Effect of The Fintech Industry on Bank Performance: A case study from Vietnam

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Doctoral Thesis Summary

Tomas Bata University in Zlín

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Faculty of Management and Economics

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Vliv fintech průmyslu na výkonnost bank: Případová studie z Vietnamu

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ABSTRACT

Fintech is an emerging technology that fundamentally changes the ways of finance. Based on that, a new industry was born: the fintech industry. Fintech companies, commercial banks, and other financial institutions using emerging technologies are the leading entities in the fintech industry. The link between fintech and banks has attracted many scholars. However, the effect of the fintech industry on bank performance has not yet been clarified by the existing publication; thus, I raise the concern "*Whether the fintech industry affects bank performance*."

Based on many reports, I explore that the Vietnamese fintech industry is an interesting case study for the reasons: (1) Vietnam is a developing country, where fintech plays a critical role in economic growth rather than others; (2) the growth rate of fintech in a number of companies, users, transactions, and infrastructure, and the rate of bank investing in technology innovation in Vietnam are higher than others, especially compared to other countries in Southeast Asia; (3) Vietnamese government has paid more attention and facilitated for the fintech industry development to toward the digital economy.

Through literature review, three research objectives are designed to clarify the research concern: (1) *to evaluate the effect of fintech company growth on four perspectives of bank performance by the Balanced Scorecard; (2) to estimate the effect of fintech popularity by Google search on bank stock return; and (3) to estimate the effect of bank investment in technology innovation on bank efficiency by Data Envelopment Analysis.*

The findings show that the fintech company growth is a pressure, which negatively links to bank financial indicators and bank customer loyalty. Bank investment in technology innovation enhances and upgrades the bank technology system seems to be ineffective, which is harmful to bank efficiency. However, fintech company growth promotes bank performance by enhancing bank internal processes and improving bank employees' knowledge and skills. Fintech popularity is a positive factor in bank stock return, and fintech company growth is positive with overall bank performance.

The thesis contributes (1) positive effect of fintech company growth on bank performance; (2) positive effect of fintech popularity on bank stock return; (3) negative effect of bank investment in technology on bank efficiency; and (4) meaningful for stakeholders in the finance and fintech industry.

Further research might extend the scope (e.g., Southeast Asia) and apply new methods (e.g., text mining approach) to measure the fintech variables and evaluate their effect on bank performance.

ABSTRAKT

Fintech je nově vznikající technologie, která zásadně mění způsoby financování. Na základě toho se zrodilo nové odvětví: fintech průmysl. Hlavními subjekty fintech průmyslu jsou fintech společnosti, komerční banky a další finanční instituce využívající nové technologie. Spojení mezi fintech a bankami přitahuje pozornost mnoha vědců. Vliv fintech odvětví na výkonnost bank však dosud nebyl v dosavadních publikacích objasněn; proto vznáším otázku "Zda fintech odvětví ovlivňuje výkonnost bank".

Na základě mnoha zpráv zkoumám, že vietnamský fintech průmysl je zajímavou případovou studií z těchto důvodů: (1) Vietnam je rozvojovou zemí, kde fintech hraje rozhodující roli v ekonomickém růstu spíše než v jiných zemích; (2) míra růstu fintech v počtu společností, uživatelů, transakcí a infrastruktury a míra investic bank do technologických inovací ve Vietnamu jsou vyšší než v jiných zemích, zejména ve srovnání s jinými zeměmi v jihovýchodní Asii; (3) vietnamská vláda věnovala větší pozornost a usnadnila rozvoj fintech průmyslu směrem k digitální ekonomice.

Prostřednictvím přehledu literatury jsou navrženy tři výzkumné cíle k objasnění výzkumného problému: (1) vyhodnotit vliv růstu fintech společností na čtyři perspektivy výkonnosti bank pomocí Balanced Scorecard; (2) odhadnout vliv popularity fintech společností pomocí vyhledávače Google na výnosnost akcií bank; a (3) odhadnout vliv investic bank do technologických inovací na efektivnost bank pomocí Data Envelopment Analysis.

Zjištění ukazují, že růst fintech společností je tlakem, který negativně souvisí s finančními ukazateli banky a loajalitou bankovních klientů. Investice bank do technologických inovací posiluje a modernizuje technologický systém banky se jeví jako neefektivní, což poškozuje efektivnost banky. Růst fintech společností však podporuje výkonnost banky tím, že zlepšuje interní procesy banky a zlepšuje znalosti a dovednosti zaměstnanců banky. Obliba fintech technologií je pozitivním faktorem návratnosti bankovních akcií, zatímco růst fintech společností pozitivně ovlivňuje celkovou výkonnost banky.

Práce přispívá k (1) pozitivnímu vlivu růstu fintech společností na výkonnost bank; (2) pozitivnímu vlivu popularity fintech na výnosnost akcií bank; (3) negativnímu vlivu investic bank do technologií na efektivitu bank; a (4) významu pro zainteresované strany ve finančním a fintech odvětví.

Další výzkum by mohl rozšířit rozsah (např. jihovýchodní Asie) a použít nové metody (např. přístup založený na vytěžování textů) k měření fintech proměnných a vyhodnocení jejich vlivu na výkonnost bank.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS, ACRONYMS AND ABBREVIATIONS USED

AGSVI	:	Average Google Search Volume Index
BITI	:	Bank investment in technology innovation
BSC	:	Balanced Scorecard
DEA	:	Data Envelopment Analysis
EFA	:	Exploratory factor analysis
FE	:	Fixed effect
GLS	:	Generalized Least Squares
GSVI	:	Google Search Volume Index
IT	:	Information technology
P2P	:	Peer-to-peer
RE	:	Random effect
SFA	:	Stochastic frontier analysis
VAR-Granger	:	Vector Autoregressive and Granger causality

1 INTRODUCTION

1.1 Motivation for the study

Since the global financial crisis of 2008-2009, the fintech field has attracted many scholars and practitioners. On the globe, there is a contemporary debate about the effect of fintech on banks. For example, Dranev et al. (2019), Lee et al. (2021), Li et al. (2017), and Wang et al. (2021) found evidence of the positive effect of fintech on bank performance. In detail, fintech improves competitiveness, service efficiency, and risk capability and reduces operating costs. However, Cheng and Qu (2020), Nguyen et al. (2021), Phan et al. (2020), and Zhao et al. (2022) found that fintech reduces bank performance.

Besides, the rise of fintech has created high pressure for the incumbents and challenges for regulators to remain stable in society and the finance industry (Philippon, 2016). Navaretti et al. (2018) gave that fintech could disrupt the existing structure of the banking industry by creating a new gateway for customers, which requires the bank to react and adopt a new strategy to survive. Elsaid (2021) indicated that fintech would get some market share from incumbents, playing the role of a substitute in the finance industry. However, the fintech growth creates new opportunities for banks to digitalization transformation, which aims to enhance their performance. Besides, through a systematic review of fintech and its relation to banking, Thakor (2020) stated that the shape and form of the relationship between fintech and banks are unclear and need further research to clarify.

Consequently, it can be seen that there is an inconsistency among scholars about the effect of fintech on banks. Therefore, further research is encouraged to clarify its effect.

1.2 Fintech and research concern

Through literature review, most scholars agree that *fintech is an emerging technology that fundamentally changes the finance industry*. Based on that and the content of using emerging technology in the finance industry, in this thesis, I propose two meanings of the fintech definition, illustrated in **Table 1.1**. *First*, the emerging technologies utilized by commercial banks are called bank fintech, which mainly indicates bank technology innovation. *Second*, other financial institutions (e.g., a fintech company, brokerage, insurance, etc.) dominated by fintech companies used emerging technologies to provide financial products or services, called the fintech-outside. These are the essential factors of the fintech industry, an emerging digital industry that plays a critical role in the economy.

The rise of the fintech industry has led to much research about the role of fintech in the relationship with commercial banks. Many studies indicate the relationship between fintech and commercial banks in the mobile payment market (Agarwal et al., 2020; Elsaid, 2020; Yudaruddin, 2022), in the retail credit market (de Roure et al., 2016; Jagtiani & Lemieux, 2017; Wan et al., 2016); and bank and fintech company cooperation (Hornuf et al., 2020; Navaretti et al., 2018; Thakor, 2020), and other strands. The existing publications provide the various dimensions of the effect of fintech on bank performance, but they have not yet indicated "*How is the effect of the fintech industry on commercial banks?*" especially regarding bank performance, which leads to raising a concern "*Whether there is the effect of the fintech industry on bank performance*".

Table 1.1 Two meanings of fintech

	+	Commercial banks	=	Bank fintech
Emerging technology	+	Fintech company Others (e.g., brokerage, insurance, etc.)	=	Fintech-outside

Source: The author

1.3 Vietnamese fintech industry context

According to Demirguc-Kunt et al. (2018), Demirgüç-Kunt and Klapper (2013), and WB (2022), in developing countries, where most population is unbanked and constraint to use the basic banking products, fintech plays the critical role in improving financial inclusion, enhancing financial literacy, and contributing economic growth. Thus, the role of fintech in developing countries is higher than others (Le, 2021; Ozili, 2018). Besides, through literature review, I explore that most publication regarding the link between fintech and bank performance focus on the developed countries rather than in developing countries. Therefore, I argue that conducting the study in developing country is necessary, which enrich the relevant knowledge.

Following the report of Statista (2021a, 2021b, 2022) and UOB (2020, 2022), around the world, Southeast Asia is the most dynamic market of the fintech industry, and Vietnam is the fastest market in the growth rate of fintech companies, fintech users, fintech transactions as well as the conditions for fintech development compared to other countries in the area.

Following the survey 2020 of the SBV, most Vietnamese commercial banks (93% of banks) are investing in technological innovation, which aim to fundamentally change the ways of banking and enhance the competitiveness. It shows that the banks are ready to compete with the fintech companies to provide advanced financial products to the customers. Besides, the report of SBV (2019, 2020) showed the propotion of commerical bank, which are applying the

emerging technologies in Vietnam is higher than others countries in the Southeast Asia.

Furthermore, in recent years, the Vietnamese government has paid more attention to facilitate the fintech industry development through many issued legal documents. The Government encourage the application of disruptive technologies, the cooperation between fintech companies and banks, and the connections between fintech platform and other platforms (especially e-commerce platform) to provide the advanced-banking products to the customers, which toward to the digital economy.

