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THÈSE

Pour obtenir le grade de Docteur en Sciences de Gestion
Présentée et soutenue publiquement par
Thi Lam Anh NGUYEN

Le 30 Janvier 2018

CORPORATE GOVERNANCE, DIVERSIFICATION, AND BANK EFFICIENCY IN SIX ASEAN COUNTRIES

JURY

Directeur de thèse :

M. Frédéric LOBEZ, Professeur à l'Université de Lille

Membres du jury:

Rapporteurs
- Mme. Aude DEVILLE, Professeure à l'Université de Nice-Côte d'Azur
- M. Christophe MOUSSU, Professeur à ESCP Europe

Suffragants
- M. Hervé ALEXANDRE, Professeur à l'Université Paris-Dauphine
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« La faculté n'entend donner aucune approbation ni improbation aux opinions émises dans les thèses; elles doivent être considérées comme propres à leurs auteurs. »

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GENERAL INTRODUCTION

Over the past decades, substantial changes have occurred in the Association of Southeast Asian Nations' (ASEAN) banking systems. The first step of banking reforms in ASEAN countries was the creation of the two-tier banking system, which separated the function of central and commercial banks. The next steps were to loosen the requirements on new entry and foreign participation in the banking sector. Those relaxations led to a rapid expansion of the ASEAN banking sectors. However, due to insufficient supervision capacity of the government and to the lack of adequate legislation and risk assessment framework, a number of dubious and under-capitalized new banks have been established. As the inevitable results, the ASEAN banking systems have become filled with a substantial amount of non-performing loans (NPLs), which consequently have made the banking sectors in the regions highly vulnerable, especially when coping with financial crises. These crises, and particularly the Asian Financial Crisis in 1997 and the Global Financial Crisis in 2008, significantly affected the banking systems in the ASEAN region, eventually leading to major banking reform and restructuring in each country.

The current banking restructuring in ASEAN mainly focuses on consolidation and regulatory strengthening. The consolidation aims to reduce the number of banks by encouraging mergers and acquisitions, while regulatory strengthening aims to exert stricter regulations to prevent excessive risk-taking behaviors and enhance banks' risk management practices. The ultimate goal is to ensure the efficiency of the banking system of each country. Hence, it is essential to evaluate the efficiency of ASEAN bank operations as well as the determinants of bank efficiency, not only for the interests of banks and their stakeholders but also for policy makers.

Besides the current important development in ASEAN banking sectors, this study is also motivated by ASEAN countries' unique institutional environments, which could impact bank efficiency and bank efficiency determinants. According to the dataset of the Worldwide Governance Indicators (WGI) projects, six dimensions explain the traditions and institutions by which authority is exercised in a country (World Bank, 2017): Voice and Accountability, Political Stability and Absence of Violence, Government Effectiveness, Regulatory Quality, Rule of Law, and Control of Corruption. While developed economies such as the US and European countries often demonstrate high scores on most of the six dimensions, ASEAN economies present an interesting mix of results. The WGI dataset shows that some of these countries have considerably low levels of Voice and Accountability (Vietnam, Cambodia, and Thailand), while others have average levels (Indonesia, Malaysia, and the Philippines).

Except for Thailand and the Philippines, with significantly low levels, other countries present average degrees of Political Stability. In terms of Government Effectiveness and Regulatory Quality, only Malaysia demonstrates very high levels, while other countries show around average scores. Regarding the Rule of Law and Control of Corruption, Malaysia is the country with above-average levels, while other countries show relatively low degrees. In summary, ASEAN countries have lower than average levels of Voice and Accountability; fairly stable political environments, average Government Effectiveness and Regulatory Quality, and relatively low levels of Rule of Law and Control of Corruption. Thus, most of the above institutional dimensions are likely to adversely affect banks' cost-saving and profit-generating abilities, and thereby their efficiency.

Concept of efficiency

The first and foremost objective of this study is to accurately measure efficiency levels for ASEAN banks. Depending on which efficiency concept is used, efficiency measurement varies accordingly. According to Mester (2008, p. 137), efficiency is generally defined as a "measure of deviation between actual performance and desired performance". Efficiency can be defined using two main approaches: technological optimization and economic optimization. Under the technological approach, technical efficiency is measured by exploring the questions of whether a bank is minimizing the input levels used to produce its current output levels or whether a bank is maximizing its output levels produced given its current input levels. Hence, the technological approach is only based on the use of technology.

On the other hand, under the economic optimization approach, economic efficiency is measured by investigating whether a bank is minimizing its costs or maximizing its profit; thus, this approach accounts for price changes and competition in the market. Moreover, as the technological efficiency ignores the values of input and input, it cannot determine whether the output level produced is optimal. Therefore, Berger and Mester (1997) argue that the economic optimization approach is believed to be the best economic foundation to evaluate the efficiency of banks and other financial institutions.

Under the approach of economic optimization, three most important concepts are: cost efficiency, standard profit efficiency, and alternative profit efficiency. Cost efficiency measures a bank's costs in relation to a best-practice bank's cost under the assumption that both banks produce the same output under the same conditions (Berger and Mester, 1997). On the other hand, standard profit efficiency measures a bank's profit in relation to the maximum

possible profit made by a best-practice bank given certain input prices and output prices levels. In other words, while all output quantities are held fixed at a possibly inefficient level in the cost efficiency, the profit efficiency allows for varying inputs and outputs when measuring revenue (Isik and Hassan, 2002). Finally, the alternative profit efficiency measures how close a bank's profit compared to the best-practice bank's profit, given its input prices and output levels – instead of output prices as in the standard profit efficiency. The alternative profit efficiency concept is often employed in the literature instead of standard profit efficiency; as in reality, it is highly difficult to accurately measure bank output prices (DeYoung and Hassan, 1998).

In addition to the three economic efficiency concepts, previous studies also discuss the difference between persistent efficiency and time-varying efficiency concept of a particular firm. According to Mundlak (1961), persistent or long-term inefficiency is likely to be caused by factors that vary across firms but likely not over time, such as management or other unobserved inputs. In contrast, time-varying or short-term inefficiency of firms is caused by factors that vary over time. Hence, time-varying inefficiency might change in short term without any changes in the firms' operations. Therefore, Mundlak (1961) notes that persistent inefficiency is unlikely to change unless major changes happened in the banks' management styles, such as a change in bank ownership. Hence, it is crucial to separate persistent inefficiency and time-varying inefficiency, as they are likely to have different management and policy implications.

In short, the specific objective of this chapter is to correctly measure the cost efficiency and alternative profit efficiency, which are then separated into persistent terms and time-varying terms. Furthermore, this chapter also aims to explain the differences in the efficiency levels of banks from different ASEAN countries using general knowledge about each country and its banking sector. To explain these differences at the bank level, the paper focuses on investigating particular bank characteristics that make some banks more efficient than others.

Corporate governance and bank efficiency

It is of particular interest for both banks and bank regulators to ensure the quality of corporate governance of the banks. Levin (1994) states that if sound corporate governance mechanisms are imposed on bank managers, more efficient capital allocation decisions will likely be made and more supervision on bank borrows will be exerted. On the other hand, if a

bank's Board of Directors imposes loose corporate governance mechanisms on its manager, the managers will be likely to ignore the interests of debt holders and shareholders and act in their own interest instead. Thus, poor corporate governance is believed to have a negative impact on bank efficiency, as has been illustrated by various banking crises in history.

Furthermore, certain features of banks make their corporate governance differs significantly from that of other non-financial institutions. First, as banks can easily hide or adjust their loan quality for long time periods, information asymmetries are considered to be larger with banks than with other firms. Hence, greater information asymmetries make it easier for bank insiders to exploit outside investors and the government (Levin, 2004). Moreover, greater information asymmetries between bank insiders and potential investors are believed to adversely affect bank corporate governance as they lessen the threat of hostile takeover in the industries. Second, as banks play highly important roles in the economy, they are often intervened heavily by the government, which adversely influence the abilities of bank managers to maximize their shareholder interests. Besides, the existence of government ownership, deposit insurance, and the role of central banks as lenders of last resort help increase the risk-taking ability and behavior of bank owners.

Caprio et al. (2007) note that certain corporate governance mechanisms can be used to help to decrease the expropriation of bank resources, improve corporate governance and promote bank efficiency. They are the ownership monitoring mechanism, internal control mechanism, disclosure monitoring mechanism and regulatory monitoring mechanism. In this vein, the second objective of this thesis is to examine the impact of these governance mechanisms on bank performance by estimating the influence of certain corporate governance features on bank efficiency.

Diversification and bank efficiency

In addition to the corporate governance practices of banks, this paper also examines bank business model as the possible determinant of bank efficiency. In particular, the third objective of this thesis is to evaluate the impact of one important aspect of bank business model on efficiency: bank diversification in terms of assets, income, and funding. As mentioned earlier, ASEAN countries are currently in the phase of consolidating and tightening regulation. Consolidation and restructuring reduce the number of banks, mainly through mergers and acquisitions. Since the banks created by mergers and acquisitions are normally larger in size and more complex than pre-merger banks, they tend to be more

diversified. Furthermore, bank supervisors also tend to encourage banks to diversify with the purpose of reducing bank risk. On the other hand, tightening regulations, particularly restrictions that limit banks from participating in investment or insurance activities, makes banks more focused.

Traditional theory supports the positive impact of diversification on bank efficiency by suggesting that diversification helps banks to gain economies of scope (Laeven and Levin, 2007), to leverage management capabilities across different products and markets (Iskandar-Datta and McLaughlin, 2007), to reduce the bankruptcy risk (Berger et al., 2010), and to help banks dealing with future uncertainty by acquiring in advance necessary skills to make effective business decisions in the new business areas (Elsas et al., 2010). However, another line of arguments suggests a negative relationship between diversification and bank efficiency, stating that diversification could increase the agency problem (Laeven and Levin, 2007); that it could dilute the comparative advantage of bank managers by making them go beyond their existing expertise (Klein and Saidenberg, 1998); that it might increase revenue and profit volatility (Berger, 2010); and that it could exaggerate the costs and consequences of banks that do not successfully enter into a new sector (Winton, 1999).

Hence, conflicts in both theory and government policy on bank diversification suggest that research on the optimal bank business model in ASEAN countries is highly useful from both managerial and regulatory perspectives.

Structure of the thesis

Based on the above overview, this study first measures the efficiency levels of banks in ASEAN countries, before investigating the impact of corporate governance on ASEAN bank efficiency. Finally, the study analyzes the question of whether diversification has a significant impact on ASEAN bank efficiency.

More specifically, this thesis aims to contribute to the banking literature through three empirical studies on bank efficiency and bank efficiency determinants. Chapter 1 measures the cost and alternative profit efficiency of ASEAN banks using the Stochastic Frontier Approach (SFA). Despite abundant literature related to bank efficiency using SFA, very few studies have attempted to separate efficiency into persistent and time-varying components while accounting for the firm effects. This is critical for the process of identifying the efficiency determinants in the long term as well as the short term, which could result in different management and policy implications. Chapter 2 investigates the impact of corporate

governance on bank efficiency by estimating the effects of bank ownership, board size, board structure, and CEO duality on cost and profit efficiency. Limited research has been conducted in this area for ASEAN banks. Moreover, current studies on corporate governance and ASEAN bank performance mostly ignore the serious problem of endogeneity, which is discussed intensively in the literature (Wintoki et al., 2012). Hence, Chapter 2 further contributes to the current literature by accounting for this problem between corporate governance and bank performance by using the Dynamic System Generalized Method of Moments (GMM). Finally, Chapter 3 analyzes the impact of diversification on ASEAN bank cost and profit efficiency. This topic is crucial given the current context of ASEAN banking sectors and the highly limited amount of empirical evidence regarding the effects of diversification on ASEAN bank performance. Moreover, Chapter 3 also contributes to the current literature by considering all three dimensions of diversification: assets, funding, and income diversification. In contrast, previous studies tend to examine each dimension individually or consider only two out of three.

The thesis employs a sample of 175 banks from six ASEAN countries: Vietnam, Cambodia, Indonesia, Malaysia, the Philippines, and Thailand. Data are collected for an eight-year period of 2007 to 2014. Data sources for estimating efficiency scores, describing different corporate governance features, and computing diversification indexes for banks are mainly from annual reports, edited financial statements of banks and the Bankscope database. Data of some macroeconomic variables used as controls for the estimated models are extracted from the website of World Bank. Data and information regarding the industry characteristics of each country's banking sector are obtained from the annual reports and supervision reports of its state bank or central bank.

Chapter 1

First, chapter 1 uses Kumbhakar et al.'s (2014) SFA model to measure the cost and profit efficiency level of six ASEAN countries (Vietnam, Cambodia, Indonesia, Malaysia, the Philippines, and Thailand) over an eight-year period (2007-2014). To measure bank efficiency, various approaches can be used. Traditionally, bank performance is measured using an accounting approach, and specifically by employing cost and profitability financial ratios. However, many researchers have criticized this approach for being limited in scope (Mlambo and Ncube, 2011; Berger and Humphrey, 1997). Recently, a new approach using econometric methods to measure cost and profit efficiency has been developed and used

widely (Berger and Humphrey, 1997). The literature on the efficiency of banks in Southeast Asian countries demonstrates the dominant use of the econometric approach to measure bank efficiency, with the two most popular measurement techniques being parametric and non-parametric techniques.

This paper uses the SFA, which is the most popular parametric technique, to measure cost and profit efficiency of ASEAN commercial banks. The technique is chosen because it corresponds to the economic concepts used in the paper and its purpose of computing scores for banks individually. In addition, this paper successfully separates persistent and time-varying components of the efficiency term while accounting for the firm effects and random error, using Kumbhakar et al.'s (2014) recently developed SFA model. This is one of the significant contributions of this paper, as a majority of previous studies have adopted SFA methods that do not account for firm effects when estimating total efficiency (Kumbhakar, 1990; Battese and Coelli, 1992, 1995); that account for firm effects but do not separate persistent and time-varying efficiency (Greene, 2005; Wang and Ho, 2010); or that separate persistent and time-varying efficiency without accounting for firm effects (Kumbhakar and Heshmati, 1995; Colombi et al., 2011).

The results show average permanent, residual, and overall cost efficiency levels of 0.8448, 0.9148, and 0.7734, respectively. On the other hand, the average permanent, residual, and overall profit efficiency scores are 0.5596, 05444, and 0.3084, respectively. The results demonstrate that ASEAN banks perform at significantly low levels of profit efficiency and considerably high levels of cost efficiency.

In terms of ranking, Indonesia is the country with the most cost-efficient but the least profit-efficient banks, while Malaysia is the country with the least cost-efficient but the most profit-efficient banking sector. To party explain these differences, some bank and industry characteristics are examined. This reveals a significant negative relationship between risk-averse level and bank cost; a positive impact of productivity growth on both bank cost and profit; a negative influence of bank branch density on bank cost and profit; and a negative effect of industry concentration on bank cost but a positive effect on bank profit. Hence, the contrast between the cost and profit efficiency levels of Indonesian and Malaysian banks can be explained by the contrasting bank and industry characteristics of the two sectors. Malaysian banks are characterized as less risk-averse; the country has a low level of productivity growth, a moderate level of branch density, and a very high level of industry concentration. On the other hand, while Indonesian banks are also less risk-averse, the

country has a very high level of productivity growth, a very high level of branch density, and a considerably low level of industry concentration.

In term of trends, generally stable trends of cost and profit efficiency are found for the sample period, which could be explained as impacts of the consolidation process accompanied by tightening regulations in individual countries.

Chapter 2

Second, chapter 2 examines the impacts of various corporate governance characteristics on bank cost and profit efficiency while accounting for the serious problem of endogeneity between governance and bank performance. Wintoki et al. (2012) identify three potential sources of endogeneity when determining the relationship between corporate governance and firm performance: dynamic endogeneity, simultaneity, and unobserved heterogeneity. First, dynamic endogeneity refers to the problem of the current value of a variable being influenced by its past values. Wintoki et al. (2012) note that a firm's current governance structure could not only be a factor that might affect its current performance but could also be influenced by its past performance. Second, simultaneity refers to the possibility that board characteristics could be determined by bank performance and vice versa. Schultz et al. (2010) suggest that a firm may elect its Board of Directors based on the expected future performance. Third, unobserved heterogeneity refers to unobservable factors that affect the relationship between two or more variables. Wintoki et al. (2012) state that some unobservable and difficult-to-quantify firm-specific characteristics (such as management ability or CEO's risk preferences) could affect a firm's corporate governance and performance.

Hence, the estimation methods used to determine the impact of corporate governance on bank efficiency must successfully control for all types of endogeneity, and one of the most recently developed methods that meet this criterion is Dynamic System GMM. However, previous studies that use GMM to estimate the influence of corporate structure on bank efficiency are highly limited, and they mostly use accounting ratios as performance measures (Andres and Vallelado, 2008; Mnasri, 2015; Akbar et al., 2016).

Due to the inefficiency of available data, Chapter 2 examines the impact of the following corporate governance mechanism aspects on bank efficiency: foreign ownership, government ownership, CEO duality, board size, and board independence. According to Micco et al. (2007), the increase of foreign presence in developing countries' banking systems helps to reduce the cost but not essentially increase the profits of their domestic banks, as it

helps to escalate the product market competition and takeover pressures. On the other hand, the presence of high levels of government ownership in the banking system is believed to negatively influence bank performance, as governments as owners could use the banks as a means to achieve political goals, which might not maximize the shareholder interests (Bai et al., 2004).

Two main streams of theory explain the role and importance of the Board of Directors: agency theory (Jensen and Meckling, 1976) and stewardship theory (Donaldson, 1990). Agency theory argues that larger boards and boards comprise a higher ratio of outside or non-executive directors will be more effective in monitoring the managers' behaviors. However, as stated by Yermack (1996), the board size must not be too large as larger boards are normally associated with higher costs, which are due to more complex communication, coordination, and decision making. In contrast, stewardship theory claims that bank managers are trustworthy and there exists no agency cost. Furthermore, Donalson (1990) points out that decisions made by inside directors are certainly better than those of outside directors, as inside directors generally have a better understanding of the business and have easier access to bank information. Hence, a board composed of a higher proportion of inside directors will be more effective at decision-making, and consequently, more focused on maximizing shareholder value.

The regression results show that the impacts of corporate governance on bank efficiency are similar for both persistent and time-varying components. In terms of corporate governance and cost efficiency, the findings show that banks with higher levels of government ownership are more cost efficient, which could be explained by their easier access to cheaper input resources. In addition, banks with higher levels of board independence demonstrate lower cost efficiency scores, which supports Petra's (2005) argument that limited business knowledge of outside directors could lead to inefficient business decisions. Furthermore, foreign ownership, board size, and CEO duality are found to have no significant impact on bank abilities to minimize costs. In terms of corporate governance and profit efficiency, no significant impact of ownership structure and bank profit efficiency is found. Similarly, no significant relationship is found for board structure and bank profit efficiency, which is in line with Hermalin and Weisbach's (2003) and Petra's (2005) arguments about outside directors' limited ability to contribute to the operations of banks.

Chapter 3

Finally, Chapter 3 analyzes the impact of diversification on ASEAN bank cost and profit efficiency. Theory suggests conflicting predictions about the effects of diversification on bank performance, with evidence to support both arguments. One line of arguments points out the benefits of diversification, suggesting that it helps banks to gain economies of scope through spreading their fixed costs over various types of product (Laeven and Levin, 2007); it leverages management expertise and skills across different products and markets (Iskandar-Datta and McLaughlin, 2007); it reduces bankruptcy risk (Berger et al., 2010); and it helps banks to deal with future uncertainty by acquiring in advance critical skills required to make effective business decisions in the new business areas (Elsas et al., 2010). Conversely, another line of arguments points out the disadvantages of diversification, stating that it might increase the agency problem between corporate insiders and small shareholders (Laeven and Levin, 2007); that it could dilute the comparative advantage of bank managers by making them go beyond their existing knowledge and skills (Klein and Saidenberg, 1998); that it might lead to increased revenue and profit volatility (Berger, 2010); and that diversification in a highly competitive market might exaggerate the consequences and costs for banks that do not successfully enter into a new business sector (Winton, 1999).

To evaluate the impact of diversification on bank efficiency, this chapter examines three measures of diversification – asset, funding, and income diversification. Then, OLS regressions are run.

In contrast to Chapter 2, the regression results of Chapter 3 show different impacts of diversification on the persistent and time-varying components of bank efficiency scores. Regarding diversification and cost efficiency, the findings show that more income-diversified banks are associated with lower cost efficiency, while more asset-diversified banks are only associated with lower persistent cost efficiency. On the other hand, results regarding the relationship between diversification and profit efficiency show that more funding-diversified banks enjoy higher levels of profit efficiency, while more asset-diversified banks only enjoy higher levels of persistent profit efficiency. Hence, in general, diversification is found to have a negative impact on bank cost efficiency but a positive impact on profit efficiency. This has important implications for banks as well as bank regulators. For ASEAN banks, the optimal business model could be income-focused and funding-diversified. For bank regulators, any regulatory restrictions or relaxations need to be considered in relation to their effects on banks' income and funding diversification. Furthermore, the chapter also reaches some

interesting results regarding the mitigating role of ownership in the relationship between diversification and efficiency. The findings show that funding diversification will help government-owned banks become more cost efficient but less profit efficient. In addition, funding and asset diversification could make foreign-owned banks less profit efficient. Therefore, business strategies and regulations needed to be developed separately for government-owned banks and foreign banks.

CHAPTER 1

Efficiency of commercial banks in six ASEAN countries

1.1. Introduction

The purpose of this paper is to examine the cost and profit efficiency of banks in Southeast Asian countries over the period of 2007 to 2014.

According to Levin (1997), it is widely confirmed that for a developing country to achieve sustainable economic growth, it must focus on developing a robust financial system, and particularly the banking system. By building an efficient banking system, the developing country can achieve low-cost monetary payments and effective fund allocations and mobilization, which can eventually promote savings and investments.

Previously, the economies in developing countries were centrally planned. Hence, in the early stage of banking sector development, the banking systems in those countries were classified as inefficient. However, in recent years the world economy has witnessed an increasing trend of financial market liberalization and banking reforms in many developing countries, including the ASEAN countries. The main purpose of banking restructuring and reforms is to build more robust and efficient banking systems. Hence, it is essential, not only for bankers and their stakeholders but for the whole economy, to assess the efficiency of bank operations in developing countries.

A vast amount of research has been conducted in the area of assessing banking institution efficiency, in both developed and developing countries (Berger and Mester, 1997; Berger and DeYoung, 1997; Girardone et al., 2004; Chortareas et al., 2012). However, research on developing countries in recent years has mostly focused on Central and Southeastern Europe (Pancurova and Lyocsa, 2011; Chortareas et al., 2011; Kasman and Yildirim, 2006; Yildirim and Philappatos, 2007), whereas fewer studies have examined other developing areas around the world, such as Latin America, Central Asia, and Southeast Asia (Tahir et al., 2012; Djalilov and Piesse, 2014; Lin et al., 2016). The present study aims to contribute to the literature by determining the efficiency levels of ASEAN commercials banks, in six countries in particular: Vietnam, Cambodia, Malaysia, Indonesia, the Philippines, and Thailand.

The ASEAN countries have been chosen for this study for several reasons. Firstly, as the banking systems in these countries are mostly in their early stages of development, restructuring and reforming are on-going processes. Specifically, Vietnamese, Indonesian, and Philippine banks are currently in the second phase of consolidation; banks in Cambodia are in the expansion stage; and Malaysia and Thailand have just finished the processes of

bank consolidation. Determining bank efficiency in these countries would be highly useful for the authorities to know whether financial reforms are effective or not. Secondly, in the early stage of development, the banking systems in ASEAN countries have already faced various major financial crises, especially the Asian Financial Crisis in 1997 and the Global Financial Crisis in 2008, which could either make the banking systems significantly weaker or help to accelerate the restructuring process and make them more efficient. Finally, although the six countries examined are in the same geographical area, their banking systems are highly diverse: each country imposes different models of development, and at different stages of development (Nguyen, 2010). Hence, it would be interesting to know whether these countries' banking systems differ significantly in terms of efficiency.

Various approaches can be used to measure bank efficiency. Traditionally, bank performance is measured using an accounting approach, specifically by employing cost and profitability financial ratios. However, many researchers have criticized this approach for its limited scope (Mlambo and Ncube, 2011; Berger and Humphrey, 1997). Recently, a new approach using econometric methods to measure cost and profit efficiency has been developed and used widely in the literature (Berger and Humphrey, 1997). In this vein, studies on the efficiency of banks in Southeast Asian countries demonstrate the dominant use of this econometric approach to measure bank efficiency, with the two most popular measurement techniques being parametric and non-parametric techniques.

The concept of bank efficiency used in this paper refers to economic efficiency, and not technological (or technical) efficiency. The author aims to measure whether a bank is minimizing its costs or maximizing its profit (economic efficiency), and not to determine whether it is maximizing its output quantity given a certain level of input quantity (technological efficiency). To measure whether a bank is minimizing its costs or maximizing its profit, the concepts of cost efficiency and profit efficiency are used, respectively. Although the level of cost efficiency is explored more extensively in the literature (Berger and DeYoung, 1997; Fries and Taci, 2005; Tahir et al., 2012), profit efficiency is considered to be the superior concept (Berger and Mester, 1997) as it focuses on both maximizing revenue and minimizing marginal costs, while cost efficiency focuses only on minimizing costs. Hence, both the concepts of cost and profit efficiency are used and explored in this paper. Furthermore, the concept of economic efficiency can be separated into two different components: persistent efficiency and time-varying efficiency. Persistent efficiency is caused

by management or other unobserved inputs that are not likely to change over time, while time-varying efficiency might vary over time without any changes in bank operations.

This paper uses the SFA to measure the cost and profit efficiency of ASEAN commercial banks over a period of eight years (2007-2014). The method is chosen as it corresponds well to the economic efficiency concepts used in the paper and the purpose of computing scores for banks individually. In addition, this paper successfully separates persistent and time-varying components for cost and profit efficiency while accounting for the firm effects and random error, using Kumbhakar et al.'s (2014) recently developed SFA model. This is one of the significant contributions of this paper, as a majority of previous studies have adopted SFA methods that do not account for firm effects when estimating total efficiency (Kumbhakar, 1990; Battese and Coelli, 1992, 1995); that account for firm effects but do not distinguish between persistent and time-varying efficiency (Greene, 2005; Wang and Ho, 2010); or that distinguish between persistent and time-varying efficiency without accounting for firm effects (Kumbhakar and Heshmati, 1995; Colombi et al., 2011).

The rest of the paper is structured as follows. Section 2 presents an overview of the literature on cost and profit efficiency, and section 3 then reviews the literature on the efficiency of banks in ASEAN countries. Subsequently, section 4 presents the methodology and data. Section 5 reports and discusses the results of efficiency estimations. Finally, section 6 concludes the paper.

1.2. Literature review on cost and profit efficiency

Given the purpose of this study, this section reviews the literature on the efficiency concept, how it pertains to banking, and different methods to measure bank efficiency.

1.2.1. The concept of efficiency

According to Mester (2008, p.137), efficiency is a "measure of deviation between actual performance and desired performance." In other words, the measurement of efficiency must be in relation to an objective function. Firstly, this measurement depends on which concept of efficiency is used. In general, there are two main approaches to defining efficiency: *technological efficiency* and *economic efficiency*.

Technological efficiency, also referred to as technical efficiency, explores the questions of whether a bank is maximizing its output produced given its levels of input; or whether a bank is minimizing the amount of input used to produce its current levels of output. In general, this approach is only based on the use of technology. Conversely, economic

efficiency investigates whether a bank is minimizing its cost or maximizing its profit. Hence, the latter approach accounts for competition and price changes in the market.

As the concept of technological efficiency ignores the values of input and output, it cannot determine whether the output produced is optimal. Moreover, it cannot account for allocative inefficiency, which refers to the fact that banks can respond in the wrong way to relative prices when choosing inputs and outputs. Some banks can choose to specialize in different inputs or outputs, which can make them more or less efficient compared to others; and using the technical approach of efficiency cannot capture this, since the relative prices of input and output are not used. Hence, the economic efficiency approach is believed to be the best economic foundation to analyze and evaluate the efficiency of financial institutions in general and banks in particular (Berger and Mester, 1997).

According to Mester (2008), the three most important concepts in economic efficiency are cost, standard profit, and alternative profit efficiency. Before going into a detailed review about each of these concepts, it is important to note that the literature also discusses the difference between persistent efficiency and time-varying efficiency of firms in general. According to Mundlak (1961), persistent inefficiency or long-term inefficiency is likely to be caused by management or other unobserved inputs, which varies across firms but not likely over time. In contrast, the time-varying or short-term inefficiency of firms might change over time, while there are no changes in the firm operations. Hence, Mundlak (1961) insists that unless there are major changes in management styles of individual firms, such as changes in firm ownership, persistent inefficiency is unlikely to change. Hence, it is crucial to separate persistent inefficiency and short-term inefficiency, as they likely have different management and policy implications.

1.2.1.1. Cost efficiency

Cost efficiency measures a bank's cost in relation to that of a best-practice bank, assuming they produce the same outputs under the same conditions. It is derived from a cost function, in which variable costs depend on the prices of variable inputs, the quantities of variable outputs, and any fixed inputs or outputs, environment factors, random error, and inefficiency term (Berger and Mester, 1997).

