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EVALUATING THE OPERATING EFFICIENCY OF COMMERCIAL BANKING SECTOR IN LAO PDR

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ABSTRACT

The objectives of this research are to explore the bank operating efficiency and to identify the factors that determine the operating efficiency of commercial banks in Lao PDR. First, the Data Envelopment Analysis (DEA) approach is employed to compare efficiency between private and foreign banks. The results show that foreign banks have higher operating efficiency comparing to private banks under intermediation and operating activities. On the other hand, private banks are more efficient under value-added function than foreign banks. For the regression analysis, we employ the Ordinary Least Squares (OLS) model to analyze the determinants of bank efficiency using both internal (bank specifies) and external (macroeconomics) variables. The results indicate that cost control is vital for developing the efficiency of the banking sector in Lao PDR.

Keywords: Bank efficiency, Data envelopment analysis, Lao PDR

Introduction

The competition in the banking industry has also been pronounced in responsive to the growing economic development and the financial sector reforms (Laowattanabhongsea & Sukcharoensin, 2018). The important role of banking industry is to fuel the economic transactions of the country; therefore, the banking sector serves as a financial intermediary in the economy, transferring capital from suppliers to demanders.

Lao PDR has experienced a rapid economic development during the last two decades. Hasty economic growth has resulted in new and challenging reform in banking sector. The main purpose of the reform is to review financial deregulation and supervision of the financial system. The focus is on a more efficient allocation of resources and a more transparent banking systems, which enhance the economic efficiency and private sector development.

The measurement of bank operating efficiency is very important to management and regulatory authorities. The efficiency measurement of bank operation provides the management of the banks and regulators with environment scanning in their strategic planning process. The importance of efficiency measurement is to enable managers to benchmark bank performance and outline areas of inefficiency for future improvements (Mostafa, 2007). From bird's-eye view, the efficiency of the financial sector is potentially vital to the long-term growth performance of the countries and provide possible suggestions to revise regulations of the banking sector, specifically, in Lao PDR.

In early years, studies in the past relating to bank efficiency usually used conventional

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accounting ratios such as return on assets to evaluate the efficiency. When analyzing the real situation, banks try to assess their strengths and weaknesses regarding products, human factor, communication policy, bank management, organization structure, apart from accounting information.

Also, bank usually assess their efficiency relative to other banks. For this purpose, banks use various methods seeking to find the most appropriate mixture of financial and non-financial assessment indicators. In economics, a production function relates output of a production process to inputs or factors of production. A bank is considered as a company with multiple input and output elements. Efficiency refers to ability of the bank to produce output with minimal resources or input, or commonly defined as the ratio of outputs over inputs (Sherman & Zhu, 2006; Chen, Chen, & Peng, 2008). In addition, by definition, technical efficiency refers to the firm ability to maximize output with the given inputs or; produce same level of outputs with minimization of inputs (Cooper, Seiford, & Tone, 2006).

To date, there are various research articles assessing the bank efficiency in many countries. However, there are only limited number of papers documenting this issue in developing frontier market. Therefore, this paper adds to the existing literature in at least two ways. First, the paper is the pioneer articles in measuring the efficiency of banking sectors in Lao PDR. Second, it looks at many efficiency angles by using the intermediate, value-added, and operating approaches to estimate the input and outputs variables so that the policy implications could be recommended. Therefore, the objectives of this research are to explore the bank operating efficiency and to test whether the home field advantage hypothesis or the global advantage hypothesis is predominant in Loa PDR.

The paper is structured as follows. The first section provides introduction. The second section provides background on the current banking system in the Lao PDR. The third section summarizes the existing literature. The fourth section explains data, variable specifications. The fifth section presents and discuss the research results. The final section summarizes findings from the study with recommended policy implications.

Current Banking System in Lao PDR

There are several components in the banking system in the Lao PDR. Lao financial industry includes Bank of the Lao PDR (BOL) act as the central bank of Laos, State-Owned Commercial Banks, Specialized Bank, Joint Stock Banks, Private Banks, Subsidiary Foreign Bank and Foreign Banks Branch as a Commercial banks; and non-bank financial institutions.

The commercial banks in Lao PDR refer to the financial institutions that licensed to conduct the banking businesses and provide financial services such as deposits, loans, accounts settlements, currency trading and other businesses in pursuant with the Law on Commercial Banks, No 56/LNA (Amended Version) (2018), dated December 7th, 2018. The Law on Commercial Banks aims to reform banking system to become more internationally recognized. It was a significant step towards the socio-economic improvement of the Lao PDR.

After Laos became 158th of WTO, the BOL stipulated increase the registered capital to local commercial bank from 100 billion kip to 300 billion kip and stipulated a foreign bank branch investment capital of at least 50 billion kip to 100 billion kip (Keovongvichith, 2012).

Thus, the foreign bank that plans to invest in Laos has to be invested in a larger scale. In addition, the BOL has announced to change the business banking operation to be electronic banking services. Those regulations illustrated above lead to a more liberalization; and hope to attract investment from foreigners in the banking industries. These deregulations have boosted more establishment of local and foreign commercial banks in Lao PDR.

