"Impact of the COVID-19 pandemic on bank efficiency in Vietnam"

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IMPACT OF THE COVID-19 PANDEMIC ON BANK EFFICIENCY IN VIETNAM

Abstract

Banking system is an important part of the financial system of each country. The operating efficiency in the commercial banking system will provide the tools and financial products more attractive and relevant to the needs of actors in the economy. The purpose of this paper is to analyze the impact of COVID-19 on the efficiency of 26 Vietnamese commercial banks. The paper uses a quantitative method with the non-parametric frontier analysis, data envelopment analysis (DEA) approach, to measure the efficiency of Vietnamese commercial banks. The paper adopts an intermediation approach as the banks are viewed as financial intermediaries providing financial services and payment services to entities in the economy. Research findings reveal that Vietnamese commercial banks have effectively leveraged the positive impacts of the COVID-19 pandemic, since the average efficiency in 2020 improved over the pre-pandemic period in 2019 on the same models for comparison and estimation. Based on such findings, the study makes some suggestions and recommendations to help Vietnamese commercial banks increase their operational efficiency in the context of the prolonged pandemic.

Keywords	banking, data envelopment analysis (DEA), efficiency, frontier analysis
JEL Classification	E44, G21, G41

INTRODUCTION

Research on operational efficiency first originates from manufacturing enterprises to make appropriate recommendations and strategies for optimizing the available resources of production units. However, in recent years, the studies on efficiency have been applied by financial institutions, especially banks, to inform management decisions for improving the banks' efficiency. The most commonly used research methodology today on analyzing the efficiency of banks is a frontier technique, including parametric and non-parametric analysis (Holod & Lewis, 2011; Gaganis et al., 2021; Ferreira, 2021; Minviel & Bouheni, 2021).

Analyzing the efficiency of economic entities in general and banks in particular is always of critical significance to the banks in the process of making important decisions for effective development (Abdel-Baki, 2010; Avkiran, 2013; Antunes et al., 2021; Gaganis et al., 2021). With concrete research findings, the banks can adjust the input cost factors to make the most of resources and deliver maximum operational efficiency.

In Vietnam, commercial banks hold an important position in the process of helping the economy's capital circulate, contributing to economic growth. When commercial banks operate effectively, they will help:

1) to speed up the capital turnover process of the economy at a lower cost;
2) to increase the savings and investment rate of the economy;

3)   to improve the efficiency of capital use by actors in the economy; and
4)   to minimize information asymmetry in the financial market, thereby contributing to promoting economic growth of the country.

Therefore, this study focuses on analyzing the impact of the COVID-19 pandemic on the performance of commercial banks to provide more empirical evidence in a country with a developing economy like Vietnam.

1.   LITERATURE REVIEW

The concept of efficiency was first introduced by Koopmans (1951), whereby a production unit is deemed efficient if the output is maximum with a given input. According to Coelli et al. (2005), an economic entity is deemed more efficient than another if it can provide more goods and services to the society without consuming more resources. In other words, enterprises are most efficient when they can maximize potential output by optimizing the given input. Technical efficiency means the ability to use the least input to produce a given unit of output or to obtain the maximum output from a given unit of input. Production units' efficiency goals also mean waste minimization.

Berger and Mester (1997) consider operational efficiency of production units as the relationship between revenues from outputs and the costs of using inputs or the ability to turn inputs into the best outputs in the course of operation. Berger and Mester (1997) views banks' efficiency as the largest output revenues that can be generated by banks given the smallest value of inputs. A bank is said to be cost-effective or reaching overall economic efficiency when it achieves both allocative and technical efficiency (Banker et al., 1984).

Within the scope of this study, banks' efficiency is considered as whether the banks use inputs and maximize potential output or whether the banks can minimize the use of inputs to achieve pre-determined output targets. Banks achieve operational efficiency when they can generate the largest output revenues by using the same amount of inputs as other banks but with the lowest costs (Hassan & Tufte, 2001; Coelli et al., 2005; Staub et al., 2010).

