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Determinants of Operational Efficiency and Total Factor Productivity Change of Major Cambodian Financial Institutions: A Data Envelopment Analysis during the Period of 2006-2013 *

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Abstract

This study is the first attempt to estimate the determinants of the operational efficiency and total factor productivity (TFP) change of major financial institutions in Cambodia during the period 2006 to 2013. The technical efficiency score and the TFP change were measured using conventional data envelopment analysis (DEA) and the Malmquist index, and these obtained indexes were then regressed to find their determinants. The empirical results obtained reveal that the efficiency of large institutions is higher and more stable than that of small institutions, and the efficiency of domestic institutions is better than that of their foreign counterparts. Furthermore, institutions that are more resilient and operationally stable can generate profits more efficiently, and institutions that are more diversified are more efficient. It was also observed that sound and diversified institutions tend to increase their total factor productivity, and some exogenous factors, such as increased household reserves of financial assets and improved economic infrastructure, contributed to the improvement of productivity change. These observations suggest that further improvement of Cambodian financial institutions requires an increase in operational capacity, appropriate selection of foreign ownership, enhanced soundness of management, and greater diversification.

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Key words: Cambodia, DEA, Commercial banks, Operational efficiency, Total factor productivity

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1. Introduction

Recently, the gradual opening of the Cambodian banking sector has resulted in rapid growth, with both foreign and local banks entering the industry. However, along with the rapid growth of the industry, with many new recent entrants, there are some problems. According to the IMF (2012), Cambodia may be overbanked compared to its regional neighbors and other countries at similar stages of development. The economic literature (Claessens and Laeven, 2004) supports the view that unlike in other industries, competition in the banking industry is related less to the raw number of banks and more to the transparency and quality of supervision of those banks. Therefore, the rapid growth of the Cambodian banking sector calls for a systematic evaluation of the effect of increased participation on efficiency.

Okuda et al. (2014) conducted a data envelopment analysis (DEA)—a non-parametric econometric method for measuring the efficiency of individual banks—on the Cambodian banking sector using micro data of individual financial institutions. They found that those institutions experienced a slight deterioration of productivity from 2006 to 2011, but the efficiency gap between the most efficient and most inefficient institutions had decreased. In addition, Okuda et al. (2013) used DEA to determine the difference in the mean efficiency of banks that have different characteristics, such as size of operation, foreign ownership, and business specifications. However, Okuda et al (2014) have not controlled for other factors such as size of financial institutions and risks that may affect efficiency, and furthermore their study has not focused on the correlation between independent variables. In Cambodian financial sector, some bank characteristics are correlated with other variables, such as size and ownership structure.[1] Thus, it is necessary to take into account this relationship when examining what makes financial institutions more efficient or what affect their productivity, for more precise understanding of the operational efficiency. The present study builds on this DEA work by identifying specific factors influencing operational efficiency of financial institutions in Cambodia.

This paper is the first attempt to estimate the determinants of the operational efficiency and total factor productivity (TFP) change of major financial institutions in Cambodia during the period 2006 to 2013. To examine not only the efficiency of financial institutions but also to identify the determinants of efficiency, we conducted a two-step DEA procedure, first estimating overall bank efficiency and total productivity

[1] For example, most foreign-owned banks are small and there is an apparent correlation between bank size and bank ownership.

change and then regressing the obtained efficiency score and Malmquist index to find the determinants, using a conventional panel data estimation. Although the Cambodian banking sector has experienced rapid growth, the available data on the sector remains limited and presents a challenge for a systematic study of banking efficiency. Because DEA is a non-parametric estimation procedure, it is well suited to a small sample investigation and was thus adopted in the present study. Data consisted of individual bank panel data for 2006 to 2013 published by the National Bank of Cambodia.

Our results suggest that (1) the efficiency of large institutions is higher and more stable than that of small institutions; (2) the institutions whose foreign capital comprises more than half of total capital are significantly inferior to local institutions with respect to overall operation; (3) institutions that are more resilient and operationally stable can generate profits more efficiently; (4) institutions that are more diversified are more efficient; (5) sound and diversified institutions tend to increase their total factor productivity; and (6) some exogenous factors, such as increased household reserves of financial assets and improved economic infrastructure, contributed to the improvement of productivity change. These observations suggest that further improvement of Cambodian financial institutions requires an increase in operational capacity, appropriate selection of foreign ownership, enhanced soundness of management, greater diversification.