From 2013 to 2017, a growing number of commercial banks; along with their total assets, total deposits and total loans have been continously increased. The total assets of the banking industry have increased from 62,269.78 billion kip to 122,408.35 billion kip. The total deposits have amplified from 35,289.90 billion kip to 68,032.53 billion kip. Also, the total loans have also improved from 35,424.30 billion kip to 66,939.36 billion kip (Bank of the Lao PDR, 2018).

The technology has played an important role in changing the lifestyle of people, which propelled the inevitably defining the ways of the banking business operation. The investments in technology are the key in the new era of competitions. Since there have been increasing numbers of smart phone usages, the operation of the banking sector in Lao PDR has been upgraded and more efficient. However, doing so requires a huge investment in transforming the industry's competitive landscape into digital banking system.

Literature Review

There are a variety of efficiency measurements, which are used to replace or combine with the traditional bank efficiency measure, namely "Efficient Frontier". The efficient frontier consists of the efficiency measure under parametric and non-parametric method. Parametric method includes Stochastic Frontier Approach (SFA), Distribution Free Approach (DFA) and Thick Frontier Approach (TFA). While the non-parametric method includes Data Envelopment Analysis (DEA) and Free Disposal Hull (FDH). The efficiencies estimated under DFA and TFA approach have limitation in presenting the efficient of each unit. So, both approaches are not suitable for the study on bank efficiency. The assumption on issue of the "Relaxation of Convexity" of the FDH efficiency approach tends to make the efficient score high rather than actual score; thus, FDH is inappropriate to apply in evaluating bank efficiency.

Alongside, SFA and DEA have been used to evaluate the maximum output for a given set of inputs and has essentially been used in the appraisement of efficiency. They can be used to estimate capacity utilization. However, there are differences between both methods. For example, DEA does not consider noise in the model, inefficiency is caused only by noise of production factors. There are no assumptions required about the behavior of producer for maximum profit or minimum cost. Standard DEA method needs only production quantity data and input variables, while SFA applies noise into model. For this reason, SFA method is suitable for studies that most data have noise and may influence the noise that we do not know such as weather, but not in evaluating bank efficiency.

The measurement of the banking sectors efficiency mostly applies Data Envelopment Analysis (DEA). The DEA approach was developed by Charnes, Cooper, and Rhodes (1978), briefly CCR. The CCR assumption is only justifiable when all decision-making units (DMUs) are operating at the optimal scale by assuming all DMUs has operating in Constant Returns to Scale (CRS), and provides the Overall Technical Efficiency (OTE). In other words, when a proportion of inputs increase, outputs proportionately upsurge in

the same fashion. However, DMUs in practice might face either economic condition which CCR model does not describe the manufacturing characteristics in DMUs.

Hence, Banker, Charnes, and Cooper (1984) extended the BCC model by relaxing the CRS assumption, which adding a restriction $\sum \gamma_i = 1$ called "Convexity Condition" into the original CCR equation. To solve the shortcoming of return to scale issue and to expand size of observations, the BCC model was used to estimate the efficiency of DMUs, which are characterized by Variable Returns to Scale (VRS).

There are numerous studies related to assessing bank efficiency by employing the DEA approach in various countries. The DEA is used as an instrument for measuring bank efficiency in many fields such as Profit Efficiency, Technical Efficiency, Cost Efficiency, Scale Efficiency and Allocative Efficiency. For example, Sufian and Habibullah (2009) used DEA approach to measure the bank efficiency in Korea in 1997, the period of Asian financial crisis. They separated the input and output variables into three different approaches, namely intermediation, value-added and operating approaches to provide the different efficient scores. The empirical result showed that the banking sector in Korea was inefficient under three approaches, while the operating approach found the inefficient in scale inefficient relative to pure technical inefficient. Besides, under the intermediation approach, it is inefficiency from pure technical relative to scale inefficiency during the pre- and post-crisis periods. Under the value-added approach, they found that the inefficient from scale outweighs pure technical inefficiency during the pre-crisis period, but the trend were imprecise during the post-crisis period.

Sufian and Habibullah (2010), also explored the efficiency over the Asian financial crisis of the Thai banking sectors by focusing only on intermediation function and classify banks into two groups as domestic and foreigner banks. The results under the DEA approach exhibited that the domestic banks had the highest efficiency in comparison to the foreign banks. Consequently, the mean technical efficiency levels of foreign banks were lower relative to domestic banks. Nevertheless, domestic banks lacked inefficiency scale, while the foreign banks' inefficiency was still in pure technical inefficiency.

Sam, Theng, and Heng (2011) applied DEA to compared Malaysian bank efficiency between domestic and foreign banking sectors during 2002 to 2009, using the intermediation approach. The study found that the average PTE score of domestic banks was higher than foreign banks. The study also suggested that domestic banks have more advantage in terms of cost than foreign banks. Since foreign bank faced different regulations, language, culture, currency and prejudices, along with sometimes, the foreign bank's executives are faced with difficulty in management institutions from a distance.

