Measuring and Forecasting Cost Efficiency of Vietnamese Commercial Banks: Past-Present-Future with Resampling Models

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Abstract- ***This study applied data envelopment analysis (DEA) Past-Present-Future based resampling model to measures and forecast the performance of 24 Vietnamese commercial banks in term of cost efficiency. Data of the past and the present years from 2014 to 2018 were collected and analyzed. Firstly, we employed DEA super slack-base measure model (super-SBM) to measure cost efficiency over period 2014-2018. Secondly, DEA Past-Present based resampling method was applied to measure cost efficiency for year 2018 along with its 95% confidence interval with 500 replicas and 5000 replicas to determine how many replicas is suitable for this study. Finally, the Past-Present-Future based resampling method was used to forecast the future data for inputs, outputs and cost efficiency score for future year 2019-2021. Findings of this study reveals that the average cost efficiency score of 24 selected banks were around 0.7 to 0.8 which implies that these commercial banks are quite far from the efficient frontier and are inefficient in term of cost. In addition, efficiency score of the future years will be lower than those of the present year. Moreover, the findings of this study also indicated the wide gap between efficiency scores of different banks. However, in the future, this gap will be narrowed. The main contribution of this study is to provide an evaluation and forecast of cost efficiency for Vietnamese commercial banks.***

Indexed Terms- ***cost efficiency; DEA super-SBM, Past-Present-Future based resampling, Vietnamese commercial banks.***

I. INTRODUCTION

In Vietnam, commercial banks have become an integral part of the national economy and dominated Vietnam's financial system after the transition process began in 1986 [1]. Despite the appeal of other kinds of the financial institute, banks are still the primary form of financial intermediation in the Vietnam [2]. In 2017, the credit growth of the Vietnamese banking sector was 18.17%. The growth in credit showed a positive sign for the banking industry as well as the entire economy [3]. However, according to financial analysts, Vietnam's economy heavily relies on credit from the banking sector in the absence of other sources, which requires the state bank need to closely monitor lending to minimize bad debts [4]. Moreover, SBV also required a commercial bank to try to reduce their operating cost and improve bank's efficiency so that they can decrease the lending interest rate for priority sectors [5]. Regarding to the vital of banks on the nation's growth and development, the performance of banks always been a particular interest to policy maker and researchers and has captured a great attention of researchers worldwide. The attention to the performance of banks has been intensified in the last two decades after the Asian financial crisis in 1997-1998 and the global financial crisis in 2007-2008 [6].

Existing bank's performance studies are numerous. In 2010, 196 studies related to bank efficiency was detailly reviewed by Fethi [7]. Previous studies related to the bank's efficiency measured by using frontier method were comprehensively reviewed and discussed by Berger [8]. Recently, another aspect of bank efficiency is cost efficiency has been received the great attention of researchers. Mokhamad Anwa's study [9] examines the cost efficiency of 111 Indonesian commercial banks over the recovery period 2002-2010 by using Stochastic Frontier Analysis (SFA). That study also applied TOBIT regression to find out the determinants of Indonesian

bank's cost efficiency. Tugba [10] conducted a study to examine technical, allocative and cost efficiency of the Turkish bank by applying DEA. The study of Mikhai [11] evaluated the cost efficiency of Russian banks over the period 2005-2013 by employing the SFA method. Gunes [12] conducted a study investigating the cost efficiency of 22 Turkish commercial banks over the restructuring period of the Turkish banking system from 2013-2015 by applying SFA. The study of Subhash [13] used DEA to evaluate the cost efficiency of branches of one single large Indian public bank for the year 2012. In 2015, banks' Cost efficiency in central and eastern Europe was assessed by Mihai [14]. The study of Idazh [15] assessed the cost efficiency of Islamic banks in Indonesia.

Regarding studies covering Vietnamese bank's performance, several studies were found in literature. Firstly, the study of Vu and Turnell [16] which employed frontier approach to measure cost efficiency of Vietnames bank during 2000-2006. The results of this study found a decrease in cost efficiency over the observed time period. Secondly, the study of Gardener [17] explored the determinants of bank's efficiency of banks in five South East Asian countries including Indonesia, Malaysia, Philippines, Thailand and Vietnam by applying two-stage DEA approach. The results of Gardener [17] indicated that state-owned banks were more efficient than joint-stock banks in term of cost and cost was negatively affected by bank's size. Thirdly, the study of Vu [18] examine the determinants of bank's profit efficiency during 2000-2006 by using two-stage DEA approach. They found that during 2000-2003, Vietnamese banks experienced the decrease in profit efficiency but witnessed the increase from 2003 to 2006 in which state-owned bank were found to be more efficient than joint-stock banks and Vietnamese banks were driven by bank's size and gross domestic production growth. Study of Nguyen [19] measured both cost and profit efficiency of Vietnamese bank during 1995-2011 by using DEA Window analysis. In their study, state-owned banks were once again found to be more efficient than joint-stock banks. Nguyen [19] examined the relationship between bad debt and cost efficiency of Vietnamese banks during 2007-2013 by applying DEA and Tobit regression. Finding of Nguyen's study reveals that during 2007-2013 the average cost efficiency of Vietnamese banking was around 0.52 and there exists a direct relationship between bad debt and cost efficiency. These studies mainly focused on examining the effect of bad debt on bank's performance or productive efficiency level and trend as well as the gap between state-owned banks and joint-stock banks [6]. Consequently, the most common finding of these studies reveals that state- owned banks outperform joint-stock banks.

Since commercial banks play the vital role on the nation's economic growth and development, the measuring and forecasting performance of commercial banks is much-needed. However; there are rare studies in literature was found to detailly measured efficiency of Vietnamese commercial banks and forecast their future performance. Therefore, authors are motivated to do this study to have an insight of efficiency of Vietnamese commercial banks in term of cost by thoroughly evaluating a performance of 24 Vietnamese commercial banks with the assess both the past and present records as well as the future potential.

In this study, the authors apply DEA super-SBM and DEA Past-Present-Future based resampling method to calculate and forecast cost efficiency of 24 selected Vietnamese commercial banks for period 2014-2021. The remainders of this study will be presented as follow: section 2 is a review of methodology used in this study and the choice of inputs, outputs. We will present empirical results in section 3 and section 4 will conclude this study with discussions. The flow of this study is presented as in Figure 1.

