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FOREIGN OWNERSHIP AND BANK EFFICIENCY: EVIDENCE FROM VIETNAM USING TWO-STAGE DEA BOOTSTRAP APPLICATION

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Abstract

This study aims to examine the relationship between foreign ownership and the efficiency of banks. Foreign ownership is examined not only in foreign banks but also through foreign stakeholders' shares in domestic banks. Therefore, the study contributes to the literature in terms of taking into account the degree of foreign ownership in the capital structure to analyze the relationship between ownership and the management of banks. The method, Two-stage DEA bootstrap of Simar and Wilson (2007), is applied to a panel dataset of 27 Vietnamese banks for the period from 2009 to 2016. The results indicate that foreign ownership has a positive effect on bank performance. In particular, the higher the share that foreign investors hold in banks over the total capital, the better banks perform. In addition, bank size, concentration level, diversification, risk, Cost Over Assets ratio (COA), as well as GDP, determine bank efficiency. One of the critical policy implications from the study is that the policymaker should consider extending the current maximum degree of foreign ownership in any local bank in order to achieve a better banking performance.

Keywords: Vietnamese banks, efficiency, foreign ownership, DEA, bootstrapping regression

INTRODUCTION

Considerable changes in bank ownership structure have been observed all over the world concerning financial globalization (Obstfeld and Taylor, 2004). Following that, the shares of foreign investors occupied in banks' capital structures have increased. Furthermore, since the financial sector in general or the banking industry, in particular, plays a vital role in economic

growth and development, recent studies focusing on the effect of foreign ownership on banking performance are numerous. The previous studies mainly focused on examining this relationship by comparing bank efficiency based on different ownership status and had mixed results. The positive effect was found in some studies of Berger et al. (2000), Jemric and Vujcic (2002), Sturm and Williams (2004), Fries and Taci (2005), Lin and Zhang (2009), Sanyal and Shankar (2011), and Shaban and James (2018) while an opposite trend was observed by others (Zajc, 2006; Lensink and Naaborg, 2007; Micco, Panizza and Yanez 2007; Cornett et al., 2010; Manovo, and Vernikov, 2017; Dinh, Fung, and Jia, 2019). In general, previous studies have concentrated on mainly only foreign banks' performance. However, the role of foreign ownership in banking performance is also presented through foreign shareholders in the domestic banks. In other words, the effect of ownership structures on banks' performance has not been explored sufficiently.

Regarding the methodology, the non-parametric method, traditional Two-Stage Data Envelopment Analysis, is one of the most popular techniques for banking efficiency analysis. However, this method has limitations that might lead to bias estimation. In detail, in the traditional two-stage method, the efficiency scores estimated in the first stage will be the dependent variable for the second stage regression (Tobit like). In this process, these estimated efficiency scores are treated as independent observations. Thus, it leads to the problem of invalid inference caused by serial correlation.

The study applies the method procedure proposed by Simar and Wilson (2007) to a panel data set of 27 commercial banks for the period from 2009 to 2016 in Vietnam in order to examine the relationship between foreign ownership and banking performance. The study contributes to the literature in several ways. First, using a more precise variable represented for the ownership of banks, particularly to the foreign share of capital instead of a dummy variable, the study provides a more comprehensive and sufficient overview of the relationship of ownership structure and banks' operational efficiency. In detail, the study examines the effect of foreign ownership not only through the foreign banks' business but also their stake holdings in local banks. Thus, it provides a better overview of the role of foreign investors in the banking market by catching up on the degree of foreign ownership in banks' capital structures. Second, the Two-Stage DEA Bootstrap method of Simar and Wilson (2007), which is applied to determine factors that affect bank efficiency, is expected to provide a more reliable result since it overcomes the drawbacks of the traditional Two-Stage DEA method. Lastly, implications for achieving a better financial system in terms of technical efficiency are obtained.

Vietnam has been one of the impressive countries in terms of achieving a high and stable economic growth over the past 30 years. Following that, the financial sector in general or

the banking industry in particular of the country, has experienced transformations along with economic development. For instance, regarding the entry of foreign investors in the banking market, Vietnam, which is not out of the globalization trend, opened its door to foreign investors to establish their business in the banking industry since the early 1990s. The foreign participants first opened their branches or set up joint venture banks with local banks. The first wholly-foreign bank had a permit to establish under the governmental Decree 22/2006/ND-CP after the accession to the WTO in 2007. From the first foreign bank, HSBC, currently there are seven foreign-owned banks in the market. Besides, the presence of foreign ownership is also observed through the capacity of taking their stakes in domestic banks as strategic partnerships. According to the current regulations, the degree of foreign ownership in any local bank is limited to 30 percent; the limit is 20 percent for a strategic stakeholder in local bank capital structure and is only 15 percent for a non-strategic partner for the regions as well as other transition and developing markets. Moreover, the period of 2009-2016 is the time when Vietnam has witnessed changes in the banking system since it covers the period of the restructuring program implementation. According to that reform, the government encouraged local banks' self-restructurings or merger and acquisition activities. The entry of foreign ownership into the financial market has been taken place in many developing countries. Analyzing the Vietnamese case is expected to reveal beneficial information and policy implications.

The structure of this paper is as follows. After the introduction part, the paper continues with section 2, which summarizes the literature on bank performance in particular to the effect of foreign ownership on bank efficiency. Following that, section 3 describes in detail the methodological process recommended by Simar and Wilson (2007), which is applied in the study. Finally, sections 4 and 5 provide the main findings and conclusions of the study, respectively.

RELATED LITERATURE REVIEW

Over the last two decades, the share of banks owned by foreign investors has risen worldwide (Cull, Peria, and Verrier, 2018). Following that, there had been a growing number of studies examining the effect of foreign ownership on bank efficiency. The majority of previous studies, applying whether the stochastic frontier approach (SFA) or data envelopment analysis (DEA) method, provide evidence showing that the foreign participants are likely to perform better than the local players. Since the presence of foreign ownership usually links with access to external finance, innovative technology, and international expertise, foreign banks are more efficient. This argument is considered as “global advantage” hypothesis (Berge et al., 2000). Focusing on