Modern methods of measuring efficiency began with the studies by Farrell (1957), which are based on the studies by Debreu (1951) and Koopmans (1951), to provide a basic definition of the efficiency of a company or production unit with multiple inputs and outputs. Economic efficiency is considered as the degree of success that production units or banks achieve in allocating inputs to optimize outputs. Coelli et al. (2005) decompose operational efficiency into different types of efficiencies such as: technical efficiency, i.e. the ability to minimize the use of inputs to produce a pre-determined output, and allocative efficiency, i.e. concerned with selecting inputs (labor, capital, technology, etc.) that produce outputs at the lowest cost. Combining technical efficiency and allocative efficiency will create overall economic efficiency or cost efficiency.

Charnes et al. (1978) introduced a parametric method of DEA analysis with a constant returns to scale (CRS) model. Due to certain limitations, Banker et al. (1984) developed this into a variable returns to scale (VRS) model. DEA is built on the measurement of operational efficiency based on the production possibility frontier of enterprises, banks or decision-making units (DMU).

When TE is equal to 1, the production unit has maximum technical efficiency, e.g. point B represents technical efficiency because it lies on the efficient isoquant curve. Through efficiency index TE_{CRS} and TE_{VRS}, it is possible to calculate scale efficiency with formula (1).

$$SE_i = TE_{CRSi}/TE_{VRSi}. \qquad (1)$$

Demir and Danisman (2021) used a research sample of 1927 listed banks from 110 countries in the period from January to May 2020 to analyze the impact of the COVID-19 pandemic on bank stock returns. Research results indicate that the COVID-19 pandemic has a positive effect on banks with large capitalization, higher customer

deposits, higher income diversification, and lower non-performing loans.

Demirguc-Kunt et al. (2021) analyze the impact of the COVID-19 pandemic on the share price of the banking sector through the control measures of governments as well as central banks. The research results show that in countries with expansionary monetary policy through liquidity support policies for banks, interest rate support policies for borrowers, the share price of the banking industry tends to increase. In contrast, in countries with prudent monetary policy, the share price of the banking sector tends to decline.

Hu and Zhang (2021) analyze the impact of the COVID-19 pandemic on the performance of companies around the world. The analysis results show that the performance of companies on a global scale tends to decline due to negative impacts from the COVID-19 pandemic. However, in countries with better universal health care systems, the performance of companies is also better.

Li et al. (2021) analyze the impact of the COVID-19 pandemic on bank profitability and risk through income diversification. The results show that when the COVID-19 pandemic strongly affects traditional credit activities, banks with a high percentage of income from credit activities will be negatively affected by the COVID-19 pandemic. In contrast, banks with good income diversification and high service revenues have increased profits by taking advantage of the positive aspects of the COVID-19 pandemic.

Through a review of related previous studies, the research hypotheses of this paper are set. The COVID-19 pandemic has a negative impact on the efficiency of commercial banks in Vietnam. Due to the impact of the COVID pandemic, the bad debt of commercial banks will increase, thereby reducing the operational efficiency of commercial banks. The hypothesis of the study is built on the basis of the research by Colesnic et al. (2020), Ferreira (2020), Demirguc-Kunt et al. (2021), Hu and Zhang (2021), and Li et al. (2021).

H1: *TE_{CRS} of Vietnamese commercial banks are negatively impacted by the COVID-19 pandemic.*

H2: *TE_{VRS} of Vietnamese commercial banks are negatively impacted by the COVID-19 pandemic.*

H3: *SE of Vietnamese commercial banks are negatively impacted by the COVID-19 pandemic.*

2. METHODS AND DATA

Data Envelopment Analysis (DEA) method was developed by Charnes et al. (1978) when evaluating the efficiency of the public sector with various inputs and outputs. The model of Charnes et al. (1978) is used to measure the overall technical efficiency of a production unit. The outstanding advantage of DEA is that when estimating the efficiency of banks, it is not necessary to choose a suitable form of production function. Besides, the DEA method can also:

1) be applicable to banks with various inputs and outputs;

2) measure inefficiencies in each input and output for banks;

3) build the efficiency frontier based on the actual sample, so the DEA analysis gives more accurate efficiency measurement results (Avkiran, 1999; Sathye, 2001).

Bank efficiency in this study is measured using a technical efficiency index by non-parametric DEA approach via DEAP 2.1 software (Coelli et al., 2005). According to Coelli et al. (2005), an economic entity is deemed more efficient than another if it can provide more goods and services to the society without consuming more resources. In other words, enterprises are most efficient when they can maximize potential output by optimizing the given input. Technical efficiency means the ability to use the least input to produce a given unit of output or to obtain the maximum output from a given unit of input.