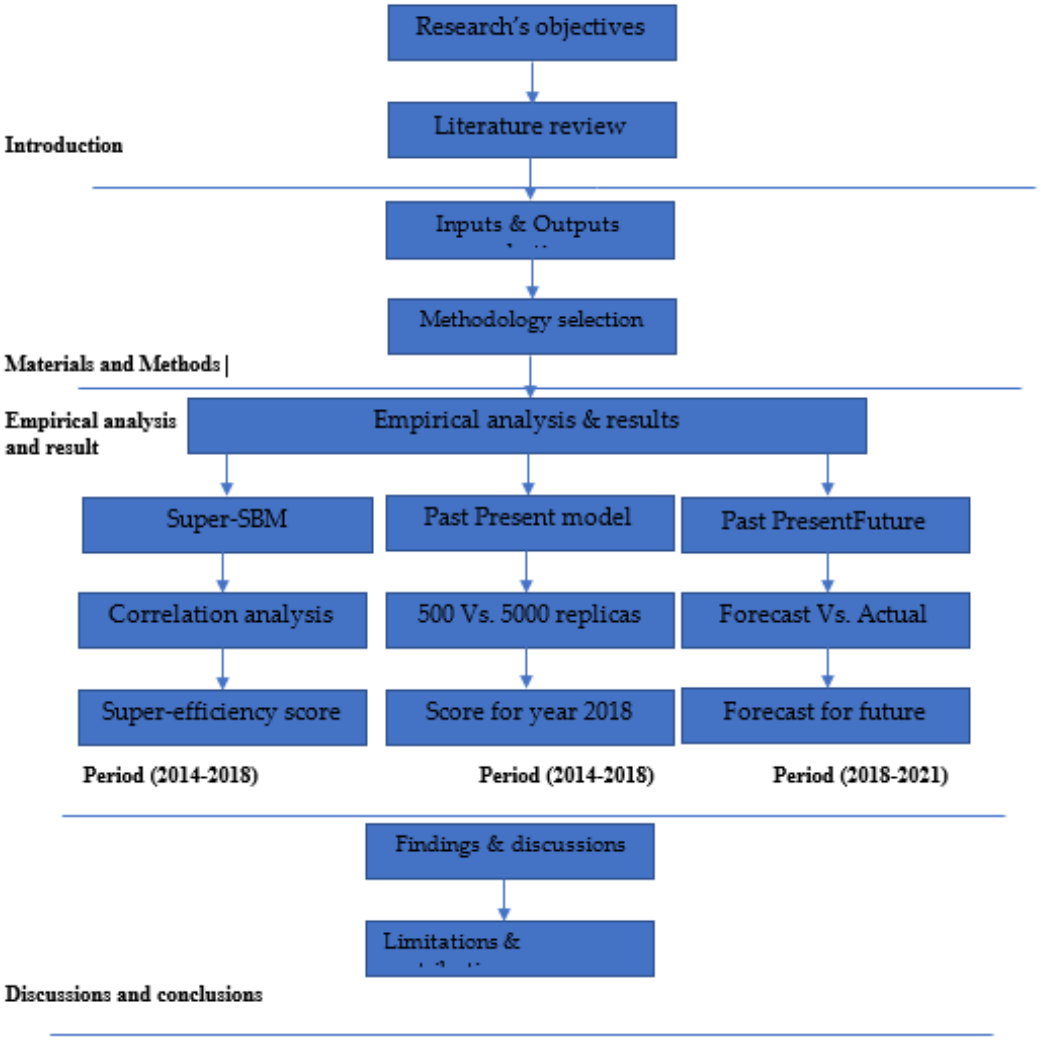

Figure 1 Research process

II. MATERIALS AND METHODS

A. Models, Inputs and Outputs

In the field of bank efficiency, there are five different approaches can be used to define inputs and outputs: (1) the intermediation approach; (2) the production approach; (3) the asset approach; (4) the user cost and (5) the value added approach in which the production and the intermediation approaches are the most popularly used ones [20].

In this study, the intermediation approach is applied to measure cost efficiency of banks. In intermediation approach, banks are considered as the financial intermediaries that make profit by borrowing funds from depositors then lending them to creditor. In this approach total loan is defined as outputs while deposit value and some expenses and costs related to the funds bank borrows from depositors are considered as the inputs such as labor cost, capital. Therefore, the inputs used in this study are total deposits, total assets and labor expense while the outputs are total loans and other earning assets. There are total 31 Vietnamese commercial banks at the present. However, several small commercial banks do not have sufficient data because some are new, and some have been merged. Therefore; due to the limitation of data access as well as to ensure the fair comparison stability consideration, the author collect data of 24 commercial banks which provide full needed data.

All data of these 24 banks are collected from their financial statements as well as annual reports. Besides, Vietnamese website for statistics on stock market such as CafeF [21] and Vietstock [22] are helpful resource for obtained needed information. The summary of statistics for input and output factors for selected 24 Vietnamese commercial banks over period 2014-2018 is reported at Table 1.

Table 1. Main statistics of inputs/outputs (average, 2014–2018).

Unit: VND million

Year	Variables	Deposits	Total Assets	Labor	Loans	OEA
2014	Max	440,471,589	661,241,727	8,894,803	452,850,666	226,869,158
	Min	11,843,167	15,823,336	79,023	11,139,340	2,413,828
	Average	119,810,917	168,358,656	2,138,941	101,103,136	56,181,965
	SD	129,151,422	186,652,152	2,292,143	128,670,613	55,513,096
2015	Max	564,583,061	850,669,649	8,665,767	610,492,394	252,607,292
	Min	13,141,759	17,748,745	134,016	11,520,181	4,019,184
	Average	143,984,021	199,418,451	2,389,081	124,992,643	59,549,201
	SD	158,894,768	231,682,740	2,684,590	159,744,314	64,646,359
2016	Max	726,021,696	1,006,377,748	10,623,575	713,632,772	291,708,678
	Min	14,168,928	19,047,890	144,374	12,430,861	4,396,534
	Average	173,852,453	238,236,449	2,613,674	150,987,525	69,573,401
	SD	199,860,349	274,172,012	2,965,163	187,044,011	74,569,472
2017	Max	859,985,173	1,202,283,843	11,436,527	855,535,525	376,979,890
	Min	14,849,499	21,319,355	184,448	13,988,536	4,770,310
	Average	200,502,668	286,047,824	2,742,755	181,429,978	82,551,307
	SD	235,289,428	332,266,341	3,118,148	222,635,892	92,382,587
2018	Max	989,671,155	1,313,037,674	11,114,537	976,333,888	404,931,323
	Min	14,678,435	20,373,555	177,312	13,559,555	4,133,876
	Average	224,968,818	315,172,533	2,861,658	204,927,493	81,509,912
	SD	265,558,543	355,076,610	3,147,170	250,254,163	91,554,541

B. Methodology

1) Resampling model in DEA

When thoroughly evaluating a performance of one decision-unit making (DMU), it is necessary that the evaluator must assess both the past and present records as well as the future potential [23]. For evaluating the DMU's performance, one of the most popular used approach is non-parametric approach named data envelopment analysis (DEA). However, in literature, it is found that there had been no model of DEA that can simultaneously take past, present and, especially, future performance indicators into account until Tone [24] proposed the model named past-present and past-present-future-based resampling.