the bank performance in developing countries, evidence which confirms the superiority of foreign banks in the operating efficiency was found on Berger et al. (2000), Jemric and Vujcic (2002), Sturm and Williams (2004), Fries and Taci (2005), Lin and Zhang (2009), Micco, Panizza and Yanez (2007), and Cornett et al. (2010). For instance, Fries and Taci (2005) applied SFA to examine banking efficiency in 15 transition countries. It showed that foreign banks have a higher cost efficiency than local banks. Similarly, Sanyal and Shankar (2011), Ferri (2009), Lin and Zhang (2009) observed the same trend for the cases of Indian and Chinese banking market. Recently, in the study of Shaban and James (2018), SFA and Tobit regression were used to investigate the effect of ownership change on banks' efficiency of 60 Indonesian commercial banks from 2005 to 2012. It revealed that private and foreign banks are more efficient than state-owned banks in terms of profit-making. A bank is considered as a foreign bank if the total capital share of foreign investors accounted for at least 50.01%, a dummy variable is presented to define the foreign ownership in the model. On the other hand, the fact that foreign banks are less efficient than other groups was found in the studies of Zajc (2006), Lensink and Naaborg (2007), Manovo and Vernikov (2017). In this case, the reasons for that observation can be explained by the “home field advantage” hypothesis. This hypothesis states that the local banks have benefits coming from the vast business network as well as the regulation. Similarly, Claessens and Van Horen (2012) found a negative effect of foreign ownership on bank performance. The very recent study (Dinh, Fung, and Jia, 2019) indicated a lower level of profit and cost efficiency of foreign banks compared to the other counterparts.

In addition, some cross-country-level studies had examined the relationship between foreign ownership and the banks' performance. For instance, Gallizo Moreno, and Salvador (2016) analyzed how the change in ownership affects banks' efficiency for the case of Central and Eastern Europe by applying the SFA method into a panel data set including 189 banks from 12 countries. It found that the effect of foreign ownership was extremely small. Lin, Doan, and Doong (2015) applied the same methodology and analyzed the efficiency and ownership structure of 12 Asian countries for the period between 2003 and 2012. It showed that bank efficiency is higher with a foreign presence. Hermes and Nhung (2010) analyzed the effect of liberalization on banks' performance for a sample of banks from 9 countries in Latin America and Asia (including Argentina, Brazil, Peru, Mexico, India, Indonesia, Korea, Pakistan, Philippine, and Thailand). By applying a panel least square fixed-effect model, the study revealed that there is a positive effect of liberalization on bank efficiency. Another research for the ASEAN countries of Gardener, Molyneux, and Linh (2011) investigated the effectiveness of 5 countries including Indonesia, the Philippine, Malaysia, Thailand, and Vietnam from 1998 to 2004 by using DEA and Tobit regression. It showed a negative impact of the post-1997 crisis

restructuring on bank performance. In addition, foreign banks perform better than local banks, while the state-owned banks achieve a higher efficiency level than private banks. This study has focused on the role of ownership in banks' operations. However, once again, it used ownership dummy variables in order to distinguish between different ownership statuses of banks among domestic state, domestic private or foreign ownership. Thus, the degree of foreign ownership has not been taken into account.

Regarding the methodology, the non-parametric method, DEA has been the most popular method in efficiency evaluation studies, thus, it has been applied worldwide with a variety of applications (Mansour and Moussawi, 2019). Recently, the method suggested by Simar and Wilson (2007) has been recognized as an advanced approach for efficiency evaluation researches. The serial correlation among DEA efficiency scores is mentioned as a serious problem coming from the traditional two-stage method (Xue and Harker, 1999; Hirschberg and Lloyd, 2002; Simar and Wilson, 2007). Sufian (2016) recently examined the Malaysian banking sector more focusing on the link between foreign ownership and banks' efficiency by applying this advanced method. It found out that it is a positive effect. However, Sufian (2016) also considered only foreign banks while using a dummy variable to define foreign ownership as most of the previous studies did.

Briefly, the previous studies have mainly focused on the operations of foreign banks while analyzing the impact of foreign ownership on the banks' efficiency. Thus, there is a lack of evidence which has taken into account the partial foreign ownership banks. In general, partial foreign ownership is not a new trend rather than a common situation in the banking industry, especially for the cases of developing countries. Moreover, in most of the previous cases, the variable represented for the foreign ownership in the regression model is a dummy variable, which will be equal to 1 when a bank is considered as foreign bank and 0 otherwise. Specifying the foreign ownership in this way leads to a lack of understanding about the degree of foreign ownership and have ignored the presence of foreign ownership through their stake holding in the local banks.

As for the Vietnamese banking sector, Nguyen (2007) employed DEA to investigate the efficiency of 13 Vietnamese banks for three years, from 2000 to 2003. Following that, the research of Nguyen and De Borge (2008) analyzed the performances of 15 Vietnamese banks between 2003 and 2006 by applying single bootstrap efficiency and Malmquist index analysis. More recently, Nguyen, Nghiem, Roca, and Sharma (2016) examined the cost efficiency of Vietnamese banks from 2000 to 2014 by applying SFA and DEA. The study indicated that the efficiency of Vietnamese banks had followed a slight upward trend in which state-owned banks have outperformed joint-stock banks. Besides, the efficiency of Vietnamese banks has

experienced a decreasing trend since partial acquisition. Public listing effects on the efficiency of banks are not statistically significant. However, none of these papers has examined the role of foreign ownership, particularly to the foreign share in Vietnam's banking system. Thus, the literature related to the performance of banks in Vietnam has not investigated the role of foreign ownership sufficiently. The presence of foreign ownership in the Vietnamese financial market not only through the foreign bank but also in the domestic bank has been increased, especially after joining WTO in 2007. Therefore, the effect of foreign ownership on the operations of banks in Vietnam has not been analyzed comprehensively.

To sum up, the change in the ownership structure of banks has taken place more intensively not only in Vietnam but also in other developing countries. Partial-foreign ownership has been a common trend in the financial market. Although the effect of foreign ownership on the performance of banks has been initially explored by examining the operation of foreign banks, the impact of foreign ownership through their participation in other domestic banks has been unknown. Therefore, the role of foreign ownership over the efficiency of banks should be considered sufficiently by analyzing the partial-foreign banks.

METHODOLOGY

Research Design and Model Specification

As can be seen from the literature, the stochastic frontier approach (SFA) and data envelopment analysis (DEA) are the two main methods applied in numerous efficiency evaluation studies. Related to the banking industry SFA was used in Fries and Taci (2005), Yao et al. (2007), Jiang, Yao, and Zhang (2009), Sun and Chang (2011). However, there are arguments that DEA is a more robust method to investigate the efficiency of financial institutions. For instance, the benefits of DEA come from the fact that DEA requires fewer assumptions while in SFA, the functional form of production function has to be specified. Therefore, using DEA instead of SFA leads to a low chance of misspecifications (Davidova and Latruff, 2007; Khan, Ali, and Khan, 2018). In addition, since DEA can be applied for various combinations of multiple inputs and outputs, this methodology is suitable for various efficiency studies among different sectors, countries as well as other economic entities. As a result, DEA has become a preferred method in terms of efficiency evaluation (Sufian and Habibullah, 2011; Hou, Wang, and Zhang, 2014).