Lim and Randhawa (2005) compare the banks that operating in Hong Kong and Singapore which have similar environment and rival national financial centers. The study separated into two points and it was found that banks in Singapore were more efficient on the production stage in term of deposit mobilization and production of financial services. Meanwhile, Hongkong banks were more efficient on the intermediation stage in term of capital used, financial intermediation, and transforming deposit into loans.

Sufian (2008) studied the efficiency of banking sectors in Malaysia during the 1997 Asian financial crisis using three different DEA approaches, namely intermediation, revenue and operating approaches. The study found

that bank had the highest efficiency under the operating approach, but the lowest efficiency under intermediation approach. The study suggested that the bank efficiency was downcast under three approaches, but the effect was more noticeable under intermediation approach. Grmanová and Ivanová (2018) explore efficiency of banks in Slovakia using DEA models and find that three largest banks at Slovak found to be efficient in both analyzed years. Jemric and Vujčic (2002) compare efficiency among old and new bank using size and ownership. The foreign-owned banks are the most efficient. The new banks are more efficient than old ones. The smaller banks are more efficient. Luciano and Regis (2007) find banking groups are less efficient than individual institutions. Davidovic, Uzelac, and Zelenovic (2019) document that state-owned banks are permanently more efficient than private banks. Castellanos and Garza-Garcia (2013) have examined the cost efficiency of banks in Mexico. They find that local banks are more efficient than foreign banks, contradicted to the result of Jemric and Vujčic (2002) or Nenovsky, Chobanov, Mihaylova, and Koleva (2008), which document that foreign-owned banks are the most efficient.

Therefore, this contradicted result is of interest to explore whether foreign-owned banks are more efficient in Laos PDR. The home-field advantage hypothesis state that local banks should be more efficient than foreign banks since they have competitive advantages such as asset size, market share and language, culture and regulations. However, foreign banks have the advantages in terms of technology and international expertise in providing global banking services.

Berger, DeYoung, Genay, and Udell (2000) propose two alternative hypotheses to explain these results, namely the "home field advantage hypothesis" and the "global advantage hypothesis". If the efficiency of the local bank is higher than that of the foreign bank, the earlier hypothesis is supported and, otherwise, the latter is supported.

Therefore, we test the mentioned hypothesis in this study to compare the efficiency of both kinds of banks and to test whether the home field advantage hypothesis or the global advantage hypothesis is predominant in Loa PDR.

Research Methodology

Data envelopment analysis method

First, we applied the DEA, Variable Returns to Scale (VRS) method, which focuses on the input-oriented model to measure the efficiency of private and foreign banks in the Lao PDR. VRS is a kind of frontier scale used in DEA method. It helps to estimate efficiencies whether an increase or decrease in input or outputs does not result in a proportional change in the outputs or inputs, respectively (Cooper, Seiford, & Zhu, 2011) We considered only the measurement of pure technical efficiency (PTE), which examines the bank efficiency without an overweight of scale efficiency and provides the suitable data on bank efficiency relative to the CRS assumption. The VRS assumption keeps the assessment of pure technical efficiency in Equation (1) in the same fashion of Kamarudin, Sufian, Nassir, Anwar, and Hussain (2019).

Equation (1): $\text{Min}, \quad k$

Subject to,

$$-\sum_{i=1}^{m} x_{ij}\,\gamma_j + \theta_k x_{ik} \geq 0 \qquad i = 1,2,3,\dots,m$$

$$-\sum_{i=1}^{m} y_{rj}\,\gamma_j \geq y_{rk} \qquad r = 1,2,3,\dots,s$$

$$\sum_{j=1}^{n} j = 1 \qquad j = 1,2,3,\dots,k,\dots,m$$

$$j \geq 0$$

Where,

k	Technical efficiency i of DMU_k
x_i	Input quantity i of DMU_k
y_r	Output quantity *i* of DMU_k
J	Efficiency weight of DMU_j
$-\sum_{j=1}^{m} x_{ij}$	Sum of input for DMU_j

s Number of output
m Number of input
n Number of DMU

The measure of efficiency score can be divided into two groups. An efficiency DMU has an efficiency score of 1 or "Best Practice" and efficiency DMU that has an efficiency score less than 1 indicates ineffective DMU. The most important step to measuring efficiency of DEA is related to choose input and output variables appropriately (Chinpruttiwong & Sukcharoensin, 2019).

Efficiency score obtained depends on the definition of variables used. Following Sufian and Habibullah (2009), this study separates the input and output variables into three different approaches including intermediation, value-added and operating approaches.

From previous literature as discussed in previous section, we then collect a set of variables and use correlation matrix screen out the highly correlated variables that can be used for proxy of each input to prevent multi-collinearity problem. Under the intermediation approach, the study considers deposits (X1) and personal expenses (X2) as inputs to produce loans (Y1) and operating profit (Y2). For the value-added approach, two types of inputs are assumed as interest expenses (3) and personal expenses (X3) to produce outputs such as deposits (X1) and loans (Y1). While, under the operating approach focus on interest expenses (X4) and personal expenses (X2) as inputs to produce interest income (Y3) and non-interest income (Y4) as output.