Dataset is taken from the audited financial statements of 26 Vietnamese commercial banks in the period of 2019–2020. Table 1 shows the information of these banks, including detailed bank code, bank name, city of a headquarter,

Table 1. The information of banks in the dataset

Bank code	Bank name	City	Charter capital (VND billions)	Website
ABB	An Binh Commercial Joint Stock Bank	Ha Noi	5,713.10	https://www.abbank.vn
ACB	Asia Commercial Joint Stock Bank	Ho Chi Minh	21,615.00	https://www.acb.com.vn
BID	Joint Stock Commercial Bank for Investment and Development of Vietnam	Ha Noi	40,220.20	https://www.bidv.com.vn
BVB	Viet Capital Commercial Joint Stock Bank	Ho Chi Minh	3,171.00	https://www.vietcapitalbank.com.vn
CTG	Vietnam Joint Stock Commercial Bank of Industry and Trade	Ha Noi	37,234.00	https://www.vietinbank.vn
EIB	Vietnam Export Import Commercial Joint Stock	Ho Chi Minh	12,355.20	https://eximbank.com.vn
HDB	Ho Chi Minh City Development Joint Stock Commercial Bank	Ho Chi Minh	16,088.48	https://www.hdbank.com.vn
KLB	Kien Long Commercial Joint Stock Bank	Kien Giang	3,237.00	https://kienlongbank.com
LPB	LienViet Commercial Joint Stock Bank – Lienviet Post Bank	Ha Noi	10,746.43	https://lienvietpostbank.com.vn
MBB	Military Commercial Joint Stock Bank	Ha Noi	27,987.60	https://www.mbbank.com.vn
MSB	The Maritime Commercial Joint Stock Bank	Ha Noi	11,750.00	https://www.msb.com.vn
NAB	Nam A Commercial Joint Stock Bank	Ho Chi Minh	3,890.00	https://www.namabank.com.vn
NCB	National Citizen bank	Ha Noi	4,101.60	https://www.ncb-bank.vn
OCB	Orient Commercial Joint Stock Bank	Ho Chi Minh	7,898.60	https://www.ocb.com.vn
PGB	Petrolimex Group Commercial Joint Stock Bank	Ha Noi	3,000.00	https://www.pgbank.com.vn
SCB	Saigon Commercial Joint Stock Bank	Ho Chi Minh	15,231.70	https://www.scb.com.vn
SGB	Saigon Bank for Industry & Trade	Ho Chi Minh	3,080.00	https://www.saigonbank.com.vn
SHB	Saigon-Hanoi Commercial Joint Stock Bank	Ha Noi	12,036.20	https://www.shb.com.vn
SSB	Southeast Asia Commercial Joint Stock Bank	Ha Noi	12,087.44	https://www.seabank.com.vn
STB	Saigon Thuong TinCommercial Joint Stock Bank	Ho Chi Minh	18,852.20	https://www.sacombank.com.vn
TCB	Vietnam Technological and Commercial Joint Stock Bank	Ha Noi	35,001.40	https://techcombank.com.vn
TPB	TienPhong Commercial Joint Stock Bank	Ha Noi	10,716.70	https://tpb.vn
VAB	Viet A Commercial Joint Stock Bank	Ha Noi	3,500.00	https://www.vietabank.com.vn
VCB	Joint Stock Commercial Bank for Foreign Trade of Vietnam	Ha Noi	37,088.80	https://vietcombank.com.vn
VIB	Vietnam International Commercial Joint Stock Bank	Ho Chi Minh	9,244.90	https://www.vib.com.vn
VPB	Vietnam Commercial Joint Stock Bank for Private Enterprise	Ha Noi	25,299.70	https://www.vpbank.com.vn

charter capital and banking websites. In this study, banks are viewed as financial intermediaries that provide financial services and payment services to entities in the economy (Luo, 2003; Sufian, 2009; Staub et al., 2010; Holod & Lewis, 2011). Therefore, under the intermediation approach, bank inputs are selected with four input variables:

4) total customer deposits,
5) personnel expenses,
6) non-interest expenses, and
7) interest expenses.

And the bank output variables include:

1) total loans,
2) interest income, and

3) non-interest income (including net income from services, net income from trading activities of securities trading, investment and net income from other activities).

