“Measuring banking efficiency in Vietnam: parametric and non-parametric methods”

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MEASURING BANKING EFFICIENCY IN VIETNAM: PARAMETRIC AND NON-PARAMETRIC METHODS

Abstract

The article aims to evaluate the business efficiency of commercial banks in Vietnam using both parametric and non-parametric approaches. In this study, the Stochastic Frontier Analysis (SFA), which belongs to a parametric method, and Data Envelopment Analysis (DEA), a non-parametric approach, are applied to a sample of 30 joint stock commercial banks in Vietnam in the period of 2011–2015. Applying Tobit regression model, the impact of bank size, bank age, and the ownership feature on the efficiency of bank service industry in Vietnam is also investigated. The analysis results show that in general, the Vietnamese banking efficiency is improving during the selected period regardless of techniques used. However, there is small level of similarity in efficiency rankings identified from the SFA and DEA models. In terms of efficiency determinants, the results show that all three variables of size, age, and state ownership have a positive impact on bank efficiency.

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Keywords Vietnamese banks, efficiency score, Stochastic Frontier Analysis (SFA), Data Envelopment Analysis (DEA)

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INTRODUCTION

The history of Vietnamese banking system started with the establishment of the State bank of Vietnam in 1951. From 1951 to 1990, the State bank of Vietnam performed a mixed function of a central bank and a commercial bank. As a result of launching an economic reform from the Government to transfer the planned economy to market oriented economy, the banking system had been separated into a state bank, entity that works a central bank and several commercial banks which receive deposits and make loans to businesses and individuals. Thank to this important step, the number of commercial banks increases dramatically from 4 banks in 1990 to the peak of 51 in 1997. The number of foreign bank branches also increases with the further level of international integration of local economy.

Understood by the Vietnamese government, in the transformation stage of the economy, the performance of banking system plays a very important role in creating sustainable economic development. Therefore, during 15 years from 2000 to 2015, in order to strengthen the banking sector in Vietnam, the Vietnamese government had implemented three different banking restructuring programs:

1) after Asian financial crisis (198–2003);
2) after joining WTO (2005–2008);
3) during economy restructuring program (2011–2015).

Among those programs, the third program is highlighted as the Government has taken intensive action plan to restructure Vietnamese commercial banks such as recapitalization, merger and acquisition (M&A), and commercial bank purchase by the state bank. This program is also the first stage in two-stage scheme to improve the transparency, efficiency and competitiveness of the banking system. Therefore, the assessment of business performance of banks in terms of banking efficiency in this first stage is necessary to determine the success of the second stage of 2016–2020.

Over the past decades, empirical studies which relate to assessing bank efficiency with modern approaches such as parametric and non-parametric have been widely implemented in different contexts. The research encompasses a variety of approaches to banking operations, measurement, and analytical techniques, which in turn produce various differing results. The parametric approach tends to focus on the production function or cost function of banks. The estimated function through the regression model can be considered as an optimal function that is used as a standard frontier line (Banker & Maindiratta, 1988). Although this parametric method can provide information about confidence intervals and standard deviations, the results would have a negative impact on the indexes if the function was incorrect (Berger & Humphrey, 1997). In addition, this method requires large sample sizes. In contrast, the non-parametric approach uses all data collected from financial institutions to estimate the optimal variation of the whole sample, and then evaluates each organization by comparing the current level with the optimal one. In researches on bank efficiency, Stochastic Frontier Analysis (SFA) and Data Envelopment Analysis (DEA) are applied in parametric and non-parametric approaches, respectively.

Despite the importance of efficiency measurement for banking sector in restructuring programs, an overview of literature shows that there is limited number of studies on this topic in Vietnam. Researches taken to compare efficiency between banks mainly focus on the first and second restructuring programs using non-parametric method – DEA (Lieu & Nguyen, 2012; Stewart et al., 2015). Because of each measure method has its own advantages and disadvantages, a study that performs the comparison of the results taken from both SFA and DEA approach could provide more reliable results. In addition, in order to support the result's contributions, several factors that affect banking efficiency in Vietnam should be considered.