Multivariate Regression Analysis

It is important to describe the factors impacting bank-specific determinants and pure technique efficiency (PTE) scores gained from the DEA model. Following the described literature review above, the linear regression model is incorporated into the analysis because the linear functional form is an appropriate one. Typically, the studies on bank-specific determinants and macroeconomics conditions such as Ataullah and Le (2006); Sufian (2010); Sufian and Habibullah (2009) among other; employ the linear regression model to evaluate the impact of various factors that may be significant in explaining profitability.

After the examination involves the solution from the first stage analysis above, the pure technique efficiency (PTE) scores gained from the DEA analysis was described and applied to regress on a set of independent variables in the Ordinary Least Squared (OLS) model. The purpose is to allow the restricted (0,1) range of efficiency values. The statistics demonstrate that the OLS model is the most reliable regression and consistent estimation of the coefficient in the procedure involving DEA because of their general quality of minimized bias and variance.

In this stage, we apply OLS method to estimate the determinant variables and bank efficiency under three approaches, which can be classified into nine regression models. For model 1, 4 and 7, include six internal bank specific variables namely asset size (LNTA), loan quality (LLP/ TL), profitability (ROA), liquidity (TL/ TA), capital strength (Equity/ TA) and expenses (NIE/ TA). Model 2, 5 and 8, add the macroeconomics control variables such as the gross domestic product (LNGDP) and inflation rates (LNINF).

The internal bank specific variables are also included in the model. Model 3, 6 and 9, contain a dummy variable (DUM_PB) which focuses on the relationship between the PTE score and a set of determinants, while the macroeconomics variables are also retained in the model. The definition and hypothesis of determinant variables are displayed in Table 2. By applying the PTE score as the dependent

variable, the multiple regression model is illustrated in Equation 2.

Equation 2:

$$PTE_{it} = \beta_0 + \beta_{it}(LNTA_{it} + \frac{LLP}{TL}_{it} + ROA_{it} + \frac{TL}{TA_{it}} + Equity/TA_{it} + NIE/TA_{it} + LNGDP_{it} + LNINF_{it} + DUM\_PB_t) + \varepsilon_{it}$$

Where,

i Refers to bank;

t Refers to time period;

y Refers to the PTE score of the bank in Lao PDR;

X Represents the determinant variables;

ε Refers to the error term.

Data Source

The data is gathered from two main resources, the Bank of the Lao PDR (BOL) and published financial statements of each bank, which can be downloaded from their respective websites. As described in Table 1, there are six kinds of bank in Lao PDR. Each of them has its unique scope of doing business and is subject to different regulatory control, only private bank and subsidiary foreign bank are considered to be comparable. Table 1 shows the number of banks in Lao PDR classified by their types of banks.

Since the state-owned commercial banks is dominated at the forefront in term of modern innovation and is outstanding from its peer. So, this study does not include State-Owned Commercial Banks into analysis. We also exclude Specialize Banks, Joint State Commercial Banks and Foreign Commercial Bank Branches due to their newly open and unable to access the data.

Moreover, these banks have no incessant data to be compared for bank efficiency between 2013 to 2017. Consequently, this study evaluates only two groups bank; Private and Subsidiary Foreign Banks (or Foreign Banks), to determine the operating efficiency and provide the determinants of the bank operating efficiency. However, the banking industry in Lao PDR is still at its early stages of development, so many of the banks have no complete data regarding the variables. Also, foreign commercial bank branches have limited access to banking services and operations, so we exclude them for the analysis. In the end, the sample of this study consists of four private and four foreign banks which have been continuously operated in the Lao PDR during 2013 to 2017.

Table 1 Number of banks in Lao PDR (Bank of the Lao PDR, 2019)

Bank types	Number
State-owned commercial bank	3
Specialized bank	1
Joint state commercial bank	3
Private bank	7
Subsidiary foreign bank	10
Foreign commercial bank branch	19

To describe the structure of commercial banks in Lao, the total number of commercial banks are 43 banks, which can be further divided into six types, namely 3 state-owned commercial banks, 1 specializes bank, 3 joint state commercial banks, 7 private commercial banks, 10 subsidiary foreign banks and 19 foreign commercial bank branches.

The study has limited for selection the observation because the number banks in each type in Lao are still small and newly established. Thus, this study considers the banks that are established before the year of 2012, operating continuously for a period of 5 years (2013 to 2017) and able to access data.

Result and Discussion

The measurement of bank efficiency score from DEA model could be divided into 2 groups. If a bank has an efficiency score of 1 is referred to "Best Practice". If the efficiency score of a bank is less than 1, that bank is labeled as "inefficiency bank". DEA approach can uncover the cause of inferior performance which can be used to understand the operating efficiency of the bank and hopefully can help to improve the bank's efficiency.