As for the financial sector, nonparametric DEA has also been a useful and well-known method for evaluating the performance of DMU. Following that, the two-stage DEA method has been widely used to define the determinants of financial institutions' efficiency. However, according to Simar and Wilson (1998), there are several problems with the conventional DEA

Two-Stage method. First, dependent variables in a DEA model are unobserved and are replaced by the estimated value. Second, the estimated efficiency scores used in the second stage might be correlated serially. The third is that the correlation between the error term of estimated DEA efficiency variables in the first stage and other environmental variables in the second step exists. Taking all of these issues, the conventional Two-Stage DEA might violate the required basic regression model assumptions. The study applies the DEA bootstrap method of Simar and Wilson (2007), which overcomes the problems mentioned above. The method's basic idea is based on a data-generating-process in order to improve statistical efficiency in the second-stage regression. The applications of the technique proposed by Simar and Wilson (2007) are various among sectors. As for banking efficiency studies, the evidence of using this advanced method are found on Okuda and Aiba (2015), Assaf, Barros, and Matousek (2011), Chortareas, Girardone, and Ventouri (2013), Stewart, Matousek, and Nguyen (2016), Wanke, and Barros (2014), Brissimis, Delis, and Papanikolaou (2008), Zhang and Matthews (2012), Kenjegalieva, Simper, and Weyman-Jones (2009), See and He (2015), Sufian (2016).

In detail, as for the estimating process of the method, Simar and Wilson (2007) provide two procedures, which are algorithm 1 and algorithm 2 considered as single bootstrap and double bootstrap method for efficiency study, respectively. Although both of these two procedures are expected to give better estimations than the traditional Two-Stage DEA, based on the Monte Carlo experiments' results, it is suggested that we would prefer the use of algorithm 2 to the algorithm 1 (Simar and Wilson, 2007). Therefore, this study applies the method proposed by Simar and Wilson (2007), in particular, algorithm 2. The process of the methodology, which is used in this study, is described as follows.

Let's assume the model is that $\gamma_{it} = f(z_{it}|\beta) = \beta z_{it} + u_{it}$

Where, γ_{it} is the technical efficiency of bank i in the year t, z_{it} is the vector of environmental variables as determinants of bank efficiency, and u_{it} is the error term.

- Step 1: In the first stage, the technical efficiency γ of each bank is obtained each year by employing an input-oriented DEA model for the case of variable return to scale assumption (see Banker, Charnes and Cooper, 1994).
- Step 2: The study obtains the estimator $\hat{\beta}$of β in the regression of γ_{it} on environmental variables z_{it} in the model by using the maximum likelihood method. The value of the estimator$\hat{\sigma}$ ofσ is also obtained from this truncated regression process.
- Step 3: Loop the next steps from a to c N_1 times to get the bootstrap-replication set $R_1 = \{\hat{\beta}_b^*, \hat{\sigma}_b^*\}_{b=1}^{N_1}$

a. For each of bank within the sample, i=1,…,m, from the normal distribution $N(0, \hat{\sigma}_u^2)$ with bilateral truncation at $-z_{it}\hat{\beta}$ and1 $- z_{it}\hat{\beta}$ draw u_{it}^*

b. For each of bank i=1, …,m, again calculate $\gamma_i^* = z_{it}\hat{\beta} + u_{1i}^*$

c. Set $x_i^* = x_i \; and \; y_i^* = y_i\hat{\gamma}_i/\gamma_i^*$ in order to create a pseudo data set, where i=1,…,m.

d. Base on the data set in section c, calculate $\hat{\gamma}_i^*$ which is considered as the bootstrap estimation of technical efficiency score by replacing X, Y with $[x_1^*, \dots, x_i^*]$ and $[y_1^*, \dots, y_i^*]$, respectively.

- Step 4: Calculate the value of $\hat{\hat{y}}_i$ which is the bias-corrected estimate for each bank where $\hat{\hat{y}}_i = \hat{y}_i - \widehat{bias}_i$ and $\widehat{bias}_i$ is the bootstrap estimate of bias.
- Step 5: Again, apply maximum likelihood method for the truncated regression of the bias-corrected estimate ($\hat{\hat{y}}_i$) on the environmental variables(z_i) in order to obtain ($\hat{\hat{\beta}}, \hat{\hat{\sigma}}$).
- Step 6: The next three steps [6.a-6.c] are repeated N_2 time, yielding a bootstrap estimate set $R_2 = \left\{\hat{\hat{\beta}}_b^*, \hat{\hat{\sigma}}_b^*\right\}_{b=1}^{N_2}$

a. For each of bank within the sample, i=1,…,m, from the normal distribution $N(0, \hat{\hat{\sigma}}_u^2)$ with bilateral truncation at $-z_{it}\hat{\hat{\beta}}$ and1 $- z_{it}\hat{\beta}$ draw u_{it}^*.

b. Calculate $\gamma_i^{**} = z_{it}\hat{\hat{\beta}} + u_i$ for each bank, i=1,…,m.

c. Apply the maximum likelihood method to the truncated regression of $\widehat{\gamma_i^*}$ on $z_i$in order to obtain the estimates ($\widehat{\widehat{\beta^*}}, \widehat{\widehat{\sigma^*}}$).

- Step 7: Use the bootstrap value in R_2 set, as well as the value of estimators, construct the confidence intervals for each of estimates.

Although the study applies the algorithm 2 procedure, the regression results of algorithm 1 are also provided for the robustness check. The explanations of the algorithm 1 are given in the appendix.

Data and variables specified

A data set is collected from the Annual Report of The State Bank of Vietnam and the financial reports of Vietnamese banks for the period from 2009 to 2016. There are 27 Vietnamese commercial banks (see Appendix) in the sample, including state-owned, joint-stock, foreign and joint venture banks. Since the first wholly- foreign bank in Vietnam has started in 2008 after Vietnam became the 150th member of WTO. Therefore, it is reasonable to choose the year 2009 as the starting point to investigate the impact of foreign ownership on banks' performance. In

addition, the data set is extended up to the year 2016 in order to keep the sample size not too small due to the data availability limitation. Noticeably, that 8-year period covers the first financial restructuring program (2011-2015) in the country, when many of the ownership structures have been changed in the banking market. Thus, the data set used is appropriate with the study's main aim and also is the most available updated data. The macroeconomic variables are retrieved from the World Bank's World Development Indicators database. In order to obtain a balanced panel data, the study excludes banks which have not been existed for the whole research period due to merger and acquisition (M& A) activities.