The cost function can be written as:

$$C = C(w, y, z, v, u_c, \epsilon_c) \tag{1.1}$$

where C is variables costs; w is a vector of prices of variable inputs; y is the vector of

quantities of variable outputs; z is the vector of quantities of any fixed netputs (inputs or outputs, e.g. physical capital such as premises or other fixed assets; or financial equity capital); v is a set of environmental or market variables that may affect performance; u_c denotes an inefficiency factor that may raise costs above the best-practice level; and ϵ_c denotes the random error.

To simplify the measurement, the inefficiency term u_c and random term ϵ_c are assumed to be multiplicatively separable from the rest of the cost function, and both sides of (1.1) can be represented in natural logs:

$$\ln C = f(w, y, z, v) + \ln u_c + \ln \epsilon_c \tag{1.2}$$

where f denotes some functional form, and $\ln u_c + \ln \epsilon_c$ is the composite error. The cost efficiency of bank b is defined as the estimated cost needed to produce bank b's output vector if the bank was as efficient as the best-practice bank in the sample facing the same exogenous variables (w, y, z, and v) divided by the actual cost of bank b, adjusted for random error:

$$CostEFF^b = \frac{\hat{C}^{min}}{\hat{C}^b} = \frac{\exp\,[\hat{f}(w^b, y^b, z^b, v^b)] \times \exp\,[\ln \hat{u}_c^{min}]}{\exp\,[\hat{f}(w^b, y^b, z^b, v^b)] \times \exp\,[\ln \hat{u}_c^b]} = \frac{\hat{u}_c^{min}}{\hat{u}_c^b} \tag{1.3}$$

where $\hat{u}_c^{min}$ is the minimum value of $\hat{u}_c^b$ across all banks in the sample.

$CostEFF^b$ can be referred to as the proportion of bank b's costs that are used efficiently. The value of $CostEFF^b$ ranges from (0,1] and equals one for the best-practice firm in the sample. For example, if $CostEFF$ of a bank is 0.80, that means it is 80% efficient or wastes 20% of its costs in comparison to the best-practice bank facing the same conditions.

1.2.1.2. Standard profit efficiency

Standard profit efficiency measures a bank's profit in relation to the maximum possible profit produced by a best-practice bank, given a certain level of input prices and output prices. Hence, while the cost function holds all output quantities fixed at a particular level that could be inefficient, the profit efficiency allows for varying outputs and inputs while measuring revenue (Isik and Hassan, 2002).

The standard profit function, in log form, is written as:

$$\ln(\pi + \theta) = f(w, p, z, v) - \ln u_\pi + \ln \epsilon_\pi \tag{1.4}$$

where π is the variable profits of a bank, including all the interest and fee income earned on the variable outputs minus variable costs C used in the cost function; θ is a constant added to every bank's profits so that the natural log taken is a positive number; p is a vector of prices of the variable outputs; z is the vector of quantities of any fixed netputs; and v is a set of environmental or market variables that may affect performance. Ln u_π represents the inefficiency term that reduces the profits, and ln ϵ_π represents the random error.

The standard profit efficiency of bank b is defined as the ratio of the predicted actual profit to the predicted maximum profit that could be earned if bank operates as efficiently as the best-practice bank in the sample, net of random error:

$$Std\ \pi\ EFF^b = \frac{\hat{\pi}^b}{\hat{\pi}^{max}} = \frac{\{\exp[\hat{f}(w^b, p^b, z^b, v^b)] \times \exp[\ln \hat{u}_\pi^b]\} - \theta}{\{\exp[\hat{f}(w^b, p^b, z^b, v^b)] \times \exp[\ln \hat{u}_\pi^{max}]\} - \theta} \quad (1.5)$$

$Std\ \pi\ EFF^b$ is the proportion of maximum profits that can be earned. For example, if $Std\ \pi\ EFF^b$ is 0.80, it means that because of inefficient revenue or (and) excessive cost, the bank is losing about 20% of the profits it could be earning. The ratio of profit efficiency equals one for the best-practice firm and, unlike cost efficiency; the profit efficiency can be negative, as banks can lose more than 100% of their potential profit.

According to Berger and Mester (1997), the profit efficiency concept is superior to the cost efficiency concept for several reasons. The first is that, since profit efficiency is based on the concept of maximizing profits, it focuses on both maximizing revenue and reducing marginal costs at the same time. The second reason is that the errors from both the inputs and outputs are accounted for in the profit efficiency concept, while only input inefficiencies are examined in the cost function. Thirdly, as the cost function evaluates efficiency while holding outputs constant, a bank valued as cost efficient at its current outputs might not be efficient at the optimal level of output.

1.2.1.3. Alternative profit efficiency

The alternative profit efficiency measures how close a bank's profit compares to the maximum profit given its input prices and output levels – rather than output prices as in the standard profit efficiency (Berger and Mester, 1997). The alternative profit function in log form is:

$$\ln(\pi + \theta) = f(w, y, z, v) + \ln u_{a\pi} + \ln \epsilon_{a\pi} \quad (1.6)$$

which is similar to the standard profit function (1.4), except that y replaces p in the function, f, which consequently yields different values for the inefficiency term $\ln u_{a\pi}$ and the random error term $\ln \epsilon_{a\pi}$. The alternative profit efficiency is the ratio of bank b's predicted actual profits to the best-practice bank's predicted maximum profit:

$$Alt\ \pi\ EFF^b = \frac{a\hat{\pi}^b}{a\hat{\pi}^{max}} = \frac{\{\exp[\hat{f}(w^b, y^b, z^b, v^b)] \times \exp[\ln \hat{u}_{a\pi}^b]\} - \theta}{\{\exp[\hat{f}(w^b, y^b, z^b, v^b)] \times \exp[\ln \hat{u}_{a\pi}^{max}]\} - \theta} \quad (1.7)$$

According to Berger and Mester (1997) and De Young and Hassan (1998), it is not necessary to measure alternative profit efficiency instead of standard profit efficiency, except under the conditions stated below. Under one or more of these conditions, the alternative profit efficiency is considered to produce more accurate results. These conditions are:

a) If there are substantial unmeasured differences in the quality of banking services offered across banks.
b) If outputs are not completely variable, so that the bank cannot achieve every output scale and product mix.
c) If under non-perfectly competitive markets, banks have some market power over the prices they charge; and
d) If output prices are not measured accurately, leading to poor estimation of profit efficiency.

1.2.1.4. Inputs and outputs for efficiency concepts

For the concepts of cost efficiency and profit efficiency, it is essential to clearly define the relevant inputs and outputs of banks. According to Zaim (1995), two main approaches can be used to determine the input and output variables: the production approach and the intermediation approach.

The production approach views a bank as a producer of deposits and loans, using capital, labor, and materials. Hence, the outputs are the number of accounts and the amount of loans outstanding, while the inputs include all operating costs.

The intermediation approach views a bank as a collector of funds, which are then intermediated to loans and other assets. Hence, outputs are loans, and inputs include labor cost, physical capital, customer deposits, and funds borrowed from other sources.

The choice of approach depends on the intent of the researcher, and on which variables will be used in the efficiency models. Sealey and Lindley (1997) state that

researchers choose variables according to what they want to test. On the other hand, Berger and Humphrey (1997) suggest that the intermediation approach is best suited for analyzing efficiency at the firm level, while the production approach is more accurate at the branch level.

1.2.2. Efficiency measurement methods

Two types of techniques have been widely applied in the literature to estimate bank efficiency: parametric and non-parametric techniques. According to Bauer, Berger, Ferrier, and Humphrey (1998), these techniques differ in their assumptions regarding the shape of the efficient frontier, the existence of random error, and the distributional assumptions imposed on the random error and inefficiency term.

1.2.2.1. Parametric techniques

This parametric category includes three methods: the SFA, the Distribution-Free Approach (DFA), and the Thick Frontier Approach (TFA).

a. Stochastic Frontier Approach

According to Maudos et al. (2002), the SFA proposes that the cause of the deviation of the observed bank's costs from the best-practice bank's cost and the cost frontier is either the inefficiency u_c or the random error ϵ_c. Then, by making explicit assumptions about their distributions, the inefficiency can be separated from random error. The inefficiency term, $\ln u$, is assumed to be one-sided (usually half-normally distributed), while the random error term, $\ln \epsilon$, is assumed to be two-sided (usually normally distributed) (Berger and Mester, 1997). According to Chang et al. (1998), u_c represents the deviations from the frontier, which are caused by factors controlled by a bank's management; whereas the random error ϵ_c is not under management control. However, according to Berger and Mester (1997), the distribution assumptions of this approach are arbitrary. Beuer and Hancock (1993) and Mester (1993) have found that when inefficiencies are unconstrained, their distributions are much closer to symmetric normal than half-normal.

b. Distribution-Free Approach

This approach assumes that each firm possesses core inefficiency over time. This core inefficiency is separated from random error by assuming that core inefficiency is persistent over time, while random errors tend to cancel each other out as time passes (Mlambo and Ncube, 2011). Therefore, the assumptions regarding the distribution of $\ln u$ and $\ln \epsilon$ in the

SFA can be relaxed when using the DFA. According to Berger and Mester (1997), this approach is often used when panel data is available. The main drawback of this approach is the incorrect measurement of inefficiency if random errors do not cancel each other out in the examined period (Weill, 2004).

Developments in the literature have allowed researchers to measure time-varying inefficiencies of firms using DFA, for instance with the model proposed by Cornwell et al. (1990). Nevertheless, DFA is still criticized for its incorrect measures This is further discussed in section 1.2.3.

c. The Thick Frontier Approach

Mlambo and Ncube (2011) state that the TFA uses a relatively large subset of firms to define the frontier. Hence, this approach is usually used to measure the efficiency of an industry (Vivas, 1997). The method assumes that random error is the cause of differences in predicted costs within the quartile of banks with the lowest average costs for a given size. Thus, inefficiency would be the cause of differences in predicted costs between the quartiles with the lowest and highest costs.

1.2.2.2. Non-parametric techniques

This category includes two methods: Data Envelopment Analysis (DEA) and Free Disposable Hull Analysis. In non-parametric methods, a bank is classified as inefficient if its costs are higher or its profits are lower than the best-practice bank after removing random error (Berger and Mester, 1997). In other words, all deviations between the observed and the minimum costs are due to inefficient behavior (Maudos et al., 2002).

DEA is a popular approach in this category. According to Boussofiane et al. (1991), DEA uses linear programming techniques to envelop observed input-output vectors as tightly as possible. Efficiency is then measured in terms of a proportional change in outputs or inputs (Ji and Lee, 2010). Hence, DEA has the advantage of it being unnecessary to impose an explicit specification of the functional form for the production function, which allows flexibility for the frontier (Berger and Humphrey, 1997). Furthermore, unlike SFA, DEA does not make any distributional assumption regarding the data. However, one major drawback of DEA, according to Mester (1994), is that it does not allow for any random error in the data, which could lead to the inaccurate measurement of inefficiency. For example, if the costs of a bank were luckily under-measured, that bank would be classified as more efficient than other banks. In contrast, the parametric methods (SFA, TFA, and DFA) have the advantage over

non-parametric methods of allowing for random error, which reduces the possibility of misidentifying a measurement error as one component of inefficiency.

In addition, the efficiency level measured based on DEA estimation refers to a bank's ability to maximize the output level given a fixed amount of input combination, or to minimize an input mix when the output level is given (Chan and Karim, 2016). Thus, DEA is often criticized for ignoring prices and is considered more suitable for measuring technological than economic efficiency. In contrast, all three parametric methods employ price data to measure whether a firm optimizes its input or output levels and mixes to minimize its cost or maximize its profit. Therefore, parametric techniques are considered to be the preferred method of measuring economic efficiency as they generally correspond well with the concept of cost and profit efficiency used in previous studies (Berger and Humphrey, 1997).

In summary, both parametric and non-parametric techniques have been used extensively in the literature, and both have their own advantages and disadvantages. Depending on the different efficiency concepts employed and the availability of data, different techniques are employed. As this study focuses on measuring the economic efficiency of ASEAN banks, it uses the parametric techniques, except for the TFA given its irrelevant role in measuring efficiency at the firm level. The next section discusses in details the estimation methods of SFA and DFA.

1.2.3. Stochastic Frontier Approach and Distribution-Free Approach

Given the developed cost and profit frontier, the estimation of the models includes the parameters of the frontier functions and the inefficiency term. According to Kumbhakar et al. (2015), there are two main approaches to estimating the frontier function, and they depend on whether the distributional assumptions are made on the error components or not.

+ The DFA: the distributional assumptions are not made on the error components.

+ The SFA: highly specific distributional assumptions are made on the error components, and the maximum likelihood (ML) method is used to estimate the frontier function.

Another assumption that affects the frontier estimation is whether the inefficiency components are time-invariant or time-varying. Time-invariant inefficiency implies that the inefficiency levels of individual firms might be different, but they do not change over time. On the other hand, time-varying inefficiency implies that the inefficiency levels are firm-specific and change over time. Kumbhakar et al. (2015) argue that the time-invariant

inefficiency assumption suggests that underperforming firms do not learn over time and that market competition does not have any effect on the firms, which might be unrealistic. Hence, the time-varying inefficiency assumption is considered to be the preferred approach as it allows for efficiency improvement or diminishment over time.

Therefore, the next section discusses the DFA and SFA under the assumption that inefficiency is individual-specific and time-varying.

1.2.3.1. The Distribution-Free Approach

One of the important models of DFA for time-varying inefficiency was developed by Cornwell et al. (1990). It is based on Schmidt-Sickles's (1984) model:

$$y_{it} = \alpha_{it} + f(x'_{it}; \beta) + v_{it} \tag{1.8}$$

where $\alpha_i \equiv \alpha_{i0} - s\, u_i$

y_{it} is the dependent variable; x'_{it} represents the independent variables; f(.) is the functional form; u_i is the inefficiency term, which is time-invariant and confounded in the firm-specific effect; $s = 1$ if the model in (1.8) is a profit function; and $s = -1$ when the model in (1.8) is a cost function. Cornwell et al. (1990) suggest replacing α_i by α_{it} to make the inefficiency term time-varying:

$$\alpha_{it} = \alpha_{0i} + \alpha_{1t} t + \alpha_{2t} t^2 \tag{1.9}$$

where, α_{0i}, α_{1i} and α_{2i} are firm-specific and t is the time trend variable. If the model is represented as:

$$y_{it} = \alpha_{0t} + x'_{it}\beta + v'_{it} \tag{1.10}$$

where $v'_{it} \equiv v_{it} + \alpha_{2t} t + \alpha_{2t} t^2$

The form of the model is similar to a standard panel data model. Then, within estimator can be performed on the model in (1.10) to obtain a consistent estimate of $\hat{\beta}$, and the estimated residuals of the model: $\hat{\epsilon}_{it} = y_{it} - x'_{it}\hat{\beta}$.

These residuals ($\hat{\epsilon}_{it}$) are then regressed on a constant, a time trend (t), and the time trend squared (t^2) for each firm i. Subsequently, α_{it} is estimated using the fitted value from the above regressions. Finally, $\hat{u}_{it}$ is achieved by $\hat{u}_{it} = \hat{\alpha}_t - \hat{\alpha}_{it}$ and $\hat{\alpha}_t = max_j(\hat{\alpha}_{jt})$. For

each time (t), the maximum $\hat{\alpha}_t$ is defined and the efficiency is then calculated relative to the best firm in the year.

The advantage of the DFA estimator is that it is simple and easy to implement as it mostly relies on the standard fixed-effects or random-effects panel data estimators and OLS regression.

However, this method also has two major drawbacks. Firstly, the model does not allow the separation of the inefficiency term and individual heterogeneity; and secondly, as t is used in the inefficiency function, it cannot be used as a regressor in x_{it} to capture technical changes. In other words, this DFA model cannot separate inefficiency from specific firm effects and does not account for technical changes of the frontier function (Kumbhakar et al., 2015).

1.2.3.2. The Stochastic Frontier Approach

As mentioned earlier, the distribution assumptions of v_{it} and u_{it} are essential in the Maximum Likelihood (ML) approach. Hence, it is crucial to test these assumptions before any application of ML estimators. This approach assumes that v_{it} is zero-mean normally distributed and that u_{it} is equal or higher than 0 with various distribution assumptions.

Compared to the DFA, the ML estimators provide a much more flexible approach to estimate inefficiency. Numerous models have been developed using the ML estimators. Kumbhakar et al. (2015) summarize four broad groups of these models:

+ *Group 1*: Models with deterministic and stochastic components: Kumbhakar (1990), Battese and Coelli (1992), and Kumbhakar and Wang (2005).

+ *Group 2*: Models that separate firm heterogeneity from inefficiency: the True Fixed-Effects Model and the True Random-Effects Model by Greene (2005) and Wang and Ho (2010).

+ *Group 3*: Models that separate persistent and time-varying inefficiency: Kumbhakar and Heshmati (1995), Colombi et al. (2011).

+ *Group 4*: Models with firm effects, persistent inefficiency, and time-varying inefficiency: Kumbhakar et al. (2014), and Colombi et al. (2014).

The main arguments of the four model groups are centered on the components of the frontier error. *Group 1* assumes that the frontier error comprises the random error (v_{it}) and the one-sided inefficiency (u_{it}), which is similar to the assumption of the DFA. Hence, *Group 1* models suffer from the same problem of not separating firm heterogeneity from

inefficiency, which leads to overestimation of inefficiency levels. On the other hand, the advantage of these models over DFA models is their ability to account for technical changes over time. To overcome the drawback of *Group 1* models, *Group 2* and *Group 3* models try to separate firm effects from the inefficiency term by assuming that the frontier error comprises random error (v_{it}), one-sided inefficiency (u_{it}), and firm effects. *Group 2* models view firm effects as being separate from inefficiency (Greene, 2005), which faces a major argument that some of the firm heterogeneities, in fact, cause their inefficiency. Hence, when firm effects are completely separated from inefficiency, the inefficiency levels of firms could be underestimated.

On the other hand, *Group 3* models view the inefficiency of firms as a combination of two components: a persistent inefficiency and a short-term inefficiency. In the stochastic frontier specification, *Group 3* models treat firm effects as persistent inefficiency, and u_{it} captures short-term inefficiency of firms. Although the concept of *Group 3* models is different from that of *Group 1* models, it is clear that the former suffer from the same problem of not separating firm effects and inefficiency, which could produce upward-biased overall inefficiency estimations.

To address all the shortcomings of overestimation or underestimation of inefficiency levels in the *Group 1, 2,* and *3* models, *Group 4* models assume that the frontier error comprises four different components: the random error, the firm effects, the persistent inefficiency, and the short-term (or residual) inefficiency (Kumbhakar et al., 2014). Having reviewed the benefits and drawbacks of different methods of the DFA and SFA, the choice is made in this study to use the most recent model that has the ability to account for firm heterogeneity and to separate persistent from residual efficiency: that is, the SFA model proposed by Kumbhakar et al. (2014). The next section provides a detailed review of the chosen model.

1.2.3.3. The Kumbhakar et al.'s (2014) model

The model is specified as:

$$y_{it} = \alpha_0 + f(x_{it};\, \beta) + \mu_i + v_{it} - s\,\eta_i - s\,u_{it} \qquad (1.11)$$

where $\eta_i > 0$ and $u_{it} > 0$ represent the persistent inefficiency and residual (short-term) inefficiency; μ_i is the firm effects; and v_{it} is the random error. The model is then rewritten as:

$$y_{it} = \alpha_0^* + f(x_{it};\ \beta) + \alpha_i + \varepsilon_{it} \quad (1.12)$$

where $\alpha_0^* = \alpha_0 - E(\eta_i) - E(u_{it})$

$$\alpha_i = \mu_i - s\,\eta_i + E(\eta_i)$$

$$\varepsilon_{it} = v_{it} - s\,u_{it} + E(u_{it})$$

Kumbhakar et al. (2014) propose a three-step approach to estimate the model:

+ Step 1: As the model in (1.12) is similar to a panel data model, a random-effects panel regression is performed to estimate $\hat{\beta}$, $\widehat{\alpha_i}$ and $\widehat{\varepsilon_{it}}$.

+ Step 2: The estimated value $\widehat{\varepsilon_{it}}$ is used to estimate time-varying inefficiency, u_{it}.

$$\varepsilon_{it} = v_{it} - s\,u_{it} + E(u_{it})$$

The procedure uses the ML estimator by assuming the distribution of v_{it} and u_{it} and ignoring the difference between the true and predicted value of ε_{it}.

$$v_{it} \sim N(0, \sigma_v^2)$$

$$u_{it} \sim N^+(0, \sigma_u^2)$$

After this process, the residual efficiency is estimated and labeled as RE.

+ Step 3: The estimated value $\widehat{\alpha_i}$ is used to estimate the persistent inefficiency, η_i.

$$\alpha_i = \mu_i - s\,\eta_i + E(\eta_i)$$

The procedure uses the ML estimator by assuming the distribution of $\mu_i$and η_i and ignoring the difference between the true and predicted values of α_i.

$$\mu_i \sim N^+(0, \sigma_\mu^2)$$

$$\eta_i \sim N^+(0, \sigma_\eta^2)$$

After this process, the persistent efficiency is estimated and labeled as PE. Finally, the overall efficiency (OE) is obtained as the product of RE and PE:

$$OE = RE \times PE \quad (1.13)$$

1.2.4. Functional forms

Translog is the most popular functional form to use for cost and profit functions in the literature (Berger and Mester, 1997). One functional form is considered to be more flexible than the translog: the Fourier-flexible functional form. Nevertheless, Berger and Mester

(1997) found only a small difference in the efficiency results measured using both of the forms. According to Mester (2003), the improvement in terms of goodness of fit that the Fourier-flexible functional form provides is small and not significant from an economic point of view. Moreover, despite its advantage compared to the translog form, the Fourier-flexible form is also limited by its sensitivity to the number of observations and may not be suitable for small samples (Ikhide, 2000). Hence, for the simplicity of this paper, the translog functional form is used.

1.2.4.1. Translog cost function

English et al. (1993) propose the following generic translog cost function:

$$\ln C(x,y) = \alpha_0 + \sum_{n=1}^{N} \beta_n \ln x_n + \sum_{m=1}^{M} \alpha_m \ln y_m + 0.5 \sum_{n=1}^{N} \sum_{n'=1}^{N} \beta_{nn'} \ln x_n \ln x_{n'} + 0.5 \sum_{m=1}^{M} \sum_{m'=1}^{M} \alpha_{mm'} \ln y_m \ln y_{m'} + \sum_{n=1}^{N} \sum_{m=1}^{M} \gamma_{nm} \ln x_n \ln y_m \quad (1.14)$$

where x is a vector of bank output quantities; and y is a vector of bank input prices.

1.2.4.2. Translog alternative profit function

Similar to the translog cost function, the alternative profit function is written as follows (Isik and Hasan, 2002):

$$\ln(\pi + \theta) = \alpha_0 + \sum_{n=1}^{N} \beta_n \ln x_n + \sum_{m=1}^{M} \alpha_m \ln y_m + 0.5 \sum_{n=1}^{N} \sum_{n'=1}^{N} \beta_{nn'} \ln x_n \ln x_{n'} + 0.5 \sum_{m=1}^{M} \sum_{m'=1}^{M} \alpha_{mm'} \ln y_m \ln y_{m'} + \sum_{n=1}^{N} \sum_{m=1}^{M} \gamma_{nm} \ln x_n \ln y_m \quad (1.15)$$

where x is a vector of bank output quantities; and y is a vector of bank input prices.

1.3. Literature review on bank cost and profit efficiency in ASEAN countries

1.3.1. Overview of banking sectors in ASEAN countries

The development of banking systems in the six ASEAN countries (Vietnam, Cambodia, Indonesia, Malaysia, the Philippines, and Thailand) follows similar patterns. The first step of banking reforms in the six countries was the creation of the two-tier banking

system, which separated the functions of central banks and commercial banks. The next steps were to loosen the requirements on new entry and foreign participation in the banking sector. Those relaxations led to a rapid expansion of the ASEAN banking sectors. However, due to the insufficient supervision capacity of the government and the lack of adequate legislation and risk assessment framework, a number of dubious and under-capitalized new banks were established. As an inevitable result, the ASEAN banking systems were filled with a substantial amount of non-performing loans (NPLs), which made the banking sectors in the regions highly vulnerable, especially when coping with financial crises. In this vein, the financial crises, particularly the Asian Financial Crisis in 1997 and the Global Financial Crisis in 2008, significantly affected the banking systems in the ASEAN countries, eventually leading to major banking reform and restructuring in each country.

Though the development patterns of the ASEAN banking sectors are somewhat similar, their paces and models of development differ considerably. The following section provides a brief summary of the recent developments of the banking system of each examined country.

1.3.1.1. Vietnam

The transition from the mono-bank system to the two-tier system happened in 1986 following the "Doi Moi" program. Alongside the central bank (the State Bank of Vietnam – SBV), there were four other types of banks: state-owned commercial banks (SOCBs), joint-stock commercial banks (JSCBs), joint-venture banks (JVBs), and branches of foreign-owned banks (BFOBs) (Vietnamese Council of State, 1990). Foreign bank branches were only allowed to operate in Vietnam after 1990.

The period from 1990 to 1997 witnessed a booming development of the Vietnamese banking sector. The number of banks quickly increased from 9 to 83 at the end of 1996. However, the market was still dominated by SOCBs and the rapid growth was under weak assessment and monitoring skills. Combined with the deepening crisis in other Asian countries, the banking system in Vietnam became fragile. Overdue loans increased substantially to 11%-12% (IMF, 1999).

To cope with the problem of the increasing rate of NPLs, two new banking laws were approved in November 1997, and in April 1998 the Bank Restructuring Committee (BRC) was established with the mission of restructuring JSCBs and SOCBs. The form of restructuring in this period focused mainly on operational reforms, debt resolving, and

recapitalization (World Bank, 1999). At the end of 2005, the NPL rate was reduced to less than 4% (SBV, 2006).

As a consequence of the earlier bank restructuring, the period of 2006 to 2010 saw a rapid growth in the banking sector as well as the financial sector in general. At the end of 2010, the number of banks had increased substantially to 104, including 5 SOCBs, 37 JSCBs, 50 BFOBs, and 7 other banks. The high rate of NPLs continued to be an important issue in this period, the main causes being loans of SOCBs to state-owned enterprises (SOEs) in Vietnam, and the fragmented nature of JSCBs with their poor abilities of risk assessment. To solve this problem, in 2006 the Vietnamese government announced its plan to partially privatize SOCBs. In 2011, the government announced its continued plan to consolidate the sector by reducing the number of commercial banks to 20 by 2020 (Tran et al., 2015).

Furthermore, new regulations were introduced to aid the restructuring process. To raise the barrier to entry in the industry and reduce the fragmentation, the required minimum capital of commercial banks was raised from 1 trillion to 3 trillion VND, and the minimum required capital adequacy ratio was increased from 8% to 9%. The consolidation process until the end of 2014 reduced the number of JSCBs from 37 to 33. Despite the efforts of the Vietnamese government, however, the level of NPLs remained high, at around 15% (World Bank, 2016). To further tackle this problem, the government launched new measurement criteria for bad debt in the Vietnamese banking sector and established the Vietnam Asset Management Company (VAMC). The problem of high NPLs also led to SBV buying out loss-making banks, such as Vietnam Construction Bank (2011), Ocean bank (2013), and GPbank (2015).

Though foreign operations were allowed in Vietnam in the 1990s under joint ventures and foreign branches until after Vietnam successfully joined the World Trade Organization (WTO) in 2007, further actions were taken to further liberate the banking sector and allow greater presences of foreign banks in Vietnam. Following the new Decree 22/2006/ND-CP in 2006, licenses were granted for five foreign banks to open wholly foreign-owned subsidiary banks (WFOBs). In addition, foreign banks were allowed to buy shares in local banks under the form of strategic partnership. However, according to Decree No.01/2014/ND-CP, the foreign ownership of Vietnamese banks is capped at 30%.

At the end of 2014, the Vietnamese banking system consisted of 7 SOCBs, 28 JSCBs, 5 WFOBs, 4 JVBs, 49 BFOBs, and 3 other banks (SBV, 2015).

1.3.1.2. Cambodia

In 1991, the Cambodian banking system switched from a mono-banking to a two-tier banking system. In this period, commercial banks were founded under the form of state joint venture banks, and 32 commercial banks were granted banking operation licenses by 1998. From 1992 to 1998, foreign subsidiaries had to fulfill the minimum capital requirement of $5 million, and 15% of the stake was owned by the National Bank of Cambodia (NBC).

From 1998 to 2001, the banking sector reform was introduced under the new Governor, H.E. Chea Chanto (NBC, 2005). The reform brought new regulations to the banking system. According to the new law, each commercial bank had to meet the minimum paid-up capital of $13 million. The new banking law also classified financial institutions into three categories: 1) full commercial banks with minimum paid-up capital of $13 million; 2) specialized banks with minimum paid-up capital of $2.5 million; and 3) licensed/registered microfinance institution (MFIs). Due to this restructuring, the number of commercial banks decreased substantially, but MFIs began to grow rapidly.

To strengthen the banking system, the NBS introduced the bank-relicensing program based on the increased capital requirements and CAMEL rating system. Before the relicensing program, in November 2000, the commercial banking system in Cambodia consisted of 31 banks (2 government-owned banks, 22 local banks, and 7 foreign branches). Just one month later, the NBC revoked the licenses of 12 banks (classified as non-viable) and put 16 other banks under conditional licenses. In addition, by 2001, the requirement of 15% NBC stake in private-owned and foreign banks was abolished.