We apply input-oriented model that presents the pure technical efficiency (PTE scores) in Lao commercial banking sectors. The results are classified by private and foreign banks using three approaches that are reported in Table 2. The empirical results suggest that the PTE scores are not significantly different between private and foreign banks under three approaches. Interestingly, the efficiency of the foreign banks exhibits large-scale asymmetry under three approaches.

Efficiency of the Private Banks

Table 2 presents average results of bank efficiency score under the three approaches for the sample of private banks. The estimations of the average efficiency score are consistently higher under operating approach, which is followed by the intermediation and value-added approach of 78.17%, 76.32% and 75.62% respectively. This evidence indicates that private banks have been inefficient in value-added, intermediation and operating aspects with average score of 24.38%, 23.68% and 21.83%, respectively. While the lowest efficiency score is found in PSV under intermediation approach, STB under value-added approach and JDB under operating approach.

Regarding intermediation approach, private banks in Lao have been inefficient in transforming deposits into loans as we can see from the average bank's efficiency score could only transform 78.17% of the inputs used for generating the same level of output. This means private banks in Lao have wasted inputs of 21.83% on average to produce the same of outputs comparing to their counterparts. However, under intermediation approach, the results show that on average IDCN is recorded to the highest efficiency score, following by STB, JDB and PSV of 95.59%, 91.98%, 61.08% and 56.62%, respectively. If the banks improve their efficiency of intermediation, they should reduce of input level on average of 4.41%, 8.02%, 38.92% and 43.38%, respectively, to produces the same level of outputs.

Under value-added approach, the results show that on average IDCN is recorded to the highest efficiency score, followed by PSV, JDB and STB of 94.35%, 85.22%, 63.65% and 59.25% respectively. The results suggest that most banks were able to keep the input level on average of 5.65%, 14.78%, 36.35% and 40.75%, respectively, for supplying the same level of outputs under the value-added approach.

For the operating approach, on average IDCN is recorded to the highest efficiency score, followed by STB, PSV and JDB of 94.80%, 88.51%, 65.39% and 63.99% respectively. In other word, on average the banks have been inefficient or they could save 5.2%, 11.49%, 34.61% and 36.01% of inputs used for generating the same level of outputs respectively. On average, private banks in Lao have used

more inputs level under value-added approach. This implies that the inefficiency of the private banks in Lao is caused by the overuse of inputs to produces the same level of outputs compared to their ability in term of intermediation and operating aspect. However, the efficiency score does not display different variation under three functions.

Table 2 Average PTE score of intermediation, value-added and operating approach for private and foreign banks in Lao PDR

DMU name	Intermediation approach	Value-added approach	Operating approach
Private banks			
JDB	0.6108	0.6365	0.6399
PSV	0.5662	0.8522	0.6539
STB	0.9198	0.5925	0.8851
IDCN	0.9559	0.9435	0.9480
Min	0.5662	0.5925	0.6399
Mean	0.7632	0.7562	0.7817
Max	0.9559	0.9435	0.9480
SD	0.2031	0.1687	0.1579
Foreign banks			
BIC	0.8800	0.8587	0.9175
ACB	0.9469	0.3601	0.9101
SCB	0.8657	0.7415	0.8982
ANZ	0.5523	0.8171	0.8090
Min	0.5523	0.3601	0.8090
Mean	0.8112	0.6943	0.8837
Max	0.9469	0.8587	0.9175
SD	0.1762	0.2281	0.0504

Remark JBD is Joint Development Bank, PSV is Phongsavanh Bank Ltd., STB is ST Bank Ltd., IDCN is Indochina Bank Ltd., BIC is BIC Bank Co., Ltd., ACB is Acleda Bank Lao., Ltd., SCB is Saigon Thuong Tin Bank Lao Co., Ltd., ANZ is Australia and Zealand Bank (Lao) Limited.

Efficiency of Foreign Banks

Interestingly, the results in Table 3 also show that on average foreign banks had higher efficiency in comparison with the private banks in the Lao PDR. Foreign banks have highest average efficient score under profitability function, followed by intermediation and production functions of 88.37%, 81.12% and 69.43%, respectively. On average, foreign banks were inefficient in production, intermediation and profitability functions of 30.57%, 18.88% and 11.37%, respectively.

Therefore, the results indicate that ANZ has lowest efficiency score under intermediation and profitability functions. Similarly, ACB is found to be lower efficiency score under

production approach. While, ACB has higher efficiency score under intermediation function. On the other hand, BIC is observed to have higher efficiency score under production and profitability functions. Our findings reject the home-field advantage hypothesis in a sense that foreign-owned banks are more efficient than local banks in line with (Nenovsky et al., 2008).

Using the intermediation function, foreign banks are inefficient in transforming deposits into loans that the average bank's efficiency score could only transform 81.12% of the inputs used to generate the same level of output. This means foreign banks have saved inputs of 18.88%, on average, to produce the same level of outputs.

Hence, for intermediation function, the evidence reveals that on average ACB has the highest efficiency score, followed by BIC, SCB and ANZ of 94.69%, 88%, 86.57% and 55.23% respectively. If, the banks wish to improve the efficiency of intermediation aspect, they should reduce of input level on average of 5.31%, 12%, 13.43% and 44.77%, respectively, to produces the same level of outputs.