Regarding the input and output choices, there is no perfect selection for all of the banking efficiency evaluations. Arguments are made in order to choose the suitable inputs and outputs for efficiency analysis. In general, there are two common approaches used to apply for banking industry studies. They are production and intermediate approach. The intermediate approach considers banks as the intermediations between lenders and borrowers. Thus, the main function of a bank is transforming deposits into loans. Following this, loans is considered as output while deposits refers to input of banks. On the other hand, the production approach which also named as value-added approach concentrates on the capacity of providing banking services to the customers. This value-added approach was first introduced by Benston (1965). Since the intermediate approach more focuses on transforming deposits into loans which is the conventional banking business operation, thus, the approach is more suitable for the cases of underdeveloped financial industries, in particular, before deregulation (See Okuda and Aiba, 2015). Therefore, the study follows the value-added approach when making a decision toward inputs and outputs since Vietnam has opened the financial market. Following that, the model includes three outputs and three inputs described in Table 1. The output variables are total loans(Y1) which are loans for the corporate sector as well as the private sector and other loans; total deposits(Y2) which are total deposits coming from private and cooperate customers; and total investment securities(Y3) measured by the combination of investment and securities for trading while interest expense (X1), operation expense (X2) and provision for loan loss (X3) are used as inputs. Tables 1 and 2 provide information related to inputs and outputs in detail.

Table 1. Inputs and output used

Outputs	**Inputs**
Loans	Interest expense
Deposits	Operation expense
Investment securities	Provision for loan loss

Table 2. Descriptive statistics of inputs and outputs (Unit: 1,000 VND)

Variable	Observations	Mean	Std. Dev.	Min	Max
Loans	216	92,300,000	144,000,000	317,529	732,000,000
Deposits	216	106,000,000	153,000,000	1,161,517	866,000,000
Investment securities	216	24,700,000	29,100,000	19,250	158,000,000
Interest expense	216	7,192,146	9,320,652	138,921	50,500,000
Operation expense	216	2,667,299	3,819,345	72,219	26,300,000
Provision for loan loss	216	1,167,002	2,181,269	0	13,000,000

Table 2 indicates that the Vietnamese banks, on average, have a higher level of their total deposits than total loans. This observation is similar to the case of banks in Taiwan (Lin, Doan and Doong, 2015) but different from the situation observed in Australia where the total loans are relatively the same as the total deposit (Sturm and Williams, 2004). Furthermore, the standard deviations of all output variables are quite high; thus, it implies that the sample reflects the differences in bank size.

As for variables used in the regression model, the efficiency of banks is regressed on ten environmental variables following the procedure proposed by Simar and Wilson (2007). The bootstrap procedure applied is explained in the methodology section. The potential determinants of banks' efficiency added to the regression models are as follows.

Bank size

From the literature, the argument that bank size determines the performance of the financial institutions is confirmed by many studies. In general, a larger size bank in terms of assets is expected to achieve a better efficiency level since it reaps the advantage of the extensive business network or market share. In addition, large companies might perform better since they can allocate their resources more efficiently, benefits from the scale (Alvarez and Crespi, 2003). For instance, Assaf, Barros, and Matousek (2011) showed a positive effect of bank size on performances of banks. Similarly, the same trend was observed in the studies of Stewart, Matousek, and Nguyen (2016); Wanke, and Barros (2014). In this study, the logarithm term of total assets was used as the variable represented for bank size.

Foreign ownership

As mentioned earlier, the study tries to utilize the degree of foreign ownership in banks' operation. Thus, a variable which is the total capital share of all foreign shareholders in a bank

is considered as a proxy for foreign ownership. A higher foreign share indicated a higher degree of foreign ownership. Thus, this specification takes into account the presence of foreign ownership among both foreign and partial-foreign ownership banks. Most of the previous studies have examined the effect of ownership, in particular, foreign ownership on the performance of banks given mixed results by merely comparing the efficiency levels between foreign banks and their counterparts. Since the main aim of the study focuses on the relationship between foreign ownership and banks' efficiency, more discussions regarding this ownership factor are already given in the literature section.

Concentration level

Since the fact that the banking sectors are dominated by some of the large banks which are likely state-owned banks or used to be transformed from the state banks is common in developing countries. It is reasonable to control the concentration level of a bank in terms of the market share in the regression model. Following Beck, Dermiguc-Kunt, and Levine (2006), the study uses the market share of an individual bank in terms of deposit as a proxy of concentration level and tests whether it determines banks' efficiency.

Risks

Risk preference has been considered as a vital element of production in the banking business. Thus, the study models it into efficiency measurement by using two variables represented for credit risk and capital risk in order to control the risk-taking behaviors of banks. The rate of provision for loan loss over total loans is used as a proxy of credit risk while the EOA, the rate of equity over total assets, is used as a proxy of capital risk. In general, it is more often to use non-performing-loan (NPL) to capture credit risk in the banking system. NPL is widely used in banking efficiency studies (Kasman and Kasman, 2015). However, due to the limitation of data availability, the study chooses the provision for loan loss information instead of NPL. Since the more NPL rate a bank has, the more provision loan loss the bank has to ensure the provision rate is expected to be a good measure of credit risk. In general, a higher credit risk level often links with lower efficiency. Evidence showing a negative effect of credit risk on bank efficiency was found on Sufian (2009); Berger and DeYoung (1997). However, in the study of Sufian (2016) credit risk presented as the rate of loan loss provision over total loans was not a statistically significant factor that determines the performance of the Malaysian banks.

As for EOA, the higher rate of EOA indicates a lower capital risk level or higher capitalism; thus, it usually links with a better performance. Most of the previous studies revealed

that a high capitalized bank likely performs better than a low capitalized bank. For instance, by analyzing the efficiency of Chinese banks from 2004 to 2009, the study of Pessarossi and Weill (2015) showed a positive impact of the capital rate on the performance of banks. Bank with a higher capital ratio is better in terms of cost-efficiency. More discussions regarding the relationship between EOA and banks' performance were found on Mester (1996), Casu and Molyneux (2003), Carbo, Gardener and Williams (2003), Williams and Nguyen (2005), Jiang, Yao, and Zhang (2009).

Diversification

The study uses the ratio of non-interest income over the total income to catch up on how banks diversify their business. It is necessary since different financial institutions might have different strategies in terms of business diversification apart from the traditional operation focusing on deposits-loans transformations. Moudud-Ul-Huq et al. (2018) indicated a robust positive effect of income diversification on banking production while analyzing the case of ASEAN countries. Okuda and Aiba (2015) also pointed out that the diversification rate significantly affects the overall operational efficiency. This evidence supports the argument that benefits from business diversification exceed the cost.