The rest of this paper is organized as follows. Section 2 provides a brief overview of the Cambodian banking sector, followed by a review of the literature and description of the two-stage DEA regression method in Section 3. Section 4 presents our estimation method and empirical results while Section 5 provides conclusion.

2. Overview of the Cambodian Banking Sector

The National Bank of Cambodia (NBC) was established on December 23, 1954, after the country gained independence from the French Government. From 1975 to 1979, under the Pol Pot regime, the banking sector was destroyed and the local currency, the riel, was abolished. In 1979, after the collapse of the Pol Pot regime, the National Bank of Cambodia was rebuilt as the central bank of Cambodia. At the same time, the Foreign Trade Bank was re-founded as a state-owned bank providing commercial banking services, and in the following year, the riel was re-introduced as the new Cambodian currency. After an initial period of stabilization, from 1991, Cambodia began a transformation from a planned economy to an increasingly market-oriented economy. Private commercial banks were established, either as branches of foreign banks or through joint ventures with the NBC. By 1998, 32 licensed commercial banks had been

established in Cambodia: almost all of them were local banks that had merged with foreign capital banks.

From 1998 to 2001, legal reforms and increased regulation of the financial sector initiated by the NBC resulted in the classification of financial institutions into three categories: commercial banks, with a minimum paid-up capital requirement of $13 million; specialized banks, with a minimum paid-up capital requirement of $2.5 million; and registered micro finance institutions (MFIs). Following this, the NBC also implemented programs to strengthen Cambodian banks through consolidation and disposal of non-performing loans. Numbers of banking licenses were revoked due to the unsound operation in order to facilitate transparency in banking sector, and by 2001, the number of financial institutions had been reduced to about half.

In Cambodia, under the *Law on Banking and Financial Institutions*, three types of banking operations are defined: (1) credit operations, including leasing, guarantees, and commitments under signature; (2) collection of non-earmarked deposits from the public; and (3) provision and processing of means of payment to customers in either national currency or foreign exchange. Any institutions able to carry out all three banking activities are defined as commercial banks, while institutions carrying out only one of these three basic activities are known as specialized banks. In practice, specialized banks in Cambodia are only involved in lending activities. Microfinance institutions, meanwhile, also engage in banking activities through the soliciting of deposits and the granting of credit, but their scope of operation is limited to certain thresholds in order to separate the banking and micro-finance markets. Furthermore, while the *Law on Banking and Financial Institutions* legally defines Cambodian banks as either locally incorporated banks or foreign banks, in practice, locally incorporated banks are varied and may include wholly foreign-owned banks, joint-venture banks with local capital banks, or subsidiaries of foreign banks.

Encouraged by these reforms, since 2000, the Cambodian banking sector has continued to grow. From 2006 to 2011, the total assets of the financial sector as a percentage of GDP increased from 26% to 63%, while the number of depositors rose from 286,000 to 1,266,000 and the number of borrowers rose from 165,000 to 295,000 (NBC, 2010). Additionally, in the late 2000s, bank loans soared, and the asset management ratio grew from 100% to 120%, while the liquidity ratio decreased from 108% to 83%. However, the strength of the banking sector has been improving, as the ratio of non-performing loans to total loans decreased from 9.8% to 2.5%, while related party lending was stable during that period—in the range of 1-2 percent of net worth. In addition, the fixed asset ratio fell from 19.0% to 10.7%, and the ratio of loans for the

real estate industry dropped from 15.9% to 9.8% of total loans.

3. Estimation Method

While the Cambodian financial sector has experienced rapid growth in recent years, there has been little research done on the efficiency of the Cambodian banking system. Okuda et al. (2014) examined the efficiency of the Cambodian banking system as a whole using DEA and found that the productivity of Cambodian financial institutions has deteriorated and that foreign banks are more efficient than local banks. The present study builds on this work to identify the determinants of efficiency in Cambodian financial institutions.

