})}{P_{i,t}}$	
$Lerner_{i,t-1}$ (Lerner1)	Lagged Lerner Index	+
ICTIndex	the ICTIndex of the Ministry of Information and Communications, representing digital transformation in banks.	-
Bank Size (Size)	$Size = \ln(Total\ Assets)$	+
Equity-to-Assets (ETA)	$ETA\ ratio = \frac{Total\ Equity}{Total\ Assets} x\ 100\%$	-/+
Debts-to-Assets (DTA)	$DTA\ ratio = \frac{Total\ Debts}{Total\ Assets} x\ 100\%$	-
Deposit-to-Debt (DTD)	$DTD\ ratio = \frac{Total\ Deposit}{Total\ Debts} x\ 100\%$	+

Figure 3. Summary of Variables Explanation and Expected Sign

3.4. Regression Model

In this study, the following regression model is formulated based on previous empirical results and the selection of variables will be introduced below:

$$Lerner_{i,t} = \beta_0 + \beta_1 Lerner_{i,t-1} + \beta_2 ICTIndex_{i,t} + \beta_3 Size_{i,t} + \beta_4 ETA_{i,t} + \beta_5 DTA_{i,t} + \beta_6 DTD_{i,t} + e_{i,t}$$

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In which,

- **i and t:** the company and time characteristics respectively
- **β:** the intercept of the regression model
- **β1, β2, β3, β4, β5** are coefficients of explanatory variables
- $\mathbf{e_{i,t}}$: the error term apprehending the influences of omitted variables and other factors that are not included in the model
- $\mathbf{Lerner_{i,t}}$: Bank competitiveness.
- $\mathbf{ICTIndex_{i,t}}$**:** the ICTIndex of the Ministry of Information and Communications, representing digital transformation in banks.
- $\mathbf{Size_{i,t}}$: Size of the bank i at time t
- $\mathbf{ETA_{i,t}}$: Equity-to-Assets Ratio of the bank i at time t
- $\mathbf{DTA_{i,t}}$: Debts-to-Assets Ratio of the bank i at time t
- $\mathbf{DTD_{i,t}}$: Deposit-to-Debt Ratio of the bank i at time t

4. ESTIMATION RESULTS AND MAJOR FINDINGS

4.1. Lerner Index

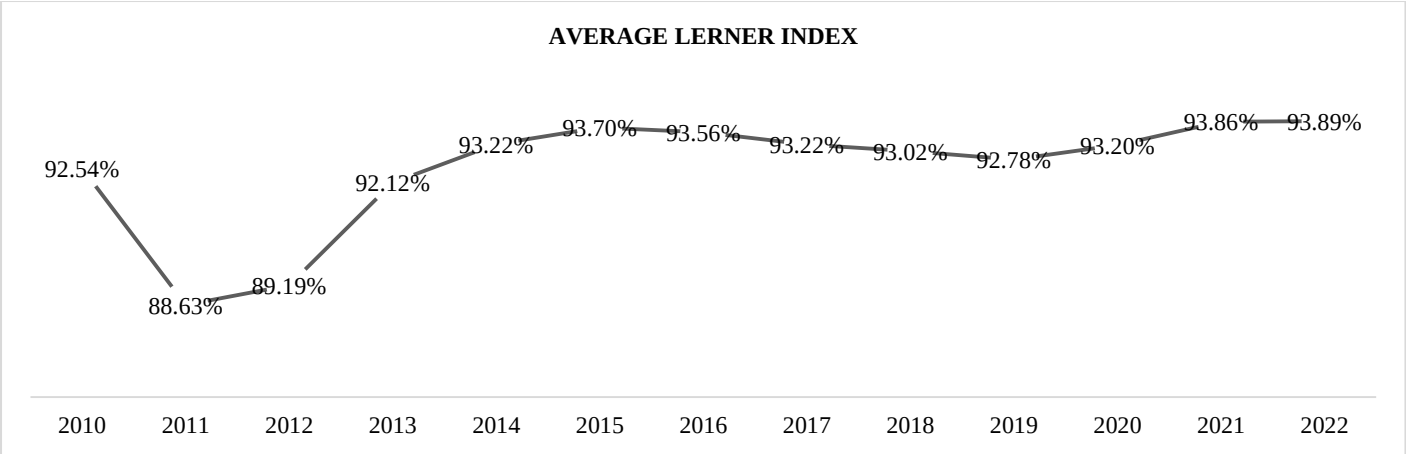

Figure 4. Average Lerner Index from 2010-2022 (Source: Author's Calculation)