Macroeconomic conditions

In order to address the concern that the efficiency of the bank might be sensitive to the macroeconomic conditions, the study adds two following variables into the model. They are GDP, is the GDP growth rate, and also the inflation rate, which is the Consumer Price Index (CPI). Typically, a stable and promising economic background supports the banking business. Thus, a higher GDP growth rate and not high inflation rate link with a higher banking efficiency level.

Others variables

The study also includes the financial ratio such as COA, which is the rate of total cost over total assets; ROA, which is the Return Over Asset ratio to the model since these two ratios are usually considered as the valuable information obtained quickly from the financial reports. The summary descriptions of all variables used in the regression model are provided in the Table 3.

Table 3. Variables descriptions for the regression model

Variable	Symbol	Expected sign	Description
Dependent variable			
Bank efficiency	**Efficiency**		Efficiency score (Algorithm 1) Bias-corrected efficiency score (Algorithm 2)
Independent variable			
Macroeconomic condition	**GDP**	**+**	Annual GDP growth
	Inflation	**-**	Inflation rate measured by the Consumer Price Index (CPI)
Bank characteristic	**Ln total asset**	**+**	Bank size measured by the nature logarithm of total assets
	HHI	**+/-**	Concentration level measured by the market share regarding deposits
	COA	**-**	The rate of the total cost over total assets
	ROA	**+**	Return on Assets measured by the ratio of profit over total assets
	EOA	**+**	The rate of equity over total assets
	Diversification	**+/-**	The rate of non-interest income over the total income
	Provision rate	**-**	The rate of provision for loan loss over total loans
Ownership structure	**Foreign share**	**+/-**	The foreign investors' share in the capital structure

ANALYSIS AND RESULTS

The results of this study follow the analyzing procedure of Simar and Wilson (2007). The efficiency estimations following algorithm 2 are presented in Table 4. The overall efficiency of Vietnamese banks for the period of the study is, on average, around 0.71 according to original efficiency estimates and approximately 0.61 as for the bias-corrected efficiency scores. In general, the bias-corrected efficiency scores are lower than those from the original efficiency estimates. However, both estimates indicate that over 8-year-period, there is a slight decrease in bank efficiency in the first haft of the research period while the second half observes a gradual increase in efficiency level. In addition, the lowest efficiency level is found for the year 2012, according to both estimations. This observation is reasonable for the following reasons. First, the Vietnamese government applied an extremely tightening monetary policy in 2012 in order to control the extremely high inflation. Thus, it might lead to a direct impact on the credit

market. Second, 2011-2012 might be an unstable period for banking business since the restructuring program for the financial sector has just started.

Table 4. Efficiency estimates

Year	Observations	Efficiency score	Bias-corrected efficiency score	Bias
2009	27	0.7316	0.6352	0.1398
2010	27	0.7404	0.6477	0.1353
2011	27	0.6018	0.5188	0.1223
2012	27	0.5493	0.4875	0.0959
2013	27	0.6630	0.5797	0.1235
2014	27	0.7772	0.6527	0.1785
2015	27	0.7791	0.6795	0.1520
2016	27	0.7983	0.6740	0.1750
	Mean	0.7051	0.6094	0.1403

Table 5. Descriptive statistics of regression variables

Variable	Observation	Mean	Std. Dev.	Min	Max
Ln total asset	216	18.18599	1.176071	15.01847	20.72965
GDP	216	0.0595	0.0053	0.0520	0.0680
Inflation	216	0.0737	0.0507	0.0088	0.1868
Foreign share	216	0.1178	0.2162	0.0000	1.0000
HHI	216	0.0347	0.0461	0.0004	0.2288
ROA	216	0.0097	0.0149	-0.0551	0.1837
COA	216	0.0727	0.0265	0.0235	0.2671
EOA	216	0.1032	0.0484	0.0038	0.3324
Diversification	215	0.2312	0.1954	-0.2594	0.9630
Provision rate	216	0.0114	0.0115	0.0000	0.1122

Table 5 provides information related to a summary statistic of all of the independent variables used in the regression model. In general, the mean value of the foreign share variable is very small, nearly 12%. If we take a look at the foreign share's summary in detail by year (see appendix), it is clear that the foreign share, on average, has gradually increased over the research period. However, it still accounted for a tiny proportion of bank capital structure. Regarding the diversification and provision rate, these two variables have quite a high standard deviation implying that the differences in credit risk and business diversification among banks

are relatively high. Similarly, the high standard deviation is also observed for the concentration variable, HHI, implying a high variation in the market share of banks in the sample.

Table 6. Determinants of efficiency for the Vietnamese banking system

	Coefficient Algorithm2		Coefficient Algorithm1	
Ln total asset	0.0620	***	0.0617	***
	(0.0163)		(0.0222)	
GDP	5.5702	***	6.1084	***
	(1.5158)		(1.9265)	
Foreign share	0.1757	***	0.2105	***
	(0.0369)		(0.0523)	
Inflation	0.1020		-0.1046	
	(0.1911)		(0.2468)	
HHI	-0.8808	***	-0.7081	*
	(0.3184)		(0.4150)	
ROA	0.4854		0.7366	
	(0.5983)		(0.9253)	
COA	-3.3506	***	-3.6086	***
	(0.4124)		(0.5900)	
Diversification	0.1486	***	0.1422	**
	(0.0449)		(0.0590)	
EOA	0.4998	**	0.4780	
	(0.2543)		(0.3491)	
Provision rate	-1.3807	*	-1.4585	*
	(0.7282)		(1.4414)	
Constant	-0.6656	**	-0.6027	
	0.3183		0.4447	
Number of observations	216		216	
Number of bootstrap replications	2000		2000	

*,**, and *** indicate 10%, 5%,and 1% significance level; Standard errors are presented in the brackets.

Note: The study can achieve a more accurate estimation with a large number of replications. However, time consumed will also rise when we increase that number (Simar and Wilson, 2007).

The result of the regression model is represented in Table 6. The study finds that foreign share has a positive effect on the efficiency of banks at 1 percent significance level, according to both two algorithms' estimations. It implies that the higher the proportion accounted for foreign

investors in a bank's capital structure, the more efficient the bank performs. This observation supports previous studies (Grigorian and Manole, 2002; Havrylchk, 2006), concluding that foreign ownership had made banks operate more efficiently. However, results provide evidence showing that not only foreign banks perform better but also the domestic banks with foreign stakeholders will increase their efficiency levels as the foreign share rises. In the developing countries where the deregulation in the financial market usually have taken place over the last two decades, the participation of the foreigner players in the banking industry has been increased gradually. The finding above is reasonable and supports the argument of (Levine, 1996; Goldberg, 2004; Stiglitz, 1993) regarding the benefits brought by the foreign bank ownership. In particular, in developing countries, foreign ownership is likely to link with a higher ability to raise capital, providing innovative products, and also improvements in technical skills. The presence of foreigners in the financial market trends to lead to increasing competition. Thus, it might improve the strength and the consolidation of the market in the long term (Detragiache, Tressel, and Gupta, 2008).As for the case of partial foreign banks, the advantage of capital coming from the foreign strategic investors may lead to an increase the efficiency of banks since it brings not only the innovative technology and management capacity but also human capital to the local banks (Nguyen, Nghiem, Roca, and Sharma, 2016). The quality of clients, thus, is better in the cases of banks with higher foreign shareholdings. Moreover, in other words, modern cooperation governance and advanced technology can be transferred to the domestic banking sector by the appearances of foreign shareholders.