Developing countries present a challenge for econometric investigation because the available data is typically limited. DEA, which uses non-parametric assumptions, is a suitable solution for use in small sample situations because it has lower data requirements than parametric approaches do. The DEA method has been used widely in the study of efficiency in banking and other industries, and a two-stage DEA method has been adopted in other studies to analyze the specific determinants of the efficiency of firms. Grigorian and Mandole (2002), for example, conducted a two-stage study of banks in transition countries using multi-country data, and found that both foreign ownership with controlling power and enterprise restructuring enhance bank efficiency. Casu and Molyneux (2003) and Barry et al. (2010) studied banking efficiency in the European Union (EU) and in six Asian countries and found that ownership structure is a crucial determinant of bank efficiency. In this paper, we also use the two-stage estimation procedure to study the Cambodian banking sector.

3.1 Measuring Efficiency Using DEA

Because operational efficiency is important to the success of enterprises, it is not surprising that the measurement of efficiency has a long history, beginning with Farell (1957), who drew upon the work of Debreu (1951) and Koopmans (1951) to define a simple measure of firm efficiency that could account for multiple inputs. Farell (1957) proposed that the efficiency of a firm consists of two components: technical efficiency, which reflects the ability of the firm to obtain maximal output from a given set of inputs, and allocative efficiency, which reflects product prices and production technology. These two measures are then combined into a measure of total economic efficiency. Following these seminal studies, Fare, Grosskopf and Lovell (1985, 1994) and Lovell (1993) have contributed to the development of modern efficiency measurement.

In contemporary efficiency theory, there are two main approaches to measuring the

efficiency of firms: stochastic frontier analysis (SFA) and data envelopment analysis (DEA). While SFA assumes a parametric functional form, DEA is a non-parametric approach to solving linear programming problems by identifying a set of best practice frontier observations. In contrast to SFA, which depends on a large sample assumption to estimate parameters, DEA makes no such assumption and can thus be used to analyze small samples. This is especially important in studies of the banking industry, since the number of banks in many countries has decreased due to mergers and acquisitions (M&A). Consequently, in many countries, it is becoming difficult to estimate bank efficiency by parametric means. Thus, just as many other banking sector studies have adopted DEA in recent years, we also adopted the DEA approach to estimate Cambodian bank efficiency due to the small available sample size.

First, we consider that bank efficiency is given by the following structure:

$$\theta_{it} = z_{it}\,\beta + u_{it}$$

where θ_{it} represents the efficiency of bank *i* at time *t*, and is written as a function of the environmental vector z_{it} that each bank faces, which is also taken to include bank characteristic variables such as bank size and the ratio of total equity to total assets. In the stage two estimation, each efficiency score θ_{it} is substituted with the score that is calculated by the DEA approach in the first stage.

There are two assumptions of the DEA model: (1) constant returns to scale (CRS) and (2) variable returns to scale (VRS). The CRS assumption is only appropriate when all firms are operating at an optimal scale. Imperfect competition, constraints on finance, and other likely situations may cause a firm to not be operating at an optimal scale. Banker, Charnes, and Cooper (1984) thus suggested an extension of the CRS model to account for variable returns to scale (VRS) situations, and the extended model is generally called the BCC-DEA. To discuss DEA in more technical terms, let us assume that there is data on *k* inputs and *m* outputs for each *N* banks. For the *i*-th firm, these are represented by input vector $x_i = (x_{i1}, x_{i2}, \dots, x_{ik})$ and output vector y_i=$(y_{i1}, y_{i2}, \dots, y_{im})$, respectively.

$$\min_{\theta,\lambda} \theta$$

$$
\begin{aligned}
& \sum_{j=1}^{n} \lambda_j x_{jl} \leq \theta x_{il} \quad l = 1, \ldots, m \\
\text{s. t.} \quad & \sum_{j=1}^{n} \lambda_j y_{jr} \geq y_{ir} \quad r = 1, \ldots, k \\
& \sum_{j=1}^{n} \lambda_j = 1 \\
& \lambda_j \geq 0, \quad j = 1, \ldots, n \\
& \theta \geq 0
\end{aligned}
$$

where θ is a scalar and λ is an N×1 vector of constants. The value of θ is the technical efficiency score for the i-th bank. It will satisfy $\theta \leq 1$, with a value of 1 indicating a point on the frontier and hence a technically efficient bank according to the Farrell (1957) definition. The linear programming problem must be solved n times, once for each bank in the sample. A value of θ is then obtained for each firm.