In the first step, financial statements of 26 commercial banks were collected from their websites. These data are listed alphabetically and classified by bank code. Four input variables and three output variables were obtained from these 26 banks financial statements and collated to prepare for the second step.

3. RESULTS

On January 23, 2020, the first case of COVID-19 was announced in Vietnam. Therefore, the study uses data collected during the period 2019–2020

Table 2. Descriptive statistics on banks for 2019

Financial indicators	Mean	SD	Min	Max	Obs
Inputs					
Total customer deposits	241,483.6	295,948.9	15,667.76	1,114,163	26
Personnel expenses	2,520.586	2,526.802	249.169	8,879.654	26
Non-interest expenses	4,698.125	4,516.111	485.2572	16,116.92	26
Interest expenses	14,192.77	15,639.87	907.431	64,769.42	26
Outputs					
Total loans	222,459.9	277,517.8	14,442.3	1,102,366	26
Interest income	23,851.89	25,694.38	1,639.732	100,747.2	26
Non-interest income	3,118.651	3,379.815	83.381	12,143.43	26

Note: Unit – VND billions.

to examine the impact of this pandemic on the banking sector. Financial indicators of 26 banks during these two years are analyzed and separated to get the data set of 52 DMUs (decision-making units) in one observation period.

Table 2 presents descriptive statistics of input and output variables in the bank efficiency analysis model in 2019. The findings show that in 2019 BID scores the highest across all four input indicators and three output indicators. SGB has the lowest total customer deposits, interest expense, total loans, and interest income among all 26 commercial banks in the study sample; VAB has the lowest personnel expenses, non-interest expenses with only VND 249,169 billion and VND 485,2572 billion, respectively. NVB has the lowest non-interest income at only VND 83,381 billion.

Statistical results of input and output variables of 26 commercial banks in 2020 are presented in Table 3. BID maintains the largest input and output variables in 2020. While VAB has the lowest personnel expenses in 2020, SGB has all 6 items:

1) total customer deposits;
2) non-interest expense;
3) interest expense;
4) total loans;
5) interest income; and
6) non-interest income, ranked at the bottom.

To analyze the impact of the COVID-19 pandemic on the efficiency of commercial banks in Vietnam, the banks in 2019 and 2020 are treated as independent DMUs. Therefore, the dataset to calculate the efficiency of 26 Vietnamese commercial banks includes 52 DMUs, and the observation period is 1. The main purpose of combining 2019 and 2020 into one observation period is to compare the COVID-19 impacts on the banks' efficiency in the period immediately before (2019) and during (2020) the pandemic. The aggregation of the observation periods also helps the banks themselves compare their own efficiency before and during the pandemic.

The statistical results on technical efficiency presented in Table 4 show that the technical efficiency under the constant returns to scale (CRS) assumption of 26 commercial banks in 2019 reaches the

Table 3. Descriptive statistics on banks for 2020

Financial indicators	Mean	SD	Min	Max	Obs
Inputs					
Total customer deposits	272,814.72	24,585.18	18,223.63	1,226,673.94	26
Personnel expenses	2,973.54	2,967.96	246.24	9,722.45	26
Non-interest expenses	5,288.58	5,125.96	468.66	17,257.12	26
Interest expenses	14,675.14	15,646.64	982.46	64,890.70	26
Outputs					
Total loans	251,175.59	302,571.68	15,330.79	1,195,239.97	26
Interest income	25,511.67	25,883.24	1,573.13	100,687.50	26
Non-interest income	3,585.93	3,946.98	158.09	14,240.35	26

Note: Unit – VND billions.

Table 4. The efficiency of 26 Vietnamese commercial banks in 2019

ID	Bank	TE_{CRS}	TE_{VRS}	SE	ID	Bank	TE_{CRS}	TE_{VRS}	SE
1	ABB	0.96	0.96	1.00	14	OCB	0.79	0.80	0.99
2	ACB	0.91	0.94	0.97	15	PGB	0.89	0.91	0.98
3	BID	0.82	0.99	0.83	16	SCB	0.86	0.99	0.87
4	BVB	0.92	0.92	1.00	17	SGB	1.00	1.00	1.00
5	CTG	0.90	1.00	0.90	18	SHB	0.77	0.94	0.82
6	EIB	0.98	1.00	0.98	19	SSB	0.73	0.73	1.00
7	HDB	0.86	1.00	0.86	20	STB	1.00	1.00	1.00
8	KLB	1.00	1.00	1.00	21	TCB	0.87	0.87	1.00
9	LPB	1.00	1.00	1.00	22	TPB	0.82	0.82	1.00
10	MBB	0.99	1.00	0.99	23	VAB	0.79	0.81	0.97
11	MSB	1.00	1.00	1.00	24	VCB	0.99	1.00	0.99
12	NAB	1.00	1.00	1.00	25	VIB	0.77	0.79	0.98
13	NVB	1.00	1.00	1.00	26	VPB	0.98	1.00	0.98