Consequently, it can be seen that Vietnam, a developing country in Southeast Asia is the interesting case study to clarify the concern about the effect of the fintech industry on bank performance.

1.4 Dissertation structure

This dissertation is structured as follows:

Section 1: Introduction. This section consists of the motivation for the study, fintech and research concern, the Vietnamese fintech industry, and dissertation structure.

Section 2: Literature review. This section reviews the relationship between banks and fintech, the effect of the fintech industry on bank performance, the research gap, and theories for the explanation.

Section 3: Research design. This section provides the research problem, goal, question, objective, hypothesis, and methodology (model, variable measurement, data analysis, and data collection).

Section 4: Results and discussion. This section reports and discuss the effect of fintech company growth on four perspectives of bank performance by Balanced Scorecard (BSC), the effect of fintech popularity by Google search on bank stock return, the effect of bank investment in technology innovation on bank efficiency by Data Envelopment Analysis (DEA), and research result aggregation.

Section 5: Conclusion. This section gives a conclusion, research contribution, implication, limitations, and further research directions.

2 LITERATURE REVIEW

2.1 Relationship between bank and fintech

Since 2015 when the study by Arner et al. (2015) was published, a vast number of fintech-related papers have been released (Goldstein et al., 2019; Gomber et al., 2017; Milian et al., 2019); thus, I am toward collecting the published articles from 2015 to the present for reviewing. Furthermore, to enhance the review quality, I strategy to select the high-quality articles published by the journals that belong to the Scopus/Web of Science database or with more than ten average citations per year (measured by the number of citations on Google Scholar divided into the number of publications years).

Reviewing many relevant studies, I explore the relationships between fintech and banks is various. I categorize these links into five strands: bank–fintech cooperation, banks and fintech in the mobile payment market, banks and fintech in the retail credit market, banking digitalization, and the effect of the fintech industry on bank performance. Of the five strands, I prefer the fifth strand. *First*, its effect is a debate, and further research is encouraged. *Second*, there are many ways to measure the fintech variables, but using Google search and accounting financial statements for fintech measurement have not yet been mentioned in relevant publications. *Third*, using the BSC approach for evaluating the effect of the fintech industry on bank performance seems rare. *Four*, the findings regarding the effect of fintech on bank performance will be meaningful for stakeholders, such as policymakers, bank managers, fintech managers, and investors, especially in developing countries like Vietnam.

2.2 Effect of the fintech industry on bank performance

The existing publications regarding the effect of the fintech industry on bank performance are conducted from various perspectives. *First*, from the perspective of the investigation scope, most studies focus on developed countries (e.g., USA, China, European), developing countries (e.g., Indonesia, India, etc.), and cross-country (e.g., Gulf Cooperation Countries, East African Community, etc.). *Second*, from the data collection perspective, most studies used secondary data (e.g., from Financial Development and Structure Dataset, Global Fintech Adoption Index, etc.); others used primary data from the survey and self-constructed data by a combination of primary and secondary data. *Third*, from the data analysis perspective, most studies applied the techniques regarding panel models; the rest relates to time series and cross-section models. Besides, I explored that most studies are quantitative research; the rest is systematic reviews and qualitative studies. Furthermore, bank performance measurements are also various, such as profitability, efficiency, stability, risk-taking, stock return, etc.

2.3 Research gap

Based on the research concern and through the literature review, I expored that:

First, the existing publications have not yet used Google search and accounting financial statements for measuring the fintech variables, and investigated its effect on bank performance.

Second, the effect of fintech company growth on four perspectives (financial, customer, internal process, and learning & growth) of firm performance by the Balanced Scorecard has not been yet to investigated by previous publications.

2.4 Theories for explanation

Following the studies by Almulla and Aljughaiman (2021) and Phan et al. (2020), theories for explanation are as below:

Customer theory by Aaker and Keller (1990) states that in the market, the new products play the complementary products for the old products; the combination brings the best experience to customers, but when new products meet customers' requirements (the same needs), they might replace the old products. It means that in the case of complementary fintech products, incumbents will benefit from the rise of fintech. In contrast, fintech offers alternative products, which negatively affect traditional banks.

Disruptive innovation theory by Christensen (1997) states that the new entrant applies disruptive technologies to provide the advance-products, which are easier to use and cost-effective and create high pressure of competition in the market against the incumbents. In the market, the gaps are filled by the new entrants' business-model innovation and product innovation. Besides, they might create different challenges affecting the incumbents in each sub-sector.

The productivity paradox theory is applied to explain the effect of bank fintech on bank efficiency. Solow (1987) initially found that in the computer age (technological innovation development), there is a significant correlation between an increase in information technology (IT) investment and a decrease in productivity. In the Vietnam case study, an increase in bank fintech might reduce bank efficiency.

3 RESEARCH DESIGN

3.1 Research problem

Based on the literature review and the context of the Vietnamese fintech industry, I am concerned about the *"How does the fintech industry affect bank performance in Vietnam?"*. This problem can be detailed in three dimensions:

- *Whether the effect of fintech company growth on the financial, customer, internal process, and learning and growth perspectives of bank performance*
- *Whether the effect of fintech popularity on bank stock return*
- *Whether the effect of bank investment in technology innovation on bank efficiency*

3.1.1 Fintech company growth and bank performance

There are many multi-dimensional approaches to evaluating firm performance, such as the methods by Brignall et al. (1991), Cross and Lynch (1989), Kaplan and Norton (2005), Keegan et al. (1989), and Neely et al. (2002).

Table 3.1 Multi-dimensional approaches to performance measurement

No.	Authors	Article	Approach	Citations
1	Keegan et al. (1989)	Are your performance measures obsolete?	The balance between internal & external measures; financial & non – financial measures	1,121
2	Cross and Lynch (1989)	Accounting for competitive performance	The pyramid	87
3	Brignall et al. (1991)	Performance measurement in service business	The determinant & results	1,594
4	Kaplan and Norton (2005)	**The balanced scorecard – measures that drive performance**	**The Balanced Scorecard**	**28,108**
5	Neely et al. (2002)	The performance prism: The scorecard for measuring and managing business success	The performance prism	2,203

Source: Google Scholar, date 22 Nov 2021

Based on the number of citations, **Table 3.1** shows that the BSC of Kaplan and Norton (2005) has the highest citations. Thus, I prefer to apply it for evaluating bank performance. Besides, through the literature review and my best knowledge, the study investigating the effect of fintech company growth on bank performance by BSC has not yet been conducted. Therefore, I believe it is a gap and needs to be filled.

Consequently, based on four perspectives (financial, customer, internal process, and learning and growth) of the BSC, I am concerned about "*Whether the effect of fintech company growth on the financial, customer, internal process, and learning and growth perspectives of bank performance*."

3.1.2 Fintech popularity and bank performance

Google search is a powerful to evaluate internet users' attention in cyberspace, such as attention on foreign currency (Smith, 2012), cryptocurrency (Kristoufek, 2013; Lin, 2021), fossil energy (Qadan & Nama, 2018), and commodity market (Bahloul & Bouri, 2016). Besides, through the literature review and my best knowledge, Google search has not yet been used for measuring the fintech variable. Thus, I argue it is a gap that needs to be filled. Besides, there is a huge fintech information in cyberspace, it is possibly to apply Google search for measuring the fintech popularity variable.

The existing publications by Asmarani and Wijaya (2020), Dranev et al. (2019), and Zhang and Zhuang (2020) show that there is a significant impact of fintech on bank stock movement. Besides, fintech development influences bank profitability, credits, and risk-taking (Phan et al., 2020; Sheng, 2021; Wang et al., 2021), which leads to a change in bank stock prices in the market.

Consequently, based on these arguments above, I am concerned about "*Whether the effect of fintech popularity on bank stock return*."

3.1.3 Bank investment in technology innovation and bank efficiency

Fintech is a technological innovation in the finance sector (Beck et al., 2016). Technological innovation mainly regards the software which supports the bank to increase performance (Arthur, 2017; Campanella et al., 2017; Scott et al., 2017). Following the bank fintech definition, which was proposed by Cheng and Qu (2020) and Thakor (2020), bank fintech regards the utilization of information technology of the traditional financial institution to optimize performance. Bagna et al. (2021), Chen et al. (2021), and Ho and Mallick (2010) provided that intangible assets are possibly to proxy firm technology innovation on the financial statements. Therefore, I use intangible assets on the financial statement to calculate the bank investment in technology innovation (BITI) based on these arguments.

Bank efficiency is one of the measures of bank performance. Thus, I use it to illustrate the effect of BITI on bank efficiency. Two popular approaches to measuring efficiency are DEA and Stochastic Frontier Analysis (SFA). Through the literature review and my best knowledge, there is a lack of studies about determinants of Vietnamese bank efficiency, which leads to poor proxies for measuring efficiency by the SFA, whereas DEA is highly appreciated in the current context of Vietnam. Therefore, I aim to apply the DEA approach to measuring bank efficiency in this thesis.

Consequently, I am concerned about "*Whether the effect of bank investment in technology innovation on bank efficiency*."

3.2 Research goal

The main goal is to "*evaluate the effect of the fintech industry on bank performance*" in Vietnam. The specific research goals are:

- *RG1: Evaluate the effect of fintech company growth on financial, customer, internal process, and learning and growth perspectives of bank performance*
- *RG2: Estimate the effect of fintech popularity on bank stock return*
- *RG3: Estimate the effect of bank investment in technology innovation on bank efficiency*

First, the four perspectives of the BSC approach are employed to evaluate the effect of fintech company growth on bank performance by conducting a qualitative study through semi-structured interviews. The fintech company is an essential part of the fintech industry in the digital era; thus, the growth of fintech companies through increasing the number of fintech companies, fintech transaction value, and fintech users significantly affects bank performance. I aim to conduct qualitative research to provide knowledge regarding this effect.

Second is the argument about using Google search to measure the internet user's attention to fintech, which proxy the fintech popularity variable. Following that, the investigation of the effect of fintech popularity on bank stock return is conducted. Due to the outcome of the Google search being time-series data, I formulated the time-series model, which is used to estimate the effect of fintech popularity on bank stock return.

