Applying SFA and DEA in Measuring Bank's Cost Efficiency in Relation to Lending Activities: The Case of Vietnamese Commercial Banks

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Abstract- 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. Loans play an important role in earning profit and efficiency of the bank. However, a bigger amount of loans may cause higher cost spent to monitor loans and manage the bigger loan portfolio. It is obvious that problem loans negatively affect both profit efficiency and cost efficiency of the bank. This study is, therefore, examining the impact of loans on cost efficiency in the context of Vietnamese commercial banks. Data of 25 Vietnamese commercial bank from 2010 to 2017 were collected and analyzed. In first step Stochastic frontier analysis (SFA) was used to measure cost efficiency. Following, we examine if the bank loan has any effect on cost efficiency by using regression and finally, Data envelopment analysis (DEA) window model was applied to evaluate bank cost efficiency and make a comparison. The results found in this paper indicated that during 2010-2017, 25 sample Vietnamese commercial banks perform well in term of cost efficiency with an average efficiency score range from 0.8 to 0.9. In addition, results also found a strong consistency between SFA and DEA Window in measuring cost efficiency. Our results also indicated that bank loans found to have a significantly negative effect on bank cost efficiency. Findings of this study can provide important insights for bankers in managing their cost efficiency. Moreover, findings of this study also suggested that results obtained from SFA and DEA are consistent, which enables researchers to have greater confidence in choosing the method measuring bank efficiency. Furthermore, this study is expected to be the first empirical study on the relationship between loans and cost efficiency of the bank; therefore, it shed a light on literature for the new aspect of bank efficiency.

Index Terms- cost efficiency, bank loans, Vietnamese commercial bank, DEA, SFA.

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 Asian [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]. To do so, the State bank of Vietnam SBV has assigned an annual credit growth quota for each bank at the beginning of the year depending on the bank's health at the year's start. In addition, SBV also required commercial banks to focus their lending on priority such as production, SMEs, agriculture. 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]. Although credit growth is a good sign for the bank, lending activities and high credit growth rate also have a negative effect on the bank's cost. Regarding the crucial role of banks on omic development, measuring the efficiency of a bank has captured great attention.

However; most previous studies focused on two issues: (1) bad debt and (2) productive efficiency [6]. There are unlimited researches examining the relationship between problems of loans and the bank's efficiency. It is hard to find research related to the relation between the bank's loans and cost efficiency, which raises the question of how the bank's loans influence cost efficiency. Bank's profit mainly comes from the loan interest rate, owing to the banking mainly depends on accepting deposit and making loans [7]. Since loans are considered as the output of banks, banks want to utilize as more funds as possible to maximize output. However, the biggest risk for the bank to make loans lies in loan default [7] as loan quality problems not only lies in customer (firms' breakdown or moral hazard) but is also caused by other external events such as economic downturns. Consequently, the bank will incur a higher cost which is used to monitor these problems [8].

In the case of the Vietnamese bank's efficiency, there are several researches which measure the bank's efficiency and examine factor affecting the bank's performance. However, these researches mostly focus on efficiency itself or the relationship between the efficiencythe of the bank with some outstanding factors such as risk, NPL, bad debt, none of these studies has focused on that bank's cost efficiency under the effect of loans. Our study is therefore expected to be the first empirical study on the relationship between bank's cost efficiency and bank's loans in the context of Vietnamese commercial banks. Findings of this study can provide important insights for bankers in managing their cost efficiency. Moreover, findings of this study also suggested that results obtained from SFA and DEA are consistent, which enables researchers to have greater confidence in choosing a method measuring bank efficiency. Furthermore, in our study, the bank's loans were found to have a significant negative influence on the bank's cost efficiency. This study is expected to be the first empirical study on the relationship between loans and cost efficiency of a bank; therefore; it shed a light on literature for the new aspect of bank efficiency. A salient limitation of this study mainly revolves around data and sample size. To address these limitations, future study should incre the ase the sample size and extend the data period.

As mention above, understanding the bank's efficiency is very important not only for the bank but also for economic growth. Therefore, evaluating the efficiency of the bank has attracted great attention of researchers and become a so popular topic in the last decades that there have been numerous studies measuring the bank's efficiency. In 2010, 196 studies related to bank efficiency was detailly reviewed by Fethi and Pasiouras [9]. Previous studies related to the bank's efficiency measured by using frontier method were comprehensively reviewed and discussed by Berger and Humphrey [10]. Recently, another aspect of bank efficiency is cost efficiency has been received the great attention of researchers. Most recent is the research of Mokhamad Anwa in 2018 [11]. Mokhamad Anwa’s study examines the cost efficiency of 111 Indonesian commercial banks over the recovery period 2002-2010 by using Stochastic Frontier Analysis (SFA). The study of Mokhamad Anwa also applied TOBIT regression to find out the determinants of Indonesian bank’s cost efficiency. Tugba [12] conducted a study to examine technical, allocative and cost efficiency of the Turkish bank by applying Data Envelopment Analysis (DEA). In the same year, the study of Mikhai [13] evaluated the cost efficiency of Russian banks over the period 2005-2013 by employing the SFA method. In 2016, Hakan Gunes [14] 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 Stochastic Frontier Analysis (SFA). The study of Subhash [15] used Data Envelopment Analysis (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 [16]. Mihai's study investigates bank cost efficiency and the determinants of bank cost efficiency of 735 observations over the period 2005 to 2011 in six emerging countries from central and eastern Europe by using SFA. The study of Idazh [17] assessed the cost efficiency of Islamic banks in Indonesia. In this study, the author used SFA to estimate the cost efficiency of Islamic 19 conventional banks over the period 2004-2010.