The main issue in the period from 1998 to 2001 was the poor quality of assets in the banking system. At the end of 2001, the level of NPLs was estimated to be 8% of total loans. However, the number was considered not to be accountable due to the lack of accounting standard and a uniform chart of bank accounts. The high NPL ratio in the Cambodian banking sector had several causes: limited access to borrowers' liability information, the lack of a credit bureau, the lack of common accounting standards, a weak legal framework, and weak supervision capacity. The ratio of NPL continued to increase and peaked at over 14% in 2002 (NBC, 2005).

To resolve this NPL problem, the existing laws and regulations were reviewed regularly. In 2003, the new chart of account (COA) was made available. The restructuring of SOCBs had made considerable progress. At the end of 2004, there were two such banks in

Cambodia, and this number decreased to one in 2005 as the Foreign Trade Bank was successfully privatized. In addition, the minimum capital requirement for commercial banks increased to $37.5 million by the end of 2010.

The period from 2006 to 2010 was the period of expansion in the Cambodian banking system. The number of banks increased significantly from 20 commercial banks in 2006 to 35 in 2010. During this period, the Cambodian government continued to focus on strengthening the legislative and supervisory frameworks to enhance the soundness of the whole system. In 2005, the Law on Negotiable Instruments of Payments Transactions was passed, while the Law on Anti-Money Laundering and Combating Financing of Terrorism and the Law on Financial Leasing were introduced in 2007 and 2009, respectively. As a result, the NPL ratio was effectively reduced from 19.4% in 2006 to 3.3% in 2014 (NBC, 2014).

At the end of 2014, the banking system in Cambodia comprised 36 commercial banks, 11 specialized banks, 7 representative offices, and 40 MFIs (NBC, 2014).

1.3.1.3. Indonesia

The evolution of the banking sector in Indonesia followed similar patterns as the development of the country's political system. The first transformation of the banking system happened when President Soeharto died and ended his rule in 1994.

The first banking reform happened in 1988, under the rule of President Soeharto. The 1980s reform partly liberalized entry and foreign ownership requirements, which eventually formed a banking system dominated by large, compromised state banks, a number of very small local private banks, and some constrained foreign banks (Hamada, 2003). However, due to the lack of prudential regulatory framework, although the first wave of banking liberalization had resulted in an explosion of new banks operating in Indonesia, the overall system faced the serious problem of extremely high NPL ratios (e.g. 20% in 1992).

The period from 1994 to 1997 witnessed a rapid growth in the financial sector, which was thought to be the effect of the banking reforms in the 1980s, though the supervision capacity of Bank Indonesia could not keep pace with the growing number of new banks. By the end of 1996, 239 banks operated in Indonesia, compared to only 111 commercial banks at the end of 1988.

In 1997, due to the vulnerable nature of the banking system, the Asian Financial Crisis hit Indonesia much harder than other Asian countries, with the effects lasting longer too. In January and February 1998, the banking system collapsed (Nasution, 2015). From 1997 to the

end of 2002, the government closed and liquidated 18 banks, froze the operations of 10 banks, and froze the business activities of 42 banks; moreover, 28 banks merged, and two banks went into self-liquidation (BI, 2004). In December 2002, the number of banks decreased to 141, compared to 239 banks in 1996. The NPL ratio peaked at 48.6% in 1999 (World Bank, 2016).

During and after the crisis, BI implemented the policy of providing emergency liquidity and purchasing sovereign bonds to restore capital adequacy of financially distressed banks. Moreover, BI also immediately closed or restructured non-viable banks, as well as restructuring the bad assets of viable banks. In June 2003, BI set the NPL indicative target at a maximum of 5% with the purpose of forcing banks to improve their loan quality. Then, in 1999, BI was made into an independent institution with the single goal of achieving the target inflation rate.

In October 2004, General Yudhoyono became Indonesia's first directly elected president, and banking policies in this period solely focused on rebuilding the Indonesian banking sector. In 2004, BI issued 14 regulations concerning commercial banking, mainly focusing on the restructuring of the banking system and ensuring the financial soundness of banks. By the end of 2004, the Indonesian banking sector comprised very few local private banks, fewer state banks, and larger and freer foreign-controlled banks. At this time, the market share of foreign-controlled banks was greater than that of local private banks (Cook, 2008).

SOCBs were partially privatized while the government still maintained a controlling stake. Hence, the Indonesian state-owned banks remain very heavily protected. Before the crisis, there were seven SOCBs in the system, and after the crisis this number as reduced to four as the result of bank mergers and the restructuring process (Nasution, 2015). At the end of 2009, all four SOCBs were partially privatized with the controlling stake of the government at more than 55%.

In 2010, the Financial Services Authority was established with the mission of regulating and supervising all financial sectors by focusing on adopting risk-oriented banking supervision according to Basel principles and by reforming the accounting system. To better maintain financial stability, the Financial Stability Forum was created in 2007. However, the institutions and legal system still remained weak as the private property rights or business contract enforcement could not be properly protected. The NPL ratio in 2010 was effectively reduced to 2.5% (World Bank, 2016).

From 2011 to 2014, the Indonesian government continued to focus on strengthening and enhancing the efficiency of its banking system using the main strategy of consolidating the sector through mergers and acquisitions. BI has planned to reduce the total number of banks from 120 in 2011 to 60-70 in 2020. Few regulations have been issued to support this consolidation process. In 2012, regulation No. 14/8/PBI/2012 was introduced, which stipulates the maximum ownership in an Indonesian bank based on types of investor (EY, 2015). Furthermore, at the end of 2012, regulation No. 14/24/PBI/2012 was issued, aiming to provide incentives for banking consolidation (EY, 2015). The NPL ratio in 2014 remained at the low level of 2.1% (World Bank, 2016)

At the end of 2014, the Indonesian banking system consisted of 4 state-owned and 114 private banks (including 26 regional development banks, 39 foreign exchange banks, 28 non-foreign exchange banks, and 21 BFOBs and joint-venture banks) (IMF, 2016).

1.3.1.4. Malaysia

In 1980, there were 97 banks in Malaysia (21 domestic banks, 17 foreign banks, 47 finance companies, and 12 merchant banks). Hence, the banking sector in this period was considered to be fragmented with a high level of NPLs (more than 30% of total loans). This led the government to attempt to consolidate the industry.

In 1994, a new two-tier regulatory system (TTRS) was introduced with the main purpose of providing incentives for smaller banks to merge (Oh, 1999). However, instead of merging, smaller banks borrowed heavily to increase their capital, which led to imprudent and aggressive lending to generate large returns. Thus, the new system resulted in high levels of poor asset quality, and it was eventually abandoned in 1999. The NPL level reached 18.6% in 1998 (World Bank, 2016). To solve this problem, Bank Negara Malaysia (BNM) acquired shares in some of the ailing commercial banks, and stronger finance companies absorbed the assets and liabilities of inefficient finance firms. As a result, the number of finance companies decreased from 47 (1990) to 40 (1996).

In July 1997, Malaysia was deeply affected by the Asian Financial Crisis, which was caused by currency speculators. In this period, the Malaysian government proposed the new scheme of banking system consolidation as one of the main policies promoting economic recovery. In July 1999, the government implemented a tough plan to have only six “anchor banks” remain after proposed mergers. Consequently, in December 2000, 50 of 54 banking institutions consolidated into 10 banking groups. In 2001, the total number of banking

institution had decreased from 71 (1999) to 47 (11 domestic banks, 14 foreign banks, 10 merchant banks, and 12 finance companies) (Ismail, 2007). Furthermore, after the Asian Financial Crisis, the government enhanced governance and risk management practices and developed better infrastructure for financial institutions. In this vein, in September 1997, the Basel Core Principles for Effective Banking Supervision were adopted in Malaysia.

From 2000 to 2007, the banking system experienced significant growth as the effect of the consolidation program. The global financial crisis then occurred in 2008 and affected a number of countries across the world. However, the impact on the Malaysian banking system was not substantial. The level of NPLs in 2008 was 2.5% of total loans, compared to 17.8% in 2001 (World Bank, 2016).

Also in this period, BNM led a 10-year Financial Sector Masterplan covering 2001 to 2010. This plan focused on restructuring the financial system and strengthening the supervisory and regulatory frameworks. In 2009, BNM took steps to further liberalize foreign participation, which resulted in the entries of seven new foreign banks (IMF, 2014). In contrast, the number of domestic banking groups was reduced to 8 in 2010, compared to 77 groups in 1997.

In 2011, NBM implemented another 10-year plan, the Financial Sector Blueprint 2011-2020, with the main aims of promoting innovation, enhancing infrastructure, and encouraging international integration of local institutions (PwC, 2012).

At the end of 2014, the banking sector of Malaysia comprised 27 commercial banks (8 domestic banks and 19 foreign banks), 19 Islamic banks, 11 investment banks, and 2 other financial institutions (BNM, 2015).

1.3.1.5. The Philippines

Prior to the 1990s, the banking sector in the Philippines had faced several crises, particularly the 1981 crisis when former Senator Benigno Aquino was assassinated. This crisis led to a massive capital flight, the peso devaluation, and increased interest rates (Gochoco-Bautista, 1999). After the crisis, various rescue efforts were made; this includes government takeovers of certain private businesses and financial institutions, resulting in the recapitalization of five commercial banks.

The banking system in the early 1990s saw a remarkable improvement as rules and regulations were relaxed, particularly for foreign banks. In 1992, the foreign exchange market was deregulated, restrictions on repatriation of foreign investment incomes were lifted, and

the Foreign Investment Act of 1991 simplified the registration process for foreign investments (Gochoco-Bautista, 1999). In 1994, 10 foreign banks were allowed to entry under specified modes. Prior to this year, only four foreign banks had operated in the Philippines under restrictive regulations. Furthermore, in 1993, the new Central Bank act was approved, aiming to ensure the independence of conducting money policy from political interference. Moreover, in 1994, the name of the central bank changed to Bangko Sentral Pilipinas (BSP).

The liberalization of the financial market in the early 1990s resulted in a surge of foreign capital inflow to the Philippines, peaking at 7% of GDP in 1996. However, the level of NPLs also increased, from about 4% prior to the crisis to 13.1% in 1999. The Asian Financial Crisis revealed the vulnerability of the Philippine banking system due to defective macroeconomic policy and premature liberalization of the capital market prior to the institution of a strong supervisory and regulatory framework for banks. In 1997, 14 banks were closed, followed by another 22 banks in 1998. However, the assets of closed banks only constituted about 0.01% and 0.04% in 1997 and 1998, respectively. At the end of 1998, the Philippine banking sector had 996 banks in total, including 53 commercial banks, 104 thrift banks, and 839 rural and cooperative banks.

To cope with the Asian Financial Crisis, the BSP implemented more reforms to improve the capacity of the banking system and to support the system's institutional structure in dealing with problem banks (Manlagnit, 2011). In the 2000s, the General Banking Law was passed, aiming to encourage existing banks to go into microfinance and strengthening the regulatory and supervision framework of banks. Incentives were also provided to encourage asset cleanup, capital buildup, and bank consolidation. In terms of asset cleanup, the Law on Special Purpose Vehicles was implemented in 2002. In addition, to improve banks' risk management, the Philippine government implemented regulations on capital adequacy ratio according to the criteria of Basel I (2001), Basel II (2007), and Basel III (2013), and in compliance with the International Accounting Standards (IAS) in 2003. In 2006, Circular No. 512 was issued, clarifying the adoption of the Philippine Financial Reporting Standard (PFRS) and Philippine Accounting Standards (FAS). In 2009, the BSP revised the rules on accreditation of external editors and/or auditing firms. Then, in 2011, the BSP enhanced the rules on capital adequacy for foreign bank branches. The NPL ratio in 2010 was effectively reduced to 3.4%. In terms of consolidation, the number of banks in the sector was reduced to 648 at the end of 2014, consisting of 36 universal and commercial banks, 69 thrift banks, and 543 rural and cooperative banks (BSP, 2014).

In 2014, the Republic Act (RA) 10641 was signed and allowed the full entry of foreign banks into the local banking industry.

1.3.1.6. Thailand

From 1983 to 1985, Thailand faced a serious financial crisis that led to a large government bailout and 25% devaluation of the baht. However, this recession turned into an economic boom in 1986 and 1987 due to cheapening Thai export and massive flows of FDI.

This FDI resulted in excessive investments during the period of 1990 to 1996, which were mainly funded by money borrowed abroad. In 1992, the foreign exchange was deregulated and it was possible for local and foreign commercial banks to borrow in foreign currencies abroad and lend money both in Thailand and internationally. As the exchange rate was fixed between the baht and the US dollar, investors could borrow abroad with a low interest rate of 5 to 8% and lend money domestically with a short-term interest rate of 10 to 11%. As a result, too much offshore borrowing occurred, making the financial system in Thailand overflow with capital and leading to an investment bubble and careless lending activities. A major portion of investments were made in the already inflated real estate sector. The banking sector in the 1990s was characterized as highly concentrated, with 15 local commercial banks (accounting for 95% of total assets) and 14 foreign banks (5% of total asset). The top five largest banks accounted for 69% of total asset in 1990 (Lauridsen, 1998).

The economic recession started in Thailand in 1996 when the property bubble burst, resulting in extensive levels of bad assets in financial companies, of which investments were financed by foreign borrowing. The NPL ratio of the Thai banking system in 1998 was estimated at 45% of total loans. The commercial banks' ability to obtain funds were significantly reduced, which made them become technically insolvent. To resolve the problem, foreign shareholders were allowed to increase their share from the maximum of 25% to 49%. One bank was closed down, while other troubled banks were acquired or merged with stronger banks or sold to foreign investors. Before the crisis, the Thai banking system had 31 commercial banks including 15 domestic banks and 16 BFOBs. Then, in 2003, the number of domestic commercial banks was reduced to 13, but the number of BFOBs increased to 18 (Satsanguan and Lewis, 2009).

To cope with the Asian Financial Crisis, new regulations on financial institutions were issued. Accounting standards were changed towards the adoption of Basel II (Nidhiprabha, 2011). In 2004, the Thai government introduced a financial master plan that aimed to

liberalize and reform banking standards. Commercial banks were categorized into four new categories: commercial banks, retail banks, BFOBs, and foreign bank subsidiaries. Furthermore, the operational scopes of commercial banks were also expanded to other related sectors, including insurance, securities, derivatives, electronic banking, and financial services. In addition, new policies were issued on credit risk management, good corporate governance, internal control, internal auditing, information disclosure, and transparency. The Thai government's strategy had succeeded, with the banking system recovering substantially with declining NPL levels and an increasing risk-weighted capital adequacy ratio. The level of NPLs decreased sharply from 42.9% in 1998 to 11.9% in 2004 and 5.2% in 2009 (World Bank, 2016). Moreover, the capital adequacy ratio increased to 8.5% in 2009, which was higher than the requirements of Basel II.

In 2008, the global financial crisis prevented Thai banks from reducing their non-performing assets. As Basel II was widely adopted in this period, loan loss provisions were set aside with higher amounts than regulation requirements. This made Thai banks better prepared to cope with the economic downturn. In 2014, the NPL level was reduced to 2.3% (World Bank, 2016).

From 2010 to 2014, the Thai government implemented the second phase of its financial sector master plan. The main purposes of the plan were to reduce the overall system operating costs, to promote competition and financial access, and to strengthen the financial infrastructure (BOT, 2010).

At the end of 2014, the Thai banking sector consisted of 31 commercial banks, including 14 domestic banks, 1 retail bank, 4 foreign subsidiaries, and 12 BFOFs (BOT, 2014).

1.3.2. Bank efficiency in ASEAN countries: empirical findings

Intensive research has been conducted in the field of bank efficiency regarding developing and transitional economies. The majority of these studies focus on evaluating the efficiency of foreign and domestic banks in developing countries; and the dominant methods used in these studies are SFA and DEA. Similarly, the literature on commercial bank efficiency in ASEAN countries presents various results using SFA and DEA. Various studies are available both on individual countries and on the whole ASEAN region.

Studies of individual countries mostly focus on Indonesia, Thailand, Malaysia, the Philippines, and Vietnam. For instance, Muazaroh et al. (2012) use SFA to examine the profit

efficiency of commercial banks in Indonesia from 2005 to 2009. They conclude that the average profit efficiency level of Indonesian banks declined over the period examined: specifically, the score decreased from 0.53 (2005) to 0.41 (2009). Based on bank types, rural development banks and foreign banks are the most profit efficient. Moreover, Viverita and Ariff (2011) measure Indonesian bank efficiency over the period of 2004 to 2008 using SFA. Their results show an overall mean cost inefficiency of 1.784 and a mean profit efficiency of 0.753.

Manlagnit (2011) uses SFA to measure the cost efficiency of commercial banks in the Philippines over the period of 1990 to 2006 and obtains a mean cost inefficiency score of 1.25. The score remains steady from 1990 to 1994 (1.30), then decreases from 1995 to 1997 (1.26). However, it increases sharply in 1998 (1.28) due to the effect of the Asian Financial Crisis in 1997. After the crisis, the Philippines commercial banks became more cost efficient and reached their lowest inefficiency level in 2005 (1.14).

Chansarn (2008) uses DEA to measure the efficiency of Thai commercial banks from 2003 to 2006. The results show that the efficiency level measured using the productional approach is higher and more stable than the level measured using the intermediation approach. The author concludes that from 2003 to 2006, Thai commercial banks were found to be more efficient using the productional than the intermediation approach. Furthermore, Chansarn (2008) reports that while all small, medium, and large banks are efficient using the productional approach, small banks are found to be the most efficient using the intermediation approach. This suggests that the use of different approaches can significantly affect the measurement of bank efficiency.

Sufian (2009) measures the efficiency of Malaysian banks over the period of 1995 to 1999 using DEA. Sufian (2009) finds that the efficiency scores for Malaysian banks are significantly different using different approaches (intermediation, value-added, and operating approach). Under the intermediation approach, the reported efficiency scores are the lowest, ranging from 0.327 (1999) to 0.570 (1997), while the highest efficiency scores are produced with the productional approach, ranging from 0.752 (1999) to 0.889 (1995). The results indicate that the level of technical efficiency of Malaysian banks has been deteriorated abruptly after the Asian Financial Crisis using all approaches, but the more pronounced deterioration was observed using the intermediation approach.

Matousek et al. (2014) measure the efficiency of banks in Vietnam from 1999 to 2009 and reach a mean technical efficiency score for the entire banking system of 0.75.

Furthermore, the authors provide separate mean technical efficiency scores for different types of banks: 0.70-0.80 for state-owned banks; 0.67-0.72 for joint-stock banks; and 0.74-0.77 for joint-venture banks. In other words, joint-venture banks and state-owned banks are found to be more efficient than joint-stock commercial banks in Vietnam. In addition, Matousek et al. (2014) report that the efficiency level of Vietnamese banks generally increases over the examined period, but it does not rise every year. In contrast, Nguyen and De Borger (2008) measure bank efficiency in Vietnam and conclude that the productivity of Vietnamese banks tends to decrease over the period of the sample (2003-2006). Moreover, also using DEA, Nguyen et al. (2013) find that cost efficiency scores of banks in Vietnam slightly increase from 0.84 in 1995 to 0.89 in 2011, and that profit efficiency scores show an upward trend from 0.52 in 1995 to 0.81 in 2007.

The studies that focus on groups of ASEAN countries are quite recent. For instance, Tahir et al. (2012) use SFA to examine the cost efficiency of commercial banks in six ASEAN countries – Indonesia, Malaysia, Singapore, Thailand, the Philippines, and Vietnam – over the period of 2003 to 2008. The overall cost inefficiency score of the sample is 1.33. The country with the most cost-efficient banks is Singapore (1.20), followed by the Philippines (1.21), Indonesia (1.27), Thailand (1.28), Vietnam (1.40), and in last place, Malaysia (1.55).

Gardener et al. (2011) use DEA to calculate the efficiency scores of banks in five ASEAN countries (Indonesia, Malaysia, the Philippines, Thailand, and Vietnam) from 1998 to 2004. The authors report technical efficiency scores for the region ranging from 58.2% (Indonesia) to 85.9% (Malaysia), and cost efficiency scores ranging from 41.9% (Indonesia) to 71.9% (Malaysia). Moreover, Gardener et al. (2011) observe a decline in efficiency scores over the period of 1998 to 2004, which indicates that the post-1997 crisis financial reform had a negative impact on bank performance.

Sun and Chang (2011) use SFA to calculate the efficiency scores of eight emerging Asian countries, including four ASEAN countries: Indonesia, the Philippines, Malaysia, and Thailand. The examined time period is from 1998 to 2008. The results show that the cost efficiency scores for the whole sample range from 0.527 in 1998 to 0.791 in 2006. Among the ASEAN countries, Malaysian banks are the most cost efficient, followed by Indonesian, Philippine, and Thai banks.

Lin et al. (2015) use SFA to measure the bank cost efficiency of 12 Asian developing countries (including five ASEAN countries, namely Indonesia, Malaysia, the Philippines,

Singapore, and Thailand) over the period of 2003 to 2012. The average cost efficiency score for the whole sample is 0.84. For ASEAN countries, Malaysia has the most cost-efficient banks (0.87), followed by Indonesia (0.86), Thailand (0.76), the Philippines (0.73), and Singapore (0.70).

Chan et al. (2016) use DEA to measure the cost efficiency of banks in five ASEAN countries (Indonesia, Malaysia, the Philippines, Singapore, and Thailand) from 1998 to 2012. The mean cost efficiency score is 0.67. The country with the highest cost efficiency score is the Philippines (0.75), followed by Thailand (0.73), Singapore (0.72), Malaysia (0.68), and Indonesia (0.61).

As reviewed, the studies on bank efficiency in ASEAN are various, in term not only of methods used, but also of approaches chosen. Furthermore, due to the differences in sample sizes and sample periods, various results of efficiency scores, are produced. Though the results are not exactly comparable, empirical evidence generally shows that Malaysia is the country with the most cost-efficient banks (Gardener et al., 2011; Sun and Chang, 2011; Lin et al., 2015); the ranks of other countries are not consistent among studies. On the other hand, some studies find that Malaysian banks are among the least cost-efficient, and while those in the Philippines are among the most cost-efficient (Tahir et al., 2012; Chan et al., 2016). In addition, the results regarding the efficiency level trend are also mixed, with some studies concluding that banks in the ASEAN countries are becoming increasingly efficient over time (Matousek et al., 2014; Nguyen et al., 2013), while other studies report a decrease in efficiency scores among these banks (Muazaroh et al., 2012; Nguyen and De Borger, 2008; Gardener et al., 2011). Lastly, compared to using the productional approach, the efficiency scores measured using the intermediation approach are found to be generally lower and to more accurately reflect the efficiency differences between groups of banks (Chansarn, 2008; Sufian, 2009).

1.4. Methodology and data

1.4.1. The model

As mentioned earlier in the efficiency concepts and efficiency measurement methods, the purpose of this study is to measure only the economic efficiency of ASEAN commercial banks, including cost and profit efficiency. Given the chosen concepts, parametric techniques are chosen to measure efficiency in this study, as these techniques are expected to yield more accurate efficiency results than non-parametric techniques. Moreover, to accurately measure

the difference in bank efficiency at the firm level, the intermediation approach is used in this paper (Chansarn, 2008; Sufian, 2009; Berger and Humphrey, 1997).

For modeling purposes, the banks are classified as multi-product, three-output, three-input firms. Total cost (TC) and pre-tax profits (PP) are the two dependent variables, while output quantities and input prices are the independent variables. Total cost is the sum of interest expenses, personnel expenses, and other administrative expenses.

The inputs are labor (L), including personnel expenses; capital (K), which is the total fixed assets; and deposits (D), which are deposits from banks and customers. The prices of input are P_L (the ratio of personnel expenses to total assets), P_D (the ratio of total interest paid to deposits), and P_K (the ratio of other administrative expenses to total fixed assets). The outputs are the amounts of loans to customers (Q_1), interbank loans (Q_2), and other earning assets (Q_3).

The choice of inputs and outputs is consistent with previous studies by Berger et al. (2010); Mlambo and Ncube (2011); Kraft et al. (2002); Vivas (1997). On the other hand, in the literature, it is preferable to estimate P_L as the ratio of personnel expenses to the total number of permanent employees, and P_K as the ratio of depreciation expenses to total fixed assets. However, due to the lack of data on the number of permanent employees and depreciation expenses of banks, a considerable number of previous studies have adopted the approach used in this paper (Girgardone et al., 2009). In other studies, such as those of Berger and Mester (1997) and Berger et al. (2010), the choices of inputs and outputs are more specific, dividing the mentioned inputs and outputs into smaller categories; however, due to the limited financial data available for the banking sector in ASEAN countries, the present study includes only three general inputs and three outputs.

In addition, this paper adopts the approach of Berger and Mester (1997) in normalizing the dependent variables and input prices by P_L for the purpose of imposing linear homogeneity on the model. As explained by Berger and Mester (1997), on the efficient frontier, when all input prices are doubled, costs will be doubled.

According to Casteuble (2015), when the cost or profit frontier only includes the input prices and output quantities, it is assumed that bank managers are risk-neutral and risk exposure is not considered to be associated with banks' production plans. However, in reality, managers' risk preference is an essential aspect of the banking industry. For example, given the same outputs produced, risk-averse banks appear to be less cost efficient than risk-neutral

banks, as they tend to incur more costs in reducing risk, for instance by allocating more resources to increasing loan monitoring or increasing their level of capital to prevent default. In contrast, from the perspective of risk-averse banks, the choices of inputs and outputs are already optimal, given their risk preferences. Nevertheless, Berger and DeYoung (1997) argue that the higher a bank's capital ratio is, the lower the bad loan levels will be, making it unnecessary for the bank to incur additional expenses to recover the loans, in turn making the bank more efficient. Though the direction of the influence of capital ratio on bank efficiency is not decisive, accounting for managers' risk aversion is crucial when estimating bank efficiency. Following the approach of Lozano-Vivas et al. (2002), Hughes and Mester (1998), and Hughes (1999), this study includes the bank's level of capital (measured by the ratio of equity to total asset) as a proxy to control for risk. As explained by Hughes and Mester (1998), risk-averse managers prefer a higher level of capital and they follow the objective of profit maximization or cost minimization only under an acceptable degree of risk.

In addition, as discussed intensively in literature, another fundamental issue that needs to be controlled for when estimating efficiency levels is bank heterogeneity (Berger and Mester, 1998; Bos and Schmiedel, 2003; Bos et al., 2009). According to Bos et al. (2009), though inefficiency of banks could be accounted for by their managers' poor abilities, it could also be the result of factors that are outside of management's direct influence. For example, banks are not free to choose their country of operation; hence, different banks could face different regulations or economic conditions. Berger (2007) notes the importance of accounting for an adequate set of environmental factors that control the economic and regional differences when estimating bank efficiency. Hence, the present study uses the following industry and environment factors as control variables.

+ The labor productivity growth rate (*prod.growth*): measured by the yearly changes in the amount of GDP per person employed. Lozano-Vivas et al. (2002) state that the banking productivity is affected by the productivity growth rate as banking costs are expected to decrease when labor productivity increases.

+ The bank branch density (*branch.dens*): measured by the number of bank branches per 100,000 inhabitants. A higher level of branch density suggests a higher level of access to financial services throughout the population. However, Lozano-Vivas et al. (2002) argue that higher levels of branch density imply higher costs, as the capacity of some branches might be underutilized. In other words, high branch density levels might reduce bank efficiency.

+ Inflation rate (*infl*): according to Sufian and Habibullah (2012), the effects of inflation on bank efficiency could be negative or positive, depending on the abilities of banks to accurately forecast the future changes in the inflation rate. If banks can fully forecast the inflation rate, they can adjust their interest rates to increase revenue, leading to higher profits. However, if banks unsuccessfully anticipate the future inflation movement, they can incur higher costs (Perry, 1992).

+ Banking industry concentration (*concentration*): the effect of market concentration on bank efficiency can be explained by two main hypotheses: the structure-conduct-performance hypothesis (Molyneux et al., 1996) and the efficient structure hypothesis (Berger, 1995; Goldberg and Rai, 1996). According to the structure-conduct-performance hypothesis (SCP), the changing market power of individual banks leads to the changes in market structure. Specifically, banks have the tendency to increase their market powers and reduce competition in the market. As a consequence, the market has fewer banks, and these have high market power but are not necessary highly-efficient. In contrast with the SCP hypothesis, the efficient structure hypothesis suggests a positive relationship between industry concentration and bank efficiency. The second hypothesis argues that banks with higher cost efficiency levels will outperform other banks and gain more market power, which eventually leads to a market dominated by more efficient banks. There are two main approaches to measuring banking industry concentration: the concentration ratio (the share of the assets held by the three or five largest banks in an economy) and the Herfindahl-Hirschman index (HHI - the sum of the squared market shares of individual banks in the sector). Although the HHI has an advantage over the concentration ratio because it accounts for the share of all banks in the system, it is more difficult to obtain accurate statistics with this method due to missing information. Hence, due to the limited availability of information about the banking sectors in ASEAN countries, the present study uses the concentration ratio of the three largest banks in a banking sector as a proxy to measure banking industry concentration.

Finally, this paper adds year dummy variables to the cost and profit function with the purpose of accounting for technical changes over time for banks in the sample.

To summarize, the cost and profit frontiers include the following independent variables: output quantities (Q_1, Q_2, and Q_3), input prices (P_L , P_K, and P_D), and controls (E.ratio, prod.growth, branch.dens, infl, concentration, and year dummies).