Third, following the bank fintech definition and the argument above, the bank fintech is possibly measured by bank investment in technology innovation. Besides, the usefulness of the DEA approach in measuring bank efficiency in developing countries like Vietnam has been confirmed; hence, the third specific goal is to estimate the effect of investment in technology innovation and bank efficiency.

3.3 Research question

First, the existing publications by Alkhazaleh and Haddad (2021), Chen et al. (2021), Frame et al. (2018), Jagtiani and Lemieux (2019), Nicoletti (2017), Phan et al. (2020), Santoso et al. (2021), and Siddiqui and Siddiqui (2020) show that the effect of fintech company growth on four perspectives (financial, customer, internal process, and learning and growth) of bank performance is heterogeneous. Thus, I consider that:

RQ1*: How* does *fintech company growth affect financial, customer, internal process, and learning and growth perspectives of bank performance?*

Second, following the studies by Beatty and Shimshack (2010), de Area Leão Pereira et al. (2018), Iyke and Ho (2021), and Nguyen et al. (2019) about using Google search to measure economic issues and investigating its effect on stock price, I concern that:

***RQ2**: How does fintech popularity affect bank performance?*

Third, bank fintech (link to innovation technology or IT investment) plays a critical role in bank operation. The relevant studies by Appiahene et al. (2019), Campanella et al. (2017), Carbó-Valverde et al. (2020), del Gaudio et al. (2021), and Gupta et al. (2018) gave that the effect of bank fintech on bank performance is heterogeneous.

***RQ3**: How does bank investment in technology innovation affect bank performance?*

3.4 Research objective

To answer the research question, the research objectives are set as follows:

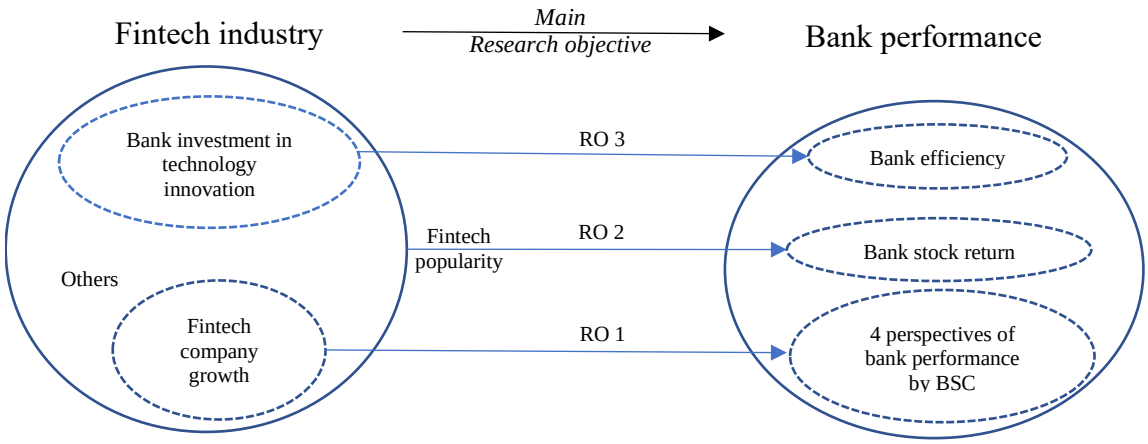

Figure 3.1 Research objectives

Source: The author

- *RO1: To evaluate the effect of fintech company growth on financial, customer, internal process, and learning and growth perspectives of bank performance*
- *RO2: To estimate the effect of fintech popularity on bank stock return*
- *RO3: To estimate the effect of bank investment in technology innovation on bank efficiency.*

3.5 Research hypothesis

The first research objective is conducted by qualitative study; thus, the relevant hypothesis of the effect of fintech companies on four perspectives is not developed.

The hypotheses regarding two other research objectives are developed as below:

Deriving from the customer and disruptive innovation theories and existing publications, I propose that:

H_1: There is a negative effect of fintech popularity on bank stock return.

Besides, following the reports by Statista (2021a, 2021b) and UOB (2020, 2022), payment and lending are the two largest segments of the fintech industry, which are expected to affect bank stock returns negatively. Thus, I propose:

H_{1a}: There is a negative effect of fintech popularity in payment on bank stock return.

H_{1b}: There is a negative effect of fintech popularity in lending on bank stock return.

Following the purpose of bank investment in technology innovation and existing publications, I propose that:

H_2: There is a positive effect of BITI on bank efficiency in Vietnam.

3.6 Methodology

3.6.1 Effect of fintech company growth on bank performance

Firstly, the orientation questionnaire is designed based on the existing publications of the BSC application for evaluating bank performance. *Secondly*, in January 2022, I phoned and emailed the potential interviewees to make an appointment. *Thirdly*, from February to April 2022, eight face-to-face interviews had conducted. *Fourthly*, the notes are coded and assigned. *Finally*, the frequency analysis is employed for data analysis.

3.6.2 Effect of fintech popularity on bank stock return

a. Model and variables

The time-series model, which illustrates the relationship between fintech popularity and bank stock return, is formulated:

$$Return_t = f\left(fin_t^k\right) \quad (3.1)$$

Where, $Return_t$ is the bank stock return at time t; and fin_t^k is the kind of k of fintech popularity at time t.

Following the existing publications regarding the fintech industry and the opinion of three experts in the finance-banking sector in Vietnam, the fintech-related keywords for extraction are selected in **Table 3.2**.

Table 3.2 Fintech-related keywords for extraction

Dimension	Keywords in English	Keywords in Vietnamese
Fintech in general	Fintech, financial technology	Công nghệ tài chính

Fintech payment	Mobile money, mobile payment, mobile wallet, e-money, e-wallet	Tiền điện tử, thanh toán di động, thanh toán online, ví điện tử
Fintech lending	Peer-to-peer lendings	Cho vay ngang hàng, cho vay online, cho vay đồng cấp

Source: The author

Based on **Table 3.2**, the Google Search Volume Index (GSVI) of keywords is collected from Google Trends from 2016w46 to 2021w46 (5 years). Due to the value of GSVI depending on the period of downloaded data, the raw GSVI is not significant for analysis. Therefore, Bijl et al. (2016) and Kim et al. (2019) proposed the Average Google Search Volume Index (AGSVI) as an alternative.

$$AGSVI_t^k = \frac{GSVI_t^k - \frac{1}{52}\sum_{i=1}^{52} GSVI_{t-i}^k}{\sigma_{GSVI_t^k}} \quad (3.2)$$

Motive from Cheng and Qu (2020), the exploratory factor analysis (EFA) method is applied to reduce the number of fintech variables and confirm the significance of choosing keywords. Besides, the value of the fintech variables will be standardized from 0 (zero) to 1 (one) by the maximum-minimum processing. Through these steps above, six fintech variables are constructed, which are categorized into three groups: Group 1 is the fintech popularity: $fin^{fintech}$ and fin^{pro}; Group 2 is the fintech popularity in payment variables: fin^{pay} and fin^{wall}; and Group 3 is the fintech popularity in lending variables: fin^{lend} and fin^{mon}.

According to the State Bank of Vietnam, at the end of 2021, there were 19 listed banks in two official stock exchanges (HOSE and HNX), but there were 11 banks that had been listed after 2016. Thus, eight banks (listed before 2016, trading code: *VCB, BID, CTG, MBB, ACB, STB, SHB, and EIB*) were selected to calculate the bank stock return variables for the reason of matching the requirement of continuous trading and compare with data from Google search.

Based on Kim et al. (2019), Kiymaz and Berument (2003), Truong et al. (2020), and Nguyen et al. (2019), Return at time t is calculated by the equation:

$$Return_t = log(BankIndex_t) - log(BankIndex_{t-1}) \quad (3.3)$$

$$BankIndex = \frac{CMV}{BMV}\ x\ 100 \quad (3.4)$$

CMV is the current market value, and BMV is the base market value.

$$CMV = \sum_{i=1}^{n}(P_i x S_i x F_i x C_i) \quad (3.5)$$

Where n is the number of bank stock in the basket; P_i is the price of bank i; S_i is the shares outstandings of bank i; F_i is the free-float rate of bank stock i; and C_i is the limited coefficient of capitalization weight of bank stock i in the index basket at the calculation time. At the weekend, GSVI is released; thus, the investors will react rationally (Bijl et al., 2016; Swamy & Dharani, 2019). Therefore, the first opening price is chosen to measure.

b. Data analysis

VAR-Granger and Copula (Gumbel, Clayton, and Normal) are applied for estimation. Pre-estimation techniques include the Dickey-Fuller and Phillips–Perrons approaches for the stationary test (Dickey & Fuller, 1979; Phillips & Perron, 1988), the lag-order selection test (Lütkepohl, 2005; Pfaff, 2008); and the co-integration test (Dolado et al., 1990; Pfaff, 2008) are employed.

3.6.3 Effect of BITI on bank efficiency

a. Model and variables

Motive from Anagnostopoulou (2008), Beccalli (2007), Ho and Mallick (2010), Lee et al. (2021), and Phan et al. (2020), the panel model is formulated for investigation:

$$Bank_{it} = \propto + \beta Fintech_{it} + \gamma Char_{it} + \theta Mar_t + \mu_i + \delta_{it} \qquad (3.6)$$

Where, $Bank_{it}$, $Fintech_{it}$, and $Char_{it}$ are the bank efficiency, bank investment in technology innovation, and characteristic variables of bank i at the time t, respectively. $\mathrm{Mar_t}$ is the macroeconomic environment. $\propto$ is the constant. β, γ, and θ are the coefficient of independent variables, respectively. μ_i denotes unobservable individual-specific effects. δ_{it} denotes the remainder disturbance.

Based on the pure DEA of Charnes et al. (1978) and Seiford and Zhu (1999), the bank efficiency is computed by labor and capital inputs, and the output is revenue. Following existing publications, I use intangible assets for proxying BITI variables, which reflects the banking technology innovation. Control variables consist of bank size (logarithm of total assets), bank age (logarithm of the number of years from the original launch to the time t), inflation, and GDP growth rate.

b. Data analysis

Based on the data collection capability and available data, the bank-level data is obtained from annual reports and audited financial statements of 23 commercial banks (*trading code: ABB, ACB, BAB, BID, CTG, EIB, HDB, KLB, LPB, MBB, MSB, NAB, NVB, OCB, SCB, SHB, SSB, STB, TCB, TPB, VCB, VIB, and VPB*) from 2011 to 2020. In this thesis, the Fixed effect (FE), Random effect (RE), Generalized least squares (GLS), and Tobit are employed.