3.2 Productivity Change Measurement

Each sample, separated by year, represents a single frontier that is constructed on the assumption of the same technology. Therefore, a comparison of efficiency measures of a DMU over a given period of time cannot be interpreted as technical progress; rather, it refers to changes in efficiency (Canhoto & Dermine, 2003). The concept of comparing the inputs of a DMU over two periods of time (period t and period t+1), whereby the input in one time period can be decreased while maintaining the same level of output in the second period, forms the basis of the Malmquist index. The Malmquist productivity index (M) enables productivity growth to be classified into changes in efficiency (the catch-up effect) and changes in technology (innovation).

The Malmquist index (M) of total factor productivity (TFP) change is the geometric mean of the two indices based on the technology used in period t and t+1, respectively[2]. In other words, $M=ET$, where M is the Malmquist productivity index, E is the change in efficiency from period t to t+1, and T is the measure of technical progress measured by shifts in the frontier from period t to t+1. Any variation in the reference technology used affects the interpretation of the index. When the reference technology is based on period t, then $M > 1$ implies an increase in productivity.

3.3 Data and Definition of Input and Output Variables

The data used in this study were annual data of financial institutions in Cambodia for the period 2006 to 2013 obtained from financial statements of each bank published by the Banking Supervision department of the NBC.

As in recent studies (Grigorian & Manole, 2002; Barry et al., 2010), two

[2] For a decomposition of the Malmquist productivity index, see Lovell (2003).

approaches, the operating approach and the value-added approach, were used to explore the differences in productivity between financial institutions.[3] The operating approach focuses on efficiency of bank revenue whereas the value-added approach focuses on efficiency in terms of assets. In other words, the operating approach focuses on activities of the income statement whereas the value-added approach focuses on the balance sheet activities, although these two activities are closely related.[4]

Accordingly, for each approach, three inputs and two outputs were chosen. In the operating approach, the input variables used were interest expense (X1), the number of branches (X2), and the number of staff members (X3), while interest income (Y1) and non-interest income (Y2) were used as output variables. In the value-added approach, the same inputs were adopted as the operating approach, but the outputs were total deposits (Y1) and gross loans (Y2). Table 2 presents the summary of data used to construct the efficiency frontiers.

Table 1. Variables used in DEA

3.4 Determinants of Bank Efficiency

The variables that are considered as potential determinants of bank efficiency are: (1) dummy variables to identify the bank ownership structure; (2) logarithms of total assets to control the effect of the size of a bank; (3) a Z-score to identify the soundness of bank operation[5]; (4) diversification rate; and (5) dummy variables that represent the specializations of banks, such as commercial banks, specialized banks, and microfinance institutions.

3.4.1 Bank Size

We use a logarithm of total assets as the variable for bank size. In many previous studies, the results of the effects of bank size on bank efficiency have been mixed and the causality has been unclear. Although Berger et al. (2005) and Brissimis et al. (2008) found a positive relationship between bank efficiency and bank size, Bonin et al. (2005) found that larger banks are less efficient in transition economies. In addition,

[3] Actually, the variables used in the DEA model vary slightly across recent studies, even though these studies use the same concepts to define the input and output variables in bank activity. This is mainly a result of the limitations in data for each country.

[4] Fethi & Pasiouras (2010) sort out recent bank studies with the application of DEA, and list the main approaches to define bank input and output.

[5] This proxy is a combination of indicators of profitability, leverage, and return volatility. If this variable increases, it indicates a decrease in overall risk exposure and an increase in bank stability (Ariss, 2010).