1.4.1.1. Cost frontier

The cost function is derived from equations (1.1), (1.2), and (1.8) in the literature review and the discussion. It can be represented by a translog function as follows:

$$\ln\left(\frac{TC}{P_L}\right) = \beta_0 + \sum_{i=1}^{2}\alpha_i \ln\frac{P_i}{P_L} + 0.5\sum_{i=1}^{2}\sum_{j=1}^{2}\alpha_{ij}\ln\frac{P_i}{P_L}\ln\frac{P_j}{P_L} + \sum_{k=1}^{3}\gamma_k lnQ_K + 0.5\sum_{k=1}^{3}\sum_{m=1}^{3}\gamma_{km}lnQ_K lnQ_M + 0.5\sum_{i=1}^{2}\sum_{m=1}^{3}\delta_{im}\ln\frac{P_i}{P_L}lnQ_M + \lambda_n controls + U_{it} + V_{it} \quad (1.16)$$

where Q is the vector of output quantities and P is the vector of input prices; i and t represent cross-sectional; U_{it} is the inefficiency term; and V_{it} is the random error. The expanded equation used in this paper is as follows:

$$\ln(\tfrac{TC}{P_L}) = \beta_0 + \alpha_1\ln\tfrac{P_K}{P_L} + \alpha_2\ln\tfrac{P_D}{P_L} + 0.5\alpha_{11}(\ln\tfrac{P_K}{P_L})^2 + 0.5\alpha_{22}(\ln\tfrac{P_D}{P_L})^2 + \alpha_{12}\ln\tfrac{P_K}{P_L}\ln\tfrac{P_D}{P_L} + \gamma_1\ln Q_1 + \gamma_2\ln Q_2 + \gamma_3\ln Q_3 + 0.5\gamma_{11}(\ln Q_1)^2 + 0.5\gamma_{22}(\ln Q_2)^2 + 0.5\gamma_{33}(\ln Q_3)^2 + \gamma_{12}\ln Q_1\ln Q_2 + \gamma_{13}\ln Q_1\ln Q_3 + \gamma_{23}\ln Q_2\ln Q_3 + \delta_{11}\ln\tfrac{P_K}{P_L}\ln Q_1 + \delta_{12}\ln\tfrac{P_K}{P_L}\ln Q_2 + \delta_{13}\ln\tfrac{P_K}{P_L}\ln Q_3 + \delta_{21}\ln\tfrac{P_D}{P_L}\ln Q_1 + \delta_{22}\ln\tfrac{P_D}{P_L}\ln Q_2 + \delta_{23}\ln\tfrac{P_D}{P_L}\ln Q_3 + \lambda_n controls + U_{it} + V_{it} \quad (1.17)$$

where $U_{it} \geq 0$, and zero is the value of the most cost-efficient firm, and the higher the value, the more inefficient the bank is.

1.4.1.2. Profit frontier

Since it is impossible in this paper to measure the differences in the quality of banking services of different banks in the sample, output prices of banks would be measured inaccurately if the standard profit function was used. Therefore, the alternative profit function is chosen instead to estimate profit inefficiency. The expanded equation for the alternative profit function is the following:

$$\ln(\tfrac{PP}{P_L}) = \beta_0 + \alpha_1\ln\tfrac{P_K}{P_L} + \alpha_2\ln\tfrac{P_D}{P_L} + 0.5\alpha_{11}(\ln\tfrac{P_K}{P_L})^2 + 0.5\alpha_{22}(\ln\tfrac{P_D}{P_L})^2 + \alpha_{12}\ln\tfrac{P_K}{P_L}\ln\tfrac{P_D}{P_L} + \gamma_1\ln Q_1 + \gamma_2\ln Q_2 + \gamma_3\ln Q_3 + 0.5\gamma_{11}(\ln Q_1)^2 + 0.5\gamma_{22}(\ln Q_2)^2 + 0.5\gamma_{33}(\ln Q_3)^2 + \gamma_{12}\ln Q_1\ln Q_2 + \gamma_{13}\ln Q_1\ln Q_3 + \gamma_{23}\ln Q_2\ln Q_3 + \delta_{11}\ln\tfrac{P_K}{P_L}\ln Q_1 + \delta_{12}\ln\tfrac{P_K}{P_L}\ln Q_2 + \delta_{13}\ln\tfrac{P_K}{P_L}\ln Q_3 + \delta_{21}\ln\tfrac{P_D}{P_L}\ln Q_1 + \delta_{22}\ln\tfrac{P_D}{P_L}\ln Q_2 + \delta_{23}\ln\tfrac{P_D}{P_L}\ln Q_3 + \lambda_n controls - U_{it} + V_{it} \quad (1.18)$$

Where $U_{it} \geq 0$ is the value of inefficiency, and PP is each bank's profit before tax. Different from the cost function, where the value of total cost (TC) of a bank is always positive, the value of its profit before tax (PP) could be negative, which is problematic for the translog profit function. Bos and Koetter (2009) propose three approaches to handle this issue. The first is to drop observations with negative profit values and only estimate the model for banks with positive profit. However, this approach prevents researchers from obtaining efficiency scores for loss-incurring banks, while they are often of particular concern. Evaluating the efficiency of these banks would help researchers to further investigate the causes of inefficiency.

The second approach is to rescale PP to ensure that it is positive for all banks, such as by adding a maximum loss observed in the sample plus a small number, so that the natural log of a positive number could be used. This approach is widely adopted in early literature on bank efficiency (Berger and Mester, 1997; Vennet, 2002; Kasman and Yildirim, 2006). However, Bos and Koetter (2009) argue that this manipulation affects the error term structure, eventually yielding inaccurate efficiency estimates.

Due to the limitations of the two previous approaches, Bos and Koetter (2009) propose an alternative solution: the "indicator" approach. The authors left-sensor the PP variable, and assign the value of 1 to PP if the observation has a negative profit value. At the same time, an additional independent variable NPI (Negative Profit Indicator) is added to the right side of the equation. NPI takes the value of one for observations with positive profit values and equals the absolute value of PP for loss-incurring banks. This approach helps to keep all observations in the sample, does not affect the error term structure, and still accounts for the loss effects by adding the NPI variable. Hence, the present study adopts Bos and Koetter's (2009) indicator approach. This leads to the modified alternative profit frontier as follows:

$$\ln(\frac{PP}{P_L}) = \beta_0 + \alpha_1 \ln\frac{P_K}{P_L} + \alpha_2 \ln\frac{P_D}{P_L} + 0.5\alpha_{11}(\ln\frac{P_K}{P_L})^2 + 0.5\alpha_{22}(\ln\frac{P_D}{P_L})^2 + \alpha_{12}\ln\frac{P_K}{P_L}\ln\frac{P_D}{P_L} +$$
$$\gamma_1 \ln Q_1 + \gamma_2 \ln Q_2 + \gamma_3 \ln Q_3 + 0.5\gamma_{11}(\ln Q_1)^2 + 0.5\gamma_{22}(\ln Q_2)^2 + 0.5\gamma_{33}(\ln Q_3)^2 +$$
$$\gamma_{12}\ln Q_1 \ln Q_2 + \gamma_{13}\ln Q_1 \ln Q_3 + \gamma_{23}\ln Q_2 \ln Q_3 + \delta_{11}\ln\frac{P_K}{P_L}\ln Q_1 + \delta_{12}\ln\frac{P_K}{P_L}\ln Q_2 +$$
$$\delta_{13}\ln\frac{P_K}{P_L}\ln Q_3 + \delta_{21}\ln\frac{P_D}{P_L}\ln Q_1 + \delta_{22}\ln\frac{P_D}{P_L}\ln Q_2 + \delta_{23}\ln\frac{P_D}{P_L}\ln Q_3 +$$
$$\theta \ln\frac{NPI}{P_L} + \lambda_n controls - U_{it} + V_{it} \qquad (1.19)$$

1.4.2. The sample

The sample of this study comprises 175 banks from six ASEAN countries: Vietnam, Cambodia, Indonesia, Malaysia, the Philippines, and Thailand. The data represent the period of 2007 to 2014.

The data on the variables are collected from the published audited financial reports of the banks in the sample over the period from 2007 to 2014. The information obtained for each bank includes:

- Interest expenses and similar expenses
- Total operating expenses
- Personnel expenses
- Profit before tax
- Loans issued
- Other earning assets and liquid assets
- Total assets
- Total fixed assets
- Equity

Data on productivity growth, bank branch density, and inflation are obtained from the World Bank website. Data on industry concentration are obtained using information from annual supervision reports by each country's state bank or central bank.

Tables 1.2a, 1.2b, and ***1.2c*** summarize the data of banks used in the model for the period of 2007 to 2014.

Table 1.2a presents the sample distribution for this study. The total number of banks in the sample is 175, with the largest contribution coming from Indonesia with 50 banks, followed by Vietnam with 36 banks. The other countries contribute approximately more than 20 banks each. The table also provides details about the total number of conventional commercial banks in the banking system of each country in the sample, which explains why Indonesia is the largest contributor.

Table 1.2b reports the descriptive statistics of dependent and independent variables of the cost and profit frontiers for the whole sample. According to table 1.2b, banks in ASEAN are vastly different from each other in terms of total cost and pre-tax profit. Bank outputs are relatively widespread. Bank inputs include price of capital, price of funds and price of labor. The higher the input prices, the higher levels of input the banks need to produce a certain

quantity of outputs. Moreover, the prices of input range widely in the sample. Regarding the control variables, the equity ratio ranges from 0.040 to 0.994 with a mean value of 0.157, which implies the existence of a certain proportion of banks in the sample that could be regarded as highly risk-averse. The productivity growth of the six countries averages at 3.3% with an interesting negative minimum value. During the sample period, the year 2009 witnesses the drop in productivity of many countries, including Cambodia, Malaysia, the Philippines, and Thailand. The average bank branch density of the sample is 8.838 and is also distributed widely from 3 to 17.9. The average inflation rate is 0.057 (5.7%), with the maximum rate reaching 0.25. The mean industry concentration ratio is 0.430, which represents the average share of assets from the three largest banks in the sectors.

Table 1.2c presents the descriptive statistics of dependent and independent variables for each country. Cambodian banks are small in size compared to other countries' banks, as they have very low levels of total cost and profit. In terms of relative cost to profit, Vietnamese banks appear to incur the highest total cost relative to the profit made in comparison with other countries. Among those other countries, Indonesian banks seem to incur the least cost to yield their level of profits. In terms of outputs produced, Malaysian and Thai banks produce the highest levels, followed by the banks from Vietnam, Indonesia, and the Philippines with similar average levels. Banks from Cambodia produce extra low output levels.

Comparing the input prices, no obvious group of banks has lower prices. Banks from Vietnam have the lowest capital prices (1.734) and labor prices (0.0073), but the highest fund prices (0.074). Cambodian banks also have relatively low fund prices (0.023) and average capital and labor prices (2.231 and 0.012). Banks from Indonesia have relatively low prices of capital (1.972) but the highest labor prices (0.134) and the second highest prices of funds (0.059). Malaysian banks have very low fund prices (0.022) and labor prices (0.0075), but their capital prices are the second highest in the sample (2.843). Philippine banks have the lowest prices of fund (0.0196), second lowest prices of capital (1.897), and average prices of labor (0.0075). Finally, Thai banks have very low labor prices (0.0085) and average fund prices (0.031), but extremely high capital prices (5.496).

In terms of control variables, Cambodian banks are likely to be the most risk-averse, with an equity ratio that is double that of other countries (0.306), followed by Thailand (0.165), Indonesia (0.134), and similar rates for the other countries. Productivity growth is higher in Vietnam, Cambodia, and Indonesia than in the Philippines, Malaysia, and Thailand.

The branch density variable represents the vast difference in coverage of banks in different ASEAN countries. Vietnam and Cambodia have the least coverage, with 3 to 4 bank branches per 100,000 inhabitants, the Philippines has an average number of 8 branches, Malaysia and Thailand have the similar number of 11 branches; and the country with highest branch density is Indonesia with more than 13 branches. Vietnam is the country with the highest average inflation rate (0.106), while Malaysia and Thailand both have the lowest levels (0.022). Regarding banking industry concentration, Vietnam and Indonesia have the least concentrated markets, while the Malaysian banking sector is the most concentrated one in the sample.

In summary, when comparing the levels of cost and profit before tax, given the combination of output levels and input prices, Malaysian and Philippine banks appear to have better combinations than banks from other countries. However, the significant differences in banks' risk preference, productivity growth, and branch density of each country emphasize the importance of controlling for bank heterogeneity when estimating bank efficiency scores.

1.5. Results and discussion

1.5.1. The OLS residual skewness test

As reviewed in depth in section 1.2.3, the SFA method is preferable to DFA when estimating the efficiency levels of banks, as the former yields more accurate results than the latter. By using SFA, researchers can account for technical changes over time, and different SFA models give different flexibility to separate the firm effects, persistent efficiency, and time-varying efficiency of banks. However, as the SFA relies on the assumption that the inefficiency term is positive, it is crucial to test this assumption before proceeding to use the method.

This paper follows the approach of Schmidt and Lin (1984), who propose a skewness test on OLS residual to check for the validity of the model specifications. In the case of a production-type stochastic frontier model with the composed error $v_{it} - u_{it}$, v_{it} symmetrically distributed around zero and $u_{it} \geq 0$, the residuals from the corresponding OLS estimation are supposed to skew to the left or have a negative skewness. In the case of a cost-type frontier model, the composed error is $v_{it} + u_{it}$, which makes the OLS residual distributions skew to the right or have a positive skewness. If the skewness test provides evidence that is consistent with the stochastic model specifications, the ML estimators are used.

The test results are presented in table 1.3. For the cost frontier, the estimated skewness of the OLS residuals is positive (0.6291) and significant. The positive value of the statistic suggests that the residual of the cost frontier is skewed to the right, which is consistent with the assumption of the SFA model.

For the profit frontier, the estimated skewness of the OLS residuals is negative (-4.1714) and significant. The negative value of the statistic indicates that the residual of the profit frontier is skewed to the left, which supports the assumptions of the SFA model. Thus, the SFA appears to be the appropriate approach to estimate the cost and profit efficiency of the banks in the sample.

1.5.2. Cost and profit frontier parameter estimations

Table 1.4 presents the translog cost and profit frontier parameter estimates using Kumbhakar et al.'s (2014) SFA model. Based on the t-statistics, the variables that better explain the cost frontier are most of the input price and output quantity variables, while the profit frontier is explained mainly by the output variables.

Concerning controls, the equity ratio is found to have a negative effect on total cost. In other words, the higher the equity ratio is, which implies a lower risk of the bank, the lower the costs will be. This result supports Berger and DeYoung's (1997) argument that higher capital ratios lead to lower levels of bad loans, which helps to reduce loan recovery costs and make banks more efficient. For the productivity growth variable, a positive relationship with total cost is found, which implies that the higher the productivity of the country is, the higher costs the banks incur. This result is unexpected, but it could be due to the low fraction that labor costs represent in a bank's total costs. On the other hand, a positive significant impact of productivity on bank profit is found, which implies that productivity growth helps to boost bank profits. This result supports Lozano-Vivas et al.'s (2002) view. Significant negative effects of branch density are found on both bank costs and profits, which implies that the higher the branch density is in a country, the lower costs the bank incurs, but also the lower its profits are. This partly supports the argument that the higher the branch density is, the higher the level of accessibility to financial services is throughout the population. No significant relationship is found between inflation and bank costs or profits. Finally, industry concentration has a significant negative effect on bank costs, which partly supports the SCP hypothesis (Molyneux et al., 1996). Moreover, a significant positive effect of concentration found on bank profits partly supports the efficient structure hypothesis (Berger, 1995; Goldberg and Rai, 1996).

In summary, the results in table 1.4 indicate the importance of controlling for technical changes and firm heterogeneity when estimating the efficiency levels of banks.

1.5.3. Cost and profit efficiency levels

1.5.3.1. Cost efficiency levels

Table 1.5a and ***1.5b*** present the yearly persistent, residual, and overall cost efficiency values for ASEAN commercial banks over the period of 2007 to 2014. The values of cost efficiency scores for all banks are smaller than 1, with 1 representing the most cost-efficient bank. The higher the score, the more cost efficient a bank is. The difference between a cost efficiency score and 1 represents the percentage of costs that one specific bank could save to produce the same output quantities under the same conditions, compared to the best-practice bank in the sample. As shown in table 1.5b, the countries with the most cost-efficient banks are Indonesia and Thailand, while Philippine and Malaysian banks show lower levels of efficiency in terms of both persistent and residual scores. The result of Malaysian banks as the least cost-efficient banks is similar to the findings of Tahir et al. (2012) and Chan et al. (2016). On the other hand, in contrast to the present findings, these authors conclude that Philippine banks among the most cost-efficient banks.

On average, the efficiency values of the whole sample range from 0.7062 to 0.8071, which implies that banks operate at relatively high levels of cost efficiency. In contrast, the cost inefficiency levels of ASEAN banks are mainly due to the persistent inefficiency factor, as the average persistent efficiency score (0.8448) is clearly lower than the average residual score (0.9148). This result is consistent with those of Manlagnit (2011) and Tahir et al. (2012). Manlagnit (2011) reports a mean cost inefficiency value of Philippine banks (1990-1996) of 1.25, while Tahir et al. (2012) present a cost efficiency score of banks in six ASEAN countries (2003-2008) of 0.67. On the other hand, the present results are high compared to those of Viverita and Ariff (2011): they report the cost inefficiency value of Indonesian banks (2004-2008) to be 1.784, indicating that inefficient banks incur 78.4% more costs than the most efficient banks. However, the differences in efficiency scores are mostly due to the differences in the sample structures and data periods.

Examining yearly average scores of cost efficiency for the whole sample over time, there is no obvious increasing or decreasing trend of cost efficiency for ASEAN banks over the period of 2007 to 2014. This does not support the findings of Matousek et al. (2014) and Nguyen et al. (2013), who indicate that ASEAN banks become more cost efficient over time;

or the findings of Muazaroh et al. (2012), Nguyen and De Borger (2008), and Gardener et al. (2011), who report decreasing trends in ASEAN bank efficiency.

1.5.3.2 Profit efficiency levels

Tables 1.5a and ***1.5b*** present the persistent, residual, and overall profit efficiency values for ASEAN commercial banks between 2007 and 2014**.** Table 1.5b reports the average values of profit efficiency scores for each country and the whole sample. The scores of profit efficiency are reported to be less than 1, indicating a certain level of profit inefficiency among the banks. The difference between the profit efficiency score and 1 demonstrates the proportion with which a bank can increase its profit without changing its outputs or inputs. Thus, the higher the score, the more profit efficient a bank is. As shown in table 1.5b, in terms of both persistent and residual scores, Malaysian and Cambodian banks show the highest levels of profit efficiency, while Vietnamese and Indonesian banks are the least profit efficient.

On average, the efficiency values of the whole sample range from 0.2778 to 0.3486, which implies that banks operate at relatively low levels of profit efficiency. This result is consistent with the study of Muahzaroh et al. (2012) on Indonesian banks (2005-2009), which reports mean profit efficiency scores ranging from 0.41 to 0.53. On the other hand, the present result is low compared to that of Viverita and Ariff (2011), who report a mean profit efficiency value of 0.753. Similarly, Nguyen et al. (2013) report profit efficiency scores for Vietnamese banks of 0.52-0.81 (1995-2011). In contrast, the profit inefficiency levels of ASEAN banks in the present study's sample come equally from both the persistent and residual inefficiency factors, which is demonstrated by the similar average scores of persistent and residual efficiency (0.5596 and 0.5444, respectively).

Examining the yearly average scores of profit efficiency for the whole sample over time reveals a small decreasing trend of profit efficiency of ASEAN banks over the period of 2007 to 2014. This supports the findings of Muazaroh et al. (2012), Nguyen and De Borger (2008), and Gardener et al. (2011), who report that ASEAN banks become less efficient over time.

Table 1.5c shows the results of the model specification validity post-estimation test for Kumbhakar et al.'s (2014) SFA model. Prior to applying the SFA model to estimate the cost and profit functions, an OLS-residual-based skewness test was performed to test the validity of the one-sided error model specification. However, after estimating the profit frontier using

SFA, Kumbhakar et al. (2015) state that the earlier test does not account for the information of the random error distribution. Hence, to test for the existence of u_{it} in the model, the generalized likelihood ratio (LR) test was performed using the log-likelihood values of OLS and the SFA model. The null hypothesis of the LR test is that no one-sided error exists. As reported in table 1.5c, the LR test results reject the null hypothesis and confirm the existence of an inefficiency term for both the cost and profit frontiers at 1% significant level.

To summarize, this study yields an interesting result implying that Indonesian banks are the most cost-efficient but the least profit-efficient banks, while Malaysian banks are the least cost efficient but the most profit efficient. The average scores of cost efficiency range from 0.7062 to 0.8071 and the average profit efficiency scores range from 0.2778 to 0.3486. This indicates that ASEAN banks operate at relatively high levels of cost efficiency but fairly low levels of profit efficiency. The general trend for cost efficiency appears to fluctuate over time, while profit efficiency tends to slowly decrease over the sample period.

1.5.4. Results of hypothesis testing

This section aims to examine the trends of cost and profit efficiency of banks in ASEAN countries over the period of 2007 to 2014. Four different hypothesis tests are conducted to identify the changes in efficiency scores of banks in the whole sample and in each individual country.

Hypothesis tests 1, 2, 3, and 4

Hypothesis 1, Ho: There is no change in time-varying cost efficiency of the selected commercial banks in ASEAN countries over the period of 2007 to 2014.

Hypothesis 2, Ho: There is no change in overall cost efficiency of the selected commercial banks in ASEAN countries over the period of 2007 to 2014.

Hypothesis 3, Ho: There is no change in time-varying profit efficiency of the selected commercial banks in ASEAN countries over the period of 2007 to 2014.

Hypothesis 4, Ho: There is no change in overall profit efficiency of the selected commercial banks in ASEAN countries over the period of 2007 to 2014.

1.5.4.1. Hypothesis 1

The one-way analysis of variance (ANOVA) test is used to determine whether the time-varying cost efficiency levels change significantly over time at a significance level of 10%. ***Table 1.6a*** summarizes the results for the individual countries and the whole sample.

The ANOVA test results indicate that the null hypothesis that there is no change in ASEAN commercial banks' time-varying cost efficiency between 2007 and 2014 is accepted for the whole sample and some individual countries (Vietnam, Cambodia, and the Philippines), but rejected for Indonesia, Malaysia, and Thailand. In other words, the levels of cost efficiency of ASEAN banks change significantly over time for Indonesia, Malaysia, and Thailand, but not for the other countries. To determine the direction of changes in cost efficiency scores, the Tukey post-hoc tests are done for the individual countries and the whole sample; results are presented in ***table 1.6b***, revealing that very little change exists in time-varying cost efficiency scores for Indonesia and Malaysia. Only the 2014 score is found to be significantly lower than in 2008 for Indonesian banks, and only the 2014 score is found to be significantly higher than in 2011 for Malaysian banks.

1.5.4.2. Hypothesis 2

The ANOVA test is used to determine whether the overall cost efficiency levels change significantly over time at a significance level of 10%. ***Table 1.6c*** summarizes the test results for the individual countries and the whole sample.

The ANOVA test results indicate that the null hypothesis that there is no change in ASEAN commercial banks' overall cost efficiency during the sample period is accepted for the whole sample and all countries individually.

1.5.4.3. Hypothesis 3

The ANOVA test is used to determine whether the time-varying profit efficiency levels change significantly over time at a significance level of 10%. ***Table 1.6e*** summarizes the test results for the individual countries and the whole sample.

The ANOVA test results indicate that the null hypothesis that there is no change in ASEAN commercial banks' time-varying profit efficiency during the sample period is accepted for the whole sample but rejected for most countries individually (except for the Philippines). The Tukey post-hoc test results in ***table 1.6f*** highlight the differences in the medians. As reported in the table, the scores for Vietnamese banks in the 2011-2014 period are significantly lower than in the 2007-2010 period. The scores for Indonesian banks in 2009, 2010, 2011, and 2014 are found to be significantly lower than in 2008, while the scores in 2012 and 2013 are significantly higher than in 2009 and 2011. This indicates a mixed trend of time-varying profit efficiency levels for Indonesia. Malaysian banks' scores for 2010-2014 are found to be significantly lower than those for 2008 and 2009, which in turn are

significantly higher than 2007. For other countries, there is no obvious trend. In other words, clear decreasing trends are only found for Vietnamese and Malaysian banks.

1.5.4.4. Hypothesis 4

The ANOVA test is used to determine whether the overall profit efficiency levels change significantly over time at a significance level of 10%. ***Table 1.6g*** summaries the test results for the individual countries and the whole sample.

The ANOVA test results indicate that the null hypothesis that there is no change in ASEAN commercial banks' overall profit efficiency during the sample period is accepted for the whole sample but rejected for three of the countries individually: Vietnam, Indonesia, and Malaysia. The Tukey post-hoc test results in ***table 1.6h*** highlight the differences in the medians. As reported in the table, clear trends are only found for Vietnamese banks, whereas no obvious trend is found for the overall efficiency scores of other countries. For Vietnamese banks, the scores for 2009, 2010, 2011, and 2014 are higher than for 2008, but the scores for 2012 and 2013 are lower than for 2009 and 2010. This indicates mixed trends for Vietnamese banks' overall profit efficiency scores.

In summary, the hypothesis tests point out the differences in cost and profit efficiency trends for banks from different countries. Over time, ASEAN banks show no substantial changes in residual and overall cost efficiency scores. However, in terms of residual profit efficiency scores, Vietnamese and Malaysian banks show clear decreasing trends and Indonesian banks show a mixed trend, while the scores do not change for the other countries. Regarding overall profit efficiency scores, only Vietnamese banks show a significant mixed trend, while scores remain mostly stable for the other countries.

1.5.5. Discussion

Except for the Cambodian banking sector, which was in an expansion phase during the sample period, banks in the other countries underwent significant consolidation processes as a consequence of the financial crises. However, although the Cambodian banking system was in an expansion phase, the focus of the Cambodian government on strengthening its legislative and supervisory framework might result in higher costs incurred by its banks. In the period examined, Vietnam completed the first phase of the consolidation process, which reduced the number of commercial banks from 37 to 33, and continued to phase 2, with the aim of reducing the number to 20 by 2020. Indonesia privatized four out of seven SOCBs in 2010 and has continued its consolidation program to reduce its number of banks from 120 to

60-70 by 2020. Similarly, the bank consolidation in the Philippines is on-going, with various incentives for banks to merge. On the other hand, the consolidations of Malaysian and Thai banks were completed in 2010, and further steps were taken to enhance bank efficiency and capacity. Furthermore, along with consolidation, the governments of the five countries also focused on strengthening their regulatory and supervisory frameworks, and especially the risk management process. A tightened risk management process would require banks to operate more prudently and avoid taking excessive risks; thus, it could unfavorably affect bank profitability.

As banks are undergoing unfinished restructuring, their operations need more time to reach their optimal efficiency levels. Therefore, the results regarding the lack of increase in profit efficiency and the lack of decrease in cost efficiency found for the whole sample are reasonable, as banks need time to adjust their operations after consolidation.

In terms of efficiency rankings, it is logical that Malaysian and Cambodian banks are found to be the most profit efficient, and that Vietnamese and Indonesian banks are the least profit efficient. This could be explained by the fact that the consolidation process was completed by 2010 in Malaysia; thus, Malaysian banks had considerably more time than banks in Vietnam and Indonesia to re-organize their operations to be more profitable. In Cambodia's case, as its banking sector was in the expansion phase, implying higher profit margins for banks compared to other countries, the high profit efficiency level is expected.

However, the results of Indonesian banks being the most cost-efficient banks while Malaysian banks are the least cost-efficient are unexpected, and in contrast to the results regarding profit efficiency. This could be explained by looking closely at the feature of banks and banking industries in the two countries. As discussed in section 1.5.2, the cost frontier estimates (table 1.4) suggest a positive effect of productivity growth but negative effects of equity ratio, branch density, and market concentration on bank costs. Hence, Malaysian banks are the least cost efficient because they are less risk-averse, and because the country has low levels of productivity growth, moderate levels of branch density, and very high levels of industry concentration. On the other hand, Indonesian banks are the most cost efficient because they are less risk-averse, and because the country has very high levels of productivity growth, very high levels of branch density, and considerably low levels of banking industry concentration. The above bank and industry characteristics could also explain why Malaysian banks are the most profit efficient while Indonesian banks are the least profit efficient. As

seen in table 1.4, a significant negative effect of branch density but positive effects of productivity growth and industry concentration on bank profits are found.

In the case of Cambodia, although its banks have very high levels of profit efficiency, low levels of cost efficiency are expected, as these banks are small in size compared to banks in other countries. As explained by McAllister and McManus (1997), larger banks enjoy economies of scale and scope and have better chances of diversifying their risk compared to smaller banks, which results in lower costs of funding and higher cost efficiency.

1.6. Conclusion

This study used SFA to measure the cost and profit efficiency levels of ASEAN commercial banks over an eight-year period (2007-2014). The sample consisted of 175 banks from six countries: Vietnam, Cambodia, Indonesia, Malaysia, the Philippines, and Thailand. Kumbhakar et al.'s (2014) SFA model was considered to be the preferred estimator of cost and profit efficiency scores for the sample.

The cost efficiency levels of ASEAN banks were found to be relatively high, with average scores of permanent, residual, and overall cost efficiency of 0.8448, 0.9148, and 0.7734, respectively. Indonesia was the country with the most cost-efficient banks, while Malaysian banks were the least cost efficient. The trends of cost efficiency for the whole sample and individual countries were found to be generally unchanged during the sample period.