3.6.4 Data collection

Primary data is collected from the semi-structured interview.

Secondary data is obtained from these sources. *First*, Google Trend provides to calculate the fintech popularity variables. *Second*, Vietstock provides bank-level data, including stock market indices, financial statements, and annual reports. *Third*, World Bank provides the macro-economic indicators.

4 RESULT AND DISCUSSION

4.1 Effect of fintech company growth on bank performance

When asking the respondents to choose the positive or negative effect of fintech company growth on bank performance, most respondents said that, at present, fintech company growth is a positive factor for banks. In detail, it is a pressure, which leads to enhanced bank performance. Besides, fintech company growth creates new rooms, which are the potential market for banks in the future. For example, the financial literacy of the non-banked population will be improved; they might open a bank account to experience, which is an opportunity for banks. Furthermore, cooperation with the fintech companies helps banks save IT investment and operation costs. Therefore, I conclude that there is a positive effect of fintech company growth on bank performance.

Table 4.1 Effect of fintech company growth on bank performance

Perspectives	Orientation ingredients	Determined ingredients	Relationship	Percentage*
Financial	Revenues, cost structure, asset utilization, profitability, economic value added, valuation, service income.	Service income (revenue)	Negative (short-term)	100%
			Positive (long-term)	
		Return on investment	Positive	87.5%
			Negative (IT investment efficiency)	62.5%
		Valuation	Positive	50%
			Negative	50%
Customer	Customer loyalty, customer retention, new customers, trust, reliability satisfaction	Customer loyalty	Negative	100%
		Customer satisfaction (in retail banking products)	Negative (younger)	100%
			Insignificant (older)	75.0%
		Trust and reliable	Positive	62.5%
Internal process	Effective in producing and delivering products, risk management, after-sale services, operation systems	Operation efficiency	Positive	100%
		Producing and delivering product	Positive	62.5%
		Risk management	Positive	50%
			Negative	50%
Learning and growth	Employee satisfaction, skills, knowledge, efficiency, training courses	Training and development programs	Positive	100%
		Employees capability	Positive	87.5%
		Employee satisfaction and retention	Negative	62.5%

*Note: * means the percentage of respondents who agree with the effect of fintech companies on the ingredient*

Source: The author

The respondent's view on the impact of fintech company growth on four perspectives of bank performance is aggregated in **Table 4.1.**

There are both positive and negative views about the effect of fintech companies on bank financial perspectives. In the short term, fintech is harmful from a bank's financial perspective, but in the long time, the bank's financial indicator will be improved by the effect of fintech. However, the thesis aims to investigate the effect in the current context; thus, I conclude that fintech company growth positively affect bank financial perspective.

Although fintech company growth increases the bank trust credit, it decreases bank customer loyalty and satisfaction, especially impacting young customers, key customers in the digital era. Thus, I conclude that fintech company growth is threatening the bank from the customer's perspective, or there is a negative effect of fintech company growth on the bank customer perspective.

Fintech company growth is a positive factor in enhancing bank internal operation performance and producing bank products, which is proof to conclude there is a positive effect of fintech company growth on the internal processes.

Employee dissatisfaction might be overcome by the increase in training courses and development programs, which are meant to enhance employees' capability. Therefore, I conclude that the effect of fintech on bank learning and growth perspective is positive.

4.2 Effect of fintech popularity on bank stock return

The characteristics of variables for data analysis are described in **Table 4.2**.

Table 4.2 Descriptive statistics and unit root test

Variable	Obs.	Mean	Std. Dev.	Min.	Max.	Dickey-Fuller test	Phillips–Perron test
$Return$	209	.0020713	.0378595	-.1315444	.1301236	-12.004***	-12.055***
$fin^{fintech}$	209	.3393684	.1807558	0	1	-12.433***	-12.508***
fin^{pay}	209	.3462506	.1760233	0	1	-12.200***	-12.333***
fin^{lend}	209	.1839054	.1022469	0	1	-13.013***	-13.110***
fin^{mon}	209	.4098034	.1475019	0	1	-12.494***	-12.772***
fin^{wall}	209	.3462138	.1820644	0	1	-12.358***	-12.465***
fin^{pro}	209	.4271674	.145622	0	1	-12.815***	-12.999***

Note: *, **, and *** are significant at the 10%, 5%, and 1% levels, respectively

Source: The author

$Return_{mean}$ indicates that the average return of 8 banks is 0.0020713 (about 0.2%/week), and $Return_{min}$= -0.131544 and $Return_{max}$= 0.1301236 mean the investors can lose and gain the largest return at approximately 13.15% and 13.01%, respectively. The means of fintech variables give that the highest searching volume keyword regards the product (fin^{pro}_{mean}= 0.4271674), next is the money, payment, wallet, fintech in general, and the lowest is lending (fin^{lend}_{mean} = 0. 1839054). The Dickey-Fuller and Phillips-Perron tests show that all original variables are stationary, which means they are eligible for further quantitative analysis.

Following the lag-order selection and cointegration test estimation results, the VAR-Granger is employed to estimate the relationship between variables. **Table 4.3** illustrates the statistical value of the effect of the variable in the row on the variable in the column.

Two bi-directional causalities between pair variables are found: $Return$ and fin^{pay} and $Return$ and fin^{lend}. The findings show that the search volume of keywords regarding the two largest segments of the fintech industry (lendings and payment) might predict the change in bank stock return, which support the

statement of Buchak et al. (2018) and Iman (2019) about the relationship between traditional banks and fintech segments in the digital era. There are two uni-directional causalities of pair variables: from $Return$ to $fin^{fintech}$, from $Return$ to fin^{wall}, and from fin^{mon} to $Return$. Besides, $Return$ might be predicted by three variables of fin^{pay}, fin^{lend}, and fin^{mon}, while $Return$ is a predictive factor of four variables of fin^{pay}, fin^{lend}, $fin^{fintech}$, and fin^{wall}.

Table 4.3 Granger causality of pair variables in the specific models

Variable	Return	$fin^{fintech}$	**Variable**	Return	fin^{pay}
Return	-	5.298*	Return	-	4.4872**
$fin^{fintech}$	3.4975	-	fin^{pay}	2.8908*	-
Variable	Return	fin^{lend}	**Variable**	Return	fin^{mon}
Return	-	18.42***	Return	-	.6059
fin^{lend}	23.696***	-	fin^{mon}	4.3291**	-
Variable	Return	fin^{wall}	**Variable**	Return	fin^{pro}
Return	-	6.3459**	Return	-	.25404
fin^{wall}	2.4163	-	fin^{pro}	2.4719	-

*Note: *, **, and *** are significant at the 10%, 5%, and 1% levels, respectively.*
The null hypothesis is that the variable in the row is not a Granger cause variable in the column.
Model 1: $Return_t = f(fin_t^{fintech})$
Model 2: $Return_t = f(fin_t^{pay})$
Model 3: $Return_t = f(fin_t^{lend})$
Model 4: $Return_t = f(fin_t^{mon})$
Model 5: $Return_t = f(fin_t^{wall})$
Model 6: $Return_t = f(fin_t^{pro})$
The estimation result of the lag-order selection test indicated that the optimal lags of two, one, two, two, two, and one are selected for responding to six specific models, respectively.
The estimation results of the cointegration test gave that that no pair-variables persist in the long run

Source: The author

The regression analysis is run based on these estimation results above to identify the effect of particular fintech popularity on bank stock return. The results are presented in **Table 4.4**. The $fin_t^{fintech}$ coefficient is 0.0576098 and a significance level of 1%, which means that the increase in the search volume of fintech increase the bank stock return. The findings show that there is a positive effect of fintech popularity on bank stock return.

The coefficients of fin_t^{pay} and fin_{t-1}^{pay} are 0.0575004 (significance level of 1%) and 0.0254605 (significance level of 10%), respectively. It means the increase or decrease of bank stock return at week t depends on the increase or decrease of search volume of fintech payment at week t and t-1. Besides, the fintech wallet is also a positive predictor of bank stock return, which is proven by the significant positive coefficients of the fintech wallet variables, namely the coefficients of fin_t^{wall} and fin_{t-2}^{wall} are 0.0622664 (significance level of 1%) and 0.0247475 (significance level of 10%), respectively. Based on the findings, I conclude that the increase in volume search regarding fintech payment reduces bank stock return.

The estimation results of model 3 ($Return_t = f(fin_t^{lend})$) shows that coefficients of fintech lending are significantly positive; namely, the increase or decrease of volume search of fintech lending at the week t and t-2 correspondingly increases or decreases in bank stock return at the week t. In detail, give that the fin_t^{lend} and fin_{t-2}^{lend} coefficients are 0.0461059

(significance level of 10%) and 0.0951207 (significance level of 1%), respectively.