This paper aims to investigate the banking efficiency in Vietnam during the first step phase in the third restructuring program taken by the Vietnamese government. The specific objectives are:

1) to compute the efficiency scores measured by two methods of parametric (SFA) and non-parametric techniques (DEA);

2) to identify the correlation between efficiency results computed by two different methods; and

3) to discover the effects of factors such as size, ownership, and age on the bank's efficiency.

The analysis results from this paper are expected to benefit not only individual commercial banks but also the Vietnamese government. For a bank, the changes in efficiency scores over the period provide further assessment of its business performance in addition to financial indicators such as ROA or ROE. For the Vietnamese government, the results provide another method to rank commercial banks in order to provide support or special control to weak banks. The Government can also make necessary adjustments to ensure the success of future restructuring program.

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1. LITERATURE REVIEW

1.1. Banking efficiency and the choice of inputs and outputs for efficiency frontier

The business performance of banks stemming from the concept of business efficiency has appeared in numerous studies since the 1950s. Despite its long-term implications, the concept of efficiency was only given explicitly in Lovell's (1992) study. According to Lovell (1992), an organization's business efficiency reflects the relationship between the output and input value in comparison with the minimum input or maximum output value that the organization is able to reach. In other words, this relationship can be measured by comparing the observed output to the maximum output that the organization achieves on a given input, or by comparing the observed input with the minimal input so that a certain amount of output can be achieved.

Among studies on efficiency, Farrel's (1957) study is notable, since he clarified the concept of efficiency. Not only did he identify each type of efficiency, but he also incorporated them into a model. Farrel (1957) introduced an efficient frontier condition in which an organization can maximize its output based on a certain amount of input. As a result, the business performance of an organization includes technical efficiency, distributional efficiency, and economic efficiency.

Technical efficiency is the ability to maximize the output from a certain amount of input or to minimize the input to obtain a certain amount of output. An organization is considered technically inefficient if it fails to produce the largest output from a given amount of input. In other words, the organization is producing at a point outside of the efficient frontier.

For banks, the choices of inputs and outputs to build the efficient frontier are not consistent in relevant empirical researches and they really affect the result of efficiency calculation (Sufian, 2011). The combinations of input and output in previous papers can be divided into into four different approaches: "production", "intermediation", "profit-oriented", and "value added". Production approach, introduced by Benston (1965) uses deposit as the main input to create loans to the banks. However, this approach ignores investing, a very important activity that can create value to a modern bank (Berger & Humphrey, 1997). The intermediation approach, in contrast, emphasizes the connection role between borrowers and lenders of banks. Thus, deposits, labor, and physical assets are inputs to produce loans and investments of a bank (Sealey & Lindley, 1977). This approach had been developed to "value-added" approach in which deposit is considered as an output of the bank because of its ability to create bank value. Profit-oriented approach considers banking business as a process to achieve profit from its expenses (Drake et al., 2006). Therefore, in order to identify an efficiency frontier, inputs are interest and non-interest expenses, while outputs are interest and non-interest revenues.

1.2. Parametric method and non-parametric method in efficiency measurement

Efficiency of banks can be measured by parametric and non-parametric methods. Both methods use input and output vectors to determine the efficient frontier. The basic difference between these two methods is that the non-parametric method does not require a specific equation for the construction of the efficient frontier, while the parametric method requires the determination of a specific function for inputs and outputs to establish the efficient frontier.

1.3. The non-parametric method

Research on the non-parametric method mainly uses Data Envelopment Analysis (DEA) which was developed by Charnes et al. (1978). DEA is used to build the efficient frontier based on the business performance of an organization without requiring a specific equation for the construction of the efficient frontier. An organization is considered to be efficient when it operates within this frontier. The efficient frontier introduced by Charnes et al. (1978) is applied with the assumption of constant return to scale – CRS or variable return to scale – VRS (Banker et al., 1988).