Havrylchyk (2006) found that the performance of Polish banks has no significant relation to bank size. Generally, large banks may have a large market share and more easily develop a large client base, which, in banking, leads to an outsized profit and enables the bank to more easily collect deposits and create loans.

3.4.2 Ownership Structure

To investigate the effect of ownership structure on bank performance, we use dummy variables to distinguish whether banks are foreign-owned or local banks. In this study, we establish a foreign-owned dummy to take the value of one if the foreign share of paid-up capital exceeds 50 percent of total paid-up capital. Although many previous studies have examined the difference between private banks and public banks, we cannot similarly categorize banks in this study, as there are no public banks in Cambodia. Most studies find that in developing countries, foreign-owned banks are more efficient than local banks (Bonin et al., 2005; Grigorian & Manole, 2002). The reasoning follows that in developing countries, foreign-owned banks from developed countries may have access to superior technologies, particularly information technologies and procedures for assessing complex quantitative information. However, foreign-owned banks may have some disadvantages to local firms in assessing soft information about local firms (Berger et al., 2005). Havrylchy (2006) studied Polish banks and found that greenfield foreign-owned banks are more efficient than foreign-owned banks that were originally local banks and were acquired by foreign banks entering the market. His finding suggests that the type of foreign bank impacts bank efficiency. To account for this, we test whether there is a significant difference in the types of foreign-owned banks.

3.4.3 Soundness of Financial Institutions

The Z-score represents the soundness and quality of bank management.[6] This variable shows whether banks consistently make a profit and whether they tend to take high risks. Many previous studies have tried to identify the soundness of a bank as one of a bank's characteristics. Resilient and stable banks may easily collect deposits from their customers; namely, they need fewer resources to produce the bank's products and they can reduce waste because there is less uncertainty in their operations. Accordingly, this variable is expected to be positively correlated with bank efficiency. Grigorian & Manole (2002) and Brissimis et al. (2008) analyzed the relationship between resilience

[6] In recent years, this indicator has been widely used in studies of this nature (Boyd et al., 2004; Ariss, 2010). We adopt the definition of Z-score according to Ariss (2010)

and bank efficiency in transition economies, and Chortarea et al. (2013) also investigated bank efficiency in 27 EU countries. These studies all found that bank resilience has a significantly positive correlation with bank efficiency.[7]

3.4.4 Diversification Rate

Many previous studies have mainly investigated the relationship between diversification and bank risks, or market values (Baele et al., 2007), but there is no evidence of a link between bank efficiency and diversification to our knowledge. Theoretically, it is unclear whether the benefit from diversification exceeds the cost. Diversifying bank business tends to increase the complexity of bank operations, but the economies of scope may be somewhat beneficial as information obtained through the intermediation business can be useful in a fee or commission-based business. Thus, we added this variable to our regression models in order to clarify the linkage. Furthermore, as the diversification rate is generally higher for foreign-owned banks, it is necessary to include a variable that can represent the extent of the diversification to of the banks' business domain in addition to a variable that represents the traditional intermediation business.

4. Empirical Results

4.1 Determinants of Efficiency

Table 2 and Table 3 show the results of our regression of bank efficiency on bank characteristics. We used two approaches to characterize a banks' inputs and outputs: the value-added approach and the operating approach. According to the Houseman test, a random effect model was efficient rather than a fixed effect model. We found that total assets had a significantly positive effect on bank efficiency in both approaches. This result means that the efficiency scores of larger banks were not far from the production frontier, which suggests that larger banks in Cambodia have a tendency to utilize their resources efficiently and in a stable manner. As mentioned earlier, banks having large market power have a strong customer base. However, there are other causal links in this relationship; for example, banks whose managements are highly efficient tend to survive in the market because of their high efficiency. Identifying the specific causal

[7] These studies use the ratio of equity to total assets to investigate the relationship between resilience and efficiency. However, it is unclear as to what the ratio represents, as an increase in the ratio of equity to assets also implies an increase in payments to shareholders. Sometimes the payments to shareholders as a percentage of total equity becomes higher than payments to borrowers as a percentage of total lending. Thus, an increase in the ratio of equity to total assets does not always mean an increase in the resilience of the bank's operation.

relationship as to what makes the size of a bank large will require further investigation.[8]

Table 2. Determinants of Efficiency in the Operating Approach
Table 3. Determinants of Efficiency in the Value-added Approach

We found that the coefficient of the Z-score was significantly positive in the operating approach and, although insignificant, also positive in the value-added approach. This result is similar to Grigorian & Manole (2002), who investigated bank efficiency in transition countries. It seems that the level of resilience strengthens the income earning efficiency of banks, but does not affect their efficiency in fund mobilization. We can interpret this result as meaning that banks that operate in a stable and resilient manner can more efficiently generate income.