Moreover, taking a look over the situation of the banking market in Vietnam, the recent period has witnessed a slight increase of the local banks having partial foreign ownership. However, the maximum rate of stakes in one local bank of foreign participants is limited at 30 percent (Decree 01/2014/ND-CP). From the viewpoint of the government as well as the central bank, these limits are announced in order to support the domestic banks and aim to ensure the safety of the national financial system. Since the banking industry is such a sensitive business, any revision in the foreign ownership related regulation can have to be considered carefully and seriously. Also, Vietnam has completed the reform, so-called "restructuring financial institutions 2011-1015", in which the government encourages or forces weaker banks to engage in merger and acquisition activities. The reform seems to be going well. However, the banking system still needs more improvements regarding small and existed weak banks so that the government is now planning for the next stage of an overhaul (Winterbottom, 2015). Some reports indicated that the Central bank of Vietnam is now considering extending the aggregate level of ownership of all foreigners in any local bank. Moreover, many of them also reported that the local banks in Vietnam need to increase a considerable amount of additional capital to catch up with the

BASEL II requirements, which have been introduced and also to deal with the non-performing-loans. However, up to the present, nothing similar to these above concrete proposals has been taken into action. Considering the result from the study regarding the effect of the foreign share and also taking into account other conditions of the economy, policy implications are suggested toward a slight extension of the foreign investor cap in a local bank. The extension process can be taken place gradually rather than have a massive change at first in that limit. It is worth to consider the revision of foreign share cap in Vietnam if we take a view on the same trend in the neighbor countries. For instance, the foreign shareholding ceiling was extended up to 100 percent since 1997 in Thailand, while the Philippines did the same thing in 2000. As for Malaysia, the limit for foreign shareholding has been changed from 30 to 40 percent in 2007. Furthermore, this implication might support the target of the process of privatization in which targeting to reduce the state ownership share of the state banks at a maximum rate of 65% by 2025 (SBV). As for the case of other private banks, this implication can help them increase capital by attracting more foreign investors. As a result, the milestone for the Vietnamese banking sector refers to increasing the banks' capital to catch up with the international standard BASEL II criteria might achieve efficiently.

As for the whole banking market, relaxing the capital cap for foreign investors in local banks is expected to bring a positive effect. According to Douma, Geoge, and Kabir (2006), Meyer et al., (2009), Chan, Koh, and Kim(2016), foreign shareholders bring additional and superior resources coming from finance, advanced technology, branding, management capacities as well as the international business experiences, thus, the effect of market imperfection is reduced. In other words, it provides access to foreign banks' global business and operation standards. Pieces of evidence were found for the case of China and Hungary in the studies of Fries and Taci (2005) and Hasan and Marton (2003), respectively.

Regarding other environmental variables, the total assets variable has a positive effect on bank efficiency at 1 percent significance level in both estimations. It suggests that a larger-size bank is more operationally efficient. Moreover, algorithms 1 and 2 confirm that EOA (equity over assets) shows a positive effect while the ratio of cost over assets (COA) reveals a negative impact on bank efficiency at the 1 percent significance level. It is likely to observe a better performance in the case of a bank with a higher ratio of EOA and less ratio of COA. Therefore, this confirms the usefulness of these traditional financial ratios in terms of evaluating bank efficiency. Interestingly, we find a positive effect of diversification variable while observing the negative impact of the concentration level and the provision rate on the performance of banks. As for the macroeconomic conditions, the results indicate a positive impact of GDP on bank

efficiency. Lastly, the study does not find any evidence to support the relationship between ROA as well as inflation and banking efficiency.

The regression result from the algorithm 1 is provided in this section for the robustness check purpose. In general, the estimate for coefficients from the algorithm 1 is similar to those from the algorithm 2. Most of the estimates keep the same size and the same significance level. Therefore, this consistency of results from these two algorithms is confirmed. Only the exception is found in the estimation of the effect of EOA on efficiency. It is a positive effect at the 5 percent significance level in the case of algorithm 2, while the effect is not significant for algorithm 1 estimate. However, as mentioned earlier, we do believe that the estimate from the algorithm 2 is more reliable. Therefore, this consistency of results from these two algorithms is confirmed.

CONCLUSION

This study analyzes the relationship between foreign ownership, more specifically in the ownership structure, and the efficiency of Vietnamese commercial banks using panel data from 2009 to 2016. It applies the more advanced method, DEA bootstrap, recommended by Simar and Wilson (2007) to investigate the determinants of bank efficiency. To the best of our knowledge, there is a lack of studies that examine such kind of relationship which takes into account ownership structure in detail or the degree of ownership in the bank's capital structure, especially, the foreign share in the domestic bank as the study does. Therefore, the study contributes to the literature by providing a deeper understanding of the effect of ownership structure on a banking system's operation.

The results show that (1) foreign ownership has a positive effect on the efficiency of banks. In detail, the higher the share of foreign investors in capital structure, the better operational efficiency level is. Following that, the study suggests that the Vietnamese government should extend the maximum degree of foreign ownership in any local bank higher than 30 percent, as is the present law. (2) Size and diversification affect the operational efficiency of banks. Thus, the study supports policies toward increasing the size of banks and encouraging banks to diversify their businesses rather than only focus on traditional credit activities. (3) The provision rate is recommended to be considered as a determinant of bank performance in terms of credit risk in banks. In order to achieve better efficiency levels, banks should carefully control NPL in the system to limit the proportion of the provision for loan loss over total loans. (4) As for capital risk preference, EOA has a positive effect on a bank's efficiency. It implies that a high-capitalized bank can achieve a better performance than a low-capitalized counterpart. (5) The study finds a negative relationship between the concentration level and bank efficiency.(6) Regarding the macroeconomic factors, GDP growth has a positive

impact on efficiency level while there no evidence supporting the effect of inflation on banks' performance. (7) Finally, the traditional financial ratios COA is revealed to be useful to determine the efficiency of banks. The less COA, the better efficiency levels a bank can achieve. There is no evidence showing the relationship between ROA and bank performance. As for the robustness check, since the regression results coming from algorithm 1 is relatively consistent with those from algorithm 2. Therefore, the findings of the study are robustly reliable.