Stochastic Frontier Analysis (SFA) and Data Envelopment Analysis (DEA) are widely used in the field of bank efficiency assessment. However; most of the previous studies use either SFA or DEA method to measure bank cost efficiency. In 2014, Yizhe Dong [18] conducted a study using both SFA and DEA for bank's cost assessment. In this study, the authors firstly obtained the bank's cost efficiency score by applying SFA and DEA, then they investigated the consistency of results obtained from these two methods. Findings of this research indicated the moderate consistency between SFA and DEA, which encourage researchers to use multiple frontier methods to measure the efficiency of banks. The study of Thiago [19] used both SFA and DEA approach cost efficiency of sample Chinese local banks and to investigate the consistency between results of bank's cost efficiency obtained by SFA and DEA. The study of Nguyen [20] used two-stage SFA and two-stage DEA to examine the cost efficiency of the Vietnamese bank over period 200-2014. Results obtained from SFA and DEA are highly consistent. The lack of study using both SFA and DEA to measure bank cost efficiency, especially in Vietnam motivated authors to do research on the cost efficiency of Vietnamese commercial banks by applying both SFA and DEA. Besides, the authors realized that in bank efficiency literature, previous researches mainly treat bank as an intermediary between lenders and borrowers. Thus, loans and other assets serve as outputs, while deposits and other liabilities are considered inputs of the banks [21]. As results, studies focus on minimizing inputs and maximizing output. In 2016, Fahlenbrach [22] conducted research on U.S bank from 1973 to 2014 and found that banks providing more loans will take higher credit risk which has a negative impact on the profitability of banks as higher of credit risk is, greater of high non-performing loan is. In the case of the Vietnamese bank's efficiency, there are several researches which measure the bank's efficiency and examine factor affecting the bank's performance. However, these researches mostly focus on efficiency itself or the relationship between the efficiency of the bank with some outstanding factors such as risk, NPL, bad debt, none of these studies has focused on that bank's cost efficiency under the effect of loans. Our study is therefore expected to be the first empirical study on the relationship between bank's cost efficiency and bank's loans in the context of Vietnamese commercial banks.

The remainders of this study will be presented as follow: section 2 is a review of related literature and research methodology used in this study. We will present empirical results in section 3 and section 4 will conclude this study with discussions.

II. IDENTIFY, RESEARCH AND COLLECT IDEA

It's the foremost preliminary step for proceeding with any research work writing. While doing this go through a complete thought process of your Journal subject and research for its viability by following means:

This section aims to describe data as well the different methods used in this study to measure the performance of Vietnamese commercial bank by evaluating cost efficiency. In this study, the author used two different methods (1) SFA and (2) DEA to measure cost efficiency of 25 Vietnamese commercial banks during 2010-2017.

2.1. Models, Inputs and Outputs

In the intermediation approach, banks are considered as the financial intermediaries that make a profit by borrowing funds from depositors then lending them to the creditor. In this approach total loan is defined as outputs while deposit value and some expenses and costs related to the funds that bank borrows from depositors are considered as the inputs such as labor cost, the capital. In this study, the author uses the intermediation approach. The sample size of this study includes 25 Vietnamese commercial banks. All data of these 25 banks are collected from their financial statements as well as annual reports. Besides, Vietnamese website for statistics on the stock market such as cafeF and Vietstock is a helpful resource for obtained needed information and figures. Table 1 below showed variables used in two methods.

Table 1: Variables selection

Variables/Models	VRS Cost DEA	SFA-TC: Cost
Inputs	Total deposit	Total deposit
	Fixed asset	Fixed asset
	Number of employees	Number of employees
Inputs price		Interest expense/total deposit
		Operating expense/Fixed assets
		Labor Expense/Number of Employees
Outputs	Customer loan	Customer loan
	Other earning assets	Other earning assets
Dependent variables		Total costs

2.2. Stochastic Frontier Analysis

The stochastic frontier analysis is applied in this study to measure the performance of Vietnamese commercial banks by using cost function. This approach has been popularly applied to measure the bank's efficiency since it was firstly proposed by Aigner [23]. In this study, the author applied the SFA cost function model to measure the efficiency of sample Vietnamese commercial banks during 2010-2017.

$$\ln TCit = \ln C(yit,wit)+\varepsilon it \quad (1)$$

TCit : total cost, C(yit,wit): cost function, Yit: output variables, wit : input prices.
This model works well in measuring cost efficiency; however; the limitation of this model is it just works when there is no inefficiency effect. In case, there existing inefficiency effects, we need another model which fits the situation. In 1995, Battese and Coelli [24] proposed a model to estimate stochastic frontier called log-likelihood function as below:

$$\ln TCit = \beta 0 + \beta ylnyit + \Sigma n\beta nlnwnit + \nu it + ui \quad (2)$$
$$ui \geq 0, \text{ i and } t = 1,\ldots, N$$

The inefficiency model is defined as follows:

$$uit = zit\delta + Wit \quad (3)$$

zit: vector of variables which may influence the efficiency of units
δ: vector of unknown parameters to be estimated
Rit: random variables reflecting effect of statistical noise

After combining inefficiency model into cost function model, cost efficiency can be measure by below model:

CE = [C(yit,Wit)exp(vit)]/[C(yit,wit)exp(vit+ zitδ+Rit) = exp (-zitδ+Rit) (4)

Recently, translog cost function which proposed by Christensen et al in 1973 [25], has been widely applied in research dealing with inputs and outputs. In recent bank efficiency literature, there are existing applications of translog cost function. Therefore, in this study, the author would like to apply translog cost function to measure the efficiency of 12 sample Vietnamese commercial banks during 2010-1017. The model measuring cost efficiency in this study is as follow:

LnTC = β0 + Σ ½βi(ln(Yi))2 + Σ ½βj(ln(Wj))2+ Σ Σβijln(Yi)ln(Wj) + Vi + Ui (5)

Where Yi is output variables; Wj is input price; Vi is random error and Ui is cost inefficiency error.