Surprisingly, we found that foreign-owned banks were significantly less efficient than local banks in their operating approaches.[9] [10] Furthermore, the estimated coefficient of the foreign-owned banks dummy was, although insignificant, negative. These results are in contrast with most studies, which have found that foreign-owned banks are superior to local banks in developing countries as they have an advantage in terms of access to new technologies. These results suggest that foreign-owned banks are not efficient since the disadvantages of foreign-owned banks exceed the advantages. That is, such banks have no effective technical advantages, and disadvantages, such as difficulties in collecting soft information on local firms and the challenges of operating in different environments from their home countries, outweigh the advantages.

The estimated coefficient of the diversification rate was significantly positive in both approaches. In other words, banks whose business is more diversified exhibit significantly higher overall bank efficiency in Cambodia. This result suggests that the operational benefits derived from diversification exceed the cost; furthermore, banks

[8] There are possibly other interpretations in the bank size variable. Micco (2006) suggest that bank size reflects the hierarchical structure that affects the process of making decisions in banks. Thus, the correlation between bank size and efficiency does not simply mean the economies of scale in DEA approach.

[9] In our sample, the foreign shares of paid-up capital fluctuated, and the foreign-owned dummies changed in several banks during the period in question. Thus, the effect of the foreign-owned dummy was estimated, even in the fixed-effect model.

[10] Okuda et al. (2014) find that foreign-owned banks are more efficient than local banks. However, their study does not control for other factors such as bank size and risks that may affect bank efficiency; moreover, a correlation may exist between bank ownership and other factors. For example, since most foreign-owned banks are small and there is an apparent correlation between bank size and bank ownership, it is necessary to identify which variable truly has an effect on bank efficiency by controlling for the other variables.

that are more diversified lend more and encourage more deposits. This is evidence to support the hypothesis that Cambodian financial institutions benefit from economies of scope. That is, Cambodian banks seem to efficiently utilize the resources used and information collected from financial intermediation activities in other activities, and they exploit the information from other activities in financial intermediation activities. Although it is still unclear how diversification leads to higher efficiency on the lending and borrowing sides, our finding implies that diversification has a great impact on the Cambodian economy by mobilizing funds more efficiently since the Cambodian banking sector obviously needs more financial deepening.

The coefficient of NPLs was not significant. In Cambodia, the risk indicator does not correlated to the efficiency of financial institutions, although Berger & DeYoung (1997) suggests that banks may have an incentive to take a high risk to increase operational efficiency in short term.

4.2 Determinants of TFP Change

Table 4 shows the results of calculations to clarify how the management efficiency of major Cambodian financial institutions changed from 2006 to 2013. Total factor productivity changes were measured by the Malmquist index. A Malmquist index coefficient of greater than one signifies improvement in productivity, whereas a coefficient smaller than one indicates deterioration in productivity. A change in total factor productivity can be re-defined as an efficiency change value that shows proximity to the production frontier and a technical change value that shows the shift of the production frontier: each of these values indicate improvement when they are greater than one and deterioration when they are smaller than one. The former is called the "catch-up effect" because it shows to what degree the management of each bank approached the point on the production possibility frontier curve that represents the most efficient bank management. The latter represents the degree of technical progress of the entire Cambodian banking sector because it shows the change of the production possibility frontier formed by the most efficient bank management.

Table 4. Cumulative TFP Change, Technical Change, and Efficiency Change

The measurement results clarified the following characteristics. As shown in the above table, the total factor productivity of major Cambodian banks improved remarkably during the seven years from 2006 to 2013. The bank average of total factor productivity was greater than one in both the value-added approach, which focuses on

the amount of financial intermediation, and the operating approach, which focuses on profitability. The latter was higher than the former.