Because DEA approach doesn't require the users to identify any function between inputs and outputs, it is applied widely in researches to calcu-

late the efficiency of bank sector within a country. For example, Pasiouras (2007) uses DEA to measure efficiency of banks in Greece from 2000 to 2004. Raphael (2013) uses DEA to evaluate the business performance of commercial banks in Tanzania in the period between 2005 and 2011, while Ouenniche and Carrales (2018) apply DEA to compute the efficiency scores of 109 banks in the UK. DEA is also implemented to compare the efficiency of banks in different countries. Svitalkova (2014) calculates the efficiency of banks operating in six countries in EU, while Chan et al. (2015) measure and compare bank efficiency in five selected Asian countries. In Vietnam, several researches have been conducted using DEA to compute bank efficiency in different selected periods. Lieu and Nguyen (2012) use two methods including total factor productivity and DEA to analyze the factors affecting the business performance of 22 commercial banks in Vietnam in the period of 2006–2009. The results show that the economic efficiency of the joint stock commercial banks tends to increase but the overall efficiency of business activities is not high and remains in decline. Nguyen (2012) performs research based on the DEA method to measure the technical efficiency and the Malmquist index of commercial banks in Vietnam in the period of 2007–2010. The results show that the banks are not effective during the financial crisis of 2008. Research undertaken by Stewart et al. (2015) presents a decrease in efficiency as a result of computation for banks in the period of 1999 and 2009.

Two-stage DEA is a center of existing papers using non-parametric method as it can reveal the impacts of factors on the bank efficiency. Raphael (2013) takes efficiency calculated by DEA in the first step as the dependent variable in a Tobit regression model. The Tobit model analysis results indicate that bank size, non-interest income and capital adequacy ratios are positively correlated with the bank efficiency, whereas bad debt has a negative impact on bank efficiency. Similarly, Steward et al. (2015) perform regression of efficiency scores obtained from stage 1 with bank size, ownership structure, and bank branch number. They find that larger or private banks are more efficient, while the number of branches negatively correlates with the bank efficiency. Ouenniche and Carrales (2018) in their research using two-stage DEA method remove any insignificant variables by running a regression model of efficiency scores with the original inputs and outputs.

1.4. The parametric method

In addition to studies using the non-parametric methods with DEA, the parametric method is also commonly used in determining the efficiency of banking business. Unlike the non-parametric method, the parametric method requires the determination of a function that expresses the relationship between inputs and outputs associated with the operation of the bank.

Fan and Shaffer (2004) have made a number of contributions to the development of a profit-maximizing function (the kind of efficiency that has not been approached much in traditional studies) as well as comparing the results of a bank's business performance when using different types of functions. The authors argue that the business performance of the bank should be approached in terms of profit efficiency since banks now tend to use high-cost but profitable inputs. By using the parametric method in assessing the bank's profit efficiency, the authors develop a marginal function that shows the relationship between the bank's profit and the input variables in its business process. This function measures the bank's maximum return that can be obtained from inputs and outputs with certain input and output prices. The marginal profit function can be constructed in two ways: the standard marginal profit function and the substituted marginal profit function.

To precisely determine the form of the standard marginal profit function as described above, several types of functions have been proposed and widely used in various studies. Examples include the Cobb-Douglas log-linear model and the translog function, as well as the Fourier function. Among translog functions, the inefficient error is extracted from the random statistical error in the Cobb-Douglas function and is considered a function dependent on the input and output variables in the model.

Despite having the requirement of specific function between inputs and outputs, the advantage of considering the inefficiency effects makes SFA be-

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come popular in bank efficiency papers (Altunbas et al., 2000; Sun & Chang, 2010; Nguyen, 2012). Recently, Galan et al. (2015) estimate the inefficiency effects for banks in Columbia, while Rekik and Lakai (2018) measure the cost and profit efficiency of banks in 14 different countries. Silva et al. (2017) identify the bank efficiency using SFA in comparison with DEA for banks in China during the 2001–2012 period. They find that efficiency results from both methods are not similar in ranking individual banks in the sample.