Tone [24] proposed a generic methodological framework to estimates the confidence interval of DEA score in a past-present time frame based on the non-oriented super slacks-based measure (super SBM) model under the constant returns-to-scale (CRS). Then, this framework is extended to the past-present-future time frame.

2) Past-Present Based Resampling

Past-present data: Let consider (X^t, Y^t) (t = 1... T) is the matrix of the historical inputs and outputs. Where t =1 is the first observed period and t = T is the last observed period with:

$X^t = (x_1^t, \dots, x_n^t) Y^t = (y_1^t, \dots, y_n^t)$ (n is the number of DMU);
$x_j^t \in R^m$ is the input vector and $y_j^t \in R^s$ is the output vector of DMU_j

The weight W_t is set for a period t with an assumption that more recent periods carry information that is more relevant to estimate efficiency scores in the present time [3]. Thus, the following Lucas number series$(l_1, \dots, l_t)$, is a candidate where$l_{t+2} = l_t + l_{t+1} (t = 1, \dots, T, T - 2; l_1 = 1, l_2 = 2)$.

Let L be the sum of the series: L = $\sum_{t=1}^{T} l_t$ the weight W_t then is defined by $W_t = {}^{l_t}/_{L} (t = 1, \dots, T)$

After setting the weight, super-efficiency score of DMUs in last period is obtained. Then, the confidence interval (CI) was gauged by using the replication process called replicas based on bootstrapping. As replicas are representative of the dataset, the preliminary analysis of the data should be done in order to find out about features of datasets [22]. The same test should be used to find out whether the replicas are representative of dataset or not, if they are not, they should be rejected and resampled again. However, for dataset which is non-correlated and homoscedastic, the hypothesis test or confidence interval based on Fisher's z transformation can be applied to compare the patterns in the past and present data.

The correlation between all pairs of inputs, outputs, and input-output all DMUs can be computed for the present time period data. Then, computing their 95% confidence intervals using Fisher's z transformation [25]. Resampled data will be discarded or approved based on the corresponding correlation. If the corresponding correlation is in the range of this interval, resampled data is accepted vice versa the resampled data is discarded if the corresponding correlation is out of the interval's range. Therefore, the inappropriate samples of the last period are eliminated from the sampling. This 95% confidence interval is optional; however, the narrower the interval is, the closer the sample will be to the last period data [25].

3) Past-Present-Future Based Resampling
After obtained the confidence interval f the last period's scores, the forecast for the future namely $(X^{t+1}, Y^{t+1})$by using past-present data (X^t, Y^t) with (t=1, …, T)and forecast the efficiency score of DMU in future time period along with their confidence intervals. In this resampling, the past-present time-based framework is extended to the past-present-future time-based framework. To do that, firstly, the future is forecasted by Letting $h^t(t = 1, \dots, T)$ be the observed data of the past-present with a certain input i (i = 1,…,m) and output r (r= 1,…,s)of a DMU …. We wish to forecast h^{T+1} from $h^t(t = 1, \dots, T)$. There are three predictions are introduced to obtain the forecasts named Trend analysis, Lucas weight analysis and the hybrid model. Once obtaining the forecasts, the super-efficiency score of the future time period will be estimated.

III. EMPIRICAL ANALYSIS AND RESULTS

A. Preliminary Results

In this section, non-oriented super-SBM model is applied to measure the cost efficiency of banks year by year. The obtained super-efficiency scores are present in Table 2 along with their graphical representation in Figure 2.In general, the efficiency scores slightly fluctuated by year and was suffered a decrease trend from 2014-2017, then notably increased in year 2018. From the results of comparing the averages of five years, it was found that the average regress from 0.789 in 2014 to the lowest 0.725 in 2015, then slightly went up year by year to the highest 0.812 in 2018.

It is observed that the distance between the score of different DMUs is notable. There is a big gap between the highest score and the lowest one. Particularly, the lowest and the highest ores in 2014, 2015, 2016, 2018 and 2018 were 0.443-1.569, 0.306-1.422, 0.332-1.608, 0.355-1.409 and 0.471-1.096 respectively. The big gap between the lowest and the highest indicated the big difference in cost efficiency of different commercial banks.

As a whole, these 24 banks are inefficiency in term of cost with the average score ranged from 0.725 to 0.812. However, by looking at individual banks, the

results indicated that some banks actually are efficient. The number of efficient banks in 2014 and 2015was 7 then decreased to 6 in 2016, the number of efficient banks in 2017 was 8 and 11 in 2018. The increase in number of efficient banks in 2018 lead to the improve of average score in compared to previous year 2014-2017. It is noted that, STB is the bank that has the lowest score over 4 year 2015-2018 of 5 year-period 2014-2018. The far distance from the efficient frontier indicated that STB bank performed very poorly in term of cost.

Among three largest commercial banks in term of total assets BID is the largest commercial bank, followed by CGT and VCB. The total assets of these three banks are higher than US$ 44 billions. The super-efficiency score of BID for 5 years all higher than 1, indicating that this bank is efficient in term of cost.Similarly, CGT performed effectively with the super-score higher than 1 of all year except the score 0.917 in 2016. Averagely, CGT bank is relatively efficient with the average score 0988. On contrary, VCB suffered the decrease in the super-efficiency score from 1.019 in 2014 to the lowest 0.629 in 2017 mainly caused by the growth of total assets and the lower ratio of total loans/total deposit. The average ratio of total loans/total deposit of VCB was around 0.8 while those in BID and CGT are 1.01 and 1 respectively.

The total assets of all left 21 banks are around or less than 50% of BID. Averagely, the score of these small banks are low. However, some small banks are still efficient or nearly reached the efficient frontier such as TP bank with the score higher than 1 for all 5 observed year, HDB bank with the score of all year higher than 1 except score of year 2018 and VPB bank with the score of all year except year 2014 are higher than 1.