Table 4.4 Effect of specific fintech popularity on bank stock return

Variable	Model 1	Model 2	Model 3	Variable	Model 4	Model 5	Model 6
$Return_{t-1}$	.1325252* [1.90]	.0981091 [1.41]	.1829064** [2.58]	$Return_{t-1}$	.1788104** [2.55]	.1264746* [1.82]	.1795226*** [2.59]
$Return_{t-2}$	-.0766004 [-1.10]	-	-.038792 [-0.55]	$Return_{t-2}$	-.000443 [-0.01]	-.0854798 [-1.23]	-
$fin_t^{fintech}$	.0576098*** [4.11]	-	-	fin_t^{mon}	-.0111405 [-0.61]	-	-
$fin_{t-1}^{fintech}$	.0152585 [1.05]	-	-	fin_{t-1}^{mon}	.0017777 [0.10]	-	-
$fin_{t-2}^{fintech}$	.0206214 [1.41]	-	-	fin_{t-2}^{mon}	.0152764 [0.84]	-	-
fin_t^{pay}	-	.0575004*** [3.99]	-	fin_t^{wall}	-	.0622664*** [4.53]	-
fin_{t-1}^{pay}	-	.0254605* [1.70]	-	fin_{t-1}^{wall}	-	.0130122 [0.90]	-
fin_t^{lend}	-	-	.0461059* [1.78]	fin_{t-2}^{wall}	-	.0247475* [1.71]	-
fin_{t-1}^{lend}	-	-	.0118123 [0.46]	fin_t^{pro}	-	-	-.0091719 [-0.51]
fin_{t-2}^{lend}	-	-	.0951207*** [3.83]	fin_{t-1}^{pro}	-	-	-.0078764 [-0.44]
Cons	-.030072*** [-3.76]	-.0268714*** [-3.76]	-.0267309*** [-3.58]	**Cons**	-.0010636 [0.09]	-.0329392*** [-4.11]	.0089404 [0.84]
F-Value	5.94***	9.30***	5.69***	**F-Value**	1.49	6.92***	2.36*

*Note: *, **, and *** are significant at the 10%, 5%, and 1% levels, respectively.*

Model 1: $Return_t = f(fin_t^{fintech})$ *Model 3:* $Return_t = f(fin_t^{lend})$ *Model 5:* $Return_t = f(fin_t^{wall})$

Model 2: $Return_t = f(fin_t^{pay})$ *Model 4:* $Return_t = f(fin_t^{mon})$ *Model 6:* $Return_t = f(fin_t^{pro})$

Source: The author

The estimation results in **Table 4.5** confirm the bi-directional causality between $Return$ and fin^{lend}; thus, we conclude a significant link between the volume of searching fintech lending and bank stock return. The development of peer-to-peer (P2P) platforms on the internet bring more advanced lending products than before for fintech companies and traditional banks (Bachmann et al., 2011; Wan et al., 2016). The curiosity about exploring P2P lending products leads to extending the credit market, which supports enhancing bank performance.

Besides, **Table 4.5** provides something interesting. The participants seem not to search only for particular fintech; they tend to find the fintech information group. The multi-link between fintech-related keywords in searching behavior is found in **Table 4.5**. There is a significant influence of this fintech on another, which means the action of searching this fintech might predict the others.

Table 4.5 Granger causality for pair variables in aggregation model

Variable	Return	$fin^{fintech}$	fin^{pay}	fin^{lend}	fin^{mon}	fin^{wall}	fin^{pro}	ALL
Return	-	1.9395	.15928	16.096***	1.2721	2.4653	1.1427	28.882***
$fin^{fintech}$	3.3195	-	1.8912	156.67***	2.9112	3.9989	.75953	179.51***
fin^{pay}	3.5353	.84315	-	127.93***	2.1413	7.5292**	.80516	152.71***
fin^{lend}	25.61***	.49132	.91805	-	3.7406	.47894	1.5426	38.559***
fin^{mon}	2.7433	9.7181***	1.555	1.8949	-	2.7632	2.1868	23.438**
fin^{wall}	2.2384	.63603	3.1008	168.83***	2.2134	-	.62177	191.63***
fin^{pro}	2.9429	11.781***	2.0084	.35991	.1992	3.2744	-	24.218**

The aggregation model: $Return_t = f(fin_t^{fintech}, fin_t^{pay}, fin_t^{lend}, fin_t^{mon}, fin_t^{wall}, fin_t^{pro})$

Note: *, **, and *** are significant at the 10%, 5%, and 1% levels, respectively.

The null hypothesis is that the variable in the row is not a Granger cause variable in the column.
Model 7: $Return_t = f(fin_t^{fintech}, fin_t^{pay}, fin_t^{lend}, fin_t^{mon}, fin_t^{wall}, fin_t^{pro})$
The estimation result of the lag-order selection test provided that two are the optimal lags of model 7
The estimation result of the cointegration test gives that the absence of a long-run relationship between variables
Source: The author

Table 4.6 shows the regression analysis, which indicates that the coefficients of $fin_{t-1}^{fintech}$ and fin_{t-1}^{wall} are 0.1355067 and -0.1409726, respectively, and both are significant levels of 10%. This finding is different from the estimation results by the Granger for the aggregation model. In the aggregation model, the Granger approach provides a significant relationship between fin^{lend} and $Return$, but the regression analysis result does not confirm it and even does not provide a significant effect of fin^{lend} on $Return$. Therefore, in this case, based on the regression analysis results, there is a positive effect of $fin_{t-1}^{fintech}$ on $Return$. The significantly negative fin_{t-1}^{wall} coefficient permits to conclude a negative effect of fintech payment on bank stock return.

Table 4.6 Effect of fintech popularity on bank stock return

Variable	$Return$	Variable	$Return$	Variable	$Return$
$Return_{t-1}$	.1559549** [2.01]	fin_{t-2}^{pay}	-.0120493 [-0.32]	fin_t^{wall}	.1128298 [1.64]
$Return_{t-2}$	-.0734844 [-0.96]	fin_t^{lend}	.0418523 [1.56]	fin_{t-1}^{wall}	-.1409726* [-1.78]
$fin_t^{fintech}$	-.1003209 [-1.47]	fin_{t-1}^{lend}	.0065759 [0.25]	fin_{t-2}^{wall}	.093766 [1.17]
$fin_{t-1}^{fintech}$	.1355067* [1.84]	fin_{t-2}^{lend}	.039088 [1.15]	fin_t^{pro}	-.010437 [-0.30]
$fin_{t-2}^{fintech}$	-.0635769 [-0.89]	fin_t^{mon}	-.0125449 [-0.36]	fin_{t-1}^{pro}	-.0299092 [-0.85]
fin_t^{pay}	.0334295 [0.83]	fin_{t-1}^{mon}	.0267434 [0.76]	fin_{t-2}^{pro}	-.0230221 [-0.66]
fin_{t-1}^{pay}	.0225771 [0.50]	fin_{t-2}^{mon}	.0300841 [0.86]	Cons	-.0338611** [-2.39]
F-Value	2.35***		Optimal lags	2	

*Note: *, **, and *** are significant at the 10%, 5%, and 1% levels, respectively.*
Model 7: $Return_t = f(fin_t^{fintech}, fin_t^{pay}, fin_t^{lend}, fin_t^{mon}, fin_t^{wall}, fin_t^{pro})$
Source: The author

Table 4.7 shows that the column of $Return$ - $fin^{fintech}$, $Return$ - fin^{pay} and $Return$ - fin^{wall}, the highest log-likelihood belonging to Normal; thus, the dependency structure between $Return$ and $fin^{fintech}$, $Return$ and fin^{pay} and $Return$ and fin^{wall} are determined a normal shape. It means the probability of simultaneous increase or decrease between bank stock return and fintech popularity is equal. In the column $Return$ - fin^{lend} the highest log-likelihood is Clayton; thus, the structural dependency between $Return$ and fin^{lend} is determined as a left-tail, which means in case of simultaneous decrease between bank stock return and fintech popularity in lending is higher than in other cases.

The estimation result by Copula confirms the significant relationship between $Return$ and fin^{lend}. However, this relationship is more robust in the case of downward than upward. The investor's taste can explain it in bank stocks and the habit of searching lendings-related keywords on Google. The decrease in searching fintech lending volume reduces bank income expectations,

influencing bank stock performance. Besides, investors are paying less attention to searching for information regarding fintech lending than before, which indicates that the investors are not enthusiastic about the bank stocks and might find other opportunities in other stocks. Furthermore, as I mentioned earlier, interest incomes are the highest proportion of the Vietnamese banks' income; hence, the decrease in bank stock returns is a sign of decreased interest incomes, which leads to changing the investor habit in searching for fintech lending information.

Table 4.7 Estimated parameter and log-likelihood by the Copula

		$Return\text{-}fin^{fintech}$	$Return\text{-}fin^{pay}$	$Return\text{-}fin^{lend}$	$Return\text{-}fin^{wall}$
Clayton	Parameter	13.1362	2.1091	10.7072*	7.9939
	Log-likelihood	7.897	10.22	3.131	7.622
Gumbel	Parameter	1.205	1.217	1.1	1.222
	Log-likelihood	7.842	7.568	2.223	10.15
Normal	Parameter	0.2892*	0.3237*	0.1408	0.3058***
	Log-likelihood	8.429	10.71	1.915	9.486

Note: (*) is considered the fittest estimation
Kendall-plot graphics show that $Return\text{-}fin^{mon}$ and $Return\text{-}fin^{wall}$ are non-dependency structure; $Return\text{-}fin^{fintech}$, $Return\text{-}fin^{pay}$, $Return\text{-}fin^{lend}$, and $Return\text{-}fin^{wall}$ have a dependency structure

Source: The author

Consequently, through the estimation results and discussion above, I conclude these points. *First*, there is a significant relationship between fintech popularity and bank stock return, as well as many segments of the fintech industry, which are also significantly linked to bank stock return. The relationship between fintech popularity and bank stock return is positive, and the contemporary change in the increase or decrease of two variables is equal. *Second*, most evidence shows that the effect of fintech popularity in payment on bank stock return is positive. The increase in volume search of payment and wallet predicts the rise in bank stock return. *Third*, fintech popularity in lending is determined to be a significant positive factor in predicting the change of bank stock return; especially, it is meaningful in the contemporary change in the decrease of both fintech lending and bank stock return. Overall, by investigating the effect of fintech popularity on bank stock return, I found the positive effect of fintech popularity including in payment and lending on bank stock return.

4.3 Effect of BITI on bank efficiency

In this sub-section, the quantitative research of the effect of BITI on bank efficiency is presented and discussed. **Table 4.8** shows the main features of all variables. Most variables have 230 observations for 23 commercial banks in 10 years (2011-2020), except the INF and GDP variables have ten observations, representing a yearly and repeated macroeconomic condition for each bank in 2011-2020.

Table 4.9 shows that all estimation results are significant at a 1% level. Besides, the $R-Square_{min}$= 0.5445 and $R-Square_{max}$= 0.5956 show that the independent variables can explain around 54%-59% of the change in bank

efficiency; the rest of the change is explained by other factors not mentioned in the model. All SIZE coefficients are positive at a significance level of 1%; meaning bank efficiency tends to increase with the extension of bank scales (increase total assets). All INF coefficients are positive at a significant level of 1%-5%, which reveals that the Vietnamese banks' efficiency depends more on the inflation indicator. With the proper inflation of Vietnam (INF_{mean}=0.0548258, about 5%), I argue that it shows suitable macroeconomic conditions for improving bank efficiency. Following the findings, a large bank is more efficient than a small one, and bank efficiency increases with high inflation. The positive effect of bank size is consistent with Phan et al. (2020); due to the strong brand name and market power, large-sized banks are more efficient than small-sized banks. It is inconsistent in estimation results of the effect of INR and ING on EFF between models.