2.3. Data Envelopment Analysis

Nowadays, Data Envelopment Analysis (DEA) has been widely used in evaluating the relative efficiency of decision-making unit (DMU), especially in the banking industry [26]. The first DEA model called CCR model was proposed in 1978 by Charnes, Cooper, and Rhodes [27] which is based on productivity concept measuring the efficiency by calculating the ratio of one single input to one single output of Debreu [28] and Farell [29]. CCR model applied the productivity concept in the situation in which there are more than one outputs and inputs with constant returns to scale (CRS). In this method, any units on the efficiency frontier are said to be efficient and their efficiency rates equal 1. The units below the efficiency frontier line have efficiency rates less than 1, which show a level of their inefficiency. The efficiency rate defined in this way takes the values from 0 to 1. In CCR model, the virtual input and virtual output of each DMU are set as below [27]:

Virtual input $=v_1x_{1o} + \cdots + v_mx_{mo}$, Virtual input = $u_1y_{1o} + \cdots + u_sy_{so}$ (6)

In which v_i and u_r represent the weight input and output respectively. The weight of input and output is determined by the linear programming which tries to maximize the ration of virtual output/virtual input. CCR fractional program of each DMU (x_o, y_o) with (o = 1, 2, … ,n) is as follow [30]:

$$\text{(FPo) max } \theta = \frac{u_1y_{1o} + u_2y_{2o} + \cdots + u_sy_{so}}{v_1x_{1o} + v_2x_{2o} + \cdots + v_mx_{mo}} \quad (7)$$

$$\text{Subject to } \frac{u_1y_{1j} + \ldots + u_sy_{sj}}{v_1x_{1j} + \cdots + v_mx_{mj}} \leq 1 \ (j = 1, \ldots, n)$$
$$v_1, v_2, \ldots, v_m \geq 1$$
$$u_1, u_2, \ldots, u_s \geq 1$$

In which virtual input and virtual output cannot exceed 1. The purpose of this is to obtain the weight of virtual input and virtual output by maximizing the ration – virtual output/virtual input.

In 1984, Banker [30] proposed another model called BCC model which measures the technical efficiency in the situation the variable returns to scale (VRC) by adding one constraint to the CCR model. The BCC fractional program is as below:

$$\text{(FPo) max } \frac{uy_o - u_o}{vx_o} \quad (8)$$
$$\text{subject to } \frac{uy_j - u_o}{vx_j} \leq 1 \ (j = 1, \ldots, n)$$
$$v \geq 0, \ u \geq 0, u_o \text{ free.}$$

There are many different models in DEA which are different with respect to the type of return to scale [31]. To measure the change of efficiency over time, Window analysis and Dynamic DEA are two popular used methods. On one hand, Dynamic DEA measures the efficiency of decision-making units (DMUs) with longtime assessment and it enables us to evaluate the performance of DMUs without neglecting carry-over activities between consecutive two time periods [32]. This feature discriminates it from Window analysis. On the other hand, DEA Window analysis is based on a dynamic perspective. It considers the same DMU in a different period of times as entirely different DMU. The outstanding characteristic of this method is that it can comprehensively describe the dynamic change of the efficiency of each DMU both in a horizontal and vertical direction. Once one window is set, the new window will be added while the previous window is deleted, which increases the number of DMU [33]. Due to the limited sample in this study, we chose to apply Window analysis as it is the most suitable method to deal with the issue of the small number of DMU.

In DEA window model, if N is considered as the number of DMUs (n = 1,2,3….N) which uses r inputs to produce p outputs in time T (t=1,2,3,…T) and DMUnt represents an observation n in period t with input vector and output vector, results of DEA window analysis can be obtained by substituting inputs and outputs of DMUnt into the CCR or the BCC models

III. WRITE DOWN YOUR STUDIES AND FINDINGS

This section aims to present the empirical efficiency results of 25 Vietnamese commercial banks during 2010-2017. Since it is difficult to access figures of some small banks as they do not public their information on the stock market and even it is hard to find figures in their own financial statement and annual report, therefore; the author just could collect figure of 25 Vietnamese commercial banks during 2010-2017 to analyze in this study.

3.1. Bank's cost efficiency obtained from SFA

Based on the literature review, it is noted that SFA is a popular used approach in measuring cost efficiency of the bank. In this section, SFA is applied to obtain a cost efficiency score of 25 Vietnamese commercial banks. Frontier 4.1 is adopted in this research to measure the cost efficiency of Vietnamese commercial on the maximum likelihood method. The efficiency scores of 25 Vietnamese commercial banks during 2010-2017 obtained from SFA approach were showed in table 2.

Table 2: SFA-Efficiency Score

	2010	2011	2012	2013	2014	2015	2016	2017	Aver.
DMU1	0.8102	0.8149	0.8122	0.8133	0.8163	0.8156	0.8158	0.8171	0.8144
DMU2	0.8133	0.8144	0.8178	0.8146	0.8147	0.8154	0.8163	0.8192	0.8157
DMU3	0.8095	0.8090	0.8162	0.8152	0.8163	0.8179	0.8173	0.8125	0.8142
DMU4	0.8127	0.8148	0.8157	0.8162	0.8161	0.8152	0.8143	0.8149	0.8150
DMU5	0.8117	0.8073	0.8122	0.8177	0.8122	0.8129	0.8123	0.8166	0.8129
DMU6	0.8136	0.8146	0.8153	0.8155	0.8146	0.8150	0.8157	0.8191	0.8154
DMU7	0.8149	0.8147	0.8156	0.8161	0.8176	0.8193	0.8198	0.8198	0.8172
DMU8	0.8156	0.8161	0.8167	0.8169	0.8173	0.8186	0.8196	0.8201	0.8176
DMU9	0.8118	0.8108	0.8112	0.8126	0.8134	0.8152	0.8181	0.8186	0.8140
DMU10	0.8128	0.8141	0.8127	0.8153	0.8159	0.8178	0.8182	0.8190	0.8157
DMU11	0.8141	0.8160	0.8162	0.8163	0.8171	0.8171	0.8184	0.8150	0.8163
DMU12	0.8135	0.8093	0.8104	0.8109	0.8152	0.8107	0.8127	0.8173	0.8125
DMU13	0.8171	0.8166	0.8145	0.8155	0.8146	0.8156	0.8166	0.8180	0.8161
DMU14	0.8185	0.8145	0.8136	0.8153	0.8157	0.8192	0.8139	0.8134	0.8155
DMU15	0.8172	0.8170	0.8169	0.8132	0.8122	0.8150	0.8155	0.8139	0.8151
DMU16	0.8182	0.8170	0.8129	0.8095	0.8150	0.8150	0.8152	0.8170	0.8150
DMU17	0.8174	0.8174	0.8126	0.8137	0.8177	0.8152	0.8125	0.8165	0.8154
DMU18	0.8180	0.8156	0.8137	0.8160	0.8126	0.8188	0.8171	0.8164	0.8160
DMU19	0.8137	0.8187	0.8110	0.8130	0.8126	0.8133	0.8162	0.8140	0.8141
DMU20	0.8164	0.8139	0.8152	0.8130	0.8114	0.8136	0.8158	0.8152	0.8143
DMU21	0.8149	0.8159	0.8136	0.8159	0.8166	0.8151	0.8144	0.8157	0.8153
DMU22	0.8152	0.8165	0.8135	0.8137	0.7954	0.8159	0.8156	0.8144	0.8125
DMU23	0.8192	0.8165	0.8178	0.8182	0.8158	0.8161	0.8161	0.8184	0.8173
DMU24	0.8132	0.8185	0.8097	0.8099	0.8172	0.8167	0.8171	0.8183	0.8151
DMU25	0.8141	0.8118	0.8092	0.8093	0.8166	0.8143	0.8200	0.8123	0.8134
Aver.	0.8147	0.8146	0.8139	0.8143	0.8144	0.8158	0.8162	0.8165	0.8150