Table 2.Super-SBM score

Banks	DMUs	2014	2015	2016	2017	2018	Average
ABB	B1	0.570	0.517	0.506	0.544	0.688	0.565
ACB	B2	0.601	0.613	0.749	0.706	0.652	0.664
BAB	B3	1.120	1.027	0.702	0.646	0.795	0.858
BID	B4	1.035	1.025	1.008	1.001	1.006	1.015
CGT	B5	1.010	1.005	0.917	1.007	1.003	0.988
EIB	B6	0.713	0.530	0.567	0.578	0.564	0.590
HDB	B7	1.246	1.205	1.266	1.409	0.801	1.186
KLB	B8	0.503	0.408	0.419	0.392	0.518	0.448
LPB	B9	0.546	0.520	0.504	0.516	1.000	0.617
MB	B10	0.695	0.678	0.722	0.690	0.758	0.709
NamABank	B11	0.658	0.531	0.394	0.605	0.657	0.569
NVB	B12	0.447	0.426	0.514	0.425	0.649	0.492
OCB	B13	0.763	0.833	0.707	0.653	1.005	0.792
PGB	B14	0.758	0.668	1.015	1.021	1.005	0.893
SCB	B15	0.443	0.418	0.426	0.418	0.477	0.436
SGB	B16	1.004	0.463	0.487	0.465	0.540	0.592
SHB	B17	0.541	0.506	0.699	0.639	0.623	0.602
STB	B18	0.576	0.306	0.332	0.335	0.471	0.404
TCB	B19	0.771	0.884	0.896	0.834	1.017	0.880
TP	B20	1.569	1.422	1.608	1.217	1.034	1.370
VCB	B21	1.019	0.791	0.658	0.629	1.006	0.821

VIB	B22	0.823	0.838	0.863	1.005	1.085	0.923
VietABank	B23	0.696	0.714	0.786	0.919	1.096	0.842
VPB	B24	0.837	1.072	1.100	1.060	1.046	1.023
Average	B25	0.789	0.725	0.744	0.738	0.812	0.762

Additionally, Figure 2 illustrates the variation between years for each bank. Specially, HDB and TP fluctuated in a positive way in 2014 and 2017 with the score is much higher than score of other banks. However; the score rapidly decreased in 2018. In contrary, VPB witnessed the stable-high score with the increase trend from 2014 to 2018. As can be seen at Figure 2, the score of HDB and TPB is much higher compared to other banks.

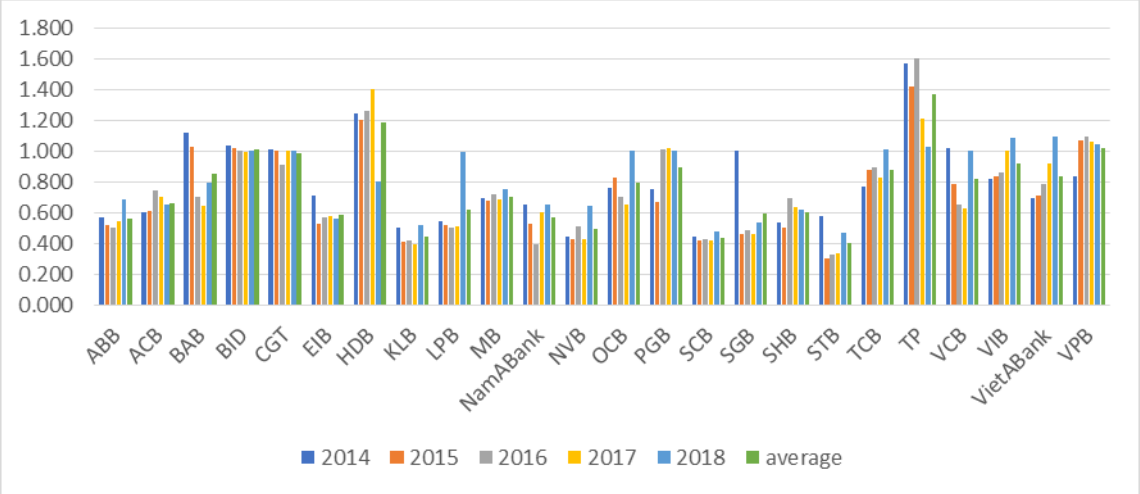

Figure 2. Panel data results

B. Illustration of the Past-Present Framework

In this stage, the efficiency score of the past and present id going to be obtained by applying PastPresent model with 500 replicas. Table 3 compared the results of 500 vs. 5000 replicas. Since the replicas number is depend on how many inputs and outputs and DMUs the study has, the comparison of 500 and 5000 replicas aims to check the variations of scores by increasing the number of replicas (Tone, 2016). Obtained results of 500 and 5000 replicas witha 95% confidence interval reveals that the difference was statistically negligible small. Therefore, 500 replicas can be acceptable in this case. Correlation matrix of the observed 2018 year is described in Table 4 and Table 5 shows the Fisher 95% confidence intervals. The correlation is ranged from -1 to +1 and the closer value to (±1), the closer relationship between variables. For example, data at Table 4 and Table 5 indicated that the correlation coefficient between Deposits and Other Earning Assets is 0.90015 and its 95% lower/upper bounds are 0.780 and 0.956respectively.

Table 3. Comparisons of 5000 and 500 replicas (Fisher 95%) period 2013 to 2017.

Banks	5000 Replicas			500 Replicas			Difference	
	97.50%	DEA	2.50%	97.50%	DEA	2.50%	97.50%	2.50%
ABB	1.036	0.688	0.356	1.028	0.688	0.363	-0.0078	0.0074
ACB	1.074	0.652	0.242	1.066	0.652	0.245	-0.0078	0.0024

Banks	5000 Replicas			500 Replicas			Difference	
	97.50%	DEA	2.50%	97.50%	DEA	2.50%	97.50%	2.50%
BAB	1.154	0.795	0.346	1.143	0.795	0.345	-0.0105	-0.0011
BID	1.016	1.006	0.256	1.006	1.006	0.267	-0.01	0.0106
CGT	1.003	1.003	0.275	1.001	1.003	0.268	-0.0012	-0.0064
EIB	0.684	0.565	0.229	0.692	0.565	0.227	0.0087	-0.0025
HDB	1.605	0.801	0.434	1.602	0.801	0.424	-0.0027	-0.0104
KLB	1.127	0.518	0.179	1.113	0.518	0.177	-0.0136	-0.0019
LPB	1.114	1.000	0.311	1.121	1.000	0.316	0.0069	0.0053
MB	1.105	0.758	0.354	1.088	0.758	0.380	-0.0169	0.0259
NamABank	1.277	0.657	0.247	1.267	0.657	0.247	-0.0092	0.0005
NVB	1.126	0.649	0.280	1.120	0.649	0.280	-0.0057	-0.0007
OCB	1.377	1.005	0.349	1.370	1.005	0.353	-0.0068	0.004
PGB	1.070	1.005	0.273	1.070	1.005	0.263	0.0002	-0.0096
SCB	1.012	0.477	0.232	1.002	0.477	0.229	-0.0095	-0.0032
SGB	0.601	0.540	0.204	0.584	0.540	0.214	-0.017	0.0095
SHB	1.064	0.623	0.222	1.068	0.623	0.210	0.004	-0.0127
STB	0.562	0.471	0.154	0.564	0.471	0.162	0.0018	0.0072
TCB	1.150	1.017	0.392	1.210	1.017	0.393	0.06	0.0004
TP	2.119	1.034	0.613	2.040	1.034	0.544	-0.0792	-0.0687
VCB	1.047	1.006	0.408	1.044	1.006	0.396	-0.0029	-0.0119
VIB	1.329	1.085	0.493	1.322	1.085	0.505	-0.0072	0.0129
VietABank	1.445	1.096	0.453	1.458	1.096	0.464	0.0126	0.0106
VPB	1.317	1.046	0.403	1.336	1.046	0.394	0.019	-0.0095
Average	1.142	0.812	0.321	1.138	0.812	0.319	-0.00395	-0.00175