Table 4.8 Descriptive statistic

Variable		Definition	Obs.	Mean	Std. Dev	Min.	Max.
Bank	EFF	Bank efficiency	230	.5269759	.1932101	.0112239	1
Fintech	INR	Intangible assets on fixed assets	230	.4761392	.1940598	.0236898	.9812289
	ING	Growth rate of intangible assets	230	.2795915	1.004721	-.9987441	11.45088
Char	AGE	Bank age	230	3.084361	.4795883	1.098612	4.143135
	Age (years)*		230	24.19565	11.15711	3	63
	SIZE	Bank total assets	230	11.91671	1.01973	9.623798	14.23204
	Size (billion VND)*		230	251,086.7	295,721.4	15,120.37	1,516,686
Mar	INF	Inflation	10	.0548258	.0492765	.006312	.1867773
	GDP	GDP growth rate	10	.0595946	.0118046	.0290584	.0707579

** denotes the original variable before the logarithm.*
The maximum absolute value of correlation coefficients between variables is 0.7238 less than 0.8; thus, all variables are eligible for further analysis

Source: The author

The coefficients of INR by models 3, 4, and part of 5 are positive significance levels of 1%-10%, while the rests are not significant. Only ING coefficients of model 5 have a positive significance level of 5%, and other ING coefficients are insignificant. Thus, it might be stated that there is an absence of the "productivity paradox" in the sample.

The estimation shows a negative effect of bank age on the association between bank fintech and bank efficiency. In detail, the coefficients of INR*AGE and ING*AGE are harmful significance levels of 1% and 5%, respectively, which might be explained by the slowness of banks in technology innovation adoption. As the outcome of the qualitative study above, the issues of bank technology innovation adoption regards bank human quality resources. According to my observation, due to its long history, the staff of mature (older) banks are not young and face problems in IT adoption. The coefficients of INR*SIZE are negative and significant at the 10% and 5% levels with the estimation results by FE and RE, respectively, whereas the coefficients of ING*SIZE are negative but insignificant. This finding partly supports the impact of bank age on the link between bank fintech and bank efficiency. Large banks and elder banks decrease the impact of bank fintech on bank efficiency.

The row of Wald test, Wooldridge test, and Bre. and Pa. test indicate that all estimation results of six models by FE or RE have heteroskedasticity and autocorrelation issues at the significance level of 1%. Therefore, the GLS approach is employed to overcome the problems of heteroskedasticity and autocorrelation. The estimation results by GLS are presented in **Table 4.10**.

Table 4.9 Estimation results by FE and RE

	FE	RE	FE	RE	FE	RE
Variable	**Model 1**		**Model 2**		**Model 3**	
Cons.	-2.164857***	-1.762069***	-2.187435***	-1.74802***	-2.978382***	-2.54451***
	[-10.75]	[-10.12]	[-10.81]	[-10.00]	[-11.42]	[-10.42]
INR	-	-	.0890651	.0418294	2.157619***	2.051156***
	-	-	[1.51]	[0.75]	[4.68]	[4.41]
ING	-	-	-.0000501	.0001347	-.0041269	-.0038581
	-	-	[-0.01]	[0.02]	[-0.68]	[-0.61]
AGE	.1299637**	.0532881	.1291733*	.046089	.3876267***	.2885146***
	[1.97]	[1.20]	[1.96]	[1.06]	[4.56]	[4.13]
SIZE	.1898248***	.1778372***	.1882895***	.1769421***	.1908197***	.1835337***
	[8.16]	[9.98]	[8.07]	[10.05]	[8.56]	[10.61]
INF	.5953438***	.3494045**	.6252868***	.346391**	.5656234***	.2994112**
	[3.69]	[2.31]	[3.84]	[2.25]	[3.63]	[2.01]
GDP	-.0629179	-.2299926	-.0750627	-.2462109	-.2063193	-.365437
	[-0.12]	[-0.44]	[-0.15]	[-0.46]	[-0.42]	[-0.72]
INR*AGE	-	-	-	-	-.6805055***	-.658018***
	-	-	-	-	[-4.52]	[-4.33]
Obs.	230	230	230	230	230	230
R-Square	0.5491	0.5445	0.5543	0.5477	0.5956	0.5888
Statistical value	61.81***	244.68***	41.67***	241.99***	42.08***	282.41***
Hausman test	16.95***		32.71***		31.34**	
Wald test	179.58***	-	174.50***	-	204.92***	-
Wooldridge test	42.649***	-	43.246***	-	49.787***	-
Variable	**Model 4**		**Model 5**		**Model 6**	
Cons.	-2.65033***	-2.423034***	-2.201918***	-1.796061***	-2.19717***	-1.771119***
	[-8.02]	[-7.60]	[-10.98]	[-10.25]	[-10.80]	[-10.00]
INR	1.209036*	1.588321**	.1021189*	.0531714	.0930426	.0457918
	[1.90]	[2.53]	[1.74]	0.96]	[1.56]	[0.82]
ING	-.0015642	-.0021325	.2131056**	.2051713**	.0474107	.031595
	[-0.25]	[-0.33]	[2.22]	[2.07]	[0.58]	[0.38]
AGE	.1171235*	.0335535	.1547093**	.065824	.1303694**	.0477141
	[1.78]	[0.77]	[2.33]	[1.47]	[1.97]	[1.08]
SIZE	.2318635***	.2385114***	.1824326***	.1753553***	.1886193***	.1782194***
	[6.85]	[7.89]	[7.84]	[9.90]	[8.07]	[10.00]
INF	.5923044***	.3248686**	.6613409***	.3923632**	.0063472***	.3612294**
	[3.64]	[2.13]	[4.08]	[2.56]	[3.88]	[2.33]
GDP	-.1194199	-.2938771	-.1042054	-.2624081	-.000671	-.2348936
	[-0.23]	[-0.56]	[-0.21]	[-0.50]	[-0.13]	[-0.44]
INR*SIZE	-.0968096*	-.1328988**	-	-	-	-
	[-1.77]	[-2.47]	-	-	-	-
ING*AGE	-	-	-.0721191**	-.0693356**	-	-
	-	-	[-2.22]	[-2.08]	-	-
ING*SIZE	-	-	-	-	-.0043258	-.0028668
	-	-	-	-	[-0.59]	[-0.38]
Obs.	230	230	230	230	230	230
R-Square	0.5612	0.5538	0.5651	0.5583	0.5551	0.5488
Statistical value	36.54***	254.40***	37.12***	251.10***	35.65***	242.09***
Hausman test	9.11		32.14***		30.72***	
Wald test	-	-	166.87***	-	175.99***	-
Wooldridge test	-	44.858***	55.065***	-	44.367***	-
Bre. and Pa. test	-	173.68***				

Note: *, **, and *** are significant level at 10%, 5%, and 1%, respectively

Model 1: $EFF_{it} = \propto + \gamma_1 AGE_{it} + \gamma_2 SIZE_{it} + \theta_1 INF_t + \theta_2 GDP_t + \mu_i + \delta_{it}$

Model 2: $EFF_{it} = \propto + \beta_1 INR_{it} + \beta_2 ING_{it} + \gamma_1 AGE_{it} + \gamma_2 SIZE_{it} + \theta_1 INF_t + \theta_2 GDP_t + \mu_i + \delta_{it}$

Model 3: $EFF_{it} = \propto + \beta_1 INR_{it} + \beta_2 ING_{it} + \gamma_1 AGE_{it} + \gamma_2 SIZE_{it} + \theta_1 INF_t + \theta_2 GDP_t + \varphi_1 INR_{it} \times AGE_{it} + \mu_i + \delta_{it}$

Model 4: $EFF_{it} = \propto + \beta_1 INR_{it} + \beta_2 ING_{it} + \gamma_1 AGE_{it} + \gamma_2 SIZE_{it} + \theta_1 INF_t + \theta_2 GDP_t + \varphi_2 INR_{it} \times SIZE_{it} + \mu_i + \delta_{it}$

Model 5: $EFF_{it} = \propto + \beta_1 INR_{it} + \beta_2 ING_{it} + \gamma_1 AGE_{it} + \gamma_2 SIZE_{it} + \theta_1 INF_t + \theta_2 GDP_t + \varphi_3 ING_{it} \times AGE_{it} + \mu_i + \delta_{it}$

Model 6: $EFF_{it} = \propto + \beta_1 INR_{it} + \beta_2 ING_{it} + \gamma_1 AGE_{it} + \gamma_2 SIZE_{it} + \theta_1 INF_t + \theta_2 GDP_t + \varphi_4 ING_{it} \times SIZE_{it} + \mu_i + \delta_{it}$

Source: The author

The row of statistical values shows that all estimation results of six models are significant at a 1% level. The same with the estimation results by FE and

RE, the coefficients of SIZE and INF by GLS are positive significance levels of 1%-10%. The coefficients of GDP are not significant.

The mixed results of the INR effect on EFF are found in **Table 4.10**. There are three negative effects (models 2, 5, and 6) and two positive effects (models 3 and 4) of INR on EFF. Besides, only one coefficient of ING is significant at a level of 10%, belonging to model 5; others are insignificant. Based on the findings of the negative effect of INR on EFF, I argue that it supports the productivity paradox theory, which means the increase in technology innovation investment decreases bank efficiency. The coefficient of INR*AGE ($\varphi_1^{model\ 3}$), INR*SIZE ($\varphi_2^{model\ 4}$), and ING*AGE ($\varphi_3^{model\ 5}$) are -0.6377515, -0.109085, and -0.0476823 and significance levels of 1%, 5%, and 10%, respectively. It means the large and elder banks are the factors that negatively affect the relationship between BITI and bank efficiency.