Under production function, the study found that on average BIC has the highest efficiency score, followed by ANZ, SCB and ACB of 85.87%, 81.71%, 74.15% and 36.01% respectively. The results suggest that the banks are able to reduce inputs level on average of 14.13%, 18.29%, 25.85% and 36.01% respectively, to generate the same level of outputs under the production function.

Similarly, the profitability function is reported that on average BIC has the highest efficiency score of 91.75%, followed by ACB, SCB and ANZ of 91.01%, 89.82%, and 80.9% respectively. This implies that, on average, foreign banks (e.g BIC ACB, SCB and ANZ) could have saved 8.25%, 8.99%, 10.18% and 19.1%, respectively, of inputs to generate the same level of outputs.

On average, foreign banks in the Lao PDR used more inputs level under production function to produce the same level of outputs, in comparison with their ability in term of intermediation and profitability.

Multivariate Regression Analysis

The empirical result from the first stage indicates that, on average, the PTE score under three approaches of the Lao private banks were lower relative to their foreign banks. The second stage explores the determinant variables, including bank specific and external macroeconomics factors. Then, we test for the determinants of operating efficiencies of Loa PDR. The definition of all variables in the regression model are listed in Table 3.

We apply OLS method to estimate the multivariate regression that classifies into the 9 regression models as present in Table 4. The regression results considering on the relationship between bank efficiency and the determinant variables. The equations include 40 firm-year observations during the period of 2013 to 2017. The value-added approach has higher adjusted R-squared, followed by intermediation approach and the operating approach. The F-test is statistically significant at 1% level under three approaches.

The empirical result indicates a positive relationship between banks efficiency and loan quality (LLP/TL) which seems to be highly significant at 1% level for intermediation approach. The result suggests that both private and foreign banks in the Lao PDR can improve their efficiency by monitoring carefully the loss provision to total loans.

As Sufian (2010) suggests that the supervisor should focus seriously on the management of loan quality that has been proven to have problems in the period study. It is noted that

under value-added approach, we find a negative relation between bank efficiency and ROA ratio (statistically significant at 1% level). This is inconsistent with the view that banks can increase their efficiency by improving their ability of the banks to earn higher margins. However, we document a negative relationship between bank profitability and ROA under value-added approach. The findings are consistent with Ataullah and Le (2006). Careful interpretation of this result should be conducted. Since deregulation of the banking sector in Lao PDR is quite new, some of them might not reach the break-even point, so the profits are slim comparing to their asset expansion. Therefore, the negative relationship of TSE score and ROA ratio should be interpret as increasing total assets of Lao banks out-lead the ability to make profit; therefore, the efficiency is reduced, accordingly.

Table 3 Definition and hypothesis of determinant variables

Variables	Definition	Hypothesis
	Bank specific variables	
LNTA	A proxy of bank size and calculates by take the natural logarithm into total asset.	+/-
LLP/ TA	A proxy of laon quality and calculates by using the ratio of loan loss provision to total loans.	-
ROA	A proxy of bank profitability and is calculated by dividing net income divides with total assets.	+
TL/ TA	A proxy of liquidity and is calculated by dividing total loan with total assets.	-
Equity/ TA	A proxy of capital strenght and calculates by shareholders equityto total assets.	+
NIE/ TA	A proxy of expenses and calculates by non interest expenses to total assets.	-
	Macroeconomics variables	
LNGDP	A proxy of gross domestic prouct and calculates by take the natural logarithm of tha national grodd domestic prouct.	+
LNINF	A proxy of inflation and calculates by the natural logarithm of inflation rate.	-
	Dummy variables	
DUM_PB	The dummy variable that takes a value of 1 is a bank is private bank, 0 otherwise.	-