average level of 90.77%, which means that to produce the same level of output, these 26 commercial banks can only utilize 90.77% of the inputs, or in other words, they are using 10.17% of inputs inefficiently (Technical Inefficiency = 1/Technical Efficiency –1). The mean technical efficiency under the variable returns to scale (VRS) assumption of 26 commercial banks in 2019 reaches 94.10%, and scale efficiency of 26 commercial banks reaches 96.55%.

KLB, LPB, MSB, NAB, NVB, SGB, STB have the highest efficiency in 2019 when their TE_{CRS}, TE_{VRS}, and SE all reach 100%. SSB has the lowest TE_{CRS}, TE_{VRS}, reaching only 73.10% and 73.30%, respectively, in 2019.

The efficiency of 26 commercial banks during the COVID-19 pandemic in 2020 is presented in Table

5. The results show that the mean TE_{CRS} of 26 commercial banks in 2020 reaches 91.78%, higher than the average of 90.77%. The mean TE_{VRS} of 26 commercial banks in 2020 reaches 94.89%, also higher than the average of 94.10% in 20219. The mean SE of 26 commercial banks in 2020 reaches 96.76%, also higher than the average of 96.55% in 2019.

EIB, KLB, MBB, NVB, PGB, SGB, STB, VCB, VPB achieve 100% efficiency across TE_{CRS}, TE_{VRS}, and SE. In 2020, VIB has the lowest TE_{CRS} with only 76.60%, in terms of TE_{VRS}, VAB has the lowest efficiency in 2020 with only 81.30%.

Table 6 shows an efficiency comparison of each bank before and during the COVID-19 pandemic. During the COVID-19 pandemic, the operational efficiency of 26 commercial banks in Vietnam tends to outdo the pre-pandemic peri-

Table 5. The efficiency of 26 Vietnamese commercial banks in 2020

ID	Bank	TE_{CRS}	TE_{VRS}	SE	ID	Bank	TE_{CRS}	TE_{VRS}	SE
1	ABB	0.93	0.93	1.00	14	OCB	0.87	0.87	1.00
2	ACB	0.97	1.00	0.97	15	PGB	1.00	1.00	1.00
3	BID	0.87	1.00	0.87	16	SCB	0.85	1.00	0.85
4	BVB	0.82	0.83	0.99	17	SGB	1.00	1.00	1.00
5	CTG	0.93	1.00	0.93	18	SHB	0.78	0.91	0.86
6	EIB	1.00	1.00	1.00	19	SSB	0.81	0.82	0.99
7	HDB	0.87	1.00	0.87	20	STB	1.00	1.00	1.00
8	KLB	1.00	1.00	1.00	21	TCB	1.00	1.00	1.00
9	LPB	0.95	1.00	0.95	22	TPB	0.82	0.82	1.00
10	MBB	1.00	1.00	1.00	23	VAB	0.79	0.81	0.97
11	MSB	0.94	0.94	1.00	24	VCB	1.00	1.00	1.00
12	NAB	0.90	0.92	0.97	25	VIB	0.77	0.82	0.94
13	NVB	1.00	1.00	1.00	26	VPB	1.00	1.00	1.00

Table 6. Efficiency comparison of 26 Vietnamese commercial banks before and during the COVID-19 pandemic