Figure 4 illustrates the Lerner index of 29 Vietnamese commercial banks from 2010 to 2022. The competitive capacity of these banks experienced a sharp decline from 2010 to 2012, followed by a gradual increase. This period saw a surge in competition within the banking industry, driven by the emergence of Fintech companies offering innovative, cost-effective financial services. Customers were drawn to these user-friendly, innovative solutions, exerting pressure on traditional banks to adapt and invest more heavily in technology. As customers increasingly turned to digital channels, their expectations for digital banking services rose, compelling traditional banks to invest in digital infrastructure. This trend reflects the broader shift towards technology investment by Vietnamese banks during the period, encompassing enhanced technological applications and comprehensive digital transformation efforts aimed at enhancing customer experiences. The decline in the Lerner index indicates a reduction in market power, signifying that traditional banks were facing heightened competition. It also underscores that traditional banks were embracing digital transformation to better cater to the needs of tech-savvy customers and to navigate the rapidly evolving financial landscape.

4.2. ICT Index

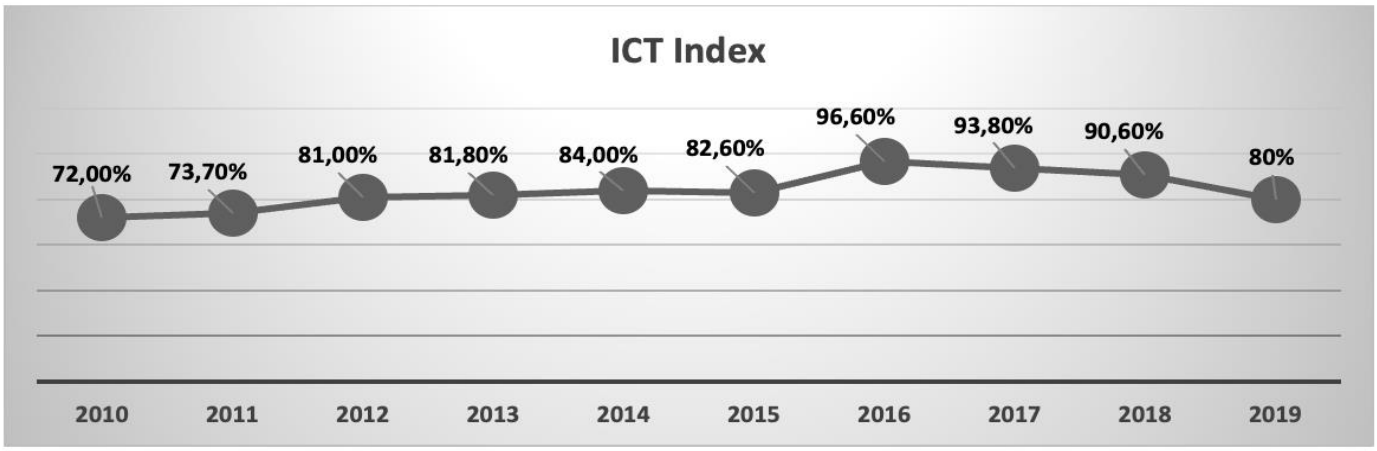

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Figure 5. ICT Index from 2010-2019 (Source: Author's Calculation)

The chart illustrates the ICT Index of the banking sector during the period 2010-2019, as depicted in Figure 5. The digital transformation journey of the banking industry exhibited an upward trend until 2016, followed by a slight decline from 96.6% to 80%. This trend can be comprehended considering the heightened competition posed by Fintech companies and tech-driven financial service providers, which created fierce competition for traditional banks. Consequently, this impelled banks to swiftly enhance and update their technology systems to sustain their competitive edge.

Furthermore, not all banks embarked on digital transformation with equal speed and efficiency. Some smaller and mid-sized banks may have lagged in adopting advanced technological solutions, potentially affecting the overall ICT Index of the industry.

The marginal decrease in the ICT Index is not necessarily a negative development, as it can reflect the industry's adaptation and fine-tuning of its technology and risk management strategies. Nevertheless, what remains crucial is that banks maintain their commitment to improving and advancing their digital transformation strategies to meet the ever-growing demands of customers and compete effectively in the increasingly complex financial landscape.

4.3. Data Description

Variables	Lerner	Lernert1	ICTindex	Size	ETA	DTA	DTD
Mean	0.92533	0.92419	0.83610	18.68143	0.09512	0.91165	0.70749
Maximum	0.98641	0.98641	0.96600	21.47497	0.96178	1.00361	1.12196
Minimum	0.84714	0.84714	0.72000	15.92274	0.02621	0.61303	0.12521
Std. Dev	0.02314	0.02355	0.07620	1.23178	0.07424	0.04524	0.14002
Skewness	-1.03917	-0.97312	0.22296	0.12463	8.21793	-1.62381	-0.41609
Kurtosis	4.65148	4.42890	2.08057	2.31629	92.56206	8.96606	3.45191
Observation	375	346	290	375	375	375	375

Table 1. Descriptive Data (Source: Author's Calculation)

The dataset consists of 375 observations for each variable, except for the ICTindex variable, which has 290 observations. This rich dataset allows for a comprehensive analysis of the relationships between these variables, shedding light on how digital transformation, bank size, and financial ratios influence banking industry competitiveness. Some variables may exhibit deviations from a normal distribution, as indicated by skewness and kurtosis values.