Table 4 Summary multivariate regression analysis model under three approaches

Variable	Intermediation approach			Value-added approach			Operating approach		
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**	**Model 7**	**Model 8**	**Model 9**
CONSTANT	0.796	0.962	0.027	1.78	3.792**	2.064	1.777**	1.047	-2.381
	(0.900)	(1.492)	(2.002)	(1.025)	(1.609)	(2.123)	(0.867)	(1.406)	(1.649)
Bank specific variables									
LNTA	-0.067	-0.051	-0.010	-0.019	-0.036	0.039	-0.087	-0.053	0.097
	(0.059)	(0.065)	(0.087)	(0.067)	(0.070)	(0.093)	(0.057)	(0.062)	(0.072)
LLP/ TL	4.314***	4.292***	4.231***	0.945	0.630	0.518	1.105	1.190	0.967
	(1.387)	(1.424)	(1.438)	(1.580)	(1.534)	(1.524)	(1.337)	(1.341)	(1.184)
ROA	4.653**	4.237*	4.310*	-6.004***	-6.063***	-5.929***	5.871***	5.194***	5.461***
	(2.091)	(2.202)	(2.222)	(2.381)	(2.373)	(2.356)	(2.051)	(2.074)	(1.830)
TL/ TA	1.320***	1.337***	1.290***	0.333	0.276	0.189	0.451	0.502*	0.330
	(0.301)	(0.310)	(0.320)	(0.343)	(0.334)	(0.339)	(0.290)	(0.292)	(0.263)
Equity/ TA	0.829**	0.904**	0.944**	-0.240	-0.302	-0.228	0.125	0.275	0.423
	(0.421)	(0.444)	(0.451)	(0.480)	(0.479)	(0.479)	(0.406)	(0.418)	(0.372)
NIE/ TA	-2.381*	-2.442*	-2.389*	-7.253***	-7.117***	-7.019***	-1.159	-1.315	-1.122
	(1.229)	(1.261)	(1.273)	(1.400)	(1.359)	(1.350)	(1.184)	(1.188)	(1.048)
Macroeconomic variables									
LNGDP		-0.064	-0.009		-0.336*	-0.234		0.022	0.223
		(0.154)	(0.174)		(0.166)	(0.184)		(0.145)	(0.143)
LNINF		0.020	0.015		0.057*	0.047		0.012	-0.008
		(0.031)	(0.032)		(0.034)	(0.034)		(0.029)	(0.027)
DUM_PB			-0.050			-0.092			-0.182***
			(0.070)			(0.074)			(0.058)
R^2	0.506	0576	0.583	0.600	0.649	0.666	0.422	0.458	0.593
Adj R^2	0.488	0.466	0.458	0.528	0.559	0.566	0.316	0.318	0.471
F-test	7.202***	5.260***	4.656***	8.264***	7.176***	6.656***	4.009***	3.278***	4.857***

Remark (1) ***, **, *, indicates significance at the 1%, 5% and 10% level, respectively. (2) Value in parentheses are standard errors.

In term of liquidity, we found a positive relationship between Lao bank efficiency and TL/ TA under the intermediation approach and significantly at 1% level. We find that liquidity is only significant when we captured with the macroeconomics variables and significantly at 10% level (Model 8). The result suggests that the higher value of the TL/ TA ratio, the higher the bank operation efficiency level. This means, commercial banks in Lao were efficient in term of transforming deposits into loans. As suggested by Sufian (2009), the positive coefficient of TL/ TA ratio implies that the banks could handle their operation efficiency well and save the cost of production.

Considering the capital strength viewpoint, we find a positive relationship between Lao banks efficiency and Equity/ TA ratio. The result is statistically significant at 5% level under intermediation approach. The higher level of capital strength leads to a higher bank efficiency level. As Sufian (2010) suggested, the strong capital structure is the heart of the bank's operation in developing countries. Capital strength could help reinforce efficiency of the bank and possibly enable them to encounter financial crisis and gain more confidence from their clients during volatile macroeconomic shocks.

In term of the expenses of the banks, the NIE/ TA ratio is negatively and highly statistically significant at 1%, meaning that NIE/ TA has a negative impact on Lao banks' efficiency under value-added approach. Under intermediation approach, the relationship is also negatively impact on to Lao bank' efficiency. This variable is statistically significant at 10% level. Higher level of expenses leads to a lower efficiency of banking sectors in the Lao PDR. In other words, the evidence suggests that Lao banks are inefficient in managing their expenses such as wages and salary of their staff and supervisor, along with the other operating expenses. Obviously, improving cost management is an essential part for developing the efficiency of the Lao banking sector, consistent with Sufian and Habibullah (2009).

When we control the effect of macroeconomic condition as LNGDP into the regression model. we document a negative relationship between LNGDP and bank efficiency. This is significant at 10% level only under value-added approach. As Sufian and Habibullah (2009) pointed out that the demand of financial services tends to grow as economies expand and societies wealthier. They discover the negative relationship between the efficiency of Korean banks and LNGDP during the 1997 Asian financial crisis. At that time, the Korea economy are among the most volatile economic growth. This leads to higher loan defaults and poor profitability of commercial banks.

However, during the year of study, Lao economics had faced a volatile economics. Higher prices of agricultural products raised export earning, while higher price of oil raise transportation cost and hence production cost raised and higher prices of import products. As a result, the commodity in Lao trend to become a higher price, (Bank of The Lao PDR, 2017). The volatile economic as mention above could directly affect the lower demand for financial services of customers, increased loan defaults and gain to poor profitability of Lao banking sectors.

On the other hand, LNINF has positive relationship and significant at 10% level. This has a great impact on bank efficiency under value-added approach. The higher inflation rate influences the potential for banks to adjust the new interest rate and earn the higher return (Model 5). As Perry (1992) suggested that the effect of bank efficiency depended on

the inflation is anticipated or unanticipated. In case of anticipated, an adjusting bank interest rate is resulted to bank revenue rise faster compared with bank costs and positively impact to the bank efficiency. In case of unanticipated, banks have decelerated of interest rates adjustment is resulted to bank cost rise faster compared with bank revenue and negatively impact to the bank efficiency. However, during the year study the inflation levels were anticipated by the Lao banks. This means bank in Laos gave the opportunity to adjust the interest rates accordingly and earn the higher profits.