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APPENDICES

Appendix 1
List of banks used in the sample

Code	Name of banks	Size	Title	Ownership structure		
				Foreign share	State share	Private domestic share
	State-owned banks					
5	Vietnam Bank for Industry and Trade (CTG)	Large	listed	30%	64%	6%
6	Joint Stock Commercial Bank for Investment and Development of Vietnam (BIDV)	Large	listed	1%	95%	3%
12	Joint Stock Commercial Bank for Foreign Trade of Vietnam (VCB)	Large	listed	21%	77%	2%
25	Vietnam Bank for Agriculture and Rural development (Agribank)	Large	unlisted	0%	100%	0%
	Joint-stock banks					
1	Asia Commercial Joint Stock Bank (ACB)	Large	listed	30%	0%	70%
2	AnBinh Commercial Joint Stock Bank (ABB)	Medium	unlisted	30%	0%	70%
3	Viet Capital Commercial Joint Stock Bank (Viet Capital Bank)	Medium	unlisted	0%	0%	100%
4	Lien Viet Commercial Joint Stock Bank (Lienviet Post Bank)	Large	unlisted	0%	0%	100%
7	Southeast Asia Commercial Joint Stock Bank (SEA bank)	Medium	unlisted	0%	0%	100%
8	The Maritime Commercial Joint Stock Bank (MSB)	Large	unlisted	0%	0%	100%
9	Tien Phong Commercial Joint Stock Bank (TPB)	Medium	unlisted	5%	0%	95%
10	Viet Nam Technological and Commercial Joint Stock Bank (Techcombank)	Large	unlisted	0%	0%	100%
11	Nam A Commercial Joint Stock Bank (NamAbank)	Small	unlisted	0%	0%	100%
13	Housing development Commercial Joint Stock Bank (HDB)	Medium	unlisted	0%	0%	100%
14	Orient Commercial Joint Stock Bank (OCB)	Small	unlisted	13%	0%	87%
15	Military Commercial Joint Stock Bank	Large	listed	20%	0%	80%
16	Vietnam International Commercial Joint Stock Bank (VIB)	Medium	unlisted	20%	0%	80%
17	National Citizen Bank (NCB)	Small	listed	0%	0%	100%
18	Saigon Bank for Industry &Trade (SGB)	Small	unlisted	0%	0%	100%
19	Saigon-Hanoi Commercial Joint Stock Bank	Large	listed	9%	0%	91%

20	Sai Gon Thuong Tin Commercial Joint Stock Bank (Sacombank)	Large	listed	9%	0%	91%
21	Viet A Commercial Joint Stock Bank (VietA bank)	Small	unlisted	0%	0%	100%
22	Vietnam Commercial Joint Stock Bank for Private Enterprise	Large	unlisted	0%	0%	100%
23	Petrolimex Group Commercial Joint Stock Bank (PGB)	Small	unlisted	5%	0%	95%
24	Vietnam Commercial Joint Stock Exim (EXB)	Large	listed	28%	0%	72%
	Foreign and Joint venture banks					
26	Indovina Bank	Small	unlisted	50%	0%	50%
27	HSBC Vietnam	Medium	unlisted	100%	0%	0%

Appendix 2

The Algorithm 1 procedure proposed by Simar and Wilson (2007)

Let's assume the model is that $\gamma_{it} = f(z_{it}|\beta) = \beta z_{it} + u_{it}$

Where γ_{it} is the technical efficiency of bank i in the year t, z_{it} is the vector of environmental variables as determinants of bank efficiency, and u_{it} is the error term.

- In the first stage, the technical efficiency γ of each bank is obtained each year by employed an input-oriented DEA model for the case of variable return to scale assumption (see Banker, Charnes & Coper, 1984).
- The study obtains the estimator $\hat{\beta}$of β in the regression of γ_{it} on environmental variables z_{it} in the model by using the maximum likelihood method. The value of the estimator$\hat{\sigma}$ ofσ is also obtained from this truncated regression process.
- I loop the next steps from a to c N times to get the bootstrap-replication set $R = \{\hat{\beta}_b^*, \hat{\sigma}_b^*\}_{b=1}^N$
    a. For each of bank within sample, i=1,…,m, from the normal distribution $N(0, \hat{\sigma}_u^2)$ with bilateral truncation at $-z_{it}\hat{\beta}$ and$1 - z_{it}\hat{\beta}$ draw u_{it}^*
    b. For each of bank i=1, …,m, again calculate $\gamma_i^* = z_{it}\hat{\beta} + u_{1i}^*$
    c. Apply the maximum likelihood method to the truncated regression of γ_{it} on z_{it}, obtain the set R described earlier
- Use the bootstrap value in R set as well as the value of estimator, construct the confidence intervals for each of estimates.

Appendix 3

Descriptive statistic of independent variables used in the regression model by year

2009	Variable	Observation	Mean	Std. Dev.	Min	Max
	Ln total asset	27	17.4450	1.2457	15.0185	19.9913
	GDP	27	0.0540	0.0000	0.0540	0.0540
	Inflation	27	0.0755	0.0000	0.0755	0.0755
	Foreign share	27	0.0961	0.2228	0.0000	1.0000
	HHI	27	0.0345	0.0525	0.0008	0.2288
	ROA	27	0.0136	0.0056	0.0037	0.0311
	COA	27	0.0593	0.0145	0.0307	0.0927
	EOA	27	0.1214	0.0695	0.0400	0.3324
	Diversification	27	0.5610	0.1185	0.3000	0.9190
	Provision rate	27	0.0089	0.0115	0.0034	0.0652