In terms of dependent variables, "Lerner" variable represents the competitiveness of bank. In terms of dependent variable, "Lerner" variable represents the competitiveness of the bank. With an average value of around 0,92533, this means a considerable number of banks exhibit a notable degree of market influence and competitiveness, which could stem from factors such as brand recognition, custom loyalty, or regulatory advantages. A higher Lerner index might suggest that some banks possess the ability to exert pricing authority, potentially leading to higher profit margins but also sparking concerns about consumer choices and overall market competitiveness.

The "ICTindex" variable, with an average value of 0.83610, suggests moderate digital adoption within the industry. This could impact bank competitiveness as increased digitalization may alter strategies and market positioning.

"Size" denotes bank size, with an average of around 18.68143, highlighting diversity in bank sizes. Larger banks may have more resources to invest in digital transformation, affecting their competitiveness.

"ETA" indicates the proportion of a bank's equity relative to its total assets, with an average of 0.09512, suggesting reliance on external funding sources over equity.

"DTA" reflects the extent of debts relative to total assets, with a mean value of approximately 0.91165, indicating significant debt levels that could impact risk profiles and competitiveness.

"DTD" represents the Deposit-to-Debt Ratio, with an average of 0.70749, indicating a relatively balanced relationship between deposits and debts on average.

4.4. Correlation Matrix

	Lerner	Lernert1	ICTIndex	Size	ETA	DTA	DTD
Lerner	1.0000						
Lernert1	0.6320	1.0000					
ICTIndex	0.3895	0.3239	1.0000				
Size	0.2199	0.2024	0.2279	1.0000			
ETA	-0.1287	-0.1631	-0.1436	-0.3522	1.0000		

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DTA	0.1405	0.2127	0.1611	0.4297	-0.4865	1.0000	
DTD	0.1767	0.0216	0.4305	0.2452	-0.1808	0.0269	1.0000

Table 2. Correlation Matrix (Source: Author's Calculation)

A correlation matrix is a powerful tool to summarize a large data set and to identify and visualize patterns in data (Gujarati and Porter, 2009).. Table 2 demonstrates the correlation matrix of the variables used in the study to estimate the relationship between digital transformation and the competitiveness of banks.

To eliminate a serious multicollinearity problem, a proposed pair correlation coefficient between independent variables should be lower than 0.8 (Gujarati and Porter, 2009). Looking at Table 2, all correlation coefficients between variables are below 0.8. Particularly, Lerner with ETA is negatively correlated while the remaining variables including Lernert1, ICTIndex, Size, DTA and DTD, all show positive correlation. One point to note is that the correlation coefficients between the dependent and independent variables are usually lower than those between independent variables but not significantly.

4.5. Regression Results

Several tests to assess the error specification of the model were carried out. The findings indicate that the model exhibited errors related to both heterogeneity and autocorrelation. These errors undermine the precision of standard error estimation, consequently leading to inaccuracies in coefficient estimation. Consequently, to address these issues and improve the model's accuracy, the Feasible Generalized Least Squares (FGLS) regression technique is employed.

Variables	Lerner
Lernert1	0.4741*** (0.0445)
ICTIndex	0.0646*** (0.0127)
Size	0.0011 (0.0010)
ETA	0.0372*** (0.0112)
DTA	0.0177 (0.0291)
DTD	0.0449*** (0.0076)
_cons	0.3579*** (0.0465)
Prob > chi2	0.0000
Wald chi-square	277.39
Standard errors in parentheses: *** p<0.05; ** p<0.01; *** p<0.001**	

Table 3. FGLS estimation results (Source: Author's Calculation)

Table 3 reveals the outcomes of FGLS regression for the FEM. Generally, the model is almost significant with the "Lerner" dependent variable. "Lernert1", "ICTIndex", "ETA" and "DTD" are significant at 0.1% level. Variable SIZE and DTA are insignificant at any level.