2. METHODOLOGY

2.1. Data collection method

The author has collected data from 30 Vietnamese joint stock banks for five years from 2011 to 2015. These are state-owned banks and private banks with no foreign commercial banks. Thus, if the banks are classified in terms of ownership, the sample includes banks in the group of joint stock commercial banks and some in the group of state commercial banks. The list of banks in the sample is summarized in Table 1.

Table 1. Banks in the research sample

No.	Bank	Code
1	Saigon Thuong Tin Commercial Joint Stock Bank	STB
2	Asia Commercial Joint Stock Bank	ACB
3	Vietnam Public Joint Stock Commercial Bank	PVF
4	Saigon Hanoi Commercial Joint Stock Bank	SHB
5	Joint Stock Commercial Bank for Foreign Trade of Vietnam	VCB
6	Vietnam Joint Stock Commercial Bank for Industry and Trade	CTG
7	Vietnam Export Import Commercial Joint Stock Bank	EIB
8	Vietnam Technological and Commercial Joint Stock Bank	TCB
9	Saigon Commercial Joint Stock Bank	SCB
10	Lien Viet Post Commercial Joint Stock Bank	LVB
11	Ho Chi Minh City Development Joint Stock Commercial Bank	HDB
12	Orient Commercial Joint Stock Bank	OCB
13	Saigon Bank for Industry and Trade	SGB
14	Saigon Commercial Joint Stock Bank	ABB
15	Tien Phong Commercial Joint Stock Bank	TPB
16	Kien Long Commercial Joint Stock Bank	KLB
17	Vietnam Asia Commercial Joint Stock Bank	VAB
18	National Citizen Commercial Joint Stock Bank	NVB
19	Nam A Commercial Joint Stock Bank	NAB
20	Ban Viet Commercial Joint Stock Bank	GDB
21	Vietnam Prosperity Joint Stock Commercial Bank	VPB
22	Military Commercial Joint Stock Bank	MBB
23	Vietnam Maritime Commercial Joint Stock Bank	MSB
24	Vietnam International Commercial Joint Stock Bank	VIB
25	Bank for Investment and Development of Vietnam	BID
26	Vietnam Thuong Tin Commercial Joint Stock Bank	VTTB
27	Petrolimex Group Commercial Joint Stock Bank	PGB
28	North Asia Commercial Joint Stock Bank	NASB
29	Southeast Asia Commercial Joint Stock Bank	SEAB
30	Eastern Asia Joint Stock Commercial Bank	EAB

The data on the variables in the model is derived from the audited annual financial statements of the banks for five years from 2011 to 2015. The financial statements are collected by the author from Stoxplus joint stock company. The 5-year period is not too long but remains enough to see the development of banks in general and the change of business performance particularly. Therefore, the data collected is cross-sectional, including 150 observations. This scope of study was chosen because this was the period when the Vietnamese banking system implemented Project 254: "Restructuring credit institutions during 2011–2015" in the third restructuring program.

2.2. Variables selection method

Because banks are a relatively special business entity, there are a number of different approaches to banking operations when assessing business performance. This study uses an "intermediation" approach to assess the business performance of a bank as it is a popular and consistent approach to a bank's business operation. The business performance of a bank is concretized by technical efficiency and assessment of the relationship between the input and output of the bank.

In the intermediation approach, banks act as intermediaries between lenders and borrowers. As a result, the outputs of banking activity are the total amount of loans and securities investments, while

the inputs are deposits, human resources and tangible assets (Sealey et al., 1977). The input and output variables in the model are calculated from the audited annual financial statements of the bank and summarized by the author (Table 2).