As can be seen at table 2, average cost efficiency of all 25 sample Vietnamese commercial banks during 2010-2017 is 0.8150, which means bank should reduce more 18.50% of their cost to reach the cost efficiency frontier. Per results at table 4, the average cost efficiency decreased from 0.8147 in 2010 to 0.8146 in 2011, then kept dropping in 2012 to 0.8139, after that Vietnamese commercial banks

experienced a slight increase in efficiency since 2013 till 2017 with average efficiency score in 2017 was 0.8165. The drop of efficiency score in the year 2011 and 2012 was caused by the project of restructuring financial institute for the period 2011-2015 of the Vietnamese government which led to many resolutions and M&A among banking system were implemented. During the first years of the restructuring, project bank had to manage to implement many different resolutions and some bank did M&A, which caused higher cost. The regress of cost efficiency score in the year 2011 and 2012 is also highly relative to the findings of To Thuy Duong [34], which examine the efficiency of the Vietnamese bank during 2008-2012. The average efficiency score increases went up again in 2013 and kept increasing until 2017, which indicated that after the first years of the project, the Vietnamese commercial bank started to recover. The higher efficiency score in the year 2017 in comparison to the year 2010 (0.8165 and 0.8147 respectively) also implied that after restructuring, banks seem to be more cost efficient than before doing that restructuring.
It is worth to noted that there is an uptrend from 2013 to the year 2017 with the efficiency score slightly increased each year showed in figure 1. However, the change is insignificant. In summary, it is notable that during 2010-2017, all observed Vietnamese commercial banks showed inefficiency in term of cost with the efficiency score lower than 1.

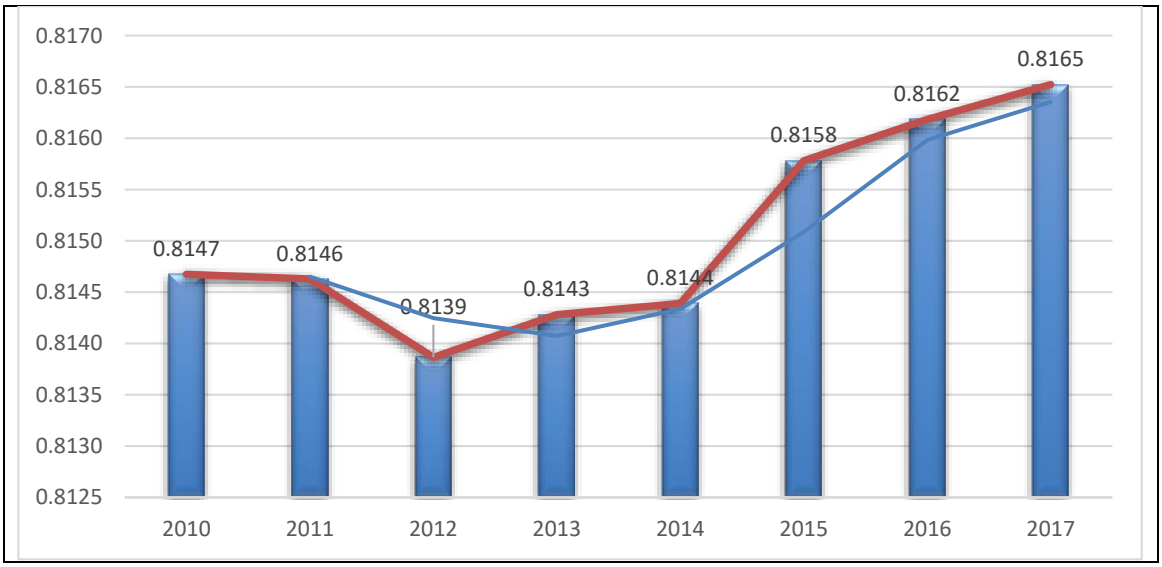

Figure 1: Cost Efficiency Scores under the SFA method

To test the inefficiency, the results of maximum likelihood method firstly obtained and presented at table 3 which showed that the parameter estimates of output and input variables are negative, which implies the negative relationship between cost and outputs and between input's prices and cost. The cost will decrease when output increases and vice versus. The same for the case of input's price. However, the negative can also simply indicate the inefficiency in using inputs which are supported by the estimate for the lambda with lambda value equal to 0.91, the p-value is 0.000, which indicates that inefficiency effects are statistically significant.
Results of maximum likelihood method imply parameters incorporated with inputs price and output value and the interaction between them.
Firstly, let consider the impact of input's prices on the bank's total cost. The increase in labor price causes a higher cost for the bank. This result is highly relative to the results found by KPMG Vietnam [35].
Secondly, if the price of fund and the price of deposit increase, there will be a decrease in the bank's cost. This can be explained by the reduction of fixed assets and the bank's deposit expansion. However, the impacts of the increase in the price of fund and price of physical capital are less than the influence of the increased price of labor. A deposit which is considered play the most important role in the Vietnamese banking system. The interaction between deposit and other variables are statistically significant. Therefore, Vietnamese bank's cost is mainly driven by interest expense.
Thirdly, how the bank's cost is when banks lend more? Lending more actually can cause a higher cost for banks as they must manage the bigger loan portfolio. In addition, the competition in the banking system in Vietnam is so high that the interest payment for deposit grows faster than the growth of the income bank gets from performing loans. On the other hand, there is an opposite relationship between the bank's cost and other earning assets of banks. The more amount banks invest in assets which can earn income, the lower the cost banks must bear. However, the significance of the impact of the bank's other earning assets on a bank's cost is not high (10.7%) while the significance of the bank's loan is high (p-0.000). Therefore, loans significantly influence the bank's cost than other earning assets do. Table 4 presents the results estimating how inefficiency variables affect the bank's cost efficiency.