The average permanent, residual, and overall profit efficiency scores of ASEAN banks were 0.5596, 0.5444 and 0.3084, respectively. This indicates that these banks operated at significantly low levels of profit efficiency. Malaysia and Cambodia were the two countries with the most profit-efficient banks, while Indonesia and Vietnam had the least profit-efficient banks in the sample. No obvious increasing or decreasing trend of profit efficiency scores was found for the whole sample. However, in terms of residual profit efficiency scores, decreasing trends were found for Vietnamese and Malaysian banks, and mixed trends were found for Indonesian banks. In terms of overall profit efficiency scores, a significant mixed trend was only found for Vietnamese banks.

The difference in efficiency score rankings and trends could be due to the fact that different countries were at different stages of their development or consolidation process, as well as due to the differences in their bank and industry characteristics. The generally stable

trend of cost and profit efficiency could be explained as due to the impacts of the consolidation processes accompanied by tightening regulations in individual countries.

In summary, this study found relative differences not only in the efficiency scores but also in the efficiency trends of banks from different countries. The paper also aimed to explain those differences using general knowledge about the banking sectors in ASEAN countries. However, many possible factors, including bank, industry, and country characteristics, could help to further rationalize those dissimilarities. Furthermore, as Kumbhakar et al.'s (2014) SFA model is able to separate banks' persistent and time-varying profit efficiency, it would help researchers to identify their determinants separately, which could result in different management and policy implications. Therefore, further research is needed.

APPENDICES

Table 1.1. Variables used to estimate the cost and profit functions

This table gives descriptions and detail measurements of the dependent variables (TC and PP) and independent variables (outputs, inputs, input prices, and controls) that are used to estimate bank efficiency.

Variable	Variable name	Description
TC	Total costs	Interest expenses and operating expenses
PP	Pre-tax Profit	Profit before taxation
Outputs		
Q_1	Loans issued	Loans issued by the bank
Q_2	Other earning assets and liquid assets	Other earning assets
Inputs		
P_1	Labor	Number of full-time employees
P_2	Capital	Fixed assets
P_3	Funds	Deposits from customers and banks
Input prices		
P_L	Labor	Personnel expenses/Total assets
P_K	Capital	Other administrative expenses/Book value of fixed assets
P_D	Funds	Interest expenses/Funds
Controls		
E.ratio	Equity ratio	Equity/Total assets
Prod.growth	Productivity	Growth of GDP per person employed
Branch.dens	Branch density	Number of bank branches per 100,000 inhabitants

Table 1.2a. Sample distribution

This table presents the distribution of the sample by country in the period from 2007-2014. The "The sample" column refers to the number of banks included in the sample. The second column refers to the total number of conventional commercial banks in the banking system of each country in the sample. The "Sample contribution" column is calculated by taking the number of banks from each country and divided by the total number of banks in the sample.

Country	Total number of conventional Commercial banks	The sample	Sample contribution
Vietnam	45	36	21%
Cambodia	36	25	14%
Indonesia	103	50	29%
Malaysia	27	23	13%
Philippines	40	20	11%
Thailand	30	21	12%
Total	**281**	**175**	**100%**

Table 1.2b. Summary statistics of dependent and independent variables

This table reports descriptive statistics (obs, mean, std. dev., min, and max) for dependent and independent variables used to estimate bank efficiency scores. Obs is the number of observations Std. dev. is the standard deviation of each variable.

Variable description	Variables	Obs	Mean	Std. Dev.	Min	Max
Total cost ($000)	TC	1064	477,000	758,000	329	4,760,000
Pre-tax profit ($000)	PP	1064	178,000	382,000	-106,000	2,670,000
Loans to customers ($000)	Q_1	1064	5,980,000	11,500,000	1	80,200,000
Interbank loans ($000)	Q_2	1064	1,150,000	2,060,000	1	16,400,000
Other earning assets ($000)	Q_3	1064	2,010,000	3,850,000	1	36,700,000
Price of capital	P_K	1064	2.498	4.162	0.096	68.287
Price of funds	P_D	1064	0.045	0.030	0.001	0.182
Price of labor	P_L	1064	0.012	0.008	0.001	0.079
Equity ratio	E.ratio	1064	0.157	0.131	0.040	0.994
Productivity growth	Prod.growth	1064	0.033	0.020	-0.029	0.069
Bank branch density	Branch.dens	1064	8.838	4.798	3	17.9
Inflation rate	Infl	1064	0.057	0.048	-0.008	0.25
Industry concentration	Concentration	1064	0.430	0.067	0.287	0.562

Table 1.2c. Variable distribution by country

This table reports the mean values of input and output variables for different countries. Input and output variables are defined in Table 1.1.

Country		Vietnam	Cambodia	Indonesia	Malaysia	Philippines	Thailand
Total cost ($000)	TC	400,000	16,300	509,000	832,000	363,000	777,000
Pre-tax profit ($000)	PP	61,300	8,942	200,000	385,000	131,000	337,000
Loans to customers ($000)	Q_1	3,020,000	208,000	4,380,000	15,100,000	4,120,000	13,100,000
Interbank loans ($000)	Q_2	1,020,000	108,000	1,120,000	918,000	1,630,000	2,470,000
Other earning assets ($000)	Q_3	871,000	6,223	1,420,000	5,250,000	2,220,000	3,900,000
Price of capital	P_K	1.734	2.231	1.972	2.843	1.897	5.496
Price of funds	P_D	0.074	0.023	0.059	0.022	0.0196	0.031
Price of labor	P_L	0.0073	0.012	0.019	0.0075	0.011	0.0085
Equity ratio	E.ratio	0.122	0.306	0.134	0.123	0.125	0.165
Productivity growth	Prod. growth	0.040	0.037	0.037	0.022	0.028	0.022
Bank branch density	Branch. dens	3.441	4.273	13.417	11.035	7.978	11.543
Inflation rate	Infl	0.106	0.055	0.057	0.024	0.041	0.026
Industry concentration	Concent ration	0.371	0.474	0.386	0.521	0.458	0.462

Table 1.3. The OLS residual skewness test

	Skewness	p-value
Cost frontier	0.6291	0.000
Profit frontier	-4.1714	0.000

Table 1.4. The frontier parameter estimates for ASEAN commercial banks (2007-2014).

This table reports the cost and profit frontier parameter estimates for the sample using the SFA model of Kumbhakar et al. (2014). The "" symbol refers to the significant level of each estimation (* significant at 10% level, ** significant at 5% level, *** significant at 1% level).*

Parameter	Variable	Cost Function		Profit Function	
		Estimates	Std.Err	Estimates	Std. Err.
α_1	ln (P_K/P_L)	0.406***	0.099	1.455***	0.553
α_2	ln (P_D/P_L)	0.102	0.110	1.655**	0.639
α_{11}	$0.5\times [ln(P_K/P_L)]^2$	0.041***	0.008	0.094*	0.048
α_{22}	$0.5\times[ln(P_D/P_L)]^2$	0.230***	0.016	0.133	0.094
α_{12}	$ln(P_K/P_L)\times ln(P_D/P_L)$	-0.054***	0.009	-0.050	0.054
γ_1	lnQ_1	0.099**	0.053	0.164	0.304
γ_2	lnQ_2	0.389***	0.056	1.106***	0.313
γ_3	lnQ_3	-0.121***	0.030	0.052	0.172
γ_{11}	$0.5\times(lnQ_1)^2$	0.037***	0.002	0.073***	0.013
γ_{22}	$0.5\times(lnQ_2)^2$	0.018***	0.011	0.041***	0.006
γ_{33}	$0.5\times(lnQ_3)^2$	0.013***	0.001	0.018***	0.005
γ_{12}	$lnQ_1\times lnQ_2$	-0.017***	0.003	-0.051***	0.017
γ_{13}	$lnQ_1\times lnQ_3$	0.005***	0.001	-0.006	0.008
γ_{23}	$lnQ_2\times lnQ_3$	-0.008***	0.001	-0.002	0.008
δ_{11}	$ln(P_K/P_L)\times lnQ_1$	-0.020***	0.005	0.019	0.027
δ_{12}	$ln(P_K/P_L)\times lnQ_2$	-0.015***	0.005	-0.083***	0.020
δ_{13}	$ln(P_K/P_L)\times lnQ_3$	0.016***	0.002	-0.019**	0.009
δ_{21}	$ln(P_D/P_L)\times lnQ_1$	0.019***	0.006	-0.020	0.033
δ_{22}	$ln(P_D/P_L)\times lnQ_2$	-0.001	0.005	-0.044**	0.030
δ_{23}	$ln(P_D/P_L)\times lnQ_3$	-0.002	0.002	0.021	0.014
λ_1	E.ratio	-1.120***	0.104	-0.589	0.575
λ_2	Prod.growth	0.621*	0.350	6.585***	2.11
λ_3	Branch.dens	-0.006**	0.002	-0.031**	0.012
λ_4	Infl	0.043	0.193	0.741	1.155
λ_5	Concentration	-0.224*	0.133	7.322***	0.768
λ_6	NPI			-0.991***	0.123

Tables 1.5a, 1.5b. Persistent, time-varying and overall efficiency scores of ASEAN commercials banks over the period of 2007-2014

Tables 1.5a and 1.5b report the average value persistent, residual and overall efficiency scores of ASEAN banks by year and country, respectively. The scores are estimated using the Kumbhakar et al. (2014) model. The efficiency score of 1 represents the most efficient bank in the sample in term of both cost and profit. The higher the score, the more cost efficient or profit efficient a bank is.

Table 1.5a. Efficiency scores by year

Year	*Cost efficiency scores*			*Profit efficiency scores*		
	Pers.	*Resid.*	*Overall*	*Pers.*	*Resid.*	*Overall*
2007	*0.8382*	*0.9124*	*0.7649*	*0.5783*	*0.5429*	*0.3158*
2008	*0.8433*	*0.9147*	*0.7724*	*0.5627*	*0.5628*	*0.3242*
2009	*0.8432*	*0.9143*	*0.7717*	*0.5663*	*0.5510*	*0.3196*
2010	*0.8483*	*0.9145*	*0.7766*	*0.5562*	*0.5489*	*0.3076*
2011	*0.8454*	*0.9143*	*0.7744*	*0.5603*	*0.5356*	*0.3028*
2012	*0.8461*	*0.9161*	*0.7755*	*0.5556*	*0.5439*	*0.3063*
2013	*0.8454*	*0.9155*	*0.7746*	*0.5572*	*0.5406*	*0.3045*
2014	*0.8433*	*0.9147*	*0.7710*	*0.5542*	*0.5387*	*0.3006*
Mean	***0.8448***	***0.9148***	***0.7734***	***0.5596***	***0.5444***	***0.3084***

Table 1.5b. Efficiency scores by country

Country	*Cost efficiency scores*			*Profit efficiency scores*		
	Pers.	*Resid.*	*Overall*	*Pers.*	*Resid.*	*Overall*
Vietnam	*0.8515*	*0.9156*	*0.7798*	*0.5452*	*0.5434*	*0.2996*
Cambodia	*0.8453*	*0.9099*	*0.7695*	*0.6204*	*0.5502*	*0.3481*
Indonesia	*0.8768*	*0.9204*	*0.8071*	*0.5132*	*0.5327*	*0.2778*
Malaysia	*0.7762*	*0.9076*	*0.7062*	*0.6247*	*0.5549*	*0.3486*
Philippines	*0.8105*	*0.9153*	*0.7421*	*0.5648*	*0.476*	*0.3223*
Thailand	*0.8627*	*0.9133*	*0.7888*	*0.5475*	*0.5522*	*0.3024*
Mean	***0.8448***	***0.9148***	***0.7734***	***0.5596***	***0.5444***	***0.3084***

Table 1.5c. The generalized likelihood ratio (LR) test for Kumbhakar et al. (2014) models

The table reports the results of the generalized likelihood ratio (LR) test for the SFA models of Kumbhakar et al. (2014) for both cost and profit functions. The LR test is the post-estimation test for the validity of SFA model specification. The null hypothesis of LR test is there exists no one-sided error (the inefficiency term) in the cost or profit frontier.

SFA models	**H_0: there exists no one-sided error**	
	LR test	**Significance**
Cost function	43.558631	Reject H_0 at 1% significant level
Profit function	77.940869	Reject H_0 at 1% significant level

Table 1.6a: ANOVA test results on the difference in time-varying cost efficiency scores between 2007-2014 for individual countries and the whole sample (Kumbhakar et al.'s (2014) model)

Country	Observation	Mean	Null hypothesis	Decision	P-Value
Vietnam	228	0.9156	All medians are equal	Accept H_0	0.9554
Cambodia	148	0.9099		Accept H_0	0.3679
Indonesia	301	0.9204		Reject H_0	0.0708
Malaysia	141	0.9076		Reject H_0	0.0127
Philippines	115	0.9153		Accept H_0	0.2191
Thailand	131	0.9133		Reject H_0	0.0891
The sample	1064	0.9148		Accept H_0	0.9987

Table 1.6c: ANOVA test results on the difference in overall cost efficiency levels between 2007-2014 for individual countries and the whole sample (Kumbhakar et al.'s (2014) model)

Country	Observation	Mean	Null hypothesis	Decision	P-Value
Vietnam	228	0.7798	All medians are equal	Accept H_0	0.9837
Cambodia	148	0.7695		Accept H_0	0.4219
Indonesia	301	0.8071		Accept H_0	0.3456
Malaysia	141	0.7062		Accept H_0	0.7924
Philippines	115	0.7421		Accept H_0	0.9673
Thailand	131	0.7888		Accept H_0	0.7268
The sample	1064	0.7734		Accept H_0	0.9837

Table 1.6b. Tukey post hoc test results on the difference in time-varying cost efficiency levels for banks in individual countries

Cost efficiency	**Contrast and Significance level** ** significant at 10% level; ** significant at 5% level, *** significant at 1% level*						
	Vietnam	***Cambodia***	***Indonesia***	***Malaysia***	***Philippines***	***Thailand***	***The sample***
2008 vs. 2007	.002	-.012	.013	.021	.019	-.019	.002
2009 vs. 2007	.003	.015	.004	-.006	.022	-.019	.002
2010 vs. 2007	.004	-.005	.006	.005	.015	-.010	.002
2011 vs. 2007	-.003	.003	.008	-.026	.018	.019	.002
2012 vs. 2007	-.005	.005	.004	.009	.019	.007	.004
042013 vs. 2007	-.001	-.005	.003	.004	.027	.005	.003
2014 vs. 2007	.001	-.029	-.004	.023	.026	.008	.002
2009 vs. 2008	.001	.027	-.009	-.028	.003	.0003	-.0004
2010 vs. 2008	.002	.007	-.006	-.016	-.004	.010	-.0002
2011 vs. 2008	-.005	.015	-.005	-.047	-.001	.038	-.0004
2012 vs. 2008	-.007	.017	-.009	-.013	.0001	.026	.001
2013 vs. 2008	-.003	.007	-.010	-.017	.008	.025	.001
2014 vs. 2008	-.001	-.017	-.017*	.002	.007	.027	-.000
2010 vs. 2009	.001	-.019	.002	.011	-.007	.009	.0002
2011 vs. 2009	-.006	-.011	.004	-.020	-.004	.038	-.000
2012 vs. 2009	-.008	-.010	-.0004	.015	-.003	.027	.002
2013 vs. 2009	-.004	-.019	-.001	.011	.005	.024	.001
2014 vs. 2009	-.002	-.044	-.008	.030	.004	.027	.0004
2011 vs. 2010	-.007	.008	.015	-.030	.003	.029	-.0002
2012 vs. 2010	-.009	.009	-.003	.004	.004	.017	.002
2013 vs. 2010	-.005	-.0003	-.003	-.0005	.012	.015	.001
2014 vs. 2010	-.003	-.025	-.010	.018	.011	.018	.0002
2012 vs. 2011	-.002	.001	-.004	.035	.001	-.012	.001
2013 vs. 2011	.003	-.008	-.005	.030	.009	-.014	.0004
2014 vs. 2011	.004	-.033	-.012	.049***	.008	-.011	-.001
2013 vs. 2012	.004	-.009	-.004	-.004	.008	-.002	-.001
2014 vs. 2012	.006	-.034	-.008	.015	.007	.0004	-.001
2014 vs. 2013	.002	-.024	-.007	.019	-.001	.003	-.001

Table 1.6d. Tukey post hoc test results on the difference in overall cost efficiency levels for banks in individual countries

Cost efficiency	**Contrast and Significance level** ** significant at 10% level; ** significant at 5% level, *** significant at 1% level*						
	Vietnam	***Cambodia***	***Indonesia***	***Malaysia***	***Philippines***	***Thailand***	***The sample***
2008 vs. 2007	.006	.010	.012	.026	.034	-.026	.007
2009 vs. 2007	.002	.045	.019	-.029	.037	-.021	.007
2010 vs. 2007	.003	.031	.024	-.017	.030	-.004	.012
2011 vs. 2007	-.001	.034	.030	-.054	.029	.019	.001
2012 vs. 2007	-.006	.037	.027	-.031	.031	.012	.010
2013 vs. 2007	.0004	.030	.026	-.037	.040	.009	.010
2014 vs. 2007	.004	-.010	.019	-.027	.041	.012	.006
2009 vs. 2008	-.004	.036	.007	-.054	.002	.005	-.001
2010 vs. 2008	-.003	.021	.012	-.043	-.004	.022	.004
2011 vs. 2008	-.007	.024	.018	-.080	-.006	.045	.002
2012 vs. 2008	-.012	.027	.014	-.057	-.001	.038	.003
2013 vs. 2008	-.006	.021	.014	-.063	.005	.035	.002
2014 vs. 2008	-.001	-.019	.007	-.053	.007	.038	-.001
2010 vs. 2009	.001	-.014	.005	.012	-.006	.017	.005
2011 vs. 2009	-.003	-.012	.011	-.026	-.008	.041	.003
2012 vs. 2009	-.008	-.009	.007	-.003	-.003	.033	.004
2013 vs. 2009	-.001	-.015	.007	-.008	.003	.030	.003
2014 vs. 2009	.003	-.055	.000	.002	.004	.033	-.001
2011 vs. 2010	-.005	.003	.006	-.040	-.002	.024	-.003
2012 vs. 2010	-.010	.006	.002	-.015	.003	.016	-.001
2013 vs. 2010	-.003	-.001	.002	-.020	.009	.013	-.002
2014 vs. 2010	.001	-.041	-.005	-.010	.011	.016	-.056
2012 vs. 2011	-.005	.003	-.004	.023	.004	-.008	.001
2013 vs. 2011	.002	-.003	-.011	.017	.010	-.010	.0002
2014 vs. 2011	.006	-.043	-.0001	.028	.012	-.008	-.003
2013 vs. 2012	.007	-.006	-.007	-.006	.006	-.003	-.001
2014 vs. 2012	.011	-.046	-.007	.004	.008	.0001	-.004
2014 vs. 2013	.004	-.040	-.007	.010	.002	.003	-.004

Table 1.6e: ANOVA test results on the difference in time-varying profit efficiency levels between 2007-2014 for individual countries and the whole sample (Kumbhakar et al. (2014) model)

Country	Observations	Mean	Null hypothesis	Decision	P-Value
Vietnam	228	0.5434	All medians are equal	Reject H_0	0.0000
Cambodia	148	0.5502		Reject H_0	0.0028
Indonesia	301	0.5327		Reject H_0	0.0000
Malaysia	141	0.5549		Reject H_0	0.0000
Philippines	115	0.4760		Accept H_0	0.8780
Thailand	131	0.5522		Reject H_0	0.0079
The sample	1064	0.5444		Accept H_0	0.9150

Table 1.6g: ANOVA test results on the difference in overall profit efficiency levels between 2007-2014 for individual countries and the whole sample (Kumbhakar et al. (2014) model)

Country	Observations	Mean	Null hypothesis	Decision	P-Value
Vietnam	228	0.2996	All medians are equal	Reject H_0	0.0000
Cambodia	148	0.3481		Accept H_0	0.1774
Indonesia	301	0.2778		Reject H_0	0.0028
Malaysia	141	0.3486		Reject H_0	0.0083
Philippines	115	0.3223		Accept H_0	0.9537
Thailand	131	0.3024		Accept H_0	0.1925
The sample	1064	0.3084		Accept H_0	0.8027

Table 1.6f. Tukey post hoc test results on the difference in time-varying profit efficiency levels for banks in individual countries (Kumbhakar et al. (2014) model)

Time-varying Profit efficiency	**Contrast and Significance level** ** significant at 10% level; ** significant at 5% level, *** significant at 1% level*						
	Vietnam	***Cambodia***	***Indonesia***	***Malaysia***	***Philippines***	***Thailand***	***The sample***
2008 vs. 2007	-.241***	.180	.042	.208***	.070	.241	.020
2009 vs. 2007	.001	.005	-.123**	.173**	.039	.214	.008
2010 vs. 2007	.022	-.034	-.050	.088	.056	.162	.006
2011 vs. 2007	-.046	.016	-.087	.111	.070	.183	-.007
2012 vs. 2007	-.171***	.109	.012	.120	.091	.071	.001
2013 vs. 2007	-.162***	.080	.003	.041	.058	.193	-.002
2014 vs. 2007	-.078	.147	-.074	.027	.058	.216	-.004
2009 vs. 2008	.243***	-.175*	-.164***	-.035	-.030	-.027	-.012
2010 vs. 2008	.263***	-.214**	-.093*	-.121	-.014	-.079	-.014
2011 vs. 2008	.196***	-.164	-.129***	-.098	.0002	-.059	-.027
2012 vs. 2008	.071	-.071	-.030	-.088	.0215	-.170	-.019
2013 vs. 2008	.080	-.100	-.038	-.17***	-.011	-.049	-.022
2014 vs. 2008	.164***	-.033	-.116***	-.18***	-.012	-.026	-.024
2010 vs. 2009	.020	-.039	.072	-.085	.016	-.052	-.002
2011 vs. 2009	-.047	.011	.035	-.062	.031	-.317	-.015
2012 vs. 2009	-.172***	.104	.135***	-.053	.052	-.143	-.007
2013 vs. 2009	-.164***	.075	.127***	-.131**	.019	-.021	-.010
2014 vs. 2009	-.079	.142	.049	-.15***	.018	.001	-.012
2011 vs. 2010	-.068	.051	-.037	.023	.014	.020	-.013
2012 vs. 2010	-.193***	.143	.063	.032	.036	-.091	-.005
2013 vs. 2010	-.184***	.114	.054	-.046	.003	.031	-.008
2014 vs. 2010	-.100	.181*	-.024	-.062	.002	.054	-.010
2012 vs. 2011	-.124**	.092	.100***	.009	.021	-.111	.008
2013 vs. 2011	-.116**	.064	.091***	-.070	-.011	.010	.005
2014 vs. 2011	-.032	130	.014	-.084	-.012	.033	.003
2013 vs. 2012	.009	-.029	-.009	-.079	-.033	.121	-.003
2014 vs. 2012	.093	.038	-.086**	-.093	-.034	.144*	-.005
2014 vs. 2013	.084	.067	-.077**	-.015	-.001	.022	-.002

Table 1.6h. Tukey post hoc test results on the difference in overall profit efficiency levels for banks in individual countries (Kumbhakar et al. (2014) model)

Overall profit efficiency	**Contrast and Significance level** ** significant at 10% level; ** significant at 5% level, *** significant at 1% level*						
	Vietnam	***Cambodia***	***Indonesia***	***Malaysia***	***Philippines***	***Thailand***	***The sample***
2008 vs. 2007	-.131***	.092	.012	.115	.024	.129	.008
2009 vs. 2007	.026	-.009	-.082	.102	-.003	.089	.004
2010 vs. 2007	.035	-.046	-.056	.049	.013	.044	-.008
2011 vs. 2007	.001	-.040	-.068	.061	.033	.063	-.013
2012 vs. 2007	-.062	.012	-.014	.064	.039	-.004	-.010
2013 vs. 2007	-.067	.017	-.020	.018	.015	.057	-.011
2014 vs. 2007	-.013	.058	-.063	-.001	.014	.065	-.015
2009 vs. 2008	.157***	-.100	-.093*	-.013	-.027	-.040	-.005
2010 vs. 2008	.167***	-.138	-.068	-.066	-.011	-.085	-.017
2011 vs. 2008	.132***	-.132	-.080	-.054	.009	-.066	-.021
2012 vs. 2008	.069	-.080	-.026	-.051	.014	-.122	-.018
2013 vs. 2008	.065	-.076	-.031	-.097	-.009	-.071	-.020
2014 vs. 2008	.118***	-.034	-.075	-.116**	-.010	-.063	-.024
2010 vs. 2009	.010	-.037	.026	-.053	.017	-.045	-.012
2011 vs. 2009	-.025	-.032	.014	-.040	.037	-.025	-.016
2012 vs. 2009	-.088**	.020	.067	-.038	.042	-.093	-.013
2013 vs. 2009	-.092**	.025	.062	-.084	.019	-.032	-.015
2014 vs. 2009	-.039	.066	.018	-.103**	.017	-.023	-.019
2011 vs. 2010	-.035	.006	-.012	.013	.020	.019	-.005
2012 vs. 2010	-.097**	.057	.042	.016	.025	-.048	-.001
2013 vs. 2010	-.102***	.062	.037	-.031	.002	.013	-.003
2014 vs. 2010	-.048	.103	-.007	-.050	.0004	.021	-.007
2012 vs. 2011	-.063	.052	.054	.003	.005	-.068	.004
2013 vs. 2011	-.067	.057	.048	-.043	-.018	-.006	.002
2014 vs. 2011	-.014	.098	.005	-.063	-.020	.002	-.002
2013 vs. 2012	-.005	.005	-.005	-.046	-.023	.062	-.002
2014 vs. 2012	.049	.046	-.049	-.065	-.025	.070	-.006
2014 vs. 2013	.053	0.041	-.044	-.019	-.002	.008	-.004

CHAPTER 2

Corporate governance and bank efficiency in six ASEAN countries

2.1. Introduction

The literature on financial systems of developing countries has confirmed that to achieve sustainable economic growth, those countries must develop a robust financial system, and particularly a robust banking system (Levin, 1997). An efficient banking system can provide lower-cost monetary payments, and mobilize and allocate funds effectively to help promote savings and investments.

Historically, the above-mentioned features of an efficient banking system were missing in the early stage of banking sector development in most countries, when their economies were centrally planned. However, in recent years, an increasing trend of financial market liberalization and banking reforms has been witnessed in many developing countries from different regions, such as Central and Southeastern Europe, Latin America, Central Asia, and Southeast Asia. The governments of those countries have been introducing significant financial sector reforms over the last years with the main goal of building a more robust and efficient banking system. Therefore, the stability and efficiency of banking sectors are not only important for bankers and their stakeholders, but also extremely significant for the proficient functioning and growth of the economy.

Due to their importance in economic systems, the governance of banks also assumes an essential role. Levin (1994) notes that if a bank's Board of Directors imposes sound corporate governance mechanisms on its managers, the managers will be more likely to make more efficient capital allocation decisions and exert more supervision on the bank's borrowers. On the other hand, if loose corporate governance mechanisms are imposed, the managers will be likely to act in their own interest instead of that of debt-and shareholders. Hence, poor corporate governance has a negative impact on bank efficiency, as has been demonstrated by a number of banking crises in history.

A remarkable amount of research has been conducted regarding the impact of corporate governance on bank performance. However, previous studies are limited in either their measurement of bank performance or their estimation methods. For instance, a majority of studies have used accounting ratios (return on assets – ROA, return on equity – ROE, or Tobin's Q) as measurements of bank performance (Andres and Vallelado, 2008; Mnasri, 2015; Akbar et al., 2016), which have been indicated to be the less accurate indicators of performance compared to technical efficiency (Tanna et al., 2011; Salim et al., 2016) and economic efficiency (Agoraki et al., 2010). Furthermore, as discussed intensively in the

literature, the relationship between corporate governance and bank performance suffers from serious problems of endogeneity (Wintoki et al., 2012; Schultz et al., 2010). Hence, the estimation methods used to determine the impact of corporate governance on bank efficiency must successfully control for all types of endogeneity. One of the most recently developed methods that meet this criterion is the Dynamic System Generalized Method of Moments (Dynamic System GMM). However, previous literature that uses GMM to estimate the influence of corporate structure on bank efficiency is highly limited, and mostly uses accounting ratios as performance measures (Andres and Vallelado, 2008; Mnasri, 2015; Akbar et al., 2016).

This study aims to contribute to the literature on the relationship between corporate governance and bank efficiency by examining banks in the Southeast Asian area, and especially in Vietnam, Cambodia, Indonesia, Malaysia, the Philippines, and Thailand. The study employs the performance measure of economic efficiency and the estimation method of Dynamic System GMM. Economic efficiency refers to the ability of banks to minimize their costs (cost efficiency) or maximize their profit (profit efficiency). According to Berger and Mester (1997), profit efficiency is considered to be a superior concept as it focuses both on maximizing revenue and minimizing marginal costs, while cost efficiency only focuses on minimizing costs. However, to ensure the completeness of the study, both economic efficiency concepts are used. The cost and profit efficiency levels are measured using the SFA method. Moreover, this paper attempts to separate the economic efficiency term into persistent (or long-term) efficiency and time-varying (or short-term) efficiency. This separation has only been done to a limited extent in the literature and it could help to further investigate the causes of bank inefficiency.