If the improvement in total factor productivity is re-defined as efficiency change and technical change, the former surpassed the latter in the measurements in both the value-added approach and the operating approach. In particular, the improvement in total factor productivity measured in the operating approach is caused mostly by efficiency change.

Table 5 summarizes the results of a regression analysis of determinants of total factor productivity changes in the operating approach, which focuses on profitability. Changes in both the level of business diversification and the Z-score, which represents the soundness of bank management as a factor to improve total factor productivity, were statistically significant. On the other hand, neither the foreign dummy, which represents ownership attributes, nor the specialization dummy, which represents the differences in the types of activities in which the banks engage, was statistically significant. These results mean that the enhanced soundness and modernization of management realized by Cambodian financial institutions increased the total factor productivity in profitability. At the same time, the statistically significant constant terms suggest that some exogenous factors, including the development of communication technology, contributed to the improvement of profitability.

Table 5. Determinants of TFP Change in the Operating Approach

Table 6 summarizes the results of the regression analysis of determinants of total factor productivity changes in the value-added approach, which focuses on the amount of financial intermediation. Only the constant terms were statistically significant as factors in improving total factor productivity. Neither management characteristics nor ownership characteristics were statistically significant. These results indicate that some factors common to all financial institutions helped Cambodian financial institutions increase the amount of financial intermediation. It is imaginable that among those factors are increased household reserves of financial assets thanks to the stabilized economy and improved economic infrastructure involved in the financial sector, including the energy, communication, and transportation infrastructure.

Table 6. Determinants of TFP Change in the Value-added Approach

5. Conclusion

In this study, we analyzed the determinants of bank managerial efficiency in Cambodia using the annual data of 22 banks in the period 2006 to 2013. To the best of our knowledge, this is the first attempt to conduct a regression analysis regarding the determinants of efficiency and TFP changes in Cambodian banks. Banking reform is currently underway in Cambodia and our results could potentially prove useful to policymakers.

Estimating the determinants of the efficiency scores of Cambodian financial institutions revealed that: (1) the efficiency of large banks is higher and more stable than that of small institutions; (2) banks with foreign capital comprising more than half of total capital are significantly inferior to local institutions with respect to overall operation of the bank; (3) institutions that are more resilient and operate in a more stable manner generate profits more efficiently; and (4) the more diversified institutions are, the more efficient they are. The estimating determinants of the Malmquist index of Cambodian financial institutions revealed that: (5) more sound and diversified institutions tend to increase their total factor productivity, and (6) some exogenous factors, such as increased household reserves of financial assets and improved economic infrastructure, contributed to the improvement of productivity change.

These results indicate that the government should encourage financial institutions to enlarge the size of business, enhance the soundness of management, and diversify their operations. In addition, the government should maintain stable macroeconomic conditions and improve the economic infrastructure, including the energy, communication, and transportation infrastructure.

There are some limitations of this study that will need to be addressed in future studies. The estimations reported in this paper include data on foreign-owned banks that have no specialty in terms of technical ability or experience. In other words, banks whose parent firms do not engage in the banking business are mixed in with banks that have a banking specialty, which potentially affected the estimation results. We need to delineate the ownership structure in more detail in order to advance the analysis of the relationship between ownership structure and bank management.

Cambodia is one of the most dollarized economies in the world. Such a complicated environment affects bank business and possibly influences bank efficiency. In fact, in a dollarized economy, foreign banks do not need to collect local currency deposits, and banks face the risk of a currency mismatch. It is important to address this point in future studies.