Table3: Maximum Likelihood Estimation

Variables	Coefficients	S. E	t	p-value
Intercept	-10.46	4.07	-2.57	0.01
LnY1	2.44	0.48	5.07	0.00
LnY2	0.35	0.48	0.74	0.46
LnW1	3.90	0.49	8.03	0.00
LnW2	0.50	0.91	0.55	0.59
LnW3	0.83	0.39	2.12	0.04
0.5*(LnY1)2	0.14	0.05	2.82	0.01
0.5*(LnY2)2	-0.09	0.03	-3.39	0.00
0.5*(LnW1)2	-0.08	0.03	-2.47	0.01
0.5*(LnW2)2	0.25	0.16	1.58	0.12
0.5*(LnW3)2	0.10	0.04	2.50	0.01
LnY1*LnY2	-0.12	0.02	-4.94	0.00
LnY1*LnW1	-0.27	0.05	-5.28	0.00
LnY1*LnW2	0.08	0.07	1.16	0.25
LnY1*LnW3	-0.11	0.03	-3.31	0.00
LnY2*LnW1	0.16	0.06	2.81	0.01
LnY2*LnW2	0.02	0.08	0.21	0.83
LnY2*LnW3	0.06	0.04	1.56	0.12
LnW1*LnW2	0.29	0.09	3.20	0.00
LnW1*LnW3	0.03	0.04	0.83	0.41
LnW2*LnW3	-0.02	0.05	-0.42	0.68
Gamma	0.91	0.46	0.21	0.00

Table 4: Inefficiency variables affects the bank's total cost

	Coefficients	S. E	t	P-value
Constant	0.746	.009	78.894	.000
CAR	0.023	.011	2.094	.039
NPL	0.002	.016	.122	.903
SIZE	-0.011	.002	-6.176	.000
EQUITY/TOTAL ASSETS	-0.057	.020	-2.790	.006
LOANS	0.009	.002	6.119	.000

Capital adequacy ratio-CAR

CAR measures the amount of bank's capital which is related to the amount of is risk-weighted credit exposure. Capital adequacy ratio is regulated in Basel regulation and banks must obligate, that why it is an important factor that all bank must concern. Previous studies in banking performance such as [36-37] showed that CAR negatively related to ROA. In this study, CAR was found to have a negative effect on the bank's cost efficiency. Banks which have higher CAR tend to have lower cost efficiency as the higher CAR creates a barrier to gain more income. This finding is supported by Abdul Mongid (2016) [38].

NPL - Non-performing loans ratio

Non-performing loans ratio is measured by the bad debt percentage to total loans distributed. Bad debt percentage is calculated the total bad debts to total loans. This ratio is very important to any bank as it can reflect the loan portfolio management of banks. The lower percentage of NPL ratio indicates better loan portfolio management. In Felix and Claudine (2008) [36], the NPL ratio was found to have a negative relationship with ROE and ROA. In this study, the author expected to find the negative relation between NPL and cost efficiency of the bank. However, the results found indicated there is no statistically significant impact of NPL on bank's cost efficiency.

Bank’s size

According to previous researches in this field, bank size found to have a tight relationship with bank performance because bank size and risk have the opposite direction. When bank size gets larger, it means the level of the bank's loans and products will become higher;

therefore; it can reduce risks of banks, which leads to improving performance. According to Demirgüç-Kunt and Huizinga (2001) [39], large-size banks tended to have a higher ratio of return on assets (ROA) than the small-size banks do. To examine the relationship between bank size and bank performance, the log of total assets is used as the proxy of bank size. Results found in this study indicated that bank size negatively influences total cost, which means bank size has a positive impact on cost efficiency.

Capital ratio - Equity/Total assets

The capital ratio which is measured by the ratio of equity to total assets found to have a positive relationship with bank performance [40]. The capital ratio was reported to support the bank's business, that why it has a positive impact on the performance of the bank [41]. In this study, the capital ratio found to have a statistically significant positive effect on bank cost efficiency.
Bank's lending-Loans
As can be seen in table 3, a statistically positive relation between lending of bank and bank's total cost illustrates a negative impact of loans and cost efficiency. It means an increase in loans causes the higher bank's cost, which makes the bank less efficiency in term of cost.

3.2. Efficiency -DEA

In the field of efficiency, there are two popular methods are used to measure the efficiency of the decision-making unit (DMU): (1) parametric method and 2) non-parametric method. For the parametric approach, SFA has been popularly applied to measure the bank's efficiency since it was first proposed. For non-parametric approach, DEA has been widely used in evaluating the relative efficiency of DMU. Since sample size of this study is quite small-25 commercial banks; therefore, the author would like to adopt DEA Window model in this study to measure bank's cost efficiency as DEA window considers each DMU as a different one over a different time period, which enables increasing the number of DMUs.

Table 5: Summary of Inputs and Outputs (Unit: Billion VND)