Table 4. Correlation Matrix

	Deposits	Total Asset	Labor	Loans	Other Earning Assets
Deposits	1	0.996	0.914	0.987	0.900
Total Assets	0.996	1	0.899	0.991	0.909
Labor	0.916	0.899	1	0.911	0.731
Loans	0.987	0.991	0.911	1	0.852
Other Earning Asset	0.900	0.909	0.731	0.852	1

Table 5. Lower/upper bounds of Fisher 95% confidence for correlation matrix.

Lower bounds						
		Deposits	Total Asset	Labor	Loans	Other Earning Assets
Upper bounds	Deposits		0.991	0.808	0.969	0.780
	Total Assets	0.998		0.778	0.978	0.800

	Labor	0.962	0.956		0.803	0.464
	Loans	0.994	0.996	0.961		0.684
	Other Earning Asset	0.956	0.961	0.876	0.934	

The present performance evaluation results

The efficiency score of each commercial bank is evaluated by using the PastPresent super-SBM model. Details of the evaluation such as DEA score, average score, ranking and 95% confidence interval with 500 replicas for year 2018 are given in Table 6 and Figure 3.

The results obtained by 500 replicas are exhibited in Table 6 where the column DEA represents the efficiency score of the present year 2018 and average indicated the average score over 500 replicas. The column rank is the ranking of average scores. As can be clearly seen from the given diagram, results fluctuated for each indicator. With DEA score, the number of efficient DMUs is 11, and the number of inefficient DMUs is 13. Among 13 inefficient banks, there are two banks that have efficiency score lower than 0.5 (STB and SCB) while other 11 bank's efficiency score are between 0.5 and 0.8.

Table 6. DEA score and confidence interval with 500 replicas for year 2018.

Banks	DMUS	97.50%	DEA	Average	2.5%	Rank
ABB	B1	1.028	0.688	0.588	0.363	13
ACB	B2	1.066	0.652	0.492	0.245	16
BAB	B3	1.143	0.795	0.674	0.345	8
BID	B4	1.006	1.006	0.457	0.267	20
CGT	B5	1.001	1.003	0.472	0.268	18
EIB	B6	0.692	0.565	0.403	0.227	22
HDB	B7	1.602	0.801	1.098	0.424	2
KLB	B8	1.113	0.518	0.483	0.177	17
LPB	B9	1.121	1.000	0.612	0.316	12
MB	B10	1.088	0.758	0.645	0.380	11
NamABank	B11	1.267	0.657	0.670	0.247	9
NVB	B12	1.120	0.649	0.551	0.280	15
OCB	B13	1.370	1.005	0.817	0.353	6
PGB	B14	1.070	1.005	0.561	0.263	14
SCB	B15	1.002	0.477	0.419	0.229	21
SGB	B16	0.584	0.540	0.381	0.214	23
SHB	B17	1.068	0.623	0.460	0.210	19
STB	B18	0.564	0.471	0.330	0.162	24
TCB	B19	1.210	1.017	0.743	0.393	7
TP	B20	2.040	1.034	1.281	0.544	1
VCB	B21	1.044	1.006	0.658	0.396	10
VIB	B22	1.322	1.085	0.960	0.505	4
VietABank	B23	1.458	1.096	1.008	0.464	3
VPB	B24	1.336	1.046	0.901	0.394	5

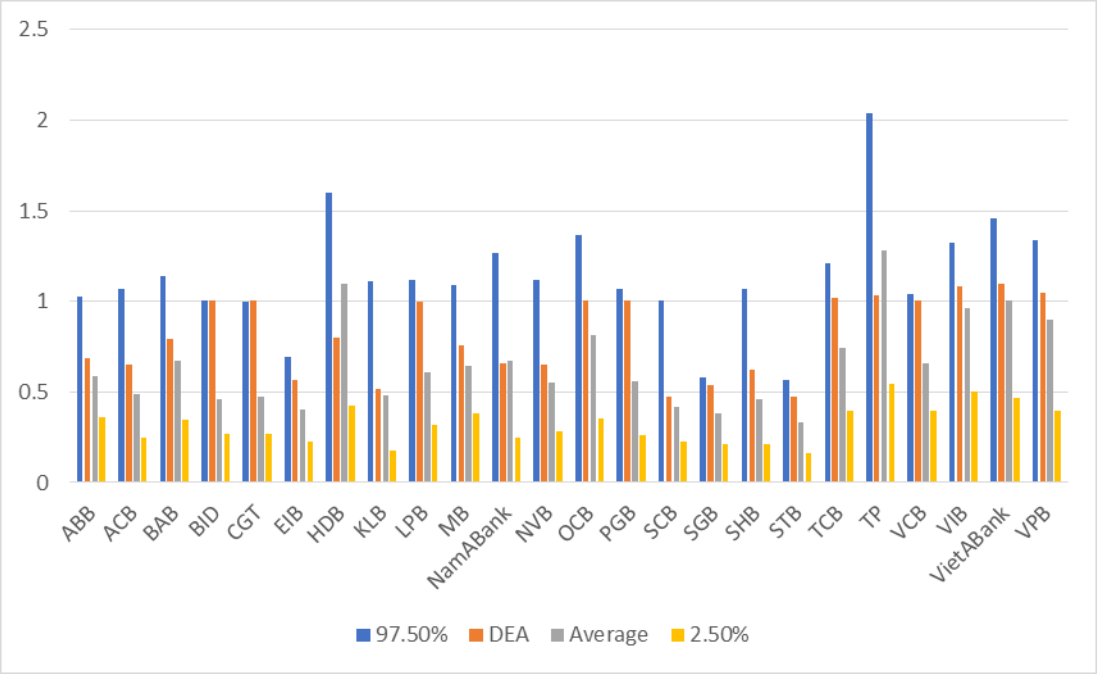

Figure 3. DEA score and confidence interval with 500 replicas

However, ranking with a confidence interval of 97.5% showed the different resulted with the higher number of efficient DMUs of 21 and lower number of inefficient DMUs of 3. DEA's average score indicated three banks (VietaBank, HDB and TP) are efficient in term of cost with the efficiency score higher than 1 in which TP bank has the highest ranking with the 97.5% confidence interval score 2.040, the average score 1.281. followed by HDB and VietaBank with the 97.5% confidence interval score was 1.602 and the average score was 1.098 for the former and 1.458 and 1.008 for the later.