There are two main reasons why this study focuses on the Southeast Asian area. Firstly, although the ASEAN countries are geographically similar, their banking systems are diverse in nature, with different models and diverse paces of development (Nguyen, 2010), which might affect their banking sector efficiency. Secondly, the emergence and development of the banking systems in those countries have faced various banking crises, especially the Asian Financial Crisis in 1997 and the Global Financial Crisis in 2008. This could either weaken their systems or help to accelerate the development process of the banking sectors.

The rest of the paper is structured as follows. Section 2 provides a brief overview of banking sectors in ASEAN countries, while section 3 reviews the literature regarding corporate governance and its impact on bank performance. Section 4 presents the

methodology, data, and summary statistics. Subsequently, section 5 reports the results of the efficiency estimations and the regression analysis of corporate governance as the determinant of bank efficiency in ASEAN countries. Finally, section 6 concludes the paper.

2.2. Overview of banking sectors in ASEAN countries

The banking systems in the six ASEAN countries (Vietnam, Cambodia, Indonesia, Malaysia, the Philippines, and Thailand) have similar development patterns, but their speed of growth varies widely. The following discusses some key trends and characteristics of ASEAN banking systems.

The creation of the two-tier banking system

The creation of the two-tier banking system was the first step in the reform of banking sectors in most countries around the world. Prior to creating this system, the mono-bank system existed, where the central bank was the only bank and fulfilled the functions of both central and commercial banks. The mono-bank system's primary goal was to transfer government funds to state-owned enterprises (SOEs) to invest them in projects that were approved by the government (Djalilov and Piesse, 2014). Hence, the clear drawbacks of this system were the inefficiency of fund allocation, the quality of banking supervision due to agency problems, and the poor process of risk assessment. Eventually, the mono-bank system led to a substantial amount of NPLs, and the two-tier banking system was created to solve this problem. The top tier consists of the traditional central bank, while the second-tier consists of newly created commercial banks.

The above situation was highly relevant in the cases of Vietnam and Cambodia, where the transition to the two-tier banking system happened in 1986 and 1991, respectively. On the other hand, in the case of the four other countries, due to their colonial histories, by the time their central banks were established (around the period of the 1940s to the 1950s) the banking systems were already two-tier with the on-going operations of long-existing foreign commercial bank branches.

Entry relaxation

Along with the introduction of the two-tier system, the governments also relaxed the new-entry requirements in the sector with the aim of quickly liberalizing it. However, as the supervision capacity and effective legislation frameworks had not yet been fully developed to keep up with the pace of liberalization, the fast growth resulted in the creation of a number of new private banks with the same features of dubious quality and severe under-capitalization.

This trend was clear in ASEAN countries, especially in Indonesia and Vietnam. By the end of 1996, there were 239 commercial banks operating in Indonesia, compared to only 111 commercial banks in 1988. Similarly, in Vietnam, the number of banks increased quickly from 9 in 1986 to 83 in 1996, peaking at 104 in 2010.

Foreign ownership

In addition to entry relaxation, the governments also loosened the regulation on foreign participation in the sector. The degree of foreign participation in some countries differed from in others.

In Vietnam and Malaysia, foreign ownership was allowed but also restricted. In Vietnam, foreign banks were allowed to operate only after 1990 by setting up joint-ventures with Vietnamese banks or by opening branches. Then, after Vietnam successfully joined the WTO in 2007, five licenses were granted for five foreign banks to open wholly foreign-owned subsidiary banks. In addition, foreign banks were allowed to buy shares in local banks under the form of strategic partnership, although foreign ownership of a Vietnamese bank was capped at 30% until 2014. In Malaysia, although foreign bank presence has been allowed for many years under the form of subsidiaries, the government still imposes some restrictions on foreign bank participation, such as not allowing foreign bank branches and limiting foreign ownership in local banks (capped at 30%).

Unlike Vietnam and Malaysia, Cambodia took a more liberal approach, allowing foreign bank branches to open since 1991 with few restrictions, and treating them equally to local commercial banks.

The cases of Indonesia, Thailand, and the Philippines are similar: all three countries allowed foreign ownership in the banking sector for a long time, but foreign entry was only truly liberalized after the Asian Financial Crisis in 1997. In Indonesia, foreign bank branches were allowed first in 1967; then, joint-ventures and subsidiaries were later allowed in 1988. Before 1998, foreign ownership in local banks was limited to 49%. After the Asian Financial Crisis, foreign investors were allowed to purchase shares of banks through stock exchanges and could own up to 99% of local listed banks and joint-venture banks. Similarly, in Thailand, prior to 1998, foreign ownership in local banks was capped at 25%, and then quickly raised to 49% in 1998. Moreover, the Philippines took the same approach as Indonesia and Thailand, but at a slower pace. Before 2000, foreign banks were limited to one of the following entry modes: owning up to 60% of voting stocks of an existing bank;

investing in up to 60% of the voting stocks of a new banking subsidiary; or establishing branches with full authority (Pamfilo, 2014). After 2000, the limit on the first mode of entry was lifted and foreign banks were allowed to acquire 100% of voting stock of an existing bank, but this only lasted for a period of seven years, from 2000 to 2007. In 2013, all the restrictions were lifted for all modes of entry, and foreign banks are now allowed to own 100% of an existing bank, invest up to 100% in a new subsidiary, and establish branches with full authority.

Financial crises and consolidation

The relaxation of new-entry requirements and foreign participation resulted in the rapid expansion of banking sectors in ASEAN countries. A number of dubious and under-capitalized new banks were established following the financial liberalization. In addition, with the insufficient supervision capacity of governments and the lack of adequate legislation and risk assessment frameworks, the early financial reforms led to a substantial amount of NPLs in the ASEAN banking systems. The high levels of bad assets made the sectors vulnerable, particularly when dealing with financial crises.

The first major crisis for ASEAN countries was the Asian Financial Crisis in 1997, which severely affected Thailand, Indonesia, the Philippines, and Malaysia. The crisis only had little impact on the two other countries because their banking developments were only at early stages and they were not yet participating in the international financial market. In contrast, the financial liberalization in Thailand, Indonesia, the Philippines, and Malaysia in the 1990s had paved the way for massive foreign capital inflows in the sectors while there was not enough space to invest them productively, leading to a misallocation of investments (Lauridsen, 1998). Thus, an investment bubble of careless lending was created, of which a substantial amount was channeled into the real estate sector, where assets were already inflated. Consequently, the property bubble burst and left substantial bad debts on the balance sheets of banking institutions that had their investments financed by short-term foreign borrowings. Soon after, foreign capital flight happened, draining the foreign exchange reserves and causing the collapse of the banking systems. In 1997, the rate of NPLs in Thailand, Indonesia, and Malaysia was 45%, 55%, and 25%, respectively. Conversely, the NPL level in the Philippines was 12.5% of total loans in 1998 and rose to 24% in 2000.

After the financial collapse in 1997, all four affected countries had to implement financial reforms to save the sectors. To strengthen the vulnerable and under-capitalized banking systems, consolidation tactics were introduced and saw considerable results. In

Thailand, the consolidation began with the large-scale closure of finance companies, reducing their number from 91 to 24. The consolidation also decreased the number of banks from 15 to 13, although the restructuring of banks in Thailand mostly occurred by recapitalization (in 1998, six banks were nationalized) (Takayasu and Yokoe, 1999). In Indonesia, from 1997 to the end of 2002, the government closed and liquidated 18 banks, froze the operations of 10 banks, and froze the business activities of 42 banks; moreover, 28 banks merged and 2 banks went into self-liquidation. In December 2002, the number of banks in Indonesia had decreased to 141 from 239 in 1996 (Bank Indonesia, 2004). In Malaysia, 50 out of 54 banking institutions were consolidated into 10 banking groups, reducing the total number of banking institutions from 71 in 1999 to 47 in 2001 (Hamedian, 2013). Similarly, in the Philippines, 14 banks were closed in 1997 and 22 other banks were closed in 1998 (Gauchoco-Bautista, 1997).

After the Asian Financial Crisis, the banking systems in the four most affected ASEAN countries were significantly strengthened, which helped them to cope effectively with the Global Financial Crisis in 2008. Hence, the Global Financial Crisis mostly impacted Vietnam and Cambodia, eventually leading to consolidation and restructuring in their banking sectors. In Vietnam, the government restructured the sectors mainly by privatizing the state-owned commercial banks (SOCBs) and reducing the number of joint-stock commercial banks (JSCBs). At the end of 2014, four out of five SOCBs were privatized, and the number of JSCBs was reduced from 37 (2011) to 33. In Cambodia, due to the liberalization process started in 1991 allowing 100% foreign ownership in banking sectors, most banks relied heavily on foreign capital (Jalilian and Reyes, 2010). As of 2007, the paid-up capital of foreign shares in Cambodian banks stood at 56%, compared to 44% of domestic shares. Hence, when the Global Financial Crisis occurred, large amounts of foreign currency were withdrawn, especially from the overpriced real estate sector. The consolidation process after the Global Financial Crisis in Cambodia then reduced the number of banking institutions to 17 banks and 3 licensed and 27 registered Microfinance Institutions (MFIs), down from 33 banks and 20 licensed and 26 registered MFIs in December 2009.

Focus on regulation

To successfully strengthen and restructure their banking systems, ASEAN countries need to establish an effective institutional and legislative infrastructure to support proper regulation, as well as appropriate accounting standards and bankruptcy laws (Djalilov and Piesse, 2014). For instance, after the Asian Financial Crisis, Thai accounting standards were

changed to prepare for Basel II adoption. The Bank of Thailand (BOT) issued guidelines for capital adequacy of banks, and also set a range of policies to monitor different credit risk, internal control, internal auditing, information disclosure, and transparency (Nidhiprabha, 2011). Moreover, the financial accounting activities of financial institutions in Thailand are required to meet standards prescribed by the accounting regulations and guidelines set by the BOT. In a similar vein, in 2004, Bank Indonesia issued 14 regulations concerning commercial banking, which mainly focus on the restructuring of the banking system and ensuring the financial soundness of banks. In 2010, the Financial Services Authority was established with the mission of regulating and supervising the entire financial sector by focusing on adopting risk-oriented banking supervision according to Basel principles, and by reforming the accounting system. Another example is the Philippines: in 2001, the central bank employed the risk-based capital adequacy ratio along the criteria of Basel I while the government tried to reduce the amount of NPLs in the banking system by issuing prudent rules and regulations of the Special Purpose Vehicle (SPV) Act of 2002. In addition, to improve banks' risk management, the government reinforced asset cleanup and strengthened the capital base in compliance with the International Accounting Standards (IAS), and shifted to risk-based capital requirements under Basel II. Furthermore, to prepare for more advanced risk measurement and implementation of the requirements of Basel II, a directive was issued in 2004 that required banks to develop and implement an internal credit risk rating system (Manlagnit, 2011).

According to Nguyen (2010), Basel II has recently been one of the priorities in ASEAN banking systems. Bank Negara Malaysia planned to adopt Basel II in full by 2010, while National Bank of Cambodia and the State Bank of Vietnam are currently in the process of preparation for this adoption.

The issue of corruption

Corruption has been an issue in developing countries for a long time. Corruption can affect the allocation of bank investments to unproductive sectors or increase bank costs, as banks need to pay bribes to government officials (Sakan and Hassan, 2001). This is also the case for ASEAN countries.

For example, in Indonesia, the Soeharto family has had a large impact on the banking sector: in 1996, the family members controlled 16.6% of the stock market by capitalization (Claessens et al., 2001), and the largest bank in Indonesia was a private bank controlled by a conglomerate that had close ties with the president. It was not until October 2004, when

General Yudhoyono became Indonesia's first directly elected president, that the banking policies started to focus on a more liberal approach.

Corruption in the banking sector in Vietnam has also been popular, as demonstrated by numerous scandals in recent years. One of the largest scandals so far was the case of Huynh Thi Huyen Nhu, a former banker of Vietinbank who was convicted of illegal asset appropriation, forgery, and defrauding investors and banks with a total amount of more than $200 million in 2014 (BBC, 2014). Another case is that of Vu Viet Hung: with the help of 12 other bankers, this former director of Vietnam Development Bank – Dak Lak-Dak Nong branch approved counterfeit loans for a total amount of $89 million in exchange for bribes in the form of a BMW car, a diamond ring, and $5.5 million in cash (McCoy, 2014). Apparently, to gain personal benefit, these bankers allocated bank loans to unproductive projects. This not only resulted in enormous amounts of NPLs for the banks, but also substantially lowered these banks' reputations.

A similar situation happened in Indonesia. The most recent corruption scandal in Indonesia banking system was that of Mr. Mulya, a former deputy governor of the Indonesian central bank. Mr. Mulya was convicted of corruption and abusing power in a bank bailout in 2008. He took $85,300 as a bribe from the owner of PT Bank Century to give the latter a short-term loan (The WSJ, 2014).

2.3. Literature review

2.3.1. Literature on corporate governance

2.3.1.1. Overview of corporate governance

The main aim of a firm is to maximize its shareholder wealth. According to Staikouras et al. (2007), the most challenging issue in modern organizations with diffuse ownership is the separation of ownership and management. Managers are viewed as agents or representatives of the shareholders (the principals) in terms of running the firm, and they receive compensation. In contrast, while the shareholders are the ultimate owners of the firm, they are not directly involved in managing it and bear the residual risk to receive the residual rewards. Though the managers are considered to have more expertise in running the firm than the shareholders do, the ultimate interests of the two parties are normally diverse and conflicted (Jensen and Meckling, 1976). For example, the managers (the agents) are more interested in their personal gains, such as high levels of remuneration or social status, while the shareholders (the principals) mainly focus on maximizing their investments in the form of

returns and capital value. Furthermore, shareholders normally lack the necessary information to monitor the managers' decision-making process efficiently, which increases the ability of managers to pursue their own interests (Fama and Jensen, 1983).

Hence, the main objective of corporate governance is expressed as follows: "suppliers of finance to corporations assure themselves of getting a return on their investment" (Shleifer and Vishny, 1997, p. 737). In other words, Jensen (1993) states that corporate governance can serve as an "internal control system" with the aim of resolving the divergence between the interests of shareholders and managers. As a result, "by eliminating or mitigating the agency problem, a sound system of corporate governance also contributes to improved corporate efficiency" (Staikouras et al., 2007, p. 3).

2.3.1.2. Corporate governance of banks

A bank is defined as an intermediary that pools money from depositors, lends it, and monitors it on their behalf (Zulkafli and Samad, 2007).

According to Levin (2004), in comparison to non-financial firms, banks are generally more opaque and more heavily intervened in by the government. Specifically, as banks can easily adjust or hide their loan quality for long periods, the information asymmetries are considered larger with banks than with other firms. Hence, in addition to their importance in the economy, banks are normally heavily regulated.

Due to their distinct characteristics, corporate governance of banks differs considerably from that of other institutions. As a result of greater information asymmetries, it is more difficult for diffuse equity and debt holders of a bank to monitor its managers, and easier for insiders to exploit the government and outside investors (Levin, 2004). Furthermore, greater information asymmetries between bank insiders and potential investors also lessen the threat of hostile takeovers in banking industries. In addition, the product market competition is also less intense in banking, as bankers normally form long-term relationships with their clients. Eventually, the smaller threat of takeover and low product market competition adversely affect the corporate governance of banks.

According to Levin (2004), the feature of heavily regulated banks is normally shown in the attempts of governments in many countries to discourage bank ownership concentration. As many governments believe that high concentration of bank ownership would lead to high concentration of power in their economies, they usually put restrictions on who can own banks, and banks must alert the government when there is any transfer of ownership.

However, concentration of bank ownership is an important solution to deal with the inability of diffuse shareholders to monitor banks. Therefore, heavy regulations on banks prevent takeovers and hinder good corporate governance in the industry. Another government policy that negatively affects bank governance is deposit insurance. Deposit insurance lowers the efforts made by depositors to monitor banks, which increases bank owners' risk-taking abilities. The existence of deposit insurance accompanied by the role of central banks as lenders of last resort have resulted in very low capital-asset ratios of banks compared to other firms. These low capital-asset ratios help to increase bank owners' incentives to take more risk. In turn, excessive risk-taking of bank owners ultimately lowers the effectiveness of bank corporate governance.

Another aspect of government intervention in the banking industry is the existence of government ownership in banks. According to Arun and Turner (2004), government ownership may lead to political intervention in banks, which can be detrimental to their corporate governance. A high proportion of government ownership is normally found in banks from developing countries. Arun and Turner (2004) also suggest that governments should encourage foreign ownership in banking sectors to increase competition in the industry, thus improving corporate governance.

According to Caprio et al. (2007), certain corporate governance mechanisms could help to reduce the expropriation of bank resources, improve corporate governance, and foster bank efficiency. Those mechanisms include the ownership monitoring mechanism, internal control mechanism, regulatory monitoring mechanism, and disclosure monitoring mechanism.

2.3.2. Corporate governance mechanisms and bank performance

2.3.2.1. Ownership monitoring mechanism

a. Large shareholders

Though diffuse shareholders can practice their corporate governance on banks by directly voting on the banks' crucial issues, they are usually less informed and lack the expertise to monitor managers compared to large shareholders (Levin, 2004). Thus, the presence of large or block shareholders can produce benefits for the diffuse shareholders, as block shareholders have more power and incentives to prevent the expropriation of bank resources (Mitton, 2002).

However, Zulkafli and Samad (2007) argue that large shareholders can use their power to extract resources from banks for their own benefits, which could conflict with the interest of minority shareholders.

Most of the empirical evidence on the relationship between block shareholders and bank performance confirms Levin's (2004) and Mitton's (2002) above arguments. Zulkafli and Samad (2007), Stancic et al. (2014), and Mnasri (2015) find significant negative effects of bank ownership concentration on bank performance in Asian, Southeast European, and Tunisian countries, respectively. On the other hand, Praptiningsih (2009) samples 52 banks from 4 ASEAN countries during the period of 2003 to 2007, and find no significant effects of block shareholders on banks' return on assets (ROA).

b. Government ownership

A high level of government ownership could lead to a conflict of interests between the government (the owners) and bank managers. The government as the owner could use banks as a means to achieve political goals, which might not maximize shareholders' interests (Bai et al., 2004).

Moreover, managers of banks could act against the interests of shareholders but in favor of some political groups to foster their political careers (La Porta et al., 2002).

The studies of Zulkafli and Samad (2007) and Mnasri (2015) confirm the negative relationship between government ownership and bank performance. Specifically, Zulkafli and Samad (2007) investigate a sample of 107 publicly listed banks in 9 emerging Asian countries and find that government ownership negatively affects bank performance for Tobin's Q but not ROA. Moreover, Mnasri (2015) examines 10 Tunisian banks (1997-2010) and reports a significant negative relationship between government ownership and both Tobin's Q and ROA measures of banks. In contrast, Praptiningsih (2009) reports no significant effect of government ownership on bank ROA.

Using efficiency scores as performance measures, Gardener et al. (2011) study five ASEAN countries from 1998 to 2004 and find that state-owned banks show higher levels of efficiency than local banks do. Similarly, Le et al. (2015), Nguyen and De Borger (2008), Vu and Turnell (2010), and Nalm and Vu (2013) use different methods (SFA and DEA) to examine bank efficiency in Vietnam, and they all find that state-owned banks are more efficient than private banks due to their market power in setting prices.

c. Foreign ownership

According to Micco et al. (2007), the increase in foreign presence in developing countries' banking systems helps to lower the cost but not necessarily increase the profit of their domestic banks. Zulkafli and Samad (2007) insist that increasing foreign ownership in banking sectors would escalate the product market competition and takeover pressures, which could lead to better governance practices of domestic banks. In contrast, Praptiningsih (2009) reports a negative impact of foreign share ownership on bank ROA. However, Zulkafli and Samad (2007) find no significant influence of foreign ownership on Tobin's Q and ROA measures.

Moreover, using efficiency scores as performance measures, Muazaoh et al. (2012) find that domestic Indonesian banks are less efficient than foreign banks, and that listed banks are also less efficient than non-listed banks. Similarly, Gardener et al. (2011) also find foreign banks to be more efficient than domestic banks.

2.3.2.2. Internal control monitoring mechanism

To monitor a bank's management, its shareholders elect a Board of Directors. The main purpose of the board is to ensure that managers' decisions always serve to optimize shareholder value (Coles et al., 2001).

Two main streams of theory explain the role and importance of the Board of Directors: agency theory (Jensen and Meckling, 1976; Eisenhardt, 1989) and stewardship theory (Donaldson, 1990; Donaldson and Preston, 1995).

Agency theory argues that a larger board and a board that comprises a higher proportion of outside or independent directors will be more effective in monitoring the behaviors of bank managers. However, Yermack (1996) notes that there is a certain limit to the size of the board, as the larger it becomes, the more costs are incurred due to the more complex coordination, communication, and decision-making.

On the other hand, stewardship theory states that bank managers are trustworthy and that no agency cost exists. Furthermore, Donaldson (1990) points out that inside directors of banks are certainly better at decision-making than outside directors, as the former are more informed and have a better understanding of the business. Hence, a board comprising a higher proportion of inside directors should lead to more effective decisions aiming at maximizing shareholder value.

Alternative theories to explain the role of the Board of Directors are the resource dependence theory (Pfeffer, 1972) and the managerial hegemony theory (Mace, 1971). The resource dependence theory explains that personal networks of individual directors of the board could give the firm better access to resources, hence maximizing the firm value (Kiel and Nicholson, 2003). On the other hand, the managerial hegemony theory suggests that the boards are simply tools dominated by management, and that the management has the real power in decision-making and directing the firm (Tanna et al., 2011).

According to Jensen (1983), at least three aspects can be used to explain the board structure of a firm: CEO duality, board size, and board independence.

a. CEO duality

According to Coles et al. (2001), the leadership structure of a firm can be combined (a single person holds the positions of both CEO and Chairman of the Board) or separated (CEO and Chairman positions are held by two different persons).

Haniffa and Cooke (2005) claim that when the CEO is also the Chairman, the management monitoring of firms will be more efficient as information asymmetry is reduced and less contracting is involved. This is confirmed in an empirical study by Mnasri (2015), which finds that CEO duality is positively associated with firm performance.

Nevertheless, Jensen (1993) insists that a separated structure is a more effective way to monitor managers, because when the CEO is also the Chairman, the power is concentrated, which could allow the CEO/Chairman to make decisions to optimize his/her own interests instead of that of the shareholders. In this vein, Zulkafli and Samad (2007) and Praptiningsih (2009) both find a negative effect of CEO duality on ASEAN banks' ROA.

b. Board size

In line with the agency theory, Coles et al. (2008) explain that more complex firms need larger boards as they have greater advising requirements. Moreover, Pfeffer (1972) notes that as large firms usually operate within various sectors in the external environment, they need larger boards including directors with diverse fields of expertise and from various backgrounds. Kyereboah-Coleman and Biekpe (2006) add that in firms with larger boards, the domination of the CEO is lessened, which might improve corporate performance.

In any case, the number of directors should be optimal, as the larger the board is, the more complex, time consuming, and costly the procedure of decision-making becomes (Yermack, 1996).

Board size and bank performance is one of the most extensively researched areas in literature, and previous studies have produced mixed results.

Some studies have found positive relationships between board size and bank performance, such as those of Adam and Mehran (2008), Belkhir (2009), Tanna et al. (2011), and Salim et al. (2016). The proxies that those studies use to measure bank performance are Tobin's Q and ROA, except for Tanna et al. (2011). Adam and Mehran (2008) sample 35 publicly traded Bank Holding Companies (BHCs); Belkhir (2009) uses a sample of 260 banks and Savings-and-Loans Holdings Companies (SLHC); and Salim et al. (2016) study Australian banks. On the other hand, Tanna et al. (2011) measure bank technical efficiency as a performance proxy, but they find similar results as the other authors do when examining 17 UK banking institutions from 2001 to 2006.

Other studies have found negative relationships between the size of Board of Directors and bank performance, including Pathan et al. (2007) for Thai banks; Agoraki et al. (2010) for large European banks; Stancic et al. (2014) for South-East European banks; and Mnasri (2015) for Tunisian banks. Except for Agoraki et al.'s (2010) study, which uses economic efficiency as the measure of bank performance, the three other studies use accounting measures such as ROA, ROE, and Tobin's Q.

Finally, some studies have also found no significant effect of board size on bank performance, such as those of Zulkafli and Samad (2007) and Praptiningsih (2009).

c. Board independence

As pointed out by Fama and Jensen (1983), the agency problem could be reduced with the inclusion of independent non-executive directors in the board, as they could help to protect the interests of outside shareholders and other stakeholders. In addition, non-executive directors could also help to improve the monitoring of management's decisions by using their additional expert knowledge and experience (Staikouras et al., 2007).

Nonetheless, Petra (2005) claims that the presence of outside directors in the board might negatively affect the operation of the board: outside directors have limited involvement in the daily activities of the firm, which could prevent them from thoroughly understanding the business. To support this argument, Goodstain et al. (1994) highlight that boards with a

high proportion of outside directors could lead to excessive monitoring and jeopardize the firm's strategies.

Hence, Andres and Vallelado (2008) note that the presence of outside directors is highly important, but that these directors should have appropriate field knowledge and abilities to resolve conflicts of interest caused by the agency problem.

Similar to board size, the empirical evidence on board independence and bank performance is also highly diverse.

Some studies have found a positive impact of board independence on bank operation, including research by Pathan et al. (2007), Tanna et al. (2011), and Busta (2007). Busta (2007) samples 69 listed banks from 5 European countries and reports that banks with a higher presence of non-executive directors on their board have higher market-to-book values and return on invested capital ratios, except for UK banks.

In contrast, Agoraki et al. (2010) report a negative effect of board independence on bank cost efficiency and no significant effect of board composition on their profit efficiency.

A number of other studies have found no significant impact of board independence on Tobin's Q or ROA of banks, including the studies of Zulkafli and Samad (2007), Adams and Mehran (2009), Praptiningsih (2009), Stancic et al. (2014), and Salim et al. (2016).

In addition, Andress and Vallelado (2008) examine 60 commercial banks in 6 OCED countries from 1996 to 2006 and find an inverted U-shaped relationship between the proportion of outside directors and bank accounting performance measures.

2.3.2.3. Regulatory monitoring mechanism

Due to the high-leverage and high-risk characteristics of banking sectors, governments' regulatory monitoring mechanisms usually relate to banks' risk management practices. According to Gersbach and Wenzelburger (2003), capital adequacy serves as an important indicator of the banking system, and it must be used as one of the policy measures in a banking crisis.

Rime (2001) suggests that when the capital adequacy requirement increases, shareholders are forced to absorb a larger part of the losses, which eventually leads to less risk-taking behavior and lowers banks' default probabilities. In addition, Das and Ghosh (2006) state that a well-capitalized bank is considered to be safer than a low-capitalized bank.

Thus, being well capitalized could help to lower banks' borrowing costs and result in efficiency improvements.

Empirical studies (Zulkafli and Samad, 2007; Praptiningsih, 2009) have mostly found a positive relationship between the capital adequacy ratio and bank performance, which is in line with Rime (2001) and Das and Ghosh (2006).

2.3.2.4. Disclosure Monitoring Mechanism

The disclosure monitoring mechanism refers to financial transparency and disclosure of a firm to provide sufficient and accurate information to its shareholders and stakeholders.

Mitton (2002) and Coles et al. (2001) confirm that the quality of financial reporting and information disclosure are the main mechanisms to assess a firm's corporate governance. Moreover, information disclosure also helps to reduce information asymmetry, which is an important problem in the banking industry.

To ensure disclosure quality, the role of external auditors is crucial. A reputable external auditor could act as a good bank supervisor to ensure depositors are informed on any financial issues that a bank might face (Mitton, 2002).

To ensure that investors are well informed about a bank's overall creditworthiness and capacity to meet its financial obligations, the role of an external rating agency is also essential. According to Nier and Braumann (2006), since rating agencies could gain access to private information, they could incorporate the information into their ratings. Hence, if a bank were rated by a major rating agency, investors would have more reliable information about it.

In this vein, Zulkafli and Samad (2007) report that Asian banks that are audited by Big 4 external auditors and rated by Big 3 rating agencies perform better than banks that are not. However, Praptiningsih (2009) only finds weak evidence of the positive relationship between the presence of Big 4 auditors and ASEAN bank performance, and no significant effect of Big 3 rating agencies.

2.4. Methodology and data

To measure the effect of corporate governance on bank efficiency in ASEAN countries, the present study is divided into two stages: the first focuses on measuring the cost and profit efficiency of banks in ASEAN countries, and the second concentrates on explaining differences in efficiency levels of banks by examining different corporate governance aspects.

2.4.1. Estimation of cost and profit efficiency

This paper aims to measure bank efficiency using the same approach as Berger and Mester (1997), which measures the relative performance of a bank in comparison to the best-practice bank. Hence, cost efficiency of a bank is measured by how close a bank's actual cost is to what a best-practice bank's cost would be to produce the same outputs (Berger and Mester, 1997). Similarly, in line with Berger and Mester (1997), a bank's profit efficiency is determined by how close a bank's profit is to what the best-practice bank would produce given the same bundle of inputs.

The literature on measuring bank efficiency is dominated by two econometric techniques: the parametric and non-parametric techniques. The most widely used methods for each technique are SFA and DEA, respectively. The literature on transition countries in Europe is dominated by the use of SFA (e.g. Bonin et al., 2005; Yildirim and Philippatos, 2007; Fang et al., 2011), while the use of DEA and SFA is mixed in the ASEAN banking efficiency literature. Traditionally, earlier papers on ASEAN banks adopted DEA as their main method (Montinola and Moreno, 2001; Chansarn, 2008; Nguyen and DeBorger, 2008; Sufian, 2009; Garderner et al., 2011; Le et al., 2015; Chan et al., 2016). However, in recent years, SFA has become more popular and is used as widely as DEA (Tahir et al.; 2012; Muazaroh et al., 2012; Viverita and Ariff, 2011; Manlagnit, 2011; Nalm and Vu, 2013; Lin et al., 2016; Chan and Karim, 2016).