Year		Inputs			Outputs	
		Deposit	Total Assets	Fixed Assets	Loans	Other Earning Assets
2010	Max	272,983	367,712	3,955	254,113	116,462
	Min	5,782	12,628	107	5,156	3,823
	Average	66,672	99,414	1,133	53,026	36,103
	SD	79,912	106,394	1,201	67,646	35,281
2011	Max	331,682	460,604	3,746	302,942	137,898
	Min	7,247	15,365	73	3,604	2,630
	Average	80,095	121,480	1,341	64,197	43,777
	SD	91,451	126,605	1,244	84,231	41,933
2012	Max	385,920	503,530	5,277	366,025	147,776
	Min	8,727	14,853	69	5,990	1,841
	Average	95,447	128,614	1,769	77,186	40,562
	SD	105,346	138,858	1,785	98,903	41,212
2013	Max	444,962	576,368	7,080	398,701	160,014
	Min	10,803	14,685	68	10,568	2,007
	Average	111,810	144,253	2,063	86,650	46,070
	SD	118,389	154,829	2,049	106,729	43,558
2014	Max	527,951	661,242	8,895	452,851	226,869
	Min	11,843	15,823	79	11,139	2,414
	Average	120,236	169,216	2,261	102,125	55,435
	SD	126,463	182,929	2,325	126,170	54,514
2015	Max	592,129	850,670	8,666	610,492	252,607
	Min	13,142	17,749	134	11,520	4,019
	Average	141,063	203,123	2,612	127,339	58,870
	SD	152,086	227,726	2,848	156,938	63,428
2016	Max	818,521	1,006,378	10,624	713,633	291,709
	Min	14,169	19,048	144	12,431	4,397
	Average	196,140	241,988	2,827	152,805	69,516
	SD	220,636	269,261	3,088	183,481	73,063
2017	Max	951,964	1,202,284	11,437	855,536	376,980
	Min	14,849	21,319	184	13,989	4,770
	Average	227,979	289,345	2,957	182,981	82,482

Year		Inputs			Outputs	
		Deposit	Total Assets	Fixed Assets	Loans	Other Earning Assets
	SD	257,597	325,954	3,231	218,270	90,517

In this section, the author would like to adopt the DEA Window method to calculate the bank's cost efficiency scores. Then, compare the efficiency distribution between the results of two different methods SFA and DEA. The consistency of the two methods can be examined according to these following consistency conditions for the efficiency measures: (1) efficiency distribution; (2) ranking; (3) identifying best and least efficient banks and (4) consistent with traditional non-frontier performance measures-accounting ratios (e.g. Return on Assets-ROA, Return on Equity- ROE).

We defined banks as the intermediation between lenders and borrowers. Summary of inputs and outputs used in the DEA Window model were presented in table 5. Efficiency scores of 25 Vietnamese commercial banks over the period 2010-2017 obtained by DEA window were presented in table 6. As shown in table 6, the average cost efficiency of all 25 sample Vietnamese commercial banks during 2010-2017 is 0.8780, indicating 12.20% of inputs is not used efficiently. The results of the DEA method showed the dcease efficiency score in the year 2011 then there was an increasing trend from 2012 to 2017 (see figure 2). The results at this step indicated that the sample Vietnamese banks performed best in the year 2017 and worst in the year 2012.

Table 6: DEA Efficiency Scores

	2010	2011	2012	2013	2014	2015	2016	2017	Average
DMU1	0.8200	0.9673	0.8455	0.8548	1	0.9823	0.9967	1	0.9333
DMU2	0.9016	0.9066	0.9981	0.9411	0.9435	0.9614	0.9742	1	0.9533
DMU3	0.9429	1	1	0.9822	0.9710	1	0.9893	1	0.9857
DMU4	0.7811	0.8042	0.8912	0.9403	0.9100	0.8428	0.8010	0.8130	0.8480
DMU5	0.7360	0.6799	0.8421	0.9560	0.8433	0.9147	0.9082	0.9166	0.8496
DMU6	0.6858	0.6873	0.8644	0.8790	0.8185	0.8575	0.8966	0.8996	0.8236
DMU7	0.6676	0.6481	0.7111	0.7377	0.8144	0.9422	0.9524	0.9621	0.8044
DMU8	0.7285	0.7578	0.8104	0.8736	0.8799	0.8977	0.9316	0.9303	0.8512
DMU9	0.7424	0.6889	0.7243	0.7709	0.8440	0.8656	0.9206	0.9158	0.8090
DMU10	0.7597	0.7924	0.7451	0.8009	0.8334	0.9945	1	1	0.8658
DMU11	0.8329	1	1	1	1	1	1	0.9700	0.9754
DMU12	1	0.9050	0.9481	0.9661	1	0.9960	0.9870	1	0.9753
DMU13	0.7937	0.7778	0.6835	0.7172	0.7078	0.7435	0.7809	0.8311	0.7544
DMU14	1	0.9424	0.8955	0.9603	0.9603	1	0.8979	0.8900	0.9433
DMU15	1	0.9709	0.9005	0.8780	0.8538	0.8924	0.8924	0.8910	0.9099
DMU16	1	1	0.6643	0.6225	0.6687	0.7665	0.7955	0.8494	0.7959
DMU17	1	0.8800	0.8874	0.8744	0.8323	0.8631	0.8041	0.9186	0.8825
DMU18	1	0.9312	0.9208	0.7366	0.7029	0.6625	0.6752	0.6868	0.7895
DMU19	0.9812	0.9118	0.9037	0.8944	0.8366	0.8460	0.8965	0.8694	0.8924
DMU20	1	1	1	0.9430	0.9038	0.9038	1	1	0.9688
DMU21	0.7780	0.7928	0.8401	0.9083	0.8951	0.8430	0.8010	0.8130	0.8339
DMU22	0.9701	1.0000	1	1	0.9813	0.9354	0.9349	0.9310	0.9691
DMU23	0.7498	0.6173	0.7928	0.6713	0.7592	0.7640	0.8197	0.8097	0.7480
DMU24	0.9028	1	0.7711	0.8133	0.8173	0.8173	0.9329	0.9712	0.8782
DMU25	1	1	0.8036	0.8076	0.8455	0.8697	0.9440	1.0000	0.9088
Average	0.8710	0.8665	0.8577	0.8612	0.8649	0.8865	0.9013	0.9147	0.8780