From Table 3, the final regression model will be:

Lerner = 0.3579 + 0.4741*Lernert1 + 0.0646*ICTIndex + 0.0011*Size + 0.0372*ETA + 0.0177*DTA + 0.0449*DTD

Independent Variables	Dependent Variable "Lerner"			
	Hypothesis	**Expected Sign**	**Result**	**Conclusion**
Lernert1	H1	+	+	Significant
ICTIndex	H2	-	+	Significant
Size	H3	+	+	Insignificant
ETA	H4	-/+	+	Significant
DTA	H5	-	+	Insignificant
DTD	H6	+	+	Significant

Table 4. Final Estimation (Source: Author's Calculation)

4.5.1. H1 Hypothesis

Research results show that: "Lernert1" has a positive effect on "Lerner" and has a 99.9% confidence level. The lagged Lerner index variable is determined to be significant with the Lerner index at a significant level of 0.1%. These results indicate that the lagged Lerner index is a decisive factor in the competitiveness of Vietnamese commercial banks. If the profitability increases by 1 percentage point and other variables in the model remain the same, the Lerner index will increase by 0.4741 percentage points.

This positive relationship offers several insights into the impact of market power in the past on the current competitiveness of banks. Firstly, it demonstrates the ability to sustain a competitive advantage over time. Banks that have historically possessed higher market power consistently maintain customer trust and attract, and retain customers in the long term (Sonono and Ortstad, 2017). Simultaneously, this relationship also showcases the credibility and reputation of banks that have been valued higher than marginal costs. Furthermore, this positive correlation can simultaneously reflect banks' ability to allocate resources and invest in strategic activities. They can invest in new technologies, enhance service quality, and expand their range of financial products, thereby enhancing their competitive advantage. This relationship can also create barriers to entry in the industry, as new banks must confront the challenge of building reputation and establishing similar credibility to existing banks. Additionally, this positive relationship demonstrates the impact of the Lagged Lerner Index on market dynamics and pricing strategies of banks, as banks with strong market power can influence the market equilibrium and compel smaller banks to adapt to new pricing strategies, shaping overall competition within the banking industry. Therefore, the lagged Lerner index and competitiveness have a positive significant relationship.

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4.5.2. H2 Hypothesis

Consistent with Liu (2021) research findings, the "ICTIndex" exerts an influence on the competitiveness of Vietnamese banks, exhibiting a positive relationship with the "Lerner" index and demonstrating statistical significance at the 0.1% level. A 1-percentage point increase in the ICTIndex, while holding other variables constant, leads to a corresponding 0.0646 percentage point increase in the Lerner index.

Firstly, the application of advanced information technology in banking operations facilitates process optimization, enhances efficiency, and reduces inefficiencies (Zhu and Jin, 2023). Consequently, banks are better positioned to provide services with lower costs and higher quality, contributing to an increased competitive stance within the market.

Furthermore, digital transformation creates opportunities for more effective customer interactions and communication through online channels and mobile applications. The capability to deliver customized services, rapid information dissemination, and responsive customer support enhances the ability to satisfy customer needs(SuperOffice, 2023). Improving customer experience and satisfaction can elevate a bank's competitive edge in attracting and retaining customers. Swift development and deployment of advanced products enable banks to capture market opportunities and bolster competitive potential.

Additionally, information technology enables banks to gather and analyze customer and market data. Enhanced comprehension of customer demands and behaviour allows banks to devise optimal pricing strategies and service offerings, thereby forging a stronger competitive advantage. A synchronized digital ecosystem augments the competitive capacity of financial institutions in the market.

Therefore, a successful digital transformation equips banks to offer personalized product services and enhance customer experience, leading to improved competitiveness. This underscores the significance of a thriving digital ecosystem in enhancing banks' competitive prowess in the market.

4.5.3. H3 Hypothesis

In this paper, there is no evidence of a relationship between bank "Size" and the "Lerner" index. The lack of significance could be attributed to the complexity of the banking sector, where the impact of bank size on competitiveness might be obscured by other factors. Different banks may employ distinct strategies and occupy varying market positions, leading to heterogeneous effects of size on competitiveness. Furthermore, the variable "Size" might not capture nuanced aspects of banking operations that influence competitiveness, such as performance, flexibility, or customer relationships.

However, the insignificance of "Size" in this study does not necessarily imply that bank size does not influence competitiveness. Instead, it suggests that within the context of the model and data employed in this study, the relationship between size and competitiveness cannot be established from a statistical perspective.

4.5.4. H4 Hypothesis

"ETA" ratio shows a positive impact on the "Lerner" index of Vietnamese commercial banks with a confidence level of up to 99.9%. This means that when this leverage ratio increases by 1 percentage point, the competitiveness of the bank will increase by 0.0372 percentage points.