Table 4.10 Estimation results by GLS

Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Cons.	-1.13399***	-1.041551***	-1.887451***	-1.663551***	-1.085919 ***	-1.048898***
	[-8.17]	[-7.54]	[-7.72]	[-5.59]	[-7.77]	[-7.56]
INR	-	-.0976398**	1.831383***	1.165358**	-.0916918*	-.0962307**
	-	[-2.02]	[3.88]	[2.11]	[-1.92]	[-1.99]
ING	-	-.0003803	-.0018887	-.0024159	.1389152*	.0294942
	-	[-0.12]	[-0.55]	[-0.64]	[1.92]	[0.61]
AGE	.0192566	.0288237	.2707736***	.0192218	.0427611	. .0289131
	[0.65]	[1.00]	[4.12]	[0.67]	[1.55]	[1.01]
SIZE	.1347925***	.128616***	.1394991***	.1840452***	.1287971***	.1292199***
	[10.90]	[10.69]	[11.75]	[6.98]	[10.92]	[10.71]
INF	.2713685**	.2658321**	.1954753	.2308783*	.2777406**	.2705661**
	[2.09]	[2.05]	[1.55]	[1.76]	[2.17]	[2.09]
GDP	-.1069441	-.1483876	-.1543906	-.0391128	-.2044459	-.1552972
	[-0.29]	[-0.40]	[-0.44]	[-0.11]	[-0.56]	[-0.42]
INR*AGE	-	-	-.6377515***	-	-	-
	-	-	[-4.10]	-	-	-
INR*SIZE	-	-	-	-.109085**	-	-
	-	-	-	[-2.28]	-	-
ING*AGE	-	-	-	-	-.0476823*	-
	-	-	-	-	[-1.93]	-
ING*SIZE	-	-	-	-	-	-.002821
	-	-	-	-	-	[-0.62]
Obs.	230	230	230	230	230	230
Statistical value	160.37***	181.79***	204.62***	214.93***	183.99***	181.94***

Note: *, **, and *** are significant level at 10%, 5%, and 1%, respectively

Model 1: $EFF_{it} = \propto + \gamma_1 AGE_{it} + \gamma_2 SIZE_{it} + \theta_1 INF_t + \theta_2 GDP_t + \mu_i + \delta_{it}$

Model 2: $EFF_{it} = \propto + \beta_1 INR_{it} + \beta_2 ING_{it} + \gamma_1 AGE_{it} + \gamma_2 SIZE_{it} + \theta_1 INF_t + \theta_2 GDP_t + \mu_i + \delta_{it}$

Model 3: $EFF_{it} = \propto + \beta_1 INR_{it} + \beta_2 ING_{it} + \gamma_1 AGE_{it} + \gamma_2 SIZE_{it} + \theta_1 INF_t + \theta_2 GDP_t + \varphi_1 INR_{it} \times AGE_{it} + \mu_i + \delta_{it}$

Model 4: $EFF_{it} = \propto + \beta_1 INR_{it} + \beta_2 ING_{it} + \gamma_1 AGE_{it} + \gamma_2 SIZE_{it} + \theta_1 INF_t + \theta_2 GDP_t + \varphi_2 INR_{it} \times SIZE_{it} + \mu_i + \delta_{it}$

Model 5: $EFF_{it} = \propto + \beta_1 INR_{it} + \beta_2 ING_{it} + \gamma_1 AGE_{it} + \gamma_2 SIZE_{it} + \theta_1 INF_t + \theta_2 GDP_t + \varphi_3 ING_{it} \times AGE_{it} + \mu_i + \delta_{it}$

Model 6: $EFF_{it} = \propto + \beta_1 INR_{it} + \beta_2 ING_{it} + \gamma_1 AGE_{it} + \gamma_2 SIZE_{it} + \theta_1 INF_t + \theta_2 GDP_t + \varphi_4 ING_{it} \times SIZE_{it} + \mu_i + \delta_{it}$

Source: The author

Furthermore, the value of EFF is from zero (0) to one (1); hence, I use the Tobit approach to robustness check the estimation results by FE, RE, and GLS. The estimation results by the Tobit can be seen in **Table 4.11**.

The row of statistical values shows that all estimation results of six models are significant at a 1% level. The estimation results by Tobit validate the significance and sign of the coefficient of INR and SIZE, which GLS finds. The SIZE coefficients are positive and significant at a 1% level. Besides, Tobit's estimation results confirmed the negative impact of bank age and size on the relationship between INR and EFF.

Following Bashayreh and Wadi (2021), Lee et al. (2021), Pham et al. (2021), and Phan et al. (2020), the lag of BITI might influence bank performance. The estimation result of the lag effect is presented in **Table 4.12**. In the statistic value row, at least one independent variable in the model might explain the change of the dependent variable.

Table 4.11 Estimation results by Tobit

	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**
Cons.	-1.072976***	-.9527417***	-1.615794***	-1.935873***	-.9856195***	-.9473538***
	[-8.83]	[-7.63]	[-7.10]	[-6.03]	[-7.73]	[-7.45]
INR	-	-.1508377***	1.606114***	1.984331***	-.1514983***	-.1502893***
	-	[-3.24]	[3.14]	[3.07]	[-3.27]	[-3.23]
ING	-	.0024664	-.0006709	-.0022581	.1606368	-.0221961
	-	[0.29]	[-0.08]	[-0.26]	[1.20]	[-0.20]
AGE	.0063934	.0246503	.2238591***	.0035274	.0356949	.024738
	[0.28]	[1.08]	[3.61]	[0.15]	[1.45]	[1.08]
SIZE	.1351016***	.1266318***	.1326401***	.2152994***	.1265453***	.126144***
	[12.50]	[11.61]	[12.31]	[7.48]	[11.64]	[11.35]
INF	-.0040389	-.0836308	-.1454704	-.0746539	-.0560139	-.0874092
	[-0.02]	[-0.45]	[-0.80]	[-0.41]	[-0.30]	[-0.47]
GDP	-.4952295	-.4972189	-.6163151	-.5488201	-.5097659	-.5019729
	[-0.66]	[-0.68]	[-0.86]	[-0.77]	[-0.70]	[-0.69]
INR*AGE	-	-	-.5720031***	-	-	-
	-	-	[-3.45]	-	-	-
INR*SIZE	-	-	-	-.1805206***	-	-
	-	-	-	[-3.31]	-	-
ING*AGE	-	-	-	-	-.0534101	-
	-	-	-	-	[-1.18]	-
ING*SIZE	-	-	-	-	-	.0022427
	-	-	-	-	-	[0.22]
Obs.	230	230	230	230	230	230
Statistic value	171.17***	181.44***	193.03***	192.17***	210.60***	181.49***

*Note: *, **, and *** are the significant level at 10%, 5%, and 1%, respectively*

Model 1: $EFF_{it} = \propto + \gamma_1 AGE_{it} + \gamma_2 SIZE_{it} + \theta_1 INF_t + \theta_2 GDP_t + \mu_i + \delta_{it}$

Model 2: $EFF_{it} = \propto + \beta_1 INR_{it} + \beta_2 ING_{it} + \gamma_1 AGE_{it} + \gamma_2 SIZE_{it} + \theta_1 INF_t + \theta_2 GDP_t + \mu_i + \delta_{it}$

Model 3: $EFF_{it} = \propto + \beta_1 INR_{it} + \beta_2 ING_{it} + \gamma_1 AGE_{it} + \gamma_2 SIZE_{it} + \theta_1 INF_t + \theta_2 GDP_t + \varphi_1 INR_{it} \times AGE_{it} + \mu_i + \delta_{it}$

Model 4: $EFF_{it} = \propto + \beta_1 INR_{it} + \beta_2 ING_{it} + \gamma_1 AGE_{it} + \gamma_2 SIZE_{it} + \theta_1 INF_t + \theta_2 GDP_t + \varphi_2 INR_{it} \times SIZE_{it} + \mu_i + \delta_{it}$

Model 5: $EFF_{it} = \propto + \beta_1 INR_{it} + \beta_2 ING_{it} + \gamma_1 AGE_{it} + \gamma_2 SIZE_{it} + \theta_1 INF_t + \theta_2 GDP_t + \varphi_3 ING_{it} \times AGE_{it} + \mu_i + \delta_{it}$

Model 6: $EFF_{it} = \propto + \beta_1 INR_{it} + \beta_2 ING_{it} + \gamma_1 AGE_{it} + \gamma_2 SIZE_{it} + \theta_1 INF_t + \theta_2 GDP_t + \varphi_4 ING_{it} \times SIZE_{it} + \mu_i + \delta_{it}$

Source: The author

Table 4.12 robust the estimation results above regarding the positive effect of bank size on bank efficiency, namely, all SIZE coefficients are significantly positive at a 1% level. The INF coefficients by FE and GLS are 1.054096 (significance level of 1%) and 0.6780286 (significance level of 5%), respectively; others are insignificant. The INR_{t-1} coefficients by FE and Tobit are 0.0991059 significance level of 10% and -0.1686798 significance level of 1%, while RE and GLS are insignificant. The ING_{t-1} coefficient by Tobit is -0.0340262 significance level of 1%, and others are insignificant. Based on these findings, I conclude that the lag effect of BITI is negative with bank efficiency.

In general, based on the estimation results by FE, RE, GLS, and Tobit, I conclude that the mixed findings regarding the effect of BITI on bank efficiency are found as mentioned above, but I evaluate that the negative impact of INR on EFF is the main finding with these reasons. *First*, the effect of INR on EFF by FE and RE is positive, but the models have heteroskedasticity and autocorrelation. Thus, the estimation results by FE and RE are less reliable than by GLS because GLS estimation has overcome two issues of heteroskedasticity

and autocorrelation. *Second*, the Tobit approach, an alternative estimator, provides booster estimation results about the link between INR and EFF. *Third*, the negative effect of INR on EFF is robust by consideration of the interaction between INR and bank characteristics on bank efficiency. *Final*, there is a negative effect of the lag of BITI on bank efficiency.

Consequently, through the estimation results and discussion, I conclude that there is a negative effect of BITI on bank efficiency.