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Table 1. Variables Used in DEA

	Value-added approach	Operating approach
Variables	Definition	
Y1:	Deposits	Interest Income
Y2:	Loans	Non-Interest Income
X1:	Interest expenses	Interest expenses
X2:	Number of branchs	Number of branchs
X3:	Number of staff	Number of staff

Table 2. Determinants of Efficiency in the Operating Approach

	Coefficient Fixed effect	t value		Coefficient Random effect	t value	
Log Total Assets	0.030662	0.99		0.030585	1.66	*
Log Z-score	0.108722	3.25	***	0.074008	3.74	***
Foreign Dummy	-0.1852	-3.51	***	-0.12162	-2.95	***
Specialization dummy						
Specialized banks	0			0.114148	1.39	
MFIs	0			0.10768	1.17	
NPLs ratio	0.059513	0.52		0.038486	0.34	
Diversification	0.378012	2.82	***	0.356257	3.04	***
Year dummy	Yes			Yes		
Constant	0.204645	0.47		0.208014	0.74	
Number of observations	181			181		
F value	5			71.99		
F test	0			0		
Wald (Random)						
Adjusted R square						

Note: ***, **, and * indicate significant levels at 1, 5, and 10%, respectively.

Table 3. Determinants of Efficiency in the Value-added Approach

	Coefficient Fixed effect	t value		Coefficient Random effect	t value	
Log Total Assets	0.090939	2.36	**	0.066	2.83	**
Log Z-score	0.092471	2.23	**	0.037787	1.51	
Foreign Dummy	-0.06837	-1.05		-0.04851	-0.94	
Specialization dummy						
Specialized banks	0			0.30988	2.97	***
MFIs	0			-0.36396	-3.09	***
NPLs ratio	-0.04011	-0.28		-0.00126	-0.01	
Diversification	0.327537	1.97	**	0.172799	1.18	
Year dummy	Yes			Yes		
Constant	-0.64479	-1.2		-0.19622	-0.55	
Number of observations	181			181		
F value	1.14			109.41		
F test Wald (Random)	0.3343			0		
Adjusted R square						

Note: ***, **, and * indicate significant levels at 1, 5, and 10%, respectively.

Table 4. Cumulative TFP Change, Technical Change, and Efficiency Change

	2006-2009	2009-2013	2006-2013
Operating Approach			
efficiency change	1.301	1.398	1.819
technical change	1.087	0.943	1.025
TFP change	1.296	1.269	1.645
Value-added Approach			
efficiency change	1.461	1.090	1.593
technical change	1.100	1.344	1.479
TFP change	1.534	1.386	2.126

Table 5. Determinants of TFP Change in the Operating Approach

	Coefficient Fixed effect	t value		Coefficient Random effect	t value	
ΔLog Total Assets	0.211742	1.19		0.217268	1.3	
ΔLog Z-score	0.352145	2.02	**	0.351556	2.14	**
Foreign Dummy	-0.35907	-0.77		-0.06499	-0.53	
Specialization dummy						
Specialized banks	0			0.17045	1.25	
MFIs	0			0.240762	1.72	*
ΔNPLs ratio	-0.56181	-1.07		-0.43967	-0.89	
ΔDiversification	0.945471	1.55		1.037949	1.76	*
Year dummy	Yes			Yes		
Constant	1.229335	4.42		1.003488	6.15	
Number of observations	142			142		
F value	2.74			36.84		
F test						
Wald (Random)	0.0037			0.0004		
Adjusted R square						

Note: ***, **, and * indicate significant levels at 1, 5, and 10%, respectively.

Table 6. Determinants of TFP Change in the Value-added Approach

	Coefficient Fixed effect	t value		Coefficient Random effect	t value	
ΔLog Total Assets	0.242989	1		0.280956	1.26	
ΔLog Z-score	0.279766	1.17		0.314801	1.43	
Foreign Dummy	-0.42305	-0.66		0.00987	0.06	
Specialization dummy						
Specialized banks	0			-0.70282	-1.06	
MFIs	0			0.826968	1.05	
ΔNPLs ratio	-0.75189	-1.05		-0.70282	-1.06	
ΔDiversification	0.792536	0.95		0.826968	1.05	
Year dummy	Yes			Yes		
Constant	1.268655	3.34		0.935309	4.71	
Number of observations	142			142		
F value	1.34			18.31		
F test						
Wald (Random)	0.2116			0.1463		
Adjusted R square						

Note: ***, **, and * indicate significant levels at 1, 5, and 10%, respectively.