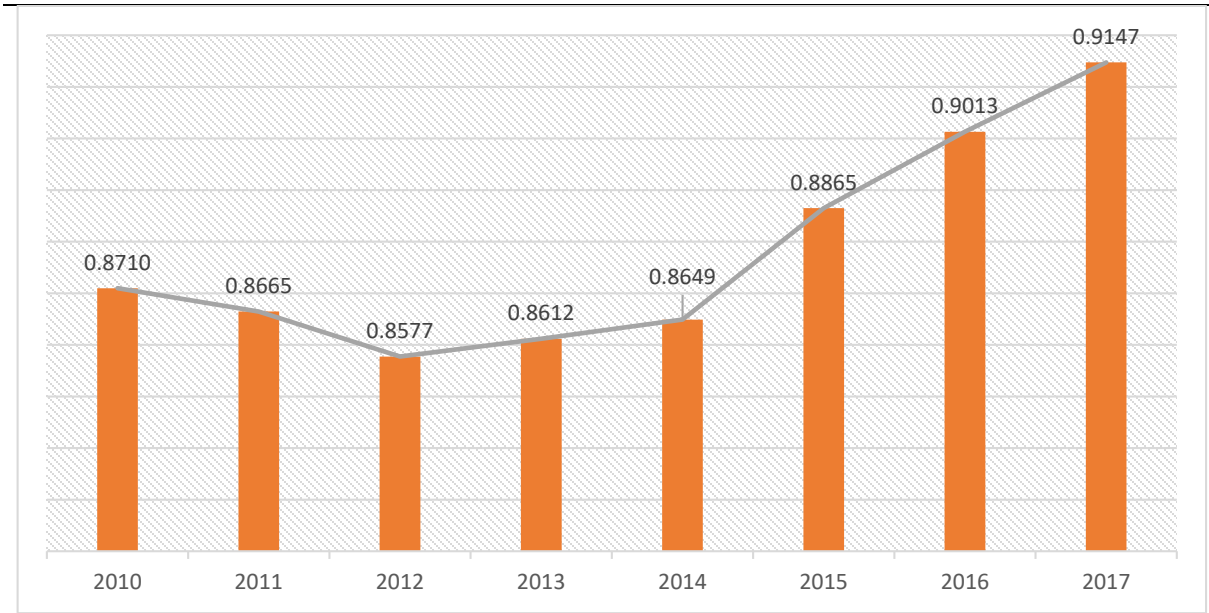

Figure 2: efficiency Scores under DEA method

3.3. Efficiency -DEA

Results of both DEA and SFA methods indicated that the efficiency score of sample Vietnamese banking slightly changed during 2010-2017; however; this change was not significant. This finding implies that during 2010-2017, Vietnamese bank sector did not show significant changes but kept roughly stable. On one hand, the results of both methods were highly relative. Both methods showed the decrease of bank's efficiency score in the year 2011 which was caused by the implementation of government project named restructuring financial institutes during 2011-2015. In 2011 and 2012, the Vietnamese banking sector experienced a decrease in efficiency at almost particular banks. After the first years of the project, we experienced the recovery of the Vietnamese banking system showed by the constantly slight increase in average efficiency scores from 2013 to 2017. However, there are some obvious differences between the results found by these two methods. The gap between efficiency scores under SFA and DEA is notable. The efficiency scores under DEA found to be significantly higher than those under the SFA method; in particular, the average efficiency score under DEA method was 0.8780 while this under SFA was 0.8150. The differences between results of two methods were not surprising as the DEA method does not account to the inefficiency effects for each sample banks while SFA does account the effects of inefficiency on the cost function. In addition, DEA and SFA are theoretically different from each other, which could be another reason explaining why the results of the two methods not completely the same. In one hand, SFA method deals with random shocks while that one is not accounted in DEA method in which efficiency frontier is technically built up by connecting all DMUs performed best, which slightly lifts up frontiers and that is why efficiency scores under DEA method are higher than those under SFA. In addition, the standard deviation of efficiency scores under the SFA method is also lower than that under DEA (0.002856 and 0.10266 respectively). The other aspects showed the inconsistency of the two methods were the value of skewness and kurtosis. This finding is similar to findings of Bauer [43].
In summary, after comparing the efficiency score distribution of two methods, it is noted that there are several differences between parametric and non-parametric method; however, these differences are not necessary to be a problem as the results of two methods are highly relative in defining the general trend efficiency scores. Summary of comparison between SFA and DEA are showed in table 7 and figure 3 below.

Table 7: Descriptive Statistics of Cost Efficiency Scores

	Minimum	Maximum	Mean	Std. Deviation	Skewness	Kurtosis
SFA	.7954	.82010	.8150	.0029	-1.882	10.302
DEA	.6173	1.0000	.8779	.1027	-.552	-.651

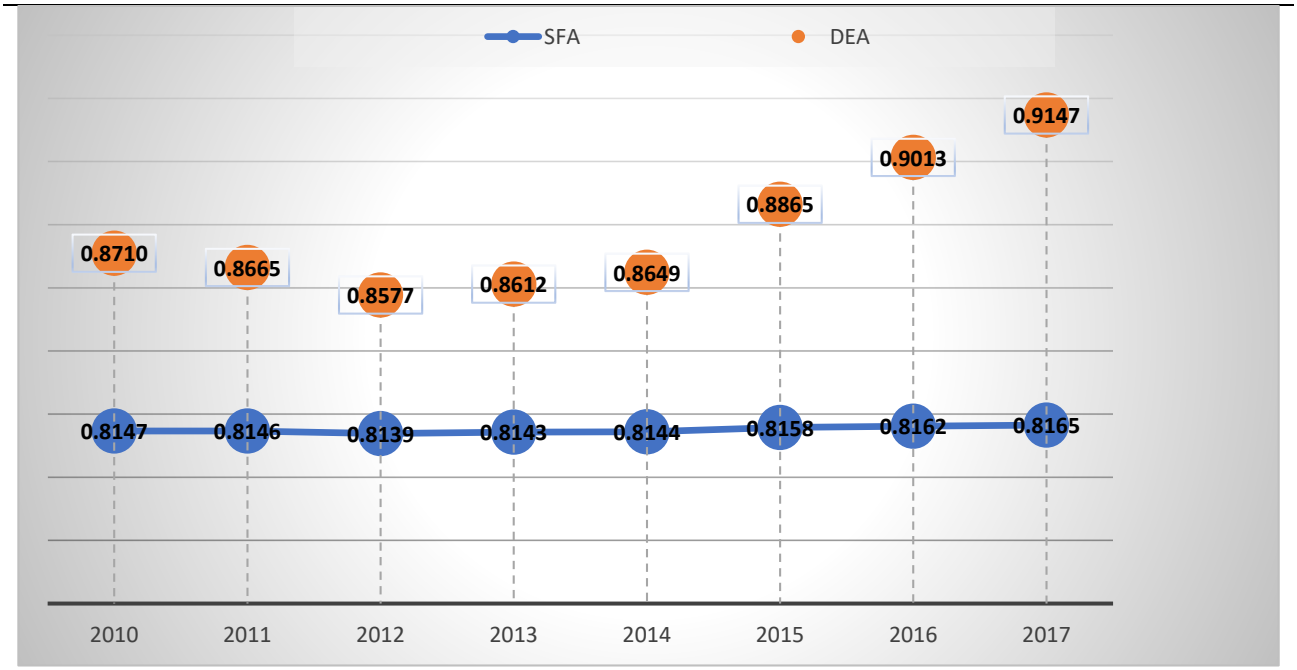

Figure 3: Efficiency Scores Comparison

Table 8 showed the summaries of rank order correlation coefficients between efficiency scores obtained from SFA and DEA. The results showed that efficiency scores obtained from SFA and DEA are statistically consistent with correlation coefficients 0.237 at the 1% level of significance.