Table 2. Input and output variables in the model

Variable	Detail
	Input
X1	Fixed assets: the net tangible fixed asset value, which is the cost of fixed assets minus accumulated depreciation
X2	Deposits of customers: total deposits of customers and other credit institutions
X3	Labor: total salary expenditures (equal to total employee salary divided by the total number of employees)
	Output
Q1	Loans to customers: the sum of money for individuals and organizations to borrow
Q2	Other assets: total loans to other credit institutions, trading securities, investment securities and long-term investments

2.3. Data analysis method

2.3.1. Parametric method (SFA)

The parametric method is a method of assessing the efficiency of banking businesses expressed by technical efficiency coupled with the determination of the efficient frontier. It uses the quantitative approach to identify the relationship between inputs and outputs in the operation of the bank in which the efficient frontier is defined as the achievable limit. In other words, it is the optimal value in the economic activity of an organization. The closer to the frontier an organization works, the more profit it achieves. The organization that operates on the frontier is considered to be the most efficient in comparison with other organizations in a particular industry.

When constructing an efficient frontier, the authors use the Cobb-Douglas linear function to describe the relationship between input and output factors in a bank's operation. Cobb-Douglas (Cobb & Douglas, 1928) linear function has the form:

Model 1:

$$\ln\left(Q_i\right) = \beta_1 + \beta_2 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i} + v_i - u_i.$$

Q_i is the output of banking operation, including customer loans (Q_1) and other assets (Q_2). Q_1 is the amount for individual customers and corporate loans and Q_2 includes loans to other credit institutions, investment securities and trading securities. Selected inputs include Fixed assets (X_1), Customer deposits (X_2) and Labor (X_3).

2.3.2. Non-parametric method (DEA)

The 2-step non-parametric or Data Envelopment Analysis (DEA) method is used in comparison with parametric method. In the first step, bank efficiency scores in each year are calculated using from DEA model (model 2) using DEAP 2.1 software with the same inputs and outputs as in model 1. In the second step, Tobit regression model in which dependent variable is the efficiency score identified from model 2 is applied to identify the impact of SIZE, GOV, AGE on bank's efficiency. Those independent variables are measured below:

- SIZE: assets size of the bank, receives 1 if it is over VND 45,000 bln and 0 otherwise;
- GOV: bank's ownership, receives 1 if it is funded by the government and 0 otherwise;
- AGE: the number of years in business of a bank.

3. RESEARCH RESULTS OF JOINT STOCK COMMERCIAL BANKS IN VIETNAM

3.1. The results of the business efficiency assessment of banks in model 1 – parameter method (SFA)

With the support of FRONTIER 4.1, the business efficiency scores of each commercial bank calculated in five years are shown in Table 3. In this table, the output and input variables in the Cobb-Douglas function are defined in model 1. The business performance of banks is arranged in a descending order to easily classi-

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fy the groups of banks with different levels of efficiency.

The highest performing banks amongst the 30 used in the model are the Bank for Investment and Development of Vietnam (BID) at 96.58%, the Vietnam Public Joint Stock Commercial Bank (PVF) at 96.28%, and the Vietnam Joint Stock Commercial Bank for Industry and Trade (CTG) at 94.52%. These banks are all large in scale with total assets of more than VND 45,000 billion and have been operating for more than 10 years. Amongst these three banks, the Bank for Investment and Development of Vietnam and the Vietnam Joint Stock Commercial Bank for Industry and Trade are state-owned, joint stock commercial banks, while the Vietnam Joint Stock Commercial Bank is only owned by the State in the capital structure. In terms of the capital structure, measured by the ratio of liabilities and equity, these banks have a debt to equity ratio (D/E) of over 10. It can be understood that these three banks use inputs effectively, as demonstrated by the average efficiency of the three banks being above 90% during the period 2011–2015.

The list of banks with the lowest level of business efficiency (less than 70%) includes seven banks, namely Ban Viet Commercial Joint Stock Bank (GDB), Vietnam Thuong Tin Commercial Joint Stock Bank (VTTB), Nam A Commercial Joint Stock Bank (NAB), Southeast Asia Commercial Joint Stock Bank (SEAB), Vietnam Maritime Commercial Joint Stock Bank (MSB), Lien Viet Post Commercial Joint Stock Bank (LVB) and Tien Phong Commercial Joint Stock Bank (TPB). These banks range from small to large in scale, but they are not state-owned commercial banks. Some of these banks have been operating for more than 20 years, such as NAB, SEAB, and MSB, whilst others have been operating for less than 10 years, such as VTTB, LVB and TPB. It is noteworthy that these banks have a relatively small debt to equity ratio (D/E), with computational ratios nearly less than 10.