Although both methods are extensively used in the literature, Berger and Humphrey (1997) argue that parametric techniques are preferable for measuring economic efficiency as they generally correspond well with the concepts of cost and profit efficiency proposed by Aigner et al. (1977) and Berger and Mester (1997), which are often used in bank efficiency studies. Furthermore, the non-parametric techniques have two major drawbacks: first, they assume no statistical measurement error as a factor that can affect outcomes (Vennet, 2002); and second, they normally ignore prices of bank inputs and outputs, and thus generally focus on measuring technological instead of economic efficiency. Therefore, this paper adopts the SFA proposed by Aigner et al. (1977) to measure bank cost and profit efficiency in ASEAN countries.

To specify the inputs and outputs of banks used in SFA, this paper follows the intermediation approach instead of the production approach. According to Zaim (1995), in the production approach, a bank is viewed as the producer of deposits and loans using capital, labor, and materials; in contrast, in the intermediation approach views banks as collectors of

funds which are then intermediated to loans and other assets. The choice of one approach leads to the varying of inputs and outputs to measure bank efficiency accordingly. While Sealy and Lindsey (1977) state that researchers can choose either approach depending on what they want to test, Berger and Humphrey (1997) argue that the production approach is more suited to measuring efficiency at the branch level, while the intermediation approach is more accurate at the firm level. Hence, the intermediation approach is more suitable for the present study, as cost and profit efficiency are calculated at firm level.

For modeling purposes, the banks are classified as multi-product, three-output, and three-input firms. The dependent variables are total cost (TC) and pre-tax profit (PP). The independent variables are output quantities and input prices. The outputs are the amount of loans to customers (Q_1), interbank loans (Q_2), and other earning assets (Q_3). The inputs are labor (L), including personnel expenses; capital (K), which is the total fixed assets; and deposits (D), which are deposits from banks and customers. The prices of inputs are P_L (ratio of personnel expenses to total assets), P_D (ratio of total interest paid to deposits), and P_K (ratio of other administrative expenses to total fixed assets), respectively. The choices of inputs and outputs are consistent with previous studies by Berger et al. (2010), Ncube (2009), Kraft et al. (2002), and Vivas (1997).

In addition, this paper adopts Berger and Mester's (1997) approach in normalizing the dependent variable and input prices by P_L for the purpose of imposing linear homogeneity on the model. As explained by Berger and Mester (1997), on the efficient frontier, costs will be doubled when all input prices are doubled.

Furthermore, following the approach of Lozano-Vivas et al. (2002), Hughes and Mester (1998), and Hughes (1999), bank level of capital (calculated as the ratio of equity to total assets) is used as a proxy to control for risk in this study. According to Hughes and Mester (1998), higher levels of capital are preferred by risk-averse managers, who follow the aim of profit maximization only under an acceptable degree of risk.

To control for the economic and regional differences when estimating bank efficiency, this study uses the four following environmental variables: the labor productivity growth rate (changes in the amount of GDP per person employed), the bank branch density (number of bank branches per 100,000 inhabitants), the inflation rate, and the concentration ratio for the banking industry (the share of assets held by the three largest banks in the sector). First, the productivity growth is expected to positively affect banking productivity, resulting in reduced cost and increased profit for banks (Lozano-Vivas et al., 2002). Second, a higher level of bank

branch density implies a higher level of accessibility to financial services throughout the population, which is forecast to help banks improve efficiency. Third, the inflation rate is expected to positively affect bank profit efficiency (if banks can fully forecast the future movement of inflation) or negatively affect bank cost efficiency (if they fail to forecast the future inflation rate) (Sufian and Habibullah, 2012). Finally, the banking industry concentration could negatively impact bank efficiency under the structure-conduct-performance hypothesis (SCP) (Molyneux et al., 1996), or positively affect bank efficiency under the efficient structure hypothesis (Berger, 1995; Goldberg and Rai, 1996). The first hypothesis assumes that as banks have the tendency to gain greater market power and lower competition in the market, a more concentrated market will likely comprise fewer banks, with high market power but low efficiency. The second hypothesis suggests that as highly efficient banks will outperform less efficient banks and gain dominant market power, a more concentrated market will likely comprise a lower number of highly efficient banks.

Lastly, to control for technical changes over time for banks in the sample, year dummy variables are added to the cost and profit functions (Berger et al., 2010).

Using a Cobb-Douglas translog functional form, the profit efficiency frontier is specified as follows:

$$\ln\left(\frac{PP}{P_L}\right) = \beta_0 + \sum_{i=1}^{2}\alpha_i \ln\frac{P_i}{P_L} + 0.5\sum_{i=1}^{2}\sum_{j=1}^{2}\alpha_{ij}\ln\frac{P_i}{P_L}\ln\frac{P_j}{P_L} + \sum_{k=1}^{3}\gamma_k lnQ_K + 0.5\sum_{k=1}^{3}\sum_{m=1}^{3}\gamma_{km}lnQ_K lnQ_M + 0.5\sum_{i=1}^{2}\sum_{m=1}^{3}\delta_{im}\ln\frac{P_i}{P_L}lnQ_M + \theta\ln\frac{NPI}{P_L} + \lambda_n controls - U_{it} + V_{it} \quad (2.1)$$

where PP is the pre-tax profit; Q is the vector of output quantities; P is the vector of input prices; i and t represent cross-sectional; U_{it} is the inefficiency term; and V_{it} is the random error. $U_{it} \geq 0$ and zero is the value of the most profit efficient firm; thus, the higher the value, the less profit efficient the bank is. Controls include the level of capital (E.ratio), productivity growth (*prod.growth*), bank branch density (*branch.dens*), inflation rate (*infl*), industry concentration (*concentration*), and year dummies.

As the value of pre-tax profit could be negative, which is problematic for the translog profit function, this paper adopts Bos and Koetter's (2009) approach by left-censoring the PP

variable and including an additional independent variable NPI (Negative Profit Indicator). PP is assigned the value of 1 if the observation has 0 or negative profit value. and the value of PP for banks with positive profits. NPI takes a value of 1 for observations with positive profits, and equals the absolute value of PP for loss-incurring banks. According to Bos and Koetter (2009), this approach prevents the drops of observations, does not affect the error term structure, and still takes into account losses by adding the NPI variable.

To estimate the profit function, Kumbhakar et al.'s (2014) SFA model is utilized. Kumbhakar et al. (2014) separate the error term into four components: the firm effects (μ_i), the persistent inefficiency (η_i), the residual (or time-varying) inefficiency (u_{it}), and the random error (v_{it}). Equation (2.1) becomes:

$$\ln\left(\frac{PP}{P_L}\right) = \beta_0 + \sum_{i=1}^{2}\alpha_i \ln\frac{P_i}{P_L} + 0.5\sum_{i=1}^{2}\sum_{j=1}^{2}\alpha_{ij}\ln\frac{P_i}{P_L}\ln\frac{P_j}{P_L} + \sum_{k=1}^{3}\gamma_k lnQ_K + 0.5\sum_{k=1}^{3}\sum_{m=1}^{3}\gamma_{km}lnQ_K lnQ_M + 0.5\sum_{i=1}^{2}\sum_{m=1}^{3}\delta_{im}\ln\frac{P_i}{P_L}lnQ_M + \theta\ln\frac{NPI}{P_L} + \lambda_n controls + \mu_i - \eta_i - u_{it} + v_{it} \quad (2.2)$$

By putting certain distributional assumptions on the error terms ($v_{it}\sim N(0,\sigma_v^2)$, $u_{it}\sim N^+(0,\sigma_u^2)$, $\eta_i\sim N^+(0,\sigma_\eta^2)$ and $\mu_i\sim N^+(0,\sigma_\mu^2)$), η_i and u_{it} are then estimated using maximum likelihood.

Similarly, the cost efficiency frontier is specified as:

$$\ln\left(\frac{TC}{P_L}\right) = \beta_0 + \sum_{i=1}^{2}\alpha_i \ln\frac{P_i}{P_L} + 0.5\sum_{i=1}^{2}\sum_{j=1}^{2}\alpha_{ij}\ln\frac{P_i}{P_L}\ln\frac{P_j}{P_L} + \sum_{k=1}^{3}\gamma_k lnQ_K + 0.5\sum_{k=1}^{3}\sum_{m=1}^{3}\gamma_{km}lnQ_K lnQ_M + 0.5\sum_{i=1}^{2}\sum_{m=1}^{3}\delta_{im}\ln\frac{P_i}{P_L}lnQ_M + \lambda_n controls + \mu_i + \eta_i + u_{it} + v_{it} \quad (2.3)$$

where the error term of the cost function is also separated into four components, as is done for the profit function. Similar to the profit function, the estimation of the cost function is done by employing Kumbhakar et al.'s (2014) SFA model.

Various models have been developed under SFA to estimate bank efficiency scores. However, Kumbhakar et al.'s (2014) one is chosen in this paper for the three following reasons. First, this model is able to separate firm heterogeneity from the inefficiency term, which is the advantage over many earlier SFA models. For example, Kumbhakar's (1990), Battese and Coelli's (1992), or Kumbhakar and Wang's (2005) model consider the total firm heterogeneity as a component of bank inefficiency, which leads to the overestimation of the inefficiency scores. Kumbhakar et al. (2014) argue that although not all firm effects lead to banks' levels of inefficiency, some of the firm heterogeneities actually can cause bank inefficiencies. Hence, the second advantage of the Kumbhakar et al. (2014) model is its ability to separate the firm effects that lead to bank inefficiency from the total firm effects. This is an improvement compared to some other models, such as Greene's (2005) true fixed-effects and true random-effects models, which consider firm heterogeneity completely separately from the inefficiency term and result in underestimated inefficiency measures. Finally, the third advantage of the chosen model is its ability to differentiate between persistent inefficiency and short-term or residual inefficiency, as different types of inefficiency might be caused by different factors. This would benefit banks in the process of determining the cause of inefficiency.

2.4.2. Estimation of corporate governance as a possible determinant of bank efficiency

2.4.2.1. GMM: the issue of endogeneity

a. The issue of endogeneity

A majority of studies testing the relationship between corporate governance and bank performance assume that a bank's corporate governance measures are exogenous factors that determine bank profitability or efficiency (Pathan et al., 2007; Zulkafli and Samad, 2007; Adams and Mehran, 2008; Agoraki et al., 2010; Tanna et al., 2011; Stancic et al., 2014). However, Berger and Mester (1997) note that the bank efficiency scores or other performance measures might be correlated to the bank's own past behaviors, and that the endogeneity problem can arise when internal bank-specific factors are included in the determinant model.

Wintoki et al. (2012) identify three sources of potential endogeneity when determining the relationship between corporate governance and firm performance.

- Dynamic endogeneity: this refers to the problem that occurs when the current value of a variable is influenced by its past values. According to Wintoki et al. (2012), the current governance structure of a firm could not only affect the firm's current performance, but it also

could be affected by the firm's past performance. This argument is built on the model of Hermalin and Weisbach (1998). These authors point out that when a firm showed poor performance in the past, it likely caused structural changes in the Boards of Directors to achieve better performance, which in turn could affect the firm's current performance. In this vein, Raheja (2005) and Harris and Raviv (2008) present empirical evidence regarding the direct influence of past performance on a firm's expected profitability, information environment, and opportunity costs of outside directors, which potentially affect the firm's board structure.

- Simultaneity: this problem occurs when two different variables are simultaneously related. In the case of corporate governance and performance relationship, board characteristics could be determined by performance and vice versa. For instance, a firm may elect its Board of Directors based on the expected performance in the future (Schultz et al., 2010). Lai and Choi (2014) examine Asian banks from 2007 to 2012 and use firm performance as an independent variable that affects board structure. Their study produces certain significant results.

- Unobserved heterogeneity: this is present when a factor that affects the relationship between two or more variables is unobservable by the researcher. Wintoki et al. (2012) note that some unobservable and difficult-to-quantify firm-specific characteristics (or firm fixed effects) could affect a firm's corporate governance and performance. Haubrich (1998) gives the example that firm performance could be affected by the abilities of its managers and the CEO's risk preferences, both of which are highly difficult to measure.

b. Estimation methods used in the literature

Many researchers have attempted to solve the endogeneity problem when examining the relationship between corporate governance and performance in both non-banking and banking institutions (Andres and Vallelado, 2008; Pasiouras et al., 2009; Belkhir, 2009; Schultz et al., 2010; Wintoki et al., 2012; Chortareas et al., 2012; Chan et al., 2015). These studies discuss the use of Generalized Methods of Moments (GMM) as an effective tool to restrict the problem of endogeneity in comparison with other commonly used methods of estimation, including OLS, Tobit regression, Fixed Effects, and Random Effects.

OLS is by far the most popular method to determine the impact of corporate governance and bank performance (Adams and Mehran, 2009; Agoraki et al., 2010; Tanna et al., 2011, Stancic et al., 2014; Salim et al., 2016). However, it is heavily criticized for its strict

assumptions required to produce consistent estimations. One of these assumptions is that corporate governance and other independent variables are strictly orthogonal to the errors. Wintoki et al. (2012) insist that with the existence of three possible sources of endogeneity between firm governance and performance, the above assumption would not hold. The inconsistency in estimation is demonstrated by contrasting empirical results, which were reviewed in section 3 of this paper.

Other authors suggest the use of Tobit regression as an alternative to OLS (Hoff, 2007) for the main reason that the efficiency scores of banks range between 0 and 1 (or have an upper limit of 100% depending on different measurement techniques). However, McDonald (2009) and Andries (2010) advocate against the use Tobit and argue that OLS is a more consistent estimator.

Moreover, some studies use methods designed specifically for panel data: the Fixed Effects model (Pathan et al., 2007; Andres and Vallelado, 2008) and the Random Effects model (Praptiningsih, 2009). Yermack (1996) and Himmelberg et al. (1999) use the Fixed Effects model in an attempt to overcome endogeneity when examining corporate governance and firm performance. The fixed effects panel assumes that if the unobservable characteristics of the firm are constant over time, it can help to eliminate unobservable heterogeneity and produce consistent estimates (Petersen, 2009). However, another important aspect of the fixed effects panel is the assumption of strict exogeneity – in other words, the model assumes that a firm's corporate governance is unrelated to past, present, and future innovations in performance (Schultz et al., 2010). Hence, since the relationship between corporate governance and performance is likely to be affected by dynamic endogeneity and simultaneity, the use of the Fixed Effects model could lead to unreliable results.

Hence, to overcome the problem of simultaneity, dynamic endogeneity, and unobservable heterogeneity, Wintoki et al. (2012) and Schultz et al. (2010) recommend the use of the dynamic GMM to estimate the relationship between corporate governance structure and firm performance. The dynamic GMM was originally developed by Arrelano and Bond (1991) and Blundell and Bond (1998), and it employs valid internal instruments (Z) for estimation to overcome endogeneity problems. The instrument validity can be tested using the Hansen-Sargan test of over-identification of restrictions.

c. The dynamic system GMM model

The following explanation of the dynamic system GMM model has been adopted from the work of Wintoki et al. (2012).

First, Wintoki et al. (2012) introduce a dynamic model of board structure and firm performance. As discussed earlier, due to the possibility of dynamic endogeneity, a firm's board structure is likely to be affected by the firm's past performance. This leads to the following model of board structure:

$$X_{it} = f\left(y_{it-1}, y_{it-2} \ldots, y_{it-p}, Z_{it}, \eta_i\right) \quad (2.4)$$

where X is the board structure, Z presents firm characteristics, y is firm performance, and η presents an unobserved firm effect.

Hence, to estimate the impact of board structure on firm performance, the following model is used:

$$y_{it} = \alpha + \sum_{s} K_s y_{it-s} + \beta X_{it} + \gamma Z_{it} + \eta_i + \epsilon_{it} \quad (2.5)$$

where ϵ_{it} is a random error term and β presents the impact of board structure on performance. However, it can be seen that this model suffers from unobserved heterogeneity.

The procedure of using a dynamic GMM model to estimate equation (2.5) includes two steps:

+ Step 1: The dynamic model (2.5) is rewritten in first differenced form to eliminate any potential bias caused by unobserved heterogeneity:

$$\Delta y_{it} = \alpha + \sum_{s} K_s \Delta y_{it-s} + \beta \Delta X_{it} + \gamma \Delta Z_{it} + \Delta \epsilon_{it} \quad (2.6)$$

+ Step 2: Equation (2.6) is estimated via GMM using lagged values of firm performance, board structure, and other firm characteristic variables as instruments for the current changes in these variables. Specifically, instruments used to estimate equation (2.6) can be drawn from the set of lagged variables, such as y_{t-k}, X_{t-k} and Z_{t-k}, where $k > p$ (p is the number of lags).

These instruments must meet two criteria to be valid. First, they must provide a source of variation for a firm's current corporate governance, such as using firm past performance as instruments for firm current governance structure in equation (2.4).

Second, the instruments must be uncorrelated with the error in the performance in equation (2.5). In other words, firm performance, corporate governance structure, and firm characteristics are assumed to have no effect on future performance changes, but could correlate with past and present performance changes (Wooldridge, 2002; Wintoki et al., 2012). According to Wintoki et al. (2012), this assumption is motivated by earlier theory and a much weaker assumption compared to the strict exogeneity assumption. This assumption can be illustrated as:

$$E(X_{it-s}\epsilon_{it}) = E(Z_{it-s}\epsilon_{it}) = E(y_{it-s}\epsilon_{it}) = 0, \ \ \forall s > p \qquad (2.7)$$

Despite its economic appeal in that it might effectively solve all three sources of endogeneity mentioned earlier, Wintoki et al. (2012) point out some shortcomings of dynamic GMM. Firstly, even though first differencing can eliminate unobserved heterogeneity, Beck et al. (2000) state that it could reduce the variation in the independent variables, which could, in turn, reduce the power of the estimation. Secondly, variables measured in levels could be weak instruments for first-differencing equations (Arellano and Bover, 1995). Thirdly, Griliches and Hausman (1986) state that the effect of measurement errors on explanatory variables could be exacerbated by using first differencing.

To overcome these shortcomings, Arellano and Bover (1995), Blundell and Bond (1998), and Wintoki et al. (2012) suggest the inclusion of equations in levels in the estimation procedure:

$$\begin{pmatrix} y_{it} \\ \Delta y_{it} \end{pmatrix} = \alpha + K \begin{pmatrix} y_{it-p} \\ \Delta y_{it-p} \end{pmatrix} + \beta \begin{pmatrix} X_{it} \\ \Delta X_{it} \end{pmatrix} + \gamma \begin{pmatrix} Z_{it} \\ \Delta Z_{it} \end{pmatrix} + \epsilon_{it} \qquad (2.8)$$

It is clear that equation (2.8) still suffers from unobserved heterogeneity; this leads to the assumption that allows for the correlation of governance structure and firm characteristics with unobserved effects but assumes that this correlation is constant over time. Wintoki et al. (2012) express this assumption in the following equation:

$$E(\Delta X_{it-s}(\eta_i + \epsilon_{it})) = E(Z_{it-s}(\eta_i + \epsilon_{it})) = E(y_{it-s}(\eta_i + \epsilon_{it})) = 0, \ \ \forall s > p \qquad (2.9)$$

Finally, GMM panel estimation is carried out using the orthogonality condition of (2.7) and (2.9). In the estimation, lagged levels of variables are used as instruments for the differenced equations, and lagged differences are used as instruments for the levels equations (Wintoki et al., 2012).

Due to the nature of the dynamic system GMM models, Wintoki et al. (2012) propose two key tests for the model assumptions.

+ The first test is the Hansen/Sargan test of over-identification of restriction, as the dynamic system GMM estimator uses multiple lags as instruments.

+ The second test is the test of second-order serial correlation. As discussed by Wintoki et al. (2012), the largest concern regarding the model is how many lag values should be included in the estimation. If enough lags are included in the models, any historical value of firm performance beyond those lags will be exogenous to current performance changes, which means that they could be used as valid instruments. In this vein, Andres and Vallelado (2008) state that the first-order serial correlation is expected given the first-differencing transformation, but if a second-order correlation is found, this signals omitted variables.

2.4.2.2. The model

a. The dependent variable

The dependent variables are the cost and profit efficiency scores of banks measured using Kumbhakar et al.'s (2014) SFA model. Two types of efficiency scores are included in the model: the overall efficiency scores (Overall ProfitEFF and Overall CostEFF) and the time-varying efficiency scores (Residual ProfitEFF and Residual CostEFF).

b. Independent variables

Due to the inefficiency of the available data, this paper examines the following corporate governance variables.

+ Foreign ownership (FOREIGN): a dummy variable equal to one if the foreign shareholding in banks is 50% or more.

+ Government ownership (GOVT): a dummy variable equal to one if the government shareholding in banks is 50% or more.

+ CEO duality (CEODUALITY): a dummy variable equal to one if a single person holds the positions of both CEO and Chairman in the bank, and zero otherwise.

+ Board size (BOARDSIZE): measured by the logarithm of the number of directors on the board (Agoraki et al., 2009; Wintoki et al., 2012).

+ Board independence (BINDEP): measured by the proportion of outside (non-executive) directors on the board.

c. Control variables

Some firm- and industry-specific factors are considered to have a significant impact on corporate governance and bank efficiency. According to Boone et al. (2007), a firm chooses its board structure in consideration of the scope and complexity of its operations. In this vein, Guest (2008) states that as a bank become larger and more complex, it needs a larger board and greater proportion of outsiders with various connections and fields of expertise, who can provide greater information and advice to the CEO. Hence, board size and board independence are expected to increase with firm complexity. Following Boone et al.'s (2007) approach, this paper uses two proxies to measure bank activity complexity: bank size and bank age. Bank size is measured by using the logarithm of total assets, while bank age is measured by taking the logarithm of the number of years since the bank was founded.

Furthermore, the effect of bank size on bank efficiency has been discussed intensively in literature. According to McAllister and McManus (1993), larger banks enjoy economies of scale and scope and have better opportunities for diversifying their risk compared to smaller banks. Hence, their cost of funding is lower, which results in higher profitability (Goddard et al., 2004). Conversely, Vallascas and Keasey (2012) argue that due to their important role in the economy, larger banks are perceived as "too big to fail", and they could thus have more incentive to follow higher risk investment strategies, since they would eventually be bailed out by the government. In other words, larger banks are not necessarily more efficient than smaller banks.

2.4.2.3. Data

The sample in this study comprises 175 banks from six ASEAN countries: Vietnam, Cambodia, Indonesia, Malaysia, the Philippines, and Thailand. The data represent the period from 2007 to 2014.

To estimate the cost and profit efficiency, the banks in the sample are classified as multi-product, three-output, and three-input firms. Total cost (TC) and pre-tax profit (PP) are the dependent variables, while output quantities and input prices are the independent variables. The outputs used in the efficiency functions are loans to customers, interbank loans, and other earning assets; the inputs are capital, funds, and labor. The choices of outputs are consistent with previous studies by Ncube (2009), Kraft et al. (2002), and Vivas (1997).

The data of the variables are collected from published audited financial reports of the banks in the sample over the period from 2007 to 2014. The information obtained for each bank includes:

- Interest expenses and similar expenses
- Total operating expenses
- Personnel expenses
- Profit before tax
- Loans to customers
- Interbank loans
- Other earning assets
- Total assets
- Total fixed assets
- Equity

The rest of the variable data are collected from the following sources:

- The data on bank ownership and board structure are collected from the Bank Scope database and from banks' annual reports.

- The data on productivity growth, bank branch density, and inflation are obtained from the World Bank website.

- The data on industry concentration are obtained using information from annual supervision reports of each country's state bank or central bank.

Tables 2.1, 2.2, 2.3a, 2.3b, 2.4a, and 2.4b present the descriptive statistics of the input and output variables used to estimate the cost and profit frontiers and the explanatory variables of efficiency.

Table 2.1 provides the definitions of input, output, and control variables of the cost and profit frontiers. Table 2.2 presents the sample distribution of this paper. The total number of banks in the sample is 175, with the largest contribution coming from Indonesia (50 banks), followed by Vietnam (36 banks). Other countries contribute between 20 and 25 banks each. However, the scattered nature of the Indonesian banking sector could explain the high proportion of Indonesian banks in the sample. At the end of 2014, there were more than 100 conventional commercial banks operating in Indonesia.

Table 2.3a reports the descriptive statistics of input, output, and control variables used in the cost and profit functions. As presented in table 2.3a, there are relatively widespread bank data in terms of total cost, pre-tax profit, output quantities, and input prices.

Table 2.3b lists the descriptive statistics of input, output, and control variables used to estimate efficiency scores per country. Based on the data on total cost and pre-tax profit, Vietnamese banks appear to incur the highest costs relative to the profits made compared to

other countries. Cambodian banks incur small absolute values of total cost and pre-tax profit, which reflects the smaller size of the country's banking system. The banks from the four other countries seem to incur similar costs as each other to yield their levels of profit. In terms of outputs produced, similar levels are found for most of the country, except for Cambodia. Thai and Malaysian banks produce the highest levels of output over the sample period. In terms of the input prices, there is no obvious group of banks with lower prices. Banks from Vietnam have the lowest price of capital (1.734) and labor (0.0073); and banks from the Philippines have the lowest price of funds (0.0196). The highest price of funds belongs to Vietnamese banks (0.074), while Thai banks have the highest price of capital (5.496) and Indonesia banks have the highest price of labor (0.019). In terms of control variables, banks from Cambodia appear to have the highest level of capital, which indicates that they are the most risk-averse banks in the sample. In contrast, Vietnam, Malaysia, and the Philippines are the countries with the least risk-averse banks. The productivity growth in Malaysia, the Philippines, and Thailand is lower than in Vietnam, Cambodia, and Indonesia. The banking branch density levels are largely different from one country to another. Indonesia has the most bank branch coverage, with more than 13 branches per 100,000 inhabitants, followed by Thailand and Malaysia with more than 11 branches, the Philippines with 8 branches, and Cambodia and Vietnam with 3 to 4 branches. Regarding inflation, Vietnam is the country with the highest inflation rate, while Malaysia and Thailand experience the lowest levels. Relating to industry concentration, Malaysia is the most concentrated market, while Vietnam and Indonesia are the least concentrated ones. In summary, there are vast differences in the characteristics of inputs and outputs used to estimate the cost and profit frontiers of banks from different countries, making it highly difficult to determine which groups of banks are more cost and profit efficient than the others. However, if only the levels of total cost and pre-tax profit are compared, given the combination of output quantities and input prices, Malaysian and Philippine banks appear to have better combinations than those from other countries.

Table 2.4a presents the descriptive statistics of the variables that could explain bank efficiency. The data show significant levels of foreign ownership (about 30%) and very low levels of government ownership (about 0.8%) for the whole sample. The CEODUALITY level is also very low, which indicates that the majority of banks in the sample employ two different persons for the two different roles. The average board size is eight members. The level of board independence is high, with an average ratio of non-executive directors in the

board of more than 86%. Finally, the average bank size of the sample is $10,050 billion, and the average bank age is 34 years.

Table 2.4b shows the statistics of explanatory variables by country. According to this table, the countries with the highest rate of foreign ownership are Cambodia and Malaysia, whereas the country with the lowest rate is Vietnam. Indonesia and the Philippines are the two countries with the highest level of government ownership, while the lowest levels are found in Cambodia and Thailand. Moreover, the banks in Thailand show the highest level of CEO duality. The board sizes of banks in Thailand and Philippines are among the highest, while those in Indonesia are the lowest. On the other hand, the board independence level of banks in Indonesia is very high (more than 90%), while that in Cambodia and Thailand is low (less than 77%) compared to other countries in the sample. Regarding the control characteristics of bank size and bank age, Vietnamese and Cambodian banks are relatively smaller and younger than banks from other countries, while banks in Malaysia and Thailand are relatively larger and older than the rest of the sample. To summarize, the board characteristics of banks from different countries are highly distinctive, making it highly difficult to group banks together based on similar features.

2.5. Results and discussion

2.5.1. Efficiency level of banks in six ASEAN countries

Tables 2.6a and 2.6b present the estimated cost efficiency and profit efficiency scores of the banking sectors in the six examined ASEAN countries from 2007 to 2014. The score for cost efficiency is equal to or less than 1, with 1 representing the bank with optimal cost. Thus, if a bank has a cost efficiency score of 0.70, this indicates that the bank could save 30% of its costs without changing its outputs or inputs. Hence, the higher the score, the more cost efficient the bank is. As can be seen in table 6b, the average cost efficiency score for the whole sample is 0.7734, with persistent efficiency as a higher contributor than residual efficiency. On average, banks in Indonesia and Thailand exhibit higher cost efficiency levels, while Philippine and Malaysian banks show the lowest levels.

The score for profit efficiency is equal to or less than 1, with 1 representing a bank with optimal profit. Thus, if a bank has a profit efficiency score of 0.60, this indicates that if the bank utilized its inputs and outputs like the optimal bank does, it could increase its profit by 40%. Hence, the higher the score, the more profit efficient a bank is. According to table 2.6b, the average profit efficiency score for the whole sample is 0.3084, with similar contributions

from persistent and residual profit efficiency. The average profit efficiency score is much lower than the cost efficiency score, which indicates that ASEAN banks are cost efficient but highly profit inefficient. Interestingly, banks in Malaysia and Cambodia show the highest levels of profit efficiency, while banks in Indonesia and Vietnam are the least profit efficient. In other words, banks that can minimize costs do not necessarily maximize their profits. This can be explained by looking at the cost and profit frontier parameter estimate results in table 2.5.