2010	Variable	Observation	Mean	Std. Dev.	Min	Max
	Ln total asset	27	17.9013	1.1520	15.9227	20.0978
	GDP	27	0.0640	0.0000	0.0640	0.0640
	Inflation	27	0.0890	0.0000	0.0890	0.0890
	Foreign share	27	0.1020	0.2216	0.0000	1.0000
	HHI	27	0.0341	0.0482	0.0017	0.2016
	ROA	27	0.0128	0.0080	0.0023	0.0473
	COA	27	0.0662	0.0127	0.0453	0.1061
	EOA	27	0.1073	0.0507	0.0494	0.2527
	Diversification	27	0.2322	0.1226	0.0342	0.5366
	Provision rate	27	0.0066	0.0032	0.0016	0.0147
2011	**Variable**	**Observation**	**Mean**	**Std. Dev.**	**Min**	**Max**
	Ln total asset	27	18.0997	1.1300	16.5476	20.1368
	GDP	27	0.0620	0.0000	0.0620	0.0620
	Inflation	27	0.1868	0.0000	0.1868	0.1868
	Foreign share	27	0.1089	0.2204	0.0000	1.0000
	HHI	27	0.0353	0.0477	0.0025	0.1940
	ROA	27	0.0101	0.0142	-0.0551	0.0275
	COA	27	0.1009	0.0233	0.0614	0.1542
	EOA	27	0.1053	0.0473	0.0426	0.2151
	Diversification	27	0.1336	0.1372	-0.0791	0.4754
	Provision rate	27	0.0100	0.0086	0.0000	0.0291
2012	**Variable**	**Observation**	**Mean**	**Std. Dev.**	**Min**	**Max**
	Ln total asset	27	18.1196	1.1597	16.5137	20.2371
	GDP	27	0.0520	0.0000	0.0520	0.0520
	Inflation	27	0.0909	0.0000	0.0909	0.0909
	Foreign share	27	0.1156	0.2165	0.0000	1.0000
	HHI	27	0.0343	0.0454	0.0033	0.1908
	ROA	27	0.0086	0.0057	0.0001	0.0212
	COA	27	0.0968	0.0210	0.0546	0.1354
	EOA	27	0.1154	0.0511	0.0547	0.2383
	Diversification	27	0.1631	0.1751	-0.1776	0.5000
	Provision rate	27	0.0121	0.0075	0.0000	0.0277
2013	**Variable**	**Observation**	**Mean**	**Std. Dev.**	**Min**	**Max**
	Ln total asset	27	18.2729	1.0914	16.5023	20.3566
	GDP	27	0.0540	0.0000	0.0540	0.0540
	Inflation	27	0.0659	0.0000	0.0659	0.0659
	Foreign share	27	0.1251	0.2180	0.0000	1.0000
	HHI	27	0.0353	0.0457	0.0036	0.1908
	ROA	27	0.0092	0.0146	0.0006	0.0787
	COA	27	0.0688	0.0169	0.0235	0.1016

	EOA	27	0.1030	0.0440	0.0038	0.2384
	Diversification	27	0.2099	0.1617	-0.0616	0.8005
	Provision rate	27	0.0123	0.0124	0.0000	0.0633
2014	**Variable**	**Observation**	**Mean**	**Std. Dev.**	**Min**	**Max**
	Ln total asset	27	18.4206	1.0785	16.5770	20.4535
	GDP	27	0.0600	0.0000	0.0600	0.0600
	Inflation	27	0.0408	0.0000	0.0408	0.0408
	Foreign share	27	0.1250	0.2171	0.0000	1.0000
	HHI	27	0.0343	0.0439	0.0004	0.1756
	ROA	27	0.0060	0.0038	0.0002	0.0131
	COA	27	0.0625	0.0158	0.0379	0.1149
	EOA	27	0.0953	0.0384	0.0512	0.2203
	Diversification	27	0.1954	0.1222	-0.0842	0.4979
	Provision rate	27	0.0144	0.0213	0.0000	0.1122
2015	**Variable**	**Observation**	**Mean**	**Std. Dev.**	**Min**	**Max**
	Ln total asset	27	18.5276	1.1095	16.6918	20.5895
	GDP	27	0.0680	0.0000	0.0680	0.0680
	Inflation	27	0.0088	0.0000	0.0088	0.0088
	Foreign share	27	0.1328	0.2190	0.0000	1.0000
	HHI	27	0.0349	0.0450	0.0030	0.1749
	ROA	27	0.0048	0.0036	0.0001	0.0129
	COA	27	0.0601	0.0116	0.0374	0.0896
	EOA	27	0.0927	0.0363	0.0476	0.1911
	Diversification	27	0.1637	0.2079	-0.2594	0.9630
	Provision rate	27	0.0137	0.0075	0.0022	0.0328
2016	**Variable**	**Observation**	**Mean**	**Std. Dev.**	**Min**	**Max**
	Ln total asset	27	18.7012	1.1057	16.7625	20.7297
	GDP	27	0.0622	0.0012	0.0620	0.0680
	Inflation	27	0.0315	0.0045	0.0088	0.0324
	Foreign share	27	0.1369	0.2192	0.0000	1.0000
	HHI	27	0.0351	0.0460	0.0027	0.1677
	ROA	27	0.0123	0.0346	0.0001	0.1837
	COA	26	0.0670	0.0429	0.0333	0.2671
	EOA	27	0.0847	0.0370	0.0439	0.1845
	Diversification	26	0.1889	0.1264	-0.0393	0.5256
	Provision rate	27	0.0135	0.0105	0.0019	0.0503

Appendix 4

Efficiency estimations of Vietnamese banks for the period from 2009 to 2016

Code	Efficiency	Bias-corrected efficiency	Bias	Lower bound	Upper bound
1	0.6510	0.5444	0.1554	0.4883	0.6437
2	0.5219	0.4771	0.0630	0.4524	0.5153
3	0.7212	0.5976	0.1720	0.5407	0.7126
4	0.8127	0.6714	0.1951	0.6092	0.8043
5	0.7952	0.6861	0.1697	0.6165	0.7862
6	0.8083	0.7111	0.1565	0.6432	0.7998
7	0.7827	0.6967	0.1200	0.6537	0.7737
8	0.8822	0.7124	0.2338	0.6371	0.8709
9	0.8285	0.6714	0.2254	0.5935	0.8189
10	0.7697	0.6844	0.1366	0.6239	0.7605
11	0.6236	0.5545	0.1071	0.5098	0.6169
12	0.7889	0.6764	0.1722	0.6079	0.7801
13	0.6183	0.5518	0.0993	0.5117	0.6110
14	0.6380	0.5850	0.0804	0.5505	0.6310
15	0.7686	0.7011	0.1039	0.6551	0.7590
16	0.6648	0.5977	0.0993	0.5577	0.6570
17	0.6256	0.5607	0.0970	0.5212	0.6182
18	0.5390	0.4907	0.0755	0.4575	0.5329
19	0.7940	0.6818	0.1677	0.6175	0.7852
20	0.5436	0.4606	0.1196	0.4174	0.5370
21	0.8992	0.7494	0.1984	0.6890	0.8874
22	0.5981	0.5370	0.0961	0.4948	0.5910
23	0.5689	0.5172	0.0783	0.4842	0.5624
24	0.6436	0.5857	0.0883	0.5467	0.6350
25	0.6631	0.5274	0.2059	0.4498	0.6557
26	0.7503	0.6509	0.1421	0.5993	0.7414
27	0.7367	0.5736	0.2286	0.5000	0.7286