Regarding the change over the years, it can be seen that the business performance of the banks has increased steadily over the years. However, this increase is not too significant, almost all of which is less than 10%.

Table 3. Results of calculating the business performance of banks in model 1

Source: Results analysis based on FRONTIER 4.1.

No.	Bank	2011	2012	2013	2014	2015	Average
1	BID	0.965	0.965	0.966	0.966	0.967	0.9658
2	PVF	0.962	0.962	0.963	0.963	0.964	0.9628
3	CTG	0.944	0.944	0.945	0.946	0.947	0.9452
4	VCB	0.881	0.883	0.885	0.886	0.888	0.8846
5	NASB	0.825	0.827	0.830	0.832	0.834	0.8296
6	STB	0.821	0.824	0.826	0.829	0.831	0.8262
7	ACB	0.812	0.814	0.817	0.820	0.822	0.817
8	EAB	0.800	0.803	0.805	0.808	0.811	0.8054
9	VIB	0.787	0.790	0.793	0.796	0.799	0.793
10	EIB	0.780	0.783	0.786	0.789	0.792	0.786
11	OCB	0.771	0.774	0.777	0.780	0.783	0.777
12	SCB	0.771	0.774	0.777	0.780	0.783	0.777
13	VPB	0.766	0.769	0.772	0.775	0.779	0.7722
14	VAB	0.749	0.752	0.756	0.759	0.762	0.7556
15	TCB	0.746	0.749	0.753	0.756	0.759	0.7526
16	MBB	0.744	0.747	0.751	0.754	0.757	0.7506
17	SGB	0.741	0.745	0.748	0.751	0.755	0.748
18	PGB	0.737	0.741	0.744	0.747	0.751	0.744
19	KLB	0.733	0.736	0.740	0.743	0.747	0.7398
20	NVB	0.731	0.734	0.738	0.741	0.745	0.7378
21	HDB	0.722	0.725	0.729	0.733	0.736	0.729
22	SHB	0.705	0.709	0.713	0.717	0.720	0.7128
23	ABB	0.704	0.707	0.711	0.715	0.719	0.7112
24	GDB	0.682	0.686	0.690	0.694	0.697	0.6898
25	VTTB	0.678	0.682	0.686	0.690	0.694	0.686
26	NAB	0.651	0.655	0.660	0.664	0.668	0.6596
27	SEAB	0.647	0.651	0.656	0.660	0.664	0.6556
28	MSB	0.647	0.651	0.655	0.660	0.664	0.6554
29	LVB	0.644	0.649	0.653	0.657	0.661	0.6528
30	TPB	0.593	0.597	0.602	0.607	0.612	0.6022

3.2. The results of the business efficiency assessment of banks in model 2 – non-parametric method (DEA)

In the first step, model 2 was developed to assess the efficiency of banking business by the method of Data Envelopment Analysis (DEA). The model consists of two output variables and three input variables with the assumption that efficiency changes with scale, that is, the output can be increased or decreased by changing the amount of input.

In the results of the technical efficiency assessment (TE) of banks in the sample, technical efficiency indicates the economical use of input resources to generate a specific amount of output of a bank in comparison with other banks. Therefore, technical efficiency receives the value within 0.1, in which the bank receiving the highest value of 1 has the highest technical efficiency in the research sample.