The positive relationship between the ETA ratio and the Lerner index within the context of Vietnamese commercial banks could be attributed to several key factors. A higher ETA signifies that a significant portion of the bank's assets is funded through owner's equity, indicating a more cautious and stable financial structure (Hacini, Boulenfad and Dahou, 2021). This heightened level of owner's equity provides security to the bank, enhancing its capacity to absorb losses and financial shocks. Thus, banks with higher ETA are better positioned to manage risks and maintain their financial well-being amidst challenging economic conditions.

Furthermore, Velliscig, Floreani and Polato (2023) commented that a higher ETA ratio reflects a robust capital base of the bank, which is crucial for compliance and meeting capital adequacy requirements. Regulatory authorities often impose minimum capital requirements to ensure that banks have sufficient resources to absorb losses and mitigate systemic risks. Banks with higher ETA are more likely to meet these regulatory standards, consequently being perceived by investors and stakeholders as safer and more reliable.

Moreover, the positive impact of ETA on the Lerner index demonstrates that banks with higher owner's equity are better equipped to pursue competitive strategies aimed at enhancing their market position. By having a stronger owner's equity base, banks can access funding sources with lower costs and maintain financial stability while implementing growth-oriented initiatives. In summary, banks with higher ETA possess a competitive edge over their counterparts.

4.5.5. H5 Hypothesis

"DTA" ratio has a positive meaning but is insignificant with the "Lerner" index. Although the expected sign of this variable is negative, the regression coefficient yields a positive value. It is possible that the complexity of the relationship between the DTA ratio and competitiveness cannot be entirely captured by a simple linear regression model. Other factors, such as variations in the business and market environment, could also influence the interaction among variables. Moreover, external factors such as interest rate fluctuations, currency changes, and global economic conditions can impact the correlation between the DTA ratio and the bank's competitiveness. This may lead to a disparity between the expected sign and the regression coefficient, rendering them incongruent and rendering the model statistically insignificant.

4.5.6. H6 Hypothesis

The "DTD" ratio affects the competitiveness of banks when having a positive impact on "Lerner" Index and is significant at 0.1% level. If this ratio increases by 1 percentage point and the other remain the same, the Lerner index will also increase by 0.0449 percentage points.

As the DTD ratio increases, indicating a higher reliance on deposits for funding compared to debt, the competitiveness of banks also improves. Because a higher DTD ratio reflects a more stable and dependable source of funding, which allows banks to better withstand economic fluctuations and external shocks. This financial stability enables banks to allocate resources more efficiently, invest in innovative services, and manage their operations with greater flexibility. As a result, banks can enhance their customer offerings, provide better terms for loans, and adapt

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to changing market demands, all of which contribute to an improved competitive position.

Moreover, relying on a higher proportion of deposits often leads to a lower cost of funds compared to relying heavily on debt. Banks can benefit from lower interest expenses, freeing up resources that can be channelled towards expanding their services, improving technology infrastructure, and developing strategic initiatives. These factors collectively enhance the attractiveness of the bank's products and services, fostering customer loyalty and attracting new clients. Furthermore, the positive impact of the DTD ratio on competitiveness is linked to the perception of financial stability and trustworthiness that a strong deposit base conveys to customers and stakeholders. A higher DTD ratio signals prudent financial management and risk mitigation, which can enhance the bank's reputation and credibility in the eyes of both customers and investors.

4.6. Summary

To summarize, a regression analysis employing the panel data was executed using Stata 14, with the FEM method emerging as the most suitable choice for the model. The outcomes of the estimation model analysis yield the following noteworthy findings:

The lagged Lerner index is a factor affecting the competitiveness of Vietnamese commercial banks. It has a positive relationship with the Lerner index, which shows the bank's competitiveness. This result is similar to the expectations of the researcher.

Digital transformation is a factor impacting the competitiveness of Vietnamese commercial banks. It has a positive relationship with the Lerner index. This result is similar to the expectations of the researcher.

Size is not a factor affecting the competitiveness of Vietnamese commercial banks.

Equity-to-assets ratio is a factor influencing the competitiveness of Vietnamese commercial banks. It has a positive relationship with the Lerner index. This result is similar to the expectations of the researcher.

Debt-to-assets ratio is not a factor affecting the competitiveness of Vietnamese commercial banks.

The deposit-to-debt ratio is another factor that influences Vietnamese banks' competitiveness. It has a positive relationship with the Lerner index. This result is similar to the expectations of the researcher.

5. Discussion, Policy Implications and Limitation

Digital transformation presents banks with opportunities for expansive customer outreach and service, driving overall financial development, though it entails a complex, risk-laden process. To fortify their competitive edge, there are some following recommendations for banks.

Firstly, banks should develop a comprehensive digital transformation strategy aiming for a digital banking model. This strategy should include specific goals, plans, and implementation timelines focusing on developing digital banking models, enhancing customer convenience, and improving customer experiences. Applying technology rigorously to the bank's operations will enable the diversification of products and services, attracting more customers.