ID	BANK	TE_{CRS}			TE_{VRS}			SE		
		2019	2020	+/−	2019	2020	+/−	2019	2020	+/−
1	ABB	0.96	0.93	−	0.96	0.93	−	1.00	1.00	+
2	ACB	0.91	0.97	+	0.94	1.00	+	0.97	0.97	−
3	BID	0.82	0.87	+	0.99	1.00	+	0.83	0.87	+
4	BVB	0.92	0.82	−	0.92	0.83	−	1.00	0.99	−
5	CTG	0.90	0.93	+	1.00	1.00	+	0.90	0.93	+
6	EIB	0.98	1.00	+	1.00	1.00	+	0.98	1.00	+
7	HDB	0.86	0.87	+	1.00	1.00	+	0.86	0.87	+
8	KLB	1.00	1.00	+	1.00	1.00	+	1.00	1.00	−
9	LPB	1.00	0.95	−	1.00	1.00	+	1.00	0.95	−
10	MBB	0.99	1.00	+	1.00	1.00	+	0.99	1.00	+
11	MSB	1.00	0.94	−	1.00	0.94	−	1.00	1.00	−
12	NAB	1.00	0.90	−	1.00	0.92	−	1.00	0.97	−
13	NVB	1.00	1.00	+	1.00	1.00	+	1.00	1.00	−
14	OCB	0.79	0.87	+	0.80	0.87	+	0.99	1.00	+
15	PGB	0.89	1.00	+	0.91	1.00	+	0.98	1.00	+
16	SCB	0.86	0.85	−	0.99	1.00	+	0.87	0.85	−
17	SGB	1.00	1.00	+	1.00	1.00	+	1.00	1.00	−
18	SHB	0.77	0.78	+	0.94	0.91	−	0.82	0.86	+
19	SSB	0.73	0.81	+	0.73	0.82	+	1.00	0.99	−
20	STB	1.00	1.00	+	1.00	1.00	+	1.00	1.00	+
21	TCB	0.87	1.00	+	0.87	1.00	+	1.00	1.00	+
22	TPB	0.82	0.82	−	0.82	0.82	−	1.00	1.00	−
23	VAB	0.79	0.79	+	0.81	0.81	+	0.97	0.97	+
24	VCB	0.99	1.00	+	1.00	1.00	+	0.99	1.00	+
25	VIB	0.77	0.77	−	0.79	0.82	+	0.98	0.94	−
26	VPB	0.98	1.00	+	1.00	1.00	+	0.98	1.00	+

od. In terms of TE_{CRS} in 2020, 19/26 banks managed to maintain or improve efficiency compared to the pre-pandemic period, only nine commercial banks, namely ABB, BVB, LPB, MSB, NAB, SCB, TPB and VIB, have lower TE_{CRS} than 2019. In terms of TE_{VRS} in 2020, only 6/26 commercial banks have lower efficiency than in 2019, including ABB, BVB, MSB, NAB, SHB and TPB. All other 20 commercial banks have the same or higher TE_{VRS} than 2019.

Table 7. Hypotheses testing results

Hypothesis	Relationship	Decision
H1	TE_{CRS} of Vietnamese commercial banks are negatively impacted by the COVID-19 pandemic.	Not Supported
H2	TE_{VRS} of Vietnamese commercial banks are negatively impacted by the COVID-19 pandemic.	Not Supported
H3	SE of Vietnamese commercial banks are negatively impacted by the COVID-19 pandemic.	Not Supported

4. DISCUSSION

Efficiency analysis of 26 Vietnamese commercial banks with DEAP 2.1 shows that the average operational efficiency of Vietnamese commercial banks increased during the COVID-19 pandemic. The operational efficiency in 2020 during the COVID-19 pandemic is higher than before the pandemic across all three efficiency indicators TE_{CRS}, TE_{VRS} and SE. Currently, there are not many studies in the world comparing the efficiency of commercial banks before and during the COVID-19 pandemic, so the research lacks a benchmark. However, according to previous studies on crisis periods, the efficiency of commercial banks will decrease due to governance capacity and suboptimal combination of inputs and outputs. A study by Ferreira (2020) with a dataset of 485 banks from all EU member states between 2011 and 2017 shows that the efficiency of commercial banks declined due to the impact of the financial crisis. Research

findings of Colesnic et al. (2020) evaluating the efficiency of 66 banks in nine Middle East countries during the period of 1998–2014 also reveals the financial crisis and oil price shock have posed negative impacts on the efficiency of the surveyed banks. In contrast, the operational efficiency of Vietnamese commercial banks during the COVID-19 pandemic did not decline like the general trend of banks in the world during crises, but tended to increase slightly. The opposite outcomes among Vietnamese commercial banks can be attributed to the following main reasons:

Firstly, Vietnamese commercial banks have been constantly consolidated and improved in terms of management and financial capacity. Many banks have not paid dividends to shareholders for many years to establish reserves for future shocks.