The results show that there are eight banks operating on the data frontier whose efficiency rate is 100% – the joint highest in the sample. These banks are: Joint Stock Commercial Bank for Foreign Trade of Vietnam (VCB), Vietnam Joint Stock Commercial Bank for Industry and Trade (CTG), Tien Phong Commercial Joint Stock Bank (TPB), Vietnam Maritime Commercial Joint Stock Bank (MSB), Bank for Investment and Development of Vietnam (BID), North Asia Commercial Joint Stock Bank (NASB), Southeast Asia Commercial Joint Stock Bank (SEAB) and Vietnam Prosperity Joint Stock Commercial Bank (VPB). They are the most efficient banks in all years of the research period. They have used resources more effectively than all the other banks. In the whole sample, 24 out of 30 banks had an efficiency rate of more than 90% and only six banks had an efficiency rating between 80 and 90%, namely Saigon Thuong Tin Commercial Joint Stock Bank (STB), Kien Long Commercial Joint Stock Bank (KLB), Orient Commercial Joint Stock Bank (OCB), Saigon Hanoi Commercial Joint Stock Bank (SHB), Eastern Asia Joint Stock Commercial Bank (EAB) and An Binh Commercial Joint Stock Bank (ABB). Saigon Commercial Joint Stock Bank (SCB), Saigon Thuong Tin Commercial Joint Stock Bank (STB) and Orient Commercial Joint Stock Bank (OCB) experienced extraordinary fluctuations in efficiency over the research period.

Table 4. Results of calculating business performance of banks in model 2

Source: Results analysis based on DEAP 2.1.

No.	Bank	2011	2012	2013	2014	2015	Average
1	VCB	1.000	1.000	1.000	1.000	1.000	1.000
2	CTG	1.000	1.000	1.000	1.000	1.000	1.000
3	TPB	1.000	1.000	1.000	1.000	1.000	1.000
4	MSB	1.000	1.000	1.000	1.000	1.000	1.000
5	BID	1.000	1.000	1.000	1.000	1.000	1.000
6	NASB	1.000	1.000	1.000	1.000	1.000	1.000
7	SEAB	1.000	1.000	1.000	1.000	1.000	1.000
8	VPB	1.000	1.000	1.000	1.000	1.000	1.000
9	TCB	1.000	0.994	1.000	1.000	1.000	0.9988
10	EIB	1.000	1.000	1.000	1.000	0.975	0.995
11	VTTB	0.904	1.000	1.000	1.000	1.000	0.9808
12	VIB	1.000	1.000	0.961	0.907	1.000	0.9736
13	GDB	1.000	1.000	1.000	0.870	0.941	0.9622
14	PVF	1.000	1.000	1.000	0.945	0.847	0.9584
15	PGB	0.927	0.923	0.939	1.000	1.000	0.9578
16	VAB	0.788	1.000	1.000	1.000	1.000	0.9576
17	HDB	0.975	0.801	1.000	1.000	1.000	0.9552
18	NAB	0.726	1.000	1.000	1.000	1.000	0.9452
19	ACB	1.000	1.000	0.928	0.820	0.873	0.9242
20	SCB	0.618	1.000	1.000	1.000	1.000	0.9236
21	NVB	1.000	1.000	1.000	0.806	0.812	0.9236
22	LVB	1.000	1.000	0.829	0.788	1.000	0.9234
23	SGB	0.612	1.000	1.000	1.000	1.000	0.9224
24	MBB	0.880	0.794	1.000	0.959	0.943	0.9152
25	STB	0.891	0.862	0.920	0.898	0.912	0.8966
26	KLB	0.824	0.849	0.946	0.952	0.909	0.896
27	OCB	0.761	0.847	0.885	1.000	0.943	0.8872
28	SHB	0.673	0.879	0.826	0.985	0.975	0.8676
29	EAB	0.775	0.752	0.903	0.831	0.802	0.8126
30	ABB	0.567	0.686	0.844	0.946	0.981	0.8048

In the second step, Tobit regression model is identified to discover the relationship of bank's size, ownership structure and age and bank's efficiency. As described in Table 5, the coefficients of all three variables are significant at the level of 5%. A bank's efficiency score is higher as it is owned by the Government. The similar finding is also discovered in the research by Chan and Chiu (2006) on Taiwan banks. However, in a research on Vietnamese banks, Chris et al. (2015) state that private banks, are more efficient than state-owned banks while the asset size has a positive impact on the efficiency of a bank. This result difference is explained by the fact that data collected in two papers is not in the same period. In terms of bank's size, the bigger the bank, the more efficient it is. In terms of age, a bank is more efficient as the number of years in service is higher.