Finally, DUM_PB has a negative relationship impact to Lao banking sector and highly significant at 1% level only in operating approach (Model 9). This supports the notion that private banks act as local banks are inefficiency comparing to subsidiary foreign banks in Lao PDR.

Conclusion and Recommendations

This study is the first study to measure the banks efficiency in Lao PDR, applying the Data Envelopment Analysis (DEA) approach. The observations are classified into two groups as private and foreign banks over the period of 2013 to 2017. The DEA method is employed in assessing input and output variables to estimate the bank efficiency in Laos. We explore three types of DEA approaches; namely intermediation, value-added and operating approaches. Then, we apply the OLS model to explore the determinants of bank efficiency under three approaches, both bank specifies and macroeconomics variables are included into regression model.

The empirical results revel that private banks have lower efficiency compared to foreign banks under intermediation and production approach. On the contrary, private banks had highest efficiency under production approach. This result is consistent with Jemric and Vujčic (2002), which document that foreign-owned banks are more efficient than local banks. However, we find that private banks did not have different variation in efficiency under three approaches, while foreign banks have higher efficiency under profitability approach, followed by intermediation approach. However, the efficiency tends to be lower in term of production aspect. Additionally, the study find that private banks present a lower efficiency score in comparison to foreign banks over the period of study.

The multiple regression analysis suggests that loan quality and liquidity had positive and highly significant on the private and foreign banks in Lao PDR under intermediation approach. Clearly, both groups of banks were effective in allocating loans to their customers. Since banks have effective management and lower costs in terms of production, so they could take advantage of appropriate market conditions and offer loans to their customers. The results in this study show somewhat a mixed relationship between bank profitability and bank efficiency under three approaches. The study suggests that the main resources of bank is deposit. Higher bank profitability leads to higher efficiency in generating deposit into potential. On the other hand, we find a negative and significant impact of deposits to bank profitability under value-added approach, meaning that banks were poor in transforming deposit in loans.

Overall, the study suggests that banks in Laos have higher costs, mainly salaries and other operating expenses. If local banks could minimize their expenses, their efficiency will increase significantly. The empirical results of this study shed light on the importance of information provided to the regulators and decision makers to review bank operating efficiency in the Lao PDR. For bankers, this

study provides information and guideline in order to improve and make better decisions on future bank's operating efficiency, accordingly. To be specific, cost control is vital for bank efficiency in Lao PDR.

To improve the performance of banks, regulators may need to encourage the use of information technologies and uplift digital skills to improve profit and efficiency of the banks in Lao PDR. Basically, the ratio of non-interest expenses to total assets is significant in the regression, non-interest expenses to total assets have played major role in determining bank efficiency. Local banks have poor cost management in terms of employee and staff cost (e.g wages, salaries, bonuses, and other legally required benefits).

To support the developing economics and population growing up day by day, many banks have expanded their business and hire more staff or salary increased and consequently to become the higher staff cost. Lao banks should reduce spending on staff expenses by better management the number of staff in each service unit appropriately. Regular overtime, when taken for granted, may discourage some staffs from finishing their work in a standard workday. Overtime work may be necessary, but get a handle on it by requiring that it be authorized and justified.

Next, Lao banks should decrease expenditure on administrative expenses. Administrative expenses are the expenses an organization incurs not directly tied to a specific function such as manufacturing, production, or sales. These expenses are related to the organization as a whole as opposed to an individual department or business unit. Therefore, these expenses should be identified for the cuts because they do not have a direct impact on a bank's main operating function.

Because administrative expenses may be eliminated without direct impact on the product being sold or produced, they are typically the first expenses that should be identified for budget cuts. The decision whether to own or rent property is generally based upon the bank's scale of operations. Ownership increase fixed costs and financial exposure for local banks.

Furthermore, staff expenses and administrative costs are related. Technology effectively reduces distance, so there is no need to require administrative persons or specialists to be physically positioned. Foreign banks have more advantage in banking technology, so they can management these costs productively so as to improve their operating efficiency. Obviously, this study demonstrates that decent cost management is important to the efficiency and growth of any bank that wants to keep up in a more competitive environment in Lao banking sectors.

A common limitation in doing research on bank efficiency in Loa PDR researchers might encounter is the problem of insufficient sample size for statistical measurement. That is why this study use DEA method, which is a parametric method to avoid small sample problem. However, we hope that future studies will make a more active attempt to minimize the amount of missing data, and that more valid statistical analyses.

Progress has been made in assessing bank efficiency in Loa PDR; however, many important research questions and model improvements still remain. Future studies can address the issue of bank's performance analysis so it can create an opportunity for governments and regulatory institutions to identify the best practices and promote them to the rest of the banking industry. Another observation from our study is that banking efficiency analysis is usually based on defining the input-output variables under various assumptions. Academics have proposed

several approaches; however, there is no consensus about the optimal input-output approaches. The issue is needed to be explored which approach is the most suitable for measuring bank efficiency in Loa PDR.

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