Second, Vietnamese commercial banks have been driving reductions in operating expenses to use inputs more effectively by promoting digital banking applications and leveraging Industrial Revolution 4.0 achievements.

Third, during the COVID-19 pandemic, the bank's revenues from credit operations suffered considerably; however, thanks to technological applications and service diversification, non-interest income of commercial banks still increased, helping to maintain and improve the operational efficiency of Vietnamese commercial banks.

Finally, Circular No. 01/2020/TT-NHNN of the State Bank of Vietnam stipulating debt rescheduling, exemption or reduction of interest and fees, retention of debt category to assist borrowers affected by the COVID-19 pandemic have temporarily relieved credit institutions from risk provision obligations, thereby reducing the banks' expenses, increasing accounting profits, and hence, overall efficiency.

Impact analysis of the COVID-19 pandemic on the efficiency of Vietnamese commercial banks shows that by the end of 2020, Vietnamese commercial banks have effectively leveraged the positive aspects and mitigated the negative aspects of the pandemic on banking operations. To help Vietnamese commercial banks increase opera-

tional efficiency in the context of the prolonged pandemic, the study proposes a number of recommendations, which are presented below.

First, commercial banks need to develop and diversify banking products and services with high added values to increase fee incomes rather than from conventional credit operations. Besides, this can also help Vietnamese commercial banks to allocate risks and avoid concentration risk due to dependence on conventional credit operations.

Second, Vietnamese commercial banks need to improve the quality of banking business administration to make the most of the available inputs such as reducing interest expenses, personnel expenses or downsizing, reducing other expenses such as administrative costs and advertising costs to improve the efficiency of banks' resources.

Third, to promote the application of new technologies, it is necessary to shift from breadth to depth of developments and applications. Vietnamese commercial banks need to develop technology development policies and make rational investments because modern technology is the key to help banks reduce costs and improve the efficiency of inputs.

Fourth, banks can also improve the quality of human resources by planning training and professional development, thereby having a team of qualified and professional banking staff to serve development requirements. It is high-quality human resources that drive Vietnamese commercial banks towards a sound roadmap to effectively utilize available resources, thereby increasing operational efficiency.

Finally, Vietnamese commercial banks need to improve their financial capacity by increasing charter capital, ensuring the minimum capital adequacy ratio in accordance with international standards and regulations of the State Bank of Vietnam and the standards of Basel III Accord. Accordingly, commercial banks need to determine an appropriate percentage of annual retained earnings to increase charter capital or conduct M&A of small banks to improve financial capacity or call for contributions from shareholders to adequately reserve for potential future shocks.

CONCLUSION

Estimating the operational efficiency of commercial banks before and during the COVID-19 pandemic helps commercial banks and regulators come up with solutions to improve performance of commercial banks in the context of the prolonged COVID-19 pandemic in Vietnam. By analyzing the efficiency of 26 Vietnamese commercial banks in the period of 2019–2020 with an intermediary approach, it has been confirmed that:

1) the operational efficiency of Vietnamese commercial banks during the COVID-19 pandemic period has improved compared to the pre-pandemic period;

2) the operational efficiency of Vietnamese commercial banks is improved thanks to the improvement of TE_{CRS}, TE_{VRS} and SE through measures to improve governance efficiency and reduce operating costs through technology application.

Although some encouraging results have been achieved, given time constraints and methodology shortcomings, the study still has certain limitations. First, the study obtains data from the financial statements of commercial banks, so the figures in the financial statements are heavily affected by current regulations applicable during the COVID-19 pandemic and may not accurately reflect the actual operational efficiency of Vietnamese commercial banks. Second, the study only adopts the DEA method to measure the efficiency of 26 Vietnamese commercial banks in the period of 2019–2020. Further studies can expand the coverage of field surveys to assess the current performance of the banks and combine parametric analysis method to estimate the efficiency of the selected banks more exactly.

Based on the research results, the paper makes recommendations to the regulatory agencies and the State Bank of Vietnam to have solutions to support the commercial banking system. The State Bank of Vietnam has also issued support policies for commercial banks in distress due to the COVID-19 pandemic to help them increase their accounting profit and improve operational efficiency.

AUTHOR CONTRIBUTIONS

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