C. Illustration of the Past-Present-Future Framework

In this section, the numerical results for the past-present-future framework. The period from 2014 to 2017, in this case is regarded as the past-present while year 2018 is considered as the future. There predictions named the linear trend model, a weighted average with Lucas Weights model and a hybrid model. As mentioned above that 500 replicas are acceptable in this study; therefore; 500 replicas are also used in this section with the 95% confidence interval to forecast the future cost efficiency score of 24 Vietnamese commercial banks.

The forecast DEA score obtained by the linear trend and confidence interval along with the actual super-SBM score for 2018 are presented at Table 7. Figure 4 exhibits 97.5% percent, 2.5% percent, forecast score and actual score. It is noted that, of the 24 commercial banks, the actual scores of 24 are included in the 95% confidence interval. The average of Forecast-Actual over the 24 DMUs was -0.057 (-5.7%).

Forecasts of efficiency scores for year 2018 by the weighted average model with Lucas weights and along with the actual score with 95% confidence intervals are reported at Table 8. In this case, all 24 banks are included in the 95% confidence interval. The average of Forecast-Actual the 24 banks was -0.025 (-2.5%)

Forecasted efficiency scores 2018 obtained by the hybrid model for 2018 and along with the actual score with 95% confidence intervals. In this case, all 24 banks are included in the 95% confidence interval. The average of Forecast-Actual the 24 banks was -0.037 (-3.7%). The results of these three predictions are consistent and the average of Forecast-Actual over the 24 DMUs is smallest in Lucas weight model. We; therefore, use the Lucas weight model to

forecast the data and efficiency score for next three years from 2019-2021.

Table 7. Forecast DEA scores, actual (2018), and confidence interval: forecasts by linear trend model

Banks	DMUs	97.50%	Forecast	Actual	2.50%
ABB	B1	1.022	0.672	0.688	0.361
ACB	B2	1.097	0.598	0.652	0.256
BAB	B3	1.160	0.726	0.795	0.340
BID	B4	1.009	0.794	1.006	0.264
CGT	B5	1.009	1.000	1.003	0.266
EIB	B6	0.596	0.540	0.565	0.219
HDB	B7	1.611	1.147	0.801	0.478
KLB	B8	1.153	0.448	0.518	0.181
LPB	B9	1.115	0.661	1.000	0.292
MB	B10	1.091	0.707	0.758	0.339
NamABank	B11	1.247	0.606	0.657	0.250
NVB	B12	1.146	0.625	0.649	0.299
OCB	B13	1.410	0.799	1.005	0.342
PGB	B14	1.088	1.035	1.005	0.172
SCB	B15	1.003	0.479	0.477	0.247
SGB	B16	0.666	0.504	0.540	0.217
SHB	B17	1.048	0.577	0.623	0.234
STB	B18	0.549	0.418	0.471	0.172
TCB	B19	1.123	0.747	1.017	0.410
TP	B20	1.789	1.013	1.034	0.397
VCB	B21	1.045	0.698	1.006	0.406
VIB	B22	1.367	1.130	1.085	0.490
VietABank	B23	1.615	1.144	1.096	0.542
VPB	B24	1.291	1.045	1.046	0.384

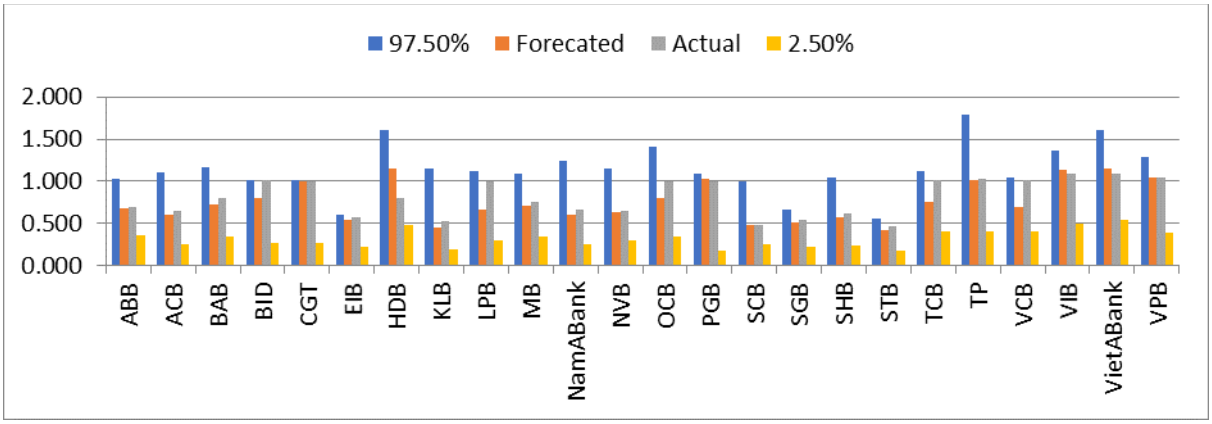

Figure 4. Confidence interval forecast score and actual 20018 score: forecast by linear trend model.

Table 8. Forecast DEA scores, actual (2018), and confidence interval: forecasts by Lucas weight model.

Banks	DMUs	97.50%	DEA	Actual	2.50%
ABB	B10	1.024	0.662	0.688	0.401
ACB	B8	1.077	0.742	0.652	0.284
BAB	B12	1.135	0.759	0.795	0.406
BID	B18	1.042	1.022	1.006	0.311
CGT	B15	1.027	0.901	1.003	0.323
EIB	B5	0.683	0.595	0.565	0.269
HDB	B13	1.546	1.216	0.801	0.573
KLB	B3	1.101	0.498	0.518	0.213
LPB	B14	1.075	0.669	1	0.359
MB	B11	1.091	0.728	0.758	0.395
NamABank	B9	1.242	0.647	0.657	0.28
NVB	B7	1.072	0.588	0.649	0.333
OCB	B17	1.302	0.835	1.005	0.433
PGB	B16	1.077	1.004	1.005	0.298
SCB	B2	0.759	0.478	0.477	0.27
SGB	B4	0.687	0.531	0.54	0.252
SHB	B6	1.062	0.634	0.623	0.261
STB	B1	0.502	0.428	0.471	0.187
TCB	B20	1.124	0.807	1.017	0.443
TP	B21	1.869	1.222	1.034	1.016
VCB	B19	1.028	0.772	1.006	0.487
VIB	B23	1.295	1.097	1.085	0.584
VietABank	B24	1.402	1.053	1.096	0.63
VPB	B22	1.23	1.006	1.046	0.444