Table 8: Spearman's Correlation for Rank Order

		SFA	DEA
SFA	Correlation Coefficient	1.000	.237**
	Sig. (2-tailed)		0.001
DEA	Correlation Coefficient	.237**	1.000
	Sig. (2-tailed)	0.001	

Despite the several differences between efficiency distribution of SFA and DEA, it is worth to examine if these two methods can be consistent in identifying the similar ranking of banks in term of efficiency scores as rank order is very important in managerial decision making [43]. Further, the author of this study would like to examine the consistency of SFA and DEA under another aspect-identifying the similar best and least efficient banks. The results of this step are presented at table 9 which indicated that SFA and DEA are highly consistent in identifying the most and least efficient banks with correlation coefficient 87.5% and significant at the 1% level.

Table 9: Spearman's Correlation for Most Efficient and Least Efficient Banks

		SFA	DEA
SFA	Correlation Coefficient	1.000	.875**
	Sig. (2-tailed)		0.000
DEA	Correlation Coefficient	.875**	1.000
	Sig. (2-tailed)	0.000	

To confirm the consistency of SFA and DEA method, the author conducted another examination which examines the correlation coefficient between efficiency scores obtained under SFA and DEA and accounting ratios (Return on Average Equity - ROAE and Return on Average Assets - ROAA). Accounting ratios such as ROAE and ROAA have been widely used since the past in evaluating the bank's performance. Therefore, if the efficiency scores obtained under two methods are consistent with ROAE and ROAA, it is more confident to determine that the measured efficiency scores are accurate. the correlation between obtained efficiency scores and ROAE and ROAA are expected to be positive. The results of this step are presented at table 10 which indicated the positive high correlation

between efficiency scores obtained from SFA, DEA and the accounting rations ROAE and ROAA. These high correlations illustrated that the efficiency scores obtained from SFA and DEA are accurate and SFA and DEA found to be consistent in this study.

Table 10: Efficiency under SFA, DEA and Accounting Ratios

	SFA	DEA
ROAE	.459**	.488**
ROAA	.252**	.330**

**: Correlation is significant at the 0.01 level

This section aims to present and compare the empirical results obtained from SFA and DEA. The results of this section indicated the strong consistency between SFA and DEA. Vietnamese commercial bank performed in term of cost efficiency moderately well with average cost efficiency score around 0.8 and closed to 0.9. however, there is still room caused by the inefficiency, to these banks to improve their cost efficiency. The inefficiency was caused by the bank's loans. The more bank lends to customers, the higher the total cost bank has, which cause lower cost efficiency.

IV. CONCLUSION

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, loans play an important role in earning profit and efficiency of the bank. Although credit growth is a good sign for the bank, lending and high credit growth rate also have a negative effect on the bank's cost. In the case of the Vietnamese bank's efficiency, there are several researches which measure the bank's efficiency and examine factor affecting the bank's performance. However, these researches mostly focus on efficiency itself or the relationship between the efficiency of the bank with some outstanding factors such as risk, NPL, bad debt, none of these studies has focused on the bank's cost efficiency under the effect of loans. Our study is therefore expected to shed the lights on the relationship between the bank's cost efficiency and the bank's loans in the context of Vietnam.

In this study, an investigation was conducted with the main objectives are (1) measure cost efficiency of Vietnamese commercial bank over period 2010-2017 and (2) examine the effect of lending activities on bank's cost efficiency. To achieve the research objectives, data of 25 Vietnamese commercial bank from 2010 to 2017 were collected and analyzed. In the first step, we used SFA to measure cost efficiency of 25 banks. After obtaining efficiency score from SFA method, we examine if bank loan has any effect on cost efficiency by using regression and finally, DEA window model was applied to evaluate bank cost efficiency and a comparison between efficiency scores obtained from SFA and DEA Window were presented. Results of our research indicated the strong consistency between SFA and DEA methods. Vietnamese commercial banks performed in term of cost efficiency moderately well with average cost efficiency score around 0.8 and closed to 0.9. However, there is still room caused by the inefficiency, to these banks to improve their cost efficiency. The inefficiency was caused by the bank's loans which have a significant negative effect on bank cost efficiency. The more bank lends to customers, the higher the total cost bank has, which cause lower cost efficiency.

Findings of this study can provide important insights for bankers in managing their cost efficiency. Moreover, findings of this study also suggested that results obtained from SFA and DEA are consistent, which enables researchers to have greater confidence in choosing a method measuring bank efficiency. Furthermore, in our study, the bank's loans were found to have a significant negative influence on the bank's cost efficiency. This study is expected to be the first empirical study on the relationship between loans and cost efficiency of a bank; therefore; it shed a light on literature for the new aspect of bank efficiency. However, more research on this topic is needed to further establish the effect of the loan on the bank's cost efficiency. Further research should consider using different types of efficiency, such as profit efficiency or different variables such as bank performance and examine whether bank loan influence profit efficiency of the bank or whether bank loan affects bank performance.

A salient limitation of this study mainly revolves around data and sample size. There are more than 40 Vietnamese commercial banks; however, due to limited data sources, we can only access data of 25 Vietnamese commercial banks. We use data of 25 banks to make the measurement in term of cost efficiency for the whole Vietnamese commercial banks, which can affect results in general. Besides, the data period in our study is short (2010-2017). To address these limitations, future study should increase the sample size and extend the data period.

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