Secondly, regarding technology infrastructure, banks should invest in their information technology infrastructure. Consistently increasing the total asset scale will help banks strengthen their capabilities, provide the potential to develop information technology, and modernize banking operations while reducing costs. The bank's technology infrastructure should be designed and invested to improve a technology platform ecosystem; thus, banks can provide experiences at the right time and place when customers need them.

Thirdly, concerning human resources in digital transformation, banks need to enhance the IT literacy of their staff. IT investments must be coupled with training for employees to maximize technology efficiency. Banks should first standardize their recruitment criteria and add IT skills to the qualifications of candidates. Concurrently, they should organize training courses to improve IT skills, especially for the bank's IT department staff. Given the rapid pace of current global development, this training should focus on operational capability, management of electronic banking businesses, and the ability to respond to and handle customer incidents and technological gaps. Moreover, with the application of IT, there is an increasing variety in the quality and geographical location of products and services. Therefore, bank staff need a comprehensive understanding of products, online operational procedures, and quick handling of electronic documents to provide customers with a sense of security, trust, and convenience.

Besides, the successful digital transformation of banks, which requires banks to enhance their competitive capabilities, also requires the collective support of regulatory authorities and policymakers. Regulatory bodies should establish a legal framework conducive to banking activities in the digital economy, encouraging and promoting healthy, transparent competition among banks, credit institutions, and financial technology companies. They should also focus on developing modern digital technology infrastructure and synchronizing and sharing the exploitation of national databases on population and enterprise databases in industries and sectors of the economy.

6. Conclusion

The Vietnamese banking sector has faced various fluctuations, including financial crises, restructuring, trade wars, and most recently, the impact of COVID-19 pandemic, along with deep financial integration and the impact of scientific and technological advancements. These factors have reshaped competition among banks. Given the pivotal role of the commercial banking system in Vietnam's economy, bank leaders and regulatory authorities must bolster financial capacity and competitive capabilities to align with the demands of economic integration.

This study delves into how digital transformation affects the competitive edge of Vietnamese commercial banks, utilizing data from 29 joint-stock commercial banks in Vietnam between 2010 and 2022. It synthesizes theoretical and empirical research on various factors, such as the Lerner index, Lagged Lerner index, ICT index, bank size, equity-to-assets ratio, debt-to-asset ratio, and deposit-to-debt ratio, influencing a bank's competitive capabilities. The results indicate that all factors have positive effects. Lagged Lerner index, ICT index, equity-to-assets ratio, and deposit-to-debt ratio are statistically significant to a bank's competitive capabilities. On the other hand, bank size and debt-to-assets ratio do not significantly impact a bank's competitive capabilities. Thus,

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recommendations are proposed to optimize digital transformation within the banking sector and enhance the digital banking model, considering identified factors and industry characteristics.