Table 4.12 Estimation results of the lag model of bank fintech variable

Variable	FE	RE	GLS	Tobit
Cons.	-2.410886***	-1.907835***	-1.135492***	-.9388503***
	[-10.76]	[-9.80]	[-7.35]	[-6.54]
INR_{t-1}	.0991059*	.0606069	-.0437627	-.1686798***
	[1.72]	[1.08]	[-0.87]	[-3.29]
ING_{t-1}	.1758143	-.0204444	-.0099505	-.0340262***
	[0.96]	[-0.77]	[-0.57]	[-2.61]
AGE	.0611454	.0097342	.0069096	.0122528
	[0.74]	[0.19]	[0.24]	[0.48]
SIZE	.2175459***	.1983952***	.1378578***	.1319964***
	[7.77]	[9.81]	[10.27]	[10.66]
INF	1.054096***	.5297402	.6780286**	-.4469602
	[3.12]	[1.62]	[2.36]	[-1.05]
GDP	.2110538	-.1188542	.0595816	-.7129583
	[0.42]	[-0.23]	[0.15]	[-0.93]
Obs.	207	207	207	207
R-Square	0.5964	0.5892	-	-
Statistic value	43.83***	245.97***	162.31***	159.38***
Hausman test	48.15***		-	-
Wald test	115.00***	-	-	-
Wooldridge test	29.586***	-	-	-

*Note: *, **, and *** are the significant level at 10%, 5%, and 1%, respectively*

Model 7: $EFF_{it} = \propto + \omega_1 INR_{i,t-1} + \omega_2 INR_{i,t-1} + \gamma_1 AGE_{it} + \gamma_2 SIZE_{it} + \gamma_3 INF_t + \gamma_4 GDP_t + + \mu_i + \delta_{it}$

Source: The author

4.4 Research result aggregation

Based on the estimation results and discussion above, the effect of the fintech industry on bank performance is aggregated as in **Table 4.13**. Most effects are positive (6/9), while the negative effect is the minority (3/9).

Based on the content of the discussion, it is clear that the fintech company growth is a pressure, which negatively links to bank financial indicators (R_{1a}) and bank customer loyalty (R_{1b}). Bank investment in technology innovation enhances and upgrades the bank technology system seems to be ineffective, which is harmful to bank efficiency (R_3). However, fintech company growth promotes bank performance by enhancing bank internal processes (R_{1c}) and improving bank employees' knowledge and skills (R_{1d}). The popularity of fintech is a positive factor in bank stock return (R_2, R_{2a}, and R_{2b}), while fintech company growth is positive with overall bank performance (R_1).

Table 4.13 Research result aggregation

Effect of the fintech industry on bank performance		Results
R_1	Effect of fintech company growth on bank performance	positive

R_{1a}	Effect of fintech company growth on the financial perspective	*negative*
R_{1b}	Effect of fintech company growth on the customer perspective	*negative*
R_{1c}	Effect of fintech company growth on the internal process perspective	positive
R_{1d}	Effect of fintech company growth on the learning & growth perspective	positive
R_2	Effect of fintech popularity on bank stock return	positive
R_{2a}	Effect of fintech popularity in payment on bank stock return	positive
R_{2b}	Effect of fintech popularity in lending on bank stock return	positive
R_3	Effect of bank investment in technology innovation on bank efficiency	*negative*

Source: The author

The findings are mixed results, but I prefer the positive effect of the fintech industry on bank performance in the case of Vietnam, which is consistent with the results of the semi-structured interview and fintech popularity. Regarding the existence of a productivity paradox in Vietnamese banks, I argue that, like the historical flow of fintech, bank investment in technology innovation is the root of bank life, although it is ineffective. The bank technologies must be regularly updated; it helps the bank maintain competitiveness, while the latest technology helps the bank break through the competition. In Vietnam, Techcombank is a typical case of applying disruptive technology to breakthroughs in business; others seem to be behind Techcombank in the digital transformation process.

5 CONCLUSION

5.1 Conclusion

Motive from the fintech development on the globe, and the contemporary debate in academics on the relationship between banks and fintech in the digital era, I strategies to explore the relationship by finding and fulfilling the gap in this field. In the fintech industry, Vietnam is an attractive market, with a growing number of fintech companies and room for development. In line with rising fintech research studies globally, some scholars studied fintech in Vietnam. By reviewing the relevant studies, I explore that most studies have not clarified the link between fintech and banks, especially regarding quantitative studies that seem rare. Besides, most quantitative studies about the relationship between banks and fintech have focused on developed countries, such as the USA, Europe, and China. Few studies are in developing countries, such as Indonesia, Nigeria, and Jordan. The study in Vietnam, a developing country, is rare. Therefore, the effect of the fintech industry on bank performance in Vietnam is conducted. The findings will provide empirical evidence to enrich the knowledge in this field.

The study aims to evaluate the holistic effect of the fintech industry on bank performance. To achieve the research aim, I designed three research studies. *First*, based on the BSC and its application in the finance industry, the qualitative research regarding the effect of fintech company growth on financial, customer, internal process, and learning and growth perspectives of bank performance is conducted through the semi-structured interview. *Second*, I use Google search to measure fintech popularity, which proxies the fintech industry development. Then, the effect of fintech popularity on bank stock return is investigated. *Third*, I use DEA for measuring bank efficiency; then, it is used to examine the effect of bank investment in technology innovation on bank efficiency. The outcomes of three research studies show that:

Regarding the effect of fintech company growth on bank performance, I found that (1) positive effect of fintech company growth on overall bank performance; (2) negative effect of fintech company growth on the financial and customer perspectives; and (3) positive effect of fintech company growth on the internal process and learning & growth perspectives.

Regarding the effect of fintech popularity on bank stock return, I found that (1) positive effect of fintech popularity on bank stock return; (2) the link between bank stock return and fintech popularity in lending is more sensitive to the simultaneous negative change of variables; (3) the link from fintech popularity to bank stock return is weaker than in the opposite direction; and (4) some changes of pairs variables in uptrend and downtrend are equal, such as pairs of fintech popularity in payment and bank stock return and fintech popularity in lending and bank stock return.

Regarding the effect of BITI on bank efficiency, I found that (1) negative effect of BITI on bank efficiency; and (2) bank age and size are the slowness factor of bank digitalization.

5.2 Research contribution

The thesis contributes to theory in these dimensions: (1) positive effect of fintech company growth on four perspectives of bank performance by BSC approach; (2) positive effect of fintech popularity (by Google search) on bank stock return; (3) negative effect of BITI on bank efficiency by DEA; and (4) new evidence involving the consumer, disruptive innovation, and productivity paradox theories.

The thesis contributes to practice in these dimensions: (1) novel fintech variable measurement of utilizing Google search and financial statement; (2) the process of data analysis regarding VAR-Granger, Copula, FE, RE, GLS, and Tobit approaches; and (3) utilizing DEA for calculating bank efficiency.

5.3 Implication

Based on the findings, I propose several implications for stakeholders. *First*, investors holding or planning to own bank stocks should consider the relationship between fintech and bank performance. Fintech popularity by Google search is a predictive factor of the bank stock movement; thus, it should be referenced for trading decisions. *Second*, based on the positive effect of fintech company growth and the negative effect of BITI on bank performance, I suggest that the collaboratory between banks and fintech is a suitable bank strategy in the digital era. The managers of banks and fintech companies should consider this cooperation, which benefits both participants and customers. *Third*, fintech is a significant part of the digital economy, while commercial banks play a role in economic development. The effect of fintech on banks might change the economy. Thus, policymakers should consider the fintech factor in the relationship between banks and the economy before deciding on public policy. The suitable policy facilitates banks and fintech development that increases the economy's added value.

5.4 Limitations and direction for further research

This thesis has some limitations, which are used for proposing the direction for further research.

First, the primary data is collected through individual interviews; thus, respondents have no consistency regarding the opinions. I argue that gathering the respondents into a group and guiding them to discuss to unify the critical ingredients will be better. Therefore, I suggest the Delphi method be utilized for further research. Besides, the Analytic Hierarchy Process might be combined to determine ingredients' weight.

Second, this thesis uses Google search and financial statements to measure fintech variables. Besides that, the fintech variables might be constructed in other ways. For example, the text mining method will be powerful for constructing the fintech index from the unstructured data (e.g., social media, newspapers, reports, voices, etc.) about fintech. I suggest that further research should consider the text mining method.

Third, this thesis is limitted to a case study of Vietnam; thus, I suggest that further research should extend the investigation scope. Other developing countries in Southeast Asia, South Asia, Africa, or a group of nations are also interesting.

Fourth, other data analysis approaches, which might play the alternative estimators, might provide interesting findings. I suggest that further research considers various estimators robustly the effect of the fintech industry on bank performance.

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LIST OF CURRENT PUBLICATIONS

Journals

1. **Tien Phat Pham**, Boris Popesko, Abdul Quddus, Ny Thi Kieu Nguyen. 2021. Innovation and Bank Efficiency in Vietnam and Pakistan. *Scientific Papers of the University of Pardubice, Series D: Faculty of Economics and Administration*, 29(2), pp. 1-11. ISSN: 1804-8048. *(Scopus)*
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Conferences

1. **Tien Phat Pham**, Abdul Quddus, Arif Ibne Asad, Boris Popesko, Sarfraz Hussain. 2021. *The factors of fintech: A literature review*. DOKBAT 2021 - 17th International Bata Conference for Ph.D. Students and Young Researchers, May 20, 2021, Zlin, The Czech Republic, pp. 395-405. ISBN: 978-80-7678-025-5.
2. **Tien Phat Pham**, Boris Popesko. 2020. *Covid-19, a chance for mobile payment*. ICBF 2020 - International Conference on Business and Finance, August 27-28, 2020, University of Economics Ho Chi Minh, Vietnam, pp. 456-464. ISBN: 978-604-301-028-2.
3. **Tien Phat Pham**, Abdul Quddus. 2020. *The role of performance on firm value: The moderation model of innovation in Vietnam*. DOKBAT 2020 - 16th International Bata Conference for Ph.D. Students and Young Researchers, September 02-03, 2020, Zlin, The Czech Republic, pp. 421-433. ISBN: 978-80-7454-935-9.
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5. Abdul Quddus, Drahomira Pavelkova, Sarfraz Hussain, **Tien Phat Pham**, Arif Ibne Asad. 2021. *Investment decisions and firm performance under economic policy uncertainty*. DOKBAT 2021 - 17th International Bata Conference for Ph.D. Students and Young Researchers, May 20, 2021, Zlin, The Czech Republic, pp. 442-454. ISBN: 978-80-7678-025-5.

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Vliv Fintechu na vietnamské banky: Případová studie z Vietnamu

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