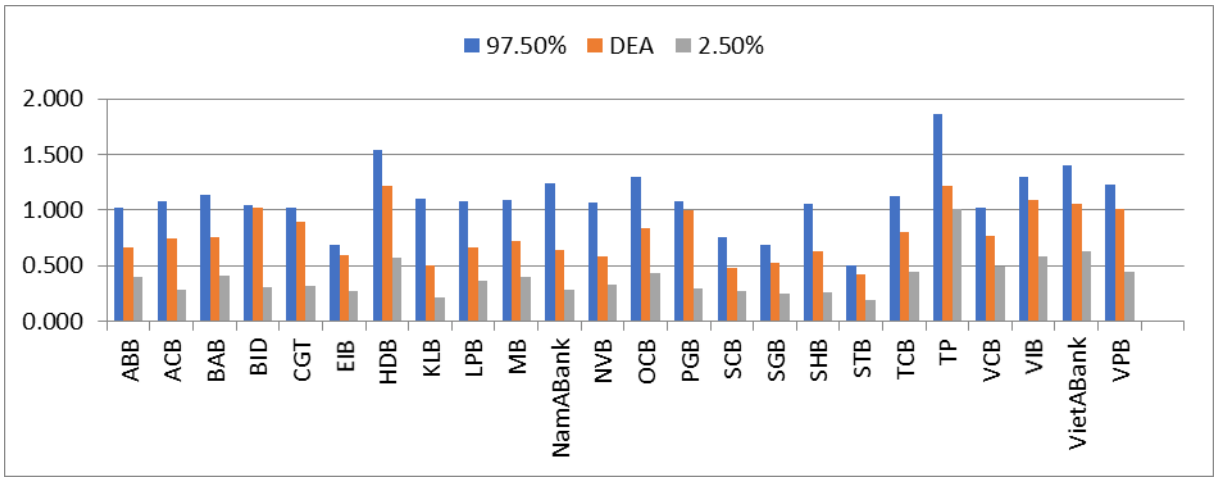

Figure 5. Confidence interval, forecast score and actual 20018 score: forecast by Lucas weight model.

D. Future Forecast Performance Evaluation Results

The cost efficiency of 24 Vietnamese commercial banks over time for the past-present-future (2014-2021) are presented at Table 10. Over this period, efficiency score of all 24 banks experienced the fluctuation with the decrease trend for the future. It was observed that average score was lowest in the past year 2017, then reached the highest in the present year 2018 and continued regressed in future years 2019-2021 mainly caused by the slower growth of total loans in the future compared to the past and present.

Averagely, during 2014-2021, of 24 banks, 4 banks are efficient which indicated that these 4 banks have a better balance between inputs and outputs than other banks in term of cost. Among these 4 efficient banks, TP bank will have the highest score, followed by HDB, VP and BID respectively. By looking at individual years, it was found the different number of efficient banks in each year. As mentioned in above section, the number of efficient banks during 2014-2018 ranged from 6 to 11, and those in future years will be 8. Additionally, is noted that the banks which efficient in 2019 will continue to be efficient in 2020 and 2021. 8 efficient banks in future will be HDB, TP,VIB, VietABank, VPB, PGB, DID and CGT. These 8 banks are from 11 banks which were efficient in 2018 and among these 11 banks, three banks used to be efficient will be inefficient in future (OCB, TCB and VCB).

In each year, as a whole observation, 24 banks are inefficient with the lower than 1 of corresponding average score for each year. In fact, efficient banks were found in each year during 2014-2021. However, the number of inefficient banks is outstanding the number of efficient ones; thus; the average score of individual years over period 2014-2021 are all low. Moreover, the efficiency score suffered the big gap between the lowest and the highest score as mention in section 3.1. While the highest scores ranged from 1 to 1.6, the lowest score was from 0.306 to 0.471. This is a reason for the low efficiency score of individual years. It was found that, this gap will be closer in the future years with the pair of lowest and highest score as follow: 0.42-1.15 in 2019, 0.416-1.186 in 2020 and 0.415-1.184 in 2021. STB is the bank that will the lowest score in all 3 future years while in contrary, HDB is the bank that will have the highest score over 2019-2021. The closer gap in the future implies the better performance of current inefficient banks.

Table 10. Past-Present-Future efficiency score for year 2014-2021

Bank	2014	2015	2016	2017	2018	2019	2020	2021	Average
ABB	0.57	0.517	0.506	0.544	0.688	0.677	0.681	0.681	0.608
ACB	0.601	0.613	0.749	0.706	0.652	0.627	0.734	0.729	0.676

BAB	1.12	1.027	0.702	0.646	0.795	0.733	0.747	0.746	0.815
BID	1.035	1.025	1.008	1.001	1.006	1.001	1.004	1.004	1.011
CGT	1.01	1.005	0.917	1.007	1.003	1.003	1.003	1.003	0.994
EIB	0.713	0.53	0.567	0.578	0.564	0.555	0.602	0.601	0.589
HDB	1.246	1.205	1.266	1.409	0.801	1.15	1.186	1.184	1.181
KLB	0.503	0.408	0.419	0.392	0.518	0.463	0.516	0.514	0.467
LPB	0.546	0.52	0.504	0.516	1	0.668	0.672	0.672	0.637
MB	0.695	0.678	0.722	0.69	0.758	0.715	0.731	0.73	0.715
NamABank	0.658	0.531	0.394	0.605	0.657	0.615	0.632	0.631	0.590
NVB	0.447	0.426	0.514	0.425	0.649	0.625	0.621	0.624	0.541
OCB	0.763	0.833	0.707	0.653	1.005	0.81	0.828	0.827	0.803
PGB	0.758	0.668	1.015	1.021	1.005	1.029	1.015	1.016	0.941
SCB	0.443	0.418	0.426	0.418	0.477	0.485	0.484	0.484	0.454
SGB	1.004	0.463	0.487	0.465	0.54	0.509	0.537	0.535	0.568
SHB	0.541	0.506	0.699	0.639	0.623	0.58	0.617	0.615	0.603
STB	0.576	0.306	0.332	0.335	0.471	0.42	0.416	0.415	0.409
TCB	0.771	0.884	0.896	0.834	1.017	0.758	0.787	0.786	0.842
TP	1.569	1.422	1.608	1.217	1.034	1.036	1.13	1.125	1.268
VCB	1.019	0.791	0.658	0.629	1.006	0.712	0.748	0.745	0.789
VIB	0.823	0.838	0.863	1.005	1.085	1.127	1.115	1.117	0.997
VietABank	0.696	0.714	0.786	0.919	1.096	1.129	1.081	1.083	0.938
VPB	0.837	1.072	1.1	1.06	1.046	1.039	1.019	1.02	1.024
Average	0.789	0.725	0.744	0.738	0.812	0.769	0.788	0.787	0.769

The average cost efficiency score of the past period (2014-2017), present year (2018) and future period (2019-2021) are illustrated at Figure 6. As observed, the cost efficiency score of some banks were so fluctuated during 2014-2021 such as HDB, LPB, NVB, OCB, TP, VCB, VIB and VietABank. The distance between efficiency score of these banks between past, present and future are far. One the other hand, the left 20 banks experienced the slight change in efficiency score. The big fluctuation between the average efficiency score of the past-present-future indicates the unstable balance between inputs and outputs.