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REFERENCES

1. Berger, A.N., Demirguc-Kunt, A., Levine, R. and Haubrich, J.G. (2004) Bank Concentration and Competition: An Evolution in the Making. *Journal of Money, Credit, and Banking* [online]. 36 (3b), pp. 433–451.
2. Binsfeld, N. (2018) Investigations into the dynamics of the ICT ecosystem in Luxembourg. [online]. Available from: https://www.academia.edu/66224829/Investigations_into_the_dynamics_of_the_ICT_ecosystem_in_Luxembourg [Accessed 3 September 2023].
3. Boru, T. and Kuhil, A. (2018) The Structure Conduct Performance Model and Competing Hypothesis- a Review of Literature. *Journal of Financial Management and Analysis*. 8, pp. 11–25.
4. CFI Team (no date) *Equity Ratio Corporate Finance Institute* [online]. Available from: https://corporatefinanceinstitute.com/resources/valuation/equity-ratio/ [Accessed 5 September 2023].
5. Church, J.R. and Ware, R. (2000) *Industrial organization: a strategic approach*. Citeseer.
6. Claessens, S. and Laeven, L. (2004) What Drives Bank Competition? Some International Evidence. *Journal of Money, Credit and Banking* [online]. 36, pp. 563–83.
7. Demirguc-Kunt, A. and Peria, M.S.M. (2010) "A framework for analyzing competition in the banking sector: an application to the case of Jordan" *Policy Research Working Paper SeriesPolicy Research Working Paper Series* [online]. Available from: https://ideas.repec.org//p/wbk/wbrwps/5499.html [Accessed 1 September 2023].
8. El-Chaarani, H. and El-Abiad, Z. (2018) The impact of technological innovation on bank performance. *El-CHAARANI H. and El-Abiad*. (2018).
9. Fernández de Guevara, J., Maudos, J. and Pérez, F. (2005) Market Power in European Banking Sectors. *Journal of Financial Services Research* [online]. 27 (2), pp. 109–137.
10. Fungáčová, Z., Pessarossi, P. and Weill, L. (2012) Is bank competition detrimental to efficiency? Evidence from China. *China Economic Review*. 27.
11. Garelli, S. (2002) *Competitiveness of Nations: The Fundamentals*. 2002 [online]. Available from: http://www.compilerpress.ca/Competitiveness/Anno/Ann o%20Garelli%20CN%20Fundamentals.htm [Accessed 21 June 2023].
12. Grandi, P. and Bozou, C.N. (2018) *Bank competition and firm credit availability: firm-bank evidence from Europe* [online]. Available from: https://hal.science/hal-01897744 [Accessed 26 August 2023].
13. Gujarati, D.N. and Porter, D.C. (2009) *Basic econometrics*. 5th ed. Boston: McGraw-Hill Irwin.
14. Hac, L.D., Khai, H.N. and Anh, L.H. (2019) Factors affecting the level of bank competition: empirical evidence in Vietnamese commercial banks.
15. Hacini, I., Boulenfad, A. and Dahou, K. (2021) The impact of liquidity risk management on the financial performance of Saudi Arabian banks. *EMAJ: Emerging Markets Journal*. 11 (1), pp. 67–75.
16. Kashorda, M. and Waema, T.M. (2011) ICT indicators in higher education: Towards an e-readiness assessment model.
17. Lerner, A. (1995) *The concept of monopoly and the measurement of monopoly power*. Springer.
18. Lerner, A.P. (1934) The Concept of Monopoly and the Measurement of Monopoly Power. *The review of economic studies*. 1(3), pp. 157–175.
19. Leuvensteijn, M. van, Bikker, J., Rixtel, A. van and Sørensen, C.K. (2011) A new approach to measuring competition in the loan markets of the euro area. *Applied Economics*. 43 (23), pp. 3155–3167.
20. Liu, M.X. (2021) *Stay competitive in the digital age: the future of banks*. International Monetary Fund.
21. Lugovsky, V. (2021) *Digital Transformation in Banking: How To Make The Change Forbes*. 29 December 2021 [online]. Available from: https://www.forbes.com/sites/forbesbusinesscouncil/2021/12/29/digital-transformation-in-banking-how-to-make-the-change/ [Accessed 21 June 2023].
22. Mehra, S. (1998) Perpetual analysis and continuous improvements: a must for organizational competitiveness. *Managerial Finance*. 24 (1), pp. 19–27.
23. Motley Fool Staff (2016) *What Is the Equity-to-Asset Ratio? The Motley Fool*. 15 January 2016 [online]. Available from: https://www.fool.com/knowledge-center/equity-to-asset-ratio.aspx [Accessed 5 September 2023].
24. Nassar, N. and TVARONAVIČIENĖ, M. (2021) *ICT MANAGEMENT FOR GREEN COMPETITIVENESS IN THE BANKING SECTOR* [online].
25. Nhan Dan Newspaper (2021) *Non-cash payment development plan in 2021-2025 approved en.nhandan.vn*. 29 October 2021 [online]. Available from: https://en.nhandan.vn/post-106031.html [Accessed 2 September 2023].
26. OECD, P. (1993) Glossary of industrial organisation economics and competition law.
27. Paisal, P., Afrizawati, A. and Sabli, H.B.M. (2023) The Effect of the Digitalization System on Customer Service Performance in the Banking Business during Post-Pandemic. *Asean International Journal of Business*. 2 (1), pp. 76–84.
28. Panzar, J.C. and Rosse, J.N. (1987) Testing for" monopoly" equilibrium. *The journal of industrial economics*. pp. 443–456.