Table 5. Tobit regression result

Source: Results analysis based on Eview 10.0.

Variable	Coefficient	Std. error	Z-statistic	Prob.
SIZE	0.152	0.054	2.815	0.005
GOV	0.391	0.047	8.360	0.000
AGE	0.022	3.002	10.078	0.000

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3.3. Comparison of business performance of Vietnamese joint stock commercial banks between parametric and non-parametric methods

A comparison of banking business performance calculated from both parametric and non-parametric methods was made by considering the correlation between the construction models in the two methods. The parametric method is attached to model 1, while the non-parametric method is associated with model 2. The results of the correlation analysis in Table 6 show that the relationship between the models is statistically significant. However, the calculated correlation coefficient was relatively low at 19.9%.

The Bank for Investment and Development of Vietnam (BID) and the Vietnam Joint Stock Commercial Bank for Industry and Trade (CTG) had the joint highest efficiency in both two models. They are both state-owned commercial joint stock banks. However, Tien Phong Commercial Joint Stock Bank (TPB), Vietnam Maritime Commercial Joint Stock Bank (MSB), North Asia Commercial Joint Stock Bank (NASB) and Southeast Asia Commercial Joint Stock Bank (SEAB) had the lowest efficiency with 60% in model 1 but were the most efficient banks in model 2.

Table 6. Correlation between parametric and non-parametric methods

Source: Results analysis based on SPSS 20.0.

	SFA 1 Model
DEA 3 Model	0.199**

Note: ** Significant at a significance level of 1%.

In the period, the merger and acquisition has been taken by Saigon Thuong Tin Commercial Joint Stock Bank (STB), Vietnam Joint Stock Commercial Bank for Industry and Trade (CTG), (BID), Joint Stock Commercial Bank for Foreign Trade of Vietnam (VCB), Vietnam Maritime Commercial Joint Stock Bank (MSB), and Vietnam Export Import Commercial Joint Stock Bank (EIB). Except for EIB, those banks have improved their efficiency scores in both models.

CONCLUSION AND RECOMMENDATIONS

The study is conducted to assess the business efficiency of 30 Vietnamese joint stock commercial banks using SFA method (linked to model 1) and DEA (linked to model 2) during 2011–2015. In general, the efficiency of banking business using the "intermediation" approach to banking operations by two methods of calculation is quite high, in which the business performance of banks calculated from the non-parametric method is even higher than that from the parametric method. Because of low correlation, the use of parametric and non-parametric methods for calculating bank efficiency yields relatively varied results for some individual banks. This finding is similar with that of research undertaken by Silva et al. (2017). This can be explained by the method of constructing different efficient frontiers in the two methods. If the parametric method builds a function between the bank's inputs and outputs, the non-parametric method forms the efficient frontier from the best banks in the sample. Analysis results of 2-stage DEA show a significant relationship between bank's size, ownership and age. A bank is more efficient if it is bigger in size or has longer time in servicing. A bank with state-owned capital also gains higher efficiency score than a bank without public ownership.

In connection to the findings of the previous study conducted by Chris et al. (2015), the restructuring program from 2011–2015 really benefits Vietnamese banks regarding efficiency improvement. Specifically, merger action between stronger banks and weaker banks can be rated as successful as the efficiency of new banks is getting higher. While it is found that state-owned commercial banks used resources more efficiently than private banks in this research, the recapitalization, an important policy of the Government for restructuring should be pursued to create fair business environment.

The choice of inputs and outputs and the sampling technique may limit the significance of the findings and the relevant recommendations of this study. For future research, the other approach of selecting

variables such as "profit-oriented approach" should be used in comparison with "intermediation" approach. In order to provide better assessment of parametric and non-parametric methods for calculating bank efficiency, larger sample size including foreign bank branches should be collected. In addition, to assess the success of restructuring program, a group of banks receiving restructuring such as recapitalization, merger and acquisition in the period should be separated for results analysis.

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