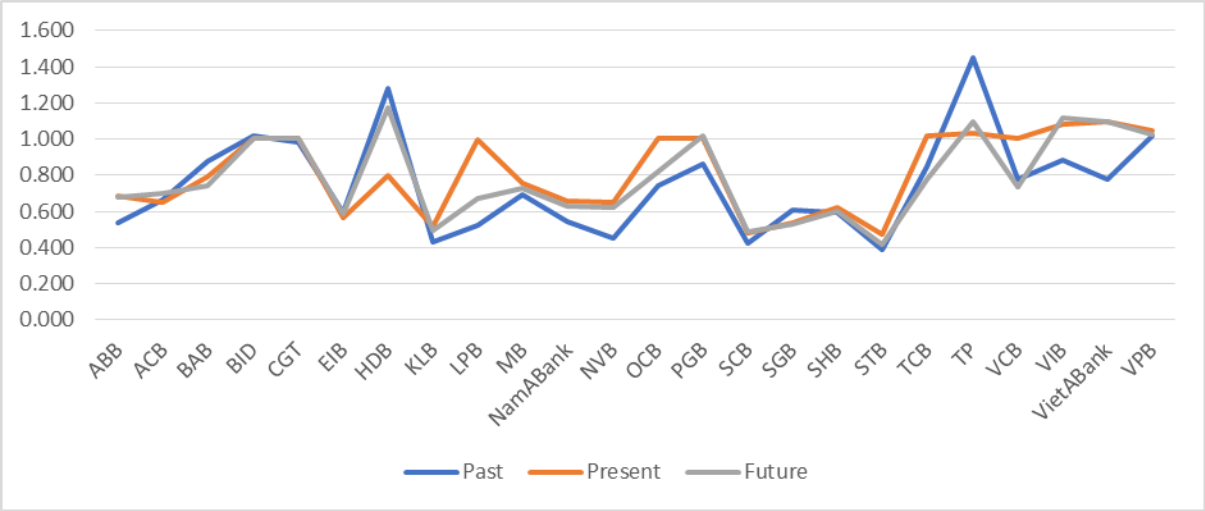

Figure 6. Past-Present-Future efficiency score for year 2014-2021

IV. DISCUSSIONS AND CONCLUSIONS

Since the banking system is considered as the lifeblood of the national economy, evaluating the bank's performance is one of the important subjects which benefit not only the banking industry only but also the economic development. Therefore; bank efficiency seems to be one of the most important concerns of banks and it is given priority over the last decades. In any banks, it is necessary to effectively utilize costs. However, it was found that most of Vietnamese commercial banks are inefficient in term of cost, which inspired authors to conduct a study to investigate the cost efficiency of Vietnamese commercial bank over past and present period 2014-2018 and to forecast the cost efficiency of these banks upcoming future year 2019-2021. To achieve the research objectives, data of 24 Vietnamese commercial bank from 2014 to 2018 were collected and analyzed. In the first step, we used DEA super-SBM model to measure cost efficiency of 24 banks for the past and present year period 2014-2018. After obtaining efficiency score from super-SBM, we use the DEA Past-Present based resampling method to measure cost efficiency for year 2018 along with its 95% confidence interval with 500 replicas and 5000 replicas to determine how many replicas is suitable for this study. Finally, the Past-Present-Future based resampling method is used to forecast the future data for inputs, outputs and cost efficiency score for future year 2019-2021.

Findings of this study reveals that the average cost efficiency score of 24 selected banks were around 0.7 to 0.8 which implies that these commercial banks are quite far from the efficient frontier and are inefficient in term of cost. In addition, efficiency score of the future years will be lower than those of the present year, indicating that the input resources as labour, capital and deposits are worse employed by these banks in the future than in present. Moreover, the findings of this study also indicated the wide gap between efficiency scores of different banks. However, in the future, this gap will be narrowed by the improvement in using input resources of some inefficient banks. Furthermore, it was found in this study that two largest banks as BID and CGT will be efficient in the future while the third largest bank VCB will suffer a low efficiency score. Finally, the findings of this study reveal that smaller banks such as TP bank or HDB bank will be ranked highest in term of cost efficiency in the future. Finding of this study provide important insights for bankers in managing and balancing the use of input resources in producing outputs for banks. Moreover, findings of this study also suggested the decrease in cost efficiency in the future which mainly caused by the slower growth of total loans. This finding carries the practical implication to policy maker, owner and banking administrators. To improve cost efficiency, commercial banks in Vietnam should strictly control the employee cost and capital as well as the total

deposits and build a long-run strategy to reduce cost and enhance input resources.

A salient limitation of this study mainly revolves around data and sample size. There are more than 30 Vietnamese commercial banks; however, due to limited data sources, we can only access data of 24 banks. We use data of 24 banks to make the measurement in term of cost efficiency for the whole Vietnamese commercial banks, which can affect results in general. To address these limitations, future study should increase the sample size. additionally, another shortcoming of this study is that this study could not detailly classify the banks according to their size to have a better insights of cost efficiency of big -size Vs. small-size bank. Moreover, this study just focusses on Vietnamese banks instead of accessing both Vietnamese and foreign banks operating in Vietnam's market. Thus, the future research should examine the difference between cost efficiency of big-size banks and small-size banks as well as the difference between Vietnamese commercial banks and foreign banks operating in Vietnam. Finally, although this study employed a flexible model as resampling model to predict the performance for future period, this study only focuses on a quantitative method. Future research should include a qualitative approach to make a good research direction.

The main contribution of this study is to provide an evaluation and forecast of cost efficiency for Vietnamese commercial banks. The research results provide policy maker, owner and banking administrators with incentives to enhance the utility of input resources. Results of this study may help in improve cost efficiency of Vietnamese commercial bank, to reduce the cost and enhance productivity and toward the sustainable development of Vietnamese commercial bank. The forecast may give useful information and practical suggestions for banking system.

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