DOI: 10.5281/zenodo.11453166

29. Peterdy, K. (2020) *Debt to Asset Ratio Corporate Finance Institute*. 30 March 2020 [online]. Available from: https://corporatefinanceinstitute.com/resources/commercial-lending/debt-to-asset-ratio/ [Accessed 5 September 2023].
30. Pham T.T. and Dao L.K.O. (2021) *FACTORS AFFECTING COMPETITIVE CAPACITY OF VIETNAM'S COMMERCIAL BANKS IN THE CONTEXT OF IMPLEMENTING THE COMPREHENSIVE AND PROGRESSIVE AGREEMENT FOR TRANS-PACIFIC PARTNERSHIP thitruongtaichinhtiente.vn*. 3 January 2021 [online]. Available from: https://thitruongtaichinhtiente.vn/cac-yeu-to-tac-dong-den-nang-luc-canh-tranh-cua-nhtm-viet-nam-khi-tham-gia-cptpp-33006.html [Accessed 21 June 2023].
31. Phan, D.H.B., Narayan, P.K., Rahman, R.E. and Hutabarat, A.R. (2020) Do financial technology firms influence bank performance? *Pacific-Basin finance journal*. 62, p. 101210.
32. SBV (2022) *LAW ON DIGITAL TRANSFORMATION IN THE BANKING INDUSTRY AND ORIENTATION FOR COMPLETION*. 14 October 2022 [online]. Available from: https://www.sbv.gov.vn/webcenter/portal/vi/menu/trangchu/ttsk/ttsk_chitiet?leftWidth=20%25&showFooter=false&showHeader=false&dDocName=SBV530226&rightWidth=0%25&centerWidth=80%25&_afrLoop=29639615103799023#%40%3F_afrLoop%3D29639615103799023%26centerWidth%3D80%2525%26dDocName%3DSBV530226%26leftWidth%3D20%2525%26rightWidth%3D0%2525%26showFooter%3Dfalse%26showHeader%3Dfalse%26_adf.ctrl-state%3Dan2ki9b9v_9 [Accessed 2 September 2023].
33. SBV (2023) *Phát triển kinh tế số tại Việt Nam: Kết quả và những vấn đề đặt ra hiện nay*. 2 February 2023 [online]. Available from: https://www.sbv.gov.vn/webcenter/portal/vi/menu/fm/ddnhnn/nctd/nctd_chitiet?leftWidth=20%25&showFooter=false&showHeader=false&dDocName=SBV559828&rightWidth=0%25&centerWidth=80%25&_afrLoop=29631410990210023#%40%3F_afrLoop%3D29631410990210023%26centerWidth%3D80%2525%26dDocName%3DSBV559828%26leftWidth%3D20%2525%26rightWidth%3D0%2525%26showFooter%3Dfalse%26showHeader%3Dfalse%26_adf.ctrl-state%3Dpf8d4mwq6_9 [Accessed 2 September 2023].
34. Schwertner, K. (2017) Digital transformation of business. *Trakia Journal of Sciences*. 15 (1), pp. 388–393.
35. Siddik, M.N.A., Sun, G., Kabiraj, S., Shanmugan, J. and Yanjuan, C. (2016) Impacts of e-banking on performance of banks in a developing economy: empirical evidence from Bangladesh. *Journal of Business Economics and Management*. 17 (6), pp. 1066–1080.
36. Sonono, B. and Ortstad, R. (2017) *The effects of the digital transformation process on banks' relationship with customers: case study of a large Swedish bank*.
37. SuperOffice (2023) *How Digital Transformation is Driving The Customer Experience*. 9 March 2023 [online]. Available from: https://www.superoffice.com/blog/digital-transformation/ [Accessed 5 September 2023].
38. Thuy, M.T.P. and Duong, M.B. (2021) Factors Affect Competitiveness of Vietnamese Commercial Banks. *Open Access Library Journal*. 8 (7), pp. 1–8.
39. Thuy, N. (2021) ICT and Bank Performance: Empirical Evidence from Vietnam. *Journal of Contemporary Issues in Business and Government* [online]. 27, pp. 4149–4153.
40. U-Din, S., Tripe, D. and Kabir, M.H. (2022) Bank size, competition, and efficiency: a post-GFC assessment of Australia and New Zealand. *New Zealand Economic Papers* [online]. 56 (2), pp. 195–217.
41. Velliscig, G., Floreani, J. and Polato, M. (2023) Capital and asset quality implications for bank resilience and performance in the light of NPLs' regulation: a focus on the Texas ratio. *Journal of Banking Regulation* [online]. 24 (1), pp. 66–88.
42. Vives, X. (2008) INNOVATION AND COMPETITIVE PRESSURE*: INNOVATION AND COMPETITIVE PRESSURE. *The Journal of Industrial Economics* [online]. 56 (3), pp. 419–469.
43. Vo, X.V. and Duong, T.A.D. (2017) Factors Affecting the Market Power of Commercial Banks in Vietnam. *VNU JOURNAL OF ECONOMICS AND BUSINESS*. 33 (1).
44. Yang, S., Li, Z., Ma, Y. and Chen, X. (2018) Does electronic banking really improve bank performance? Evidence in China. *International Journal of Economics and Finance*. 10 (2), pp. 82–94.
45. Yap, J.T. (2004) *A note on the competitiveness debate*. PIDS Discussion Paper Series.
46. Zhu, Y. and Jin, S. (2023) How Does the Digital Transformation of Banks Improve Efficiency and Environmental, Social, and Governance Performance? *Systems* [online]. 11 (7), p. 328.

DOI: 10.5281/zenodo.11453166