The results in table 2.5 show that the cost of a bank is explained by almost every output quantity and input price variable, while its profit is mainly explained by the output quantity variables. Regarding the control variables, the equity ratio has a significant negative impact on the cost but no effect on the profit of a bank. This supports Casteuble's (2015) argument that risk-averse banks tend to be less cost efficient than risk-neutral banks as they incur more costs in reducing risk, such as higher loan monitoring costs. Furthermore, productivity growth has a significant positive impact on both cost and profit of a bank, which confirms Lozano-Vivas et al.'s (2002) view that increasing labor productivity leads to reduced banking costs and increased banking profits. In contrast, the bank branch density has a significant negative impact on both cost and profit of a bank; this supports the argument that higher levels of branch density imply higher costs as the capacity of some branches might be under-utilized (Lozano-Vivas et al., 2002). Finally, the industry concentration ratio shows a significant negative effect on bank cost but a significant positive effect on bank profit. This partly supports both the structure-conduct-performance and the efficient structure hypotheses. When the market becomes more concentrated, the reduced market competition does not force banks to reduce their costs, but as banks' market power increases, they are in better positions to generate greater profits.

Hence, the contrast between the efficiency of banks in Malaysia and Indonesia can partly be explained by some of the bank and industry characteristics. Banks in Malaysia are the most profit efficient but also the least cost efficient because they are less risk-averse, and because the country has a low level of productivity growth, a moderate level of branch density, and very high level of industry concentration. On the other hand, banks in Indonesia are the most cost efficient but also the least profit efficient since they are less risk-averse, and since the country has a very high level of productivity growth, a very high level of branch density, and a considerably low level of industry concentration.

2.5.2. Corporate governance and bank efficiency

2.5.2.1. Results

Tables 2.7a and 2.7b report the empirical evidence about the effect of corporate governance on the cost and profit efficiency of ASEAN banks. The relationship is estimated using three different methods: OLS, Fixed Effects, and Dynamic System GMM. For each method, two different models are run: (a) the model with residual efficiency scores as the dependent variable, and (b) the model with overall efficiency scores as the dependent variable. Hence, in total, six different models are run for each type of efficiency score.

a. Corporate governance and cost efficiency

Table 2.7a exhibits the estimation of the relationship between corporate governance and bank cost efficiency. The OLS model (1a) shows no significant relationship between corporate governance and residual cost efficiency of banks. When using overall cost efficiency scores as dependent variables, the OLS model (1b) yields significant negative impacts of foreign ownership and CEO duality, and significant positive impacts of government ownership and board size on the overall cost efficiency of banks. That indicates almost the effects of corporate governance are on bank persistent cost efficiency.

On the other hand, when controlled for firm effects, the Fixed Effects models (2a and 2b) only report no significant effect of corporate governance variables on both types of cost efficiency scores.

After controlling for the endogeneity issue, the Dynamic System GMM models (3a and 3b) show a significant positive impact of government ownership and a significant negative impact of board independent on all cost efficiency scores. However, stronger impacts are found for the model of overall CostEFF, which implies greater effects of corporate governance on persistent cost efficiency compared to time-varying efficiency.

In terms of control variables, a significant negative relationship between bank size and cost efficiency is found for most of the models. This implies that the larger the bank is, the less cost-efficient it is.

In summary, the results in table 2.7a exhibit the inconsistency that occurs in model estimation without controlling for firm effects and the endogeneity issue. By using the Dynamic System GMM models, this study finds evidence for a positive effect of government ownership and a negative effect of board independence on bank cost efficiency. In other

words, banks with higher levels of government ownership and banks with lower levels of board independence exhibit higher degrees of cost efficiency.

b. Corporate governance and profit efficiency

Table 2.7b presents the estimation of the relationship between corporate governance and profit efficiency of banks. The OLS models (4a) and (4b) show significant positive relationships between CEO duality and both the profit efficiency scores. Furthermore, model (4b) show an additional positive relationship between board size and bank overall profit efficiency.

When controlling for firm effects, the Fixed Effects model (5a) finds only a positive relationship between board size and time-varying profit efficiency, while the Fixed Effects model (5b) only yields a positive relationship between CEO duality and overall profit efficiency levels.

However, when controlling for the endogeneity issue, both Dynamic System GMM models (6a) and (6b) show no significant relationship between corporate governance explanatory variables and profit efficiency of banks.

Regarding control variables, inconsistent relationships are found between bank size, bank age, and the profit efficiency scores across models.

In summary, due to the diverse and weak evidence across the different models, the results demonstrate that corporate governance aspects including ownership structure and board structure have no significant impact on the abilities of ASEAN banks to maximize their profits. However, after accounting for firm effects and the endogeneity issue, a positive relationship is found between bank size and time-varying profit efficiency, as well as between bank age and overall profit efficiency. In other words, larger banks exhibit a greater ability to maximize profits in the short term, while older banks exhibit a greater ability to do so in the long term.

2.5.2.2. Discussion

a. Corporate governance and cost efficiency

The significant positive relationship found between government ownership and bank cost efficiency is consistent with the findings of Gardener et al. (2011), Le et al. (2015), Nguyen and De Borger (2008), Vu and Turnell (2010), and Nalm and Vu (2013); all of these studies conclude that government-owned banks are more efficient than private banks.

However, regarding foreign ownership, these studies' results differ from those in this paper. They all conclude that foreign ownership has a significant positive impact on cost efficiency, while the present study finds no significant relationship between the two. However, Djalilov and Piesse (2014) do not find a significant effect of foreign ownership on cost efficiency for Central Asian banks either. The possible explanation for these results is that government-owned banks in ASEAN countries have possible access to cheaper inputs due to their relationship with the government, while foreign banks in the area have not reached the optimal size to utilize their knowledge and experience.

Due to the limited nature of the literature on the relationship between corporate structure and cost efficiency, it is difficult to determine this paper's results are consistent with those of previous studies. However, the closest studies are those of Agoraki et al. (2010), Tanna et al. (2011), and Salim et al. (2016). Agoraki et al. (2010) use the OLS method to estimate the effect of corporate governance on bank cost efficiency in European countries. The authors find a negative correlation between board size, board independence, on bank cost efficiency.

Both Tanna et al. (2011) and Salim et al. (2016) use technical efficiency measured using the DEA approach as an indicator of bank performance. Tanna et al. (2011) perform an OLS regression and find a significant positive relationship between board size, board independence, and technical efficiency. On the other hand, Salim et al. (2016) use truncated regression and also find a significant positive impact of board size on technical efficiency, but no significant impact of board independence on bank technical efficiency scores.

Hence, the results of Agoraki et al. (2010) partly support the findings of the present study. The finding that a higher level of board independence leads to lower cost efficiency supports Petra's (2005) argument that outside directors might have a limited understanding of the business and might make less efficient decisions and influence the bank's ability to minimize cost.

Moreover, the negative relationship between bank size and cost efficiency supports Vallascas and Keasey's (2012) argument that larger banks have more incentives than smaller banks do to pursue riskier investment strategies, and thereby incur greater costs.

b. Corporate governance and profit efficiency

In terms of the impact of ownership structure on profit efficiency, the results of this study differ broadly from those of previous studies. Moreover, while the findings of

Praptingsih (2009) and Zulkafli and Samad (2007) are consistent with the present results, the methods of estimation are different (EGLS and Random Effects, respectively) from GMM. Hence, the confirmation is weak. On the other hand, using GMM, Mnasri (2015) confirms the significant effect of government ownership on bank ROA and Tobin's Q. The results of the present paper show that higher government ownership in ASEAN banks might help banks to access cheaper inputs, which could lead to lower costs but not necessarily to higher profit. This could be explained by the other operational purposes of government-owned banks besides the profit-maximizing aims, such as political ones.

In terms of the effect of board structure on profit efficiency, the results of this study are consistent with previous empirical evidence, and support Hermalin and Weisbach's (2003) view that board composition is not related to firm performance. Hermalin and Weisbach (2003) and Petra (2005) argue that the presence of outside directors alone does not solve the problem of deficiencies presented in board meetings. Furthermore, Schultz et al. (2010) and Wintoki et al. (2012) also use Dynamic System GMM to evaluate the impacts of CEO duality, board size, and board independence on firm performance (measured by Tobin's Q and ROA) and find no significant results. Schultz et al. (2010) and Wintoki et al. (2012) also compare the results using different estimation methods (OLS and Fixed Effects) with those using Dynamic System GMM and find that they differ vastly. While OLS or Fixed Effects might show some significant effects of board structure on firm performance, dynamic system GMM shows no such relationship. Mnasri (2015) adopts Wintoki et al.'s (2012) approach and produces similar results for board structure and Tunisian bank performance measured by ROA and ROE. Similarly, Akbar et al. (2016) also use Wintoki et al.'s (2012) approach and find no significant evidence of corporate governance on UK bank performance (ROA).

Other studies, however, report different findings. Agoraki et al. (2010) use profit efficiency as a measurement for bank performance and find a negative relationship between board size and profit efficiency, and no relationship between board independence and profit efficiency. Andres and Vallelado (2008) utilize the GMM approach to conduct similar research on banks in Canada, France, Italy, Spain, the US, and the UK. However, their results show a significant U-shaped relationship between board size and bank performance (Tobin's Q), and a significant positive relationship between board independence and bank Tobin's Q.

Regardless of the different estimation methods, previous studies' main measures of bank performance are accounting variables (ROA or Tobin's Q). Hence, the results of the

present study, using economic efficiency as the measure of bank performance, are not exactly comparable to previous literature.

2.5.3. Robustness check

Tables 2.7a and 2.7b demonstrate the results of the relationship between corporate governance and bank efficiency using different estimation methods, including pooled OLS, Fixed Effects, and Dynamic System GMM. The OLS model is criticized for its inability to control for endogeneity between corporate governance and bank performance. The Fixed Effects panel model is used to control for possible unobserved heterogeneity between the relationship of corporate governance and bank performance. However, as discussed by Wintoki et al. (2012) and Schultz et al. (2010), this model can only account for one type of endogeneity, which is unobservable heterogeneity, and hence ignores dynamic endogeneity and the simultaneity issue.

Therefore, Schultz et al. (2010) insist that if endogeneity is present, pooled OLS and the Fixed Effects panel will produce biased parameter estimates, while consistent estimation would be achieved by dynamic GMM. However, if endogeneity is not present and the regressors are exogenous, GMM would be less efficient than OLS and the Fixed Effects panel in producing parameter estimates. Thus, to test the necessity of using the dynamic GMM approach instead of OLS or the Fixed Effects panel in the present study, the Durbin-Wu-Hausman (DWH) test was applied to test for endogeneity in corporate governance measures (Durbin, 1954; Wu, 1973; Hausman, 1978). Table 8 presents the results of this test, which strongly indicate that endogeneity is a significant concern when both cost efficiency scores and profit efficiency scores are used as dependent variables. Hence, the results of the DWH test for endogeneity justify the need to use the dynamic system GMM panel method of estimation.

2.6. Conclusion

This study examined the impact of corporate governance on the cost and profit efficiency of banks from six ASEAN countries over the period of 2007 to 2014. The results showed differences in both cost and profit efficiency scores among the six countries. The average cost efficiency scores ranged from 0.7062 to 0.8071, and the average profit efficiency scores from 0.2778 to 0.3486. Malaysia was the country with the least cost-efficient but most profit-efficient banking sector, while Indonesia was the country with the most cost-efficient but least profit-efficient banking sector.

To explain the difference between the different ASEAN countries in terms of bank efficiency, this study examined the impact of various aspects of corporate governance on cost and profit efficiency, including ownership structure (foreign ownership and government ownership) and board structure (CEO duality, board size, and board independence).

The estimation method used was Dynamic System GMM, which accounts for three different types of endogeneity between corporate governance and bank performance: dynamic endogeneity, simultaneity, and unobserved heterogeneity (Wintoki et al., 2012). The results produced are highly interesting, and some challenge previous empirical literature.

In terms of corporate governance and cost efficiency, the findings showed that banks with higher government ownership were more cost efficient, which could be explained by their easier access to cheaper input resources. In addition, banks with a higher level of board independence demonstrated lower cost efficiency scores, supporting Petra's (2005) argument that outside directors' limited business knowledge could lead to inefficient business decisions. On the other hand, foreign ownership, board size, and CEO duality were found to have no significant impact on a bank's ability to minimize its cost.

In terms of corporate governance and profit efficiency, no significant impact of ownership structure and bank profits was found. Similarly, no significant relationship was found between board structure and bank profit efficiency, which is in line with Hermalin and Weisbach's (2003) and Petra's (2005) argument about outside directors' limited abilities to contribute to banks' operations.

As the process of bank restructuring in ASEAN country is still on-going, the understanding of determinants of bank efficiency is critical to create a well-functioning sector. However, since the sector development is a continuous process, changes and new issues require further research. In a similar vein, missing literature and inconsistent findings suggest that further research on the corporate governance mechanism and bank efficiency is highly necessary.

APPENDICES

Table 2.1. Variables used to estimate the cost and profit functions

This table gives descriptions and detail measurements of the dependent variables (TC and PP) and independent variables (outputs, inputs, input prices, and controls) that are used to estimate bank efficiency.

Variable	Variable name	Description
TC	Total costs	Interest expenses and operating expenses
PP	Pre-tax Profit	Profit before taxation
Outputs		
Q_1	Loans to customers	Loans issued by the bank to retail clients
Q_2	Interbank loans	Loans issued by the bank to other credit institutions
Q_3	Other earning assets	Other earning assets
Inputs		
P_1	Labor	Number of full-time employees
P_2	Capital	Fixed assets
P_3	Funds	Deposits from customers and banks
Input prices		
P_L	Labor	Personnel expenses/Total assets
P_K	Capital	Other administrative expenses/Book value of fixed assets
P_D	Funds	Interest expenses/Funds
Controls		
E.ratio	Equity ratio	Equity/Total assets
Prod.growth	Productivity	Growth of GDP per person employed
Branch.dens	Branch density	Number of bank branches per 100,000 inhabitants
Infl	Inflation	Inflation rate
Concentration	Industry concentration	Share of assets of 3 largest banks in a banking sector

Table 2.2. Sample distribution

This table presents the distribution of the sample by country in the period from 2007-2014. The "The sample" column refers to the number of banks included in the sample. The second column refers to the total number of conventional commercial banks in the banking system of each country in the sample. The "Sample contribution" column is calculated by taking the number of banks from each country and divided by the total number of banks in the sample.

Country	Total number of conventional Commercial banks	The sample	Sample contribution
Vietnam	45	36	21%
Cambodia	36	25	14%
Indonesia	103	50	29%
Malaysia	27	23	13%
Philippines	40	20	11%
Thailand	30	21	12%
Total	**281**	**175**	**100%**

Table 2.3a. Summary statistics of dependent and independent variables

This table reports descriptive statistics (obs, mean, std. dev., min, and max) for dependent and independent variables used to estimate bank efficiency scores. Obs is the number of observations Std. dev. is the standard deviation of each variable.

Variable description	Variables	Obs	Mean	Std. Dev.	Min	Max
Total cost ($000)	TC	1064	477,000	758,000	329	4,760,000
Pre-tax profit ($000)	PP	1064	178,000	382,000	-106,000	2,670,000
Loans to customers ($000)	Q_1	1064	5,980,000	11,500,000	1	80,200,000
Interbank loans ($000)	Q_2	1064	1,150,000	2,060,000	1	16,400,000
Other earning assets ($000)	Q_3	1064	2,010,000	3,850,000	1	36,700,000
Price of capital	P_K	1064	2.498	4.162	0.096	68.287
Price of funds	P_D	1064	0.045	0.030	0.001	0.182
Price of labor	P_L	1064	0.012	0.008	0.001	0.079
Equity ratio	E.ratio	1064	0.157	0.131	0.040	0.994
Productivity growth	Prod.growth	1064	0.033	0.020	-0.029	0.069
Bank branch density	Branch.dens	1064	8.838	4.798	3	17.9
Inflation rate	Infl	1064	0.057	0.048	-0.008	0.25
Industry concentration	Concentration	1064	0.430	0.067	0.287	0.562

Table 2.3b. Variable distribution by country

This table reports the mean values of input, output and control variables used to calculate the cost and profit efficiency scores, for different countries. The variables are defined in Table 2.1.

Country		Vietnam	Cambodia	Indonesia	Malaysia	Philippines	Thailand
Total cost ($000)	TC	400,000	16,300	509,000	832,000	363,000	777,000
Pre-tax profit ($000)	PP	61,300	8,942	200,000	385,000	131,000	337,000
Loans to customers ($000)	Q_1	3,020,000	208,000	4,380,000	15,100,000	4,120,000	13,100,000
Interbank loans ($000)	Q_2	1,020,000	108,000	1,120,000	918,000	1,630,000	2,470,000
Other earning assets ($000)	Q_3	871,000	6,223	1,420,000	5,250,000	2,220,000	3,900,000
Price of capital	P_K	1.734	2.231	1.972	2.843	1.897	5.496
Price of funds	P_D	0.074	0.023	0.059	0.022	0.0196	0.031
Price of labor	P_L	0.0073	0.012	0.019	0.0075	0.011	0.0085
Equity ratio	E.ratio	0.122	0.306	0.134	0.123	0.125	0.165
Productivity growth	Prod. growth	0.040	0.037	0.037	0.022	0.028	0.022
Bank branch density	Branch. dens	3.441	4.273	13.417	11.035	7.978	11.543
Inflation rate	Infl	0.106	0.055	0.057	0.024	0.041	0.026
Industry concentration	Concentration	0.371	0.474	0.386	0.521	0.458	0.462

Table 2.4a. Descriptive statistics of possible determinants of bank efficiency

The table contains the characteristics of explanatory variables that determine bank efficiency. The results are based on a sample of 175 banks with their data collected from 2007-2014. FOREIGN is one if the foreign shareholdings in the banks is 50% and above, zero otherwise. GOVT is one if the government shareholdings in the banks is 50% and above, zero otherwise. CEODUAL is one if the CEO is also the Chairman of the board, zero otherwise. BOARDSIZE is the number of directors on the board. BINDEP is the percentage of non-executive directors on the board. BANKSIZE is expressed by the total asset of banks in billion dollars and the log value of total asset. BANKAGE is expressed by the number of years a bank in operation and the log value of the total number of years. Median values are shown without the parentheses and standard deviations are shown in parentheses.

Variables	2007	2008	2009	2010	2011	2012	2013	2014
FOREIGN	0.262	0.273	0.293	0.281	0.314	0.307	0.321	0.301
	(0.44)	(0.45)	(0.459)	(0.45)	(0.47)	(0.46)	(0.47)	(0.46)
GOVT	0.082	0.090	0.081	0.082	0.075	0.066	0.077	0.072
	(0.28)	(0.29)	(0.273)	(0.28)	(0.26)	(0.25)	(0.27)	(0.26)
CEODUAL	0.000	0.011	0.057	0.034	0.031	0.048	0.054	0.059
	(0.00)	(0.11)	(0.23)	(0.18)	(0.18)	(0.21)	(0.22)	(0.24)
BOARDSIZE	7.574	8.159	8.146	7.740	7.616	7.777	7.845	7.830
	(3.68)	(4.09)	(4.08)	(3.87)	(3.63)	(3.79)	(3.833)	(3.70)
BINDEP	0.886	0.861	0.868	0.877	0.884	0.874	0.871	0.879
	(0.18)	(0.17)	(0.16)	(0.15)	(0.143)	(0.15)	(0.15)	(0.132)
BANKSIZE	7,887	8,467	8,069	8,976	9,857	10,410	11,410	12,760
($bil.)	(12,300)	(12,820)	(13,490)	(15,360)	(17,860)	(19,660)	(21,260)	(23,240)
BANKSIZE	21.42	21.47	21.32	21.45	21.47	21.51	21.62	21.84
(log)	(1.94)	(2.06)	(2.05)	(1.99)	(2.02)	(1.96)	(1.98)	(1.88)
BANK AGE	29.49	31.82	32.85	33.79	34.26	35.02	35.92	38.41
(years)	(19.99)	(24.67)	(27.69)	(27,89)	(27.44)	(27.79)	(27.84)	(28.49)
BANK AGE	3.14	3.13	3.114	3.174	3.19	3.24	3.27	3.37
(log)	(0.75)	(0.93)	(0.99)	(0.910)	(0.92)	(0.85)	(0.86)	(0.80)
No. of observations	61	88	123	146	159	166	168	153

Table 2.4b. Descriptive statistics of possible determinants of banks effciency by country

This table reports the mean values of explanatory variables used to determine bank efficiency by country. The definitions of variables are given in Table 2.4a.

Country	Foreign	Govt	CEO Dual	Boad size	Bindep	Banksize ($bil.)	Banksize (log)	Bankage (year)	Bankage (log)
Vietnam	0.013	0.092	0.000	7.241	0.860	5,375	21.72	19.197	2.809
Cambodia	0.581	0.000	0.061	6.905	0.774	376	19.03	12.527	2.218
Indonesia	0.292	0.123	0.020	4.558	0.995	7,307	21.06	38.817	3.520
Malaysia	0.546	0.057	0.000	8.531	0.877	25,110	22.91	43.411	3.404
Philippines	0.173	0.139	0.087	11.530	0.861	8,471	22.26	56.504	3.828
Thailand	0.336	0.000	0.114	13.404	0.752	20,600	22.98	47.404	3.630
Sample	0.298	0.077	0.041	7.829	0.875	10,050	21.53	34.534	3.219

Table 2.5. The frontier parameter estimates for ASEAN commercial banks (2007-2014).

This table reports the cost and profit frontier parameter estimates for the sample using the SFA model of Kumbhakar et al. (2014). The "" symbol refers to the significant level of each estimation (* significant at 10% level, ** significant at 5% level, *** significant at 1% level).*

Parameter	Variable	Cost Function		Profit Function	
		Estimates	Std.Err	Estimates	Std. Err.
α_1	ln (P_K/P_L)	0.406***	0.099	1.455***	0.553
α_2	ln (P_D/P_L)	0.102	0.110	1.655**	0.639
α_{11}	$0.5\times [ln(P_K/P_L)]^2$	0.041***	0.008	0.094*	0.048
α_{22}	$0.5\times[ln(P_D/P_L)]^2$	0.230***	0.016	0.133	0.094
α_{12}	$ln(P_K/P_L)\times ln(P_D/P_L)$	-0.054***	0.009	-0.050	0.054
γ_1	lnQ_1	0.099**	0.053	0.164	0.304
γ_2	lnQ_2	0.389***	0.056	1.106***	0.313
γ_3	lnQ_3	-0.121***	0.030	0.052	0.172
γ_{11}	$0.5\times(lnQ_1)^2$	0.037***	0.002	0.073***	0.013
γ_{22}	$0.5\times(lnQ_2)^2$	0.018***	0.011	0.041***	0.006
γ_{33}	$0.5\times(lnQ_3)^2$	0.013***	0.001	0.018***	0.005
γ_{12}	$lnQ_1\times lnQ_2$	-0.017***	0.003	-0.051***	0.017
γ_{13}	$lnQ_1\times lnQ_3$	0.005***	0.001	-0.006	0.008
γ_{23}	$lnQ_2\times lnQ_3$	-0.008***	0.001	-0.002	0.008
δ_{11}	$ln(P_K/P_L)\times lnQ_1$	-0.020***	0.005	0.019	0.027
δ_{12}	$ln(P_K/P_L)\times lnQ_2$	-0.015***	0.005	-0.083***	0.020
δ_{13}	$ln(P_K/P_L)\times lnQ_3$	0.016***	0.002	-0.019**	0.009
δ_{21}	$ln(P_D/P_L)\times lnQ_1$	0.019***	0.006	-0.020	0.033
δ_{22}	$ln(P_D/P_L)\times lnQ_2$	-0.001	0.005	-0.044**	0.030
δ_{23}	$ln(P_D/P_L)\times lnQ_3$	-0.002	0.002	0.021	0.014
λ_1	E.ratio	-1.120***	0.104	-0.589	0.575
λ_2	Prod.growth	0.621*	0.350	6.585***	2.11
λ_3	Branch.dens	-0.006**	0.002	-0.031**	0.012
λ_4	Infl	0.043	0.193	0.741	1.155
λ_5	Concentration	-0.224*	0.133	7.322***	0.768
λ_6	NPI			-0.991***	0.123

Table 2.6a, 2.6b. Persisstent, time-varying and overall efficiency scores of ASEAN commercials banks over the period of 2007-2014

Tables 2.6a and 2.6b report the average value persistent, residual and overall efficiency scores of ASEAN banks by year and country, respectively. The scores are estimated using the Kumbhakar et al. (2014) model. The efficiency score of 1 represents the most efficient bank in the sample in term of both cost and profit. The higher the score, the more cost efficient or profit efficient a bank is.

Table 2.6a. Efficiency scores by year

Year	*Cost efficiency scores*			*Profit efficiency scores*		
	Pers.	*Resid.*	*Overall*	*Pers.*	*Resid.*	*Overall*
2007	*0.8382*	*0.9124*	*0.7649*	*0.5783*	*0.5429*	*0.3158*
2008	*0.8433*	*0.9147*	*0.7724*	*0.5627*	*0.5628*	*0.3242*
2009	*0.8432*	*0.9143*	*0.7717*	*0.5663*	*0.5510*	*0.3196*
2010	*0.8483*	*0.9145*	*0.7766*	*0.5562*	*0.5489*	*0.3076*
2011	*0.8454*	*0.9143*	*0.7744*	*0.5603*	*0.5356*	*0.3028*
2012	*0.8461*	*0.9161*	*0.7755*	*0.5556*	*0.5439*	*0.3063*
2013	*0.8454*	*0.9155*	*0.7746*	*0.5572*	*0.5406*	*0.3045*
2014	*0.8433*	*0.9147*	*0.7710*	*0.5542*	*0.5387*	*0.3006*
Mean	***0.8448***	***0.9148***	***0.7734***	***0.5596***	***0.5444***	***0.3084***

Table 2.6b. Efficiency scores by country

Country	*Cost efficiency scores*			*Profit efficiency scores*		
	Pers.	*Resid.*	*Overall*	*Pers.*	*Resid.*	*Overall*
Vietnam	*0.8515*	*0.9156*	*0.7798*	*0.5452*	*0.5434*	*0.2996*
Cambodia	*0.8453*	*0.9099*	*0.7695*	*0.6204*	*0.5502*	*0.3481*
Indonesia	*0.8768*	*0.9204*	*0.8071*	*0.5132*	*0.5327*	*0.2778*
Malaysia	*0.7762*	*0.9076*	*0.7062*	*0.6247*	*0.5549*	*0.3486*
Philippines	*0.8105*	*0.9153*	*0.7421*	*0.5648*	*0.476*	*0.3223*
Thailand	*0.8627*	*0.9133*	*0.7888*	*0.5475*	*0.5522*	*0.3024*
Mean	***0.8448***	***0.9148***	***0.7734***	***0.5596***	***0.5444***	***0.3084***

Table 2.7a. Coporate Governance and bank cost efficiency

In this table, the author report results from the estimation of the model:

$$CostEFF = f(Cost\ EFF_{t-1}, Explanatory\ variables, Controls)$$

CostEFF is the cost efficiency score of a bank. Model (a) and (b) represents the results for Residual CostEFF and Overall CostEFF as dependent variables, respectively. Explanatory variables include FOREIGN, GOVT CEODUAL; BSIZE (the size of the board measured by the logarithm of the number of board members) and BINDEP. Control variables include BANKSIZE (log) and BANKAGE (log) and country dummies variables. The results are based on a sample of 175 ASEAN banks with data collected from 2007-2014.

*All t-statistics are based on robust standard errors. ***, ** and * present significance at 1%, 5% and 10% level, respectively. AR(1) and AR(2) are tests for first-order and second-order serial correlation in the first-differenced residuals with the null hypothesis of no serial correlation. The Hansen test of over-identification is under the null hypothesis that all instruments are valid. The Diff-in-Hansen test of exogeneity is under the null hypothesis that instruments used for the equations in levels are exogenous.*

Regressor	CostEFF					
	OLS		Fixed-Effects		Dynamic System GMM	
	Resid. (1a)	Overall (1b)	Resid. (2a)	Overall (2b)	Resid. (3a)	Overall (3b)
CostEFF (t-1)					**0.377*** **	**0.454*** **
					(0.058)	(0.082)
FOREIGN	-0.002	**-0.012** **			0.0005	0.002
	(0.003)	(0.005)			(0.003)	(0.006)
GOVT	0.002	**0.032*** **	0.015	0.013	**0.007***	**0.020** **
	(0.003)	(0.007)	(0.024)	(0.019)	(0.004)	(0.009)
CEODUAL	-0.015	**-0.053*** **	-0.006	-0.005	-0.027	-0.040
	(0.012)	(0.019)	(0.013)	(0.010)	(0.028)	(0.027)
BOARDSIZE	-0.0003	**0.015** **	-0.003	-0.003	0.025	0.021
	(0.005)	(0.007)	(0.009)	(0.007)	(0.021)	(0.017)
BINDEP	-0.0007	-0.021	0.020	0.013	**-0.052***	**-0.066***
	(0.012)	(0.019)	(0.021)	(0.017)	(0.028)	(0.035)
BANKSIZE	0.0004	**-0.007*** **	**-0.012*** **	**-0.010*** **	**-0.004***	**-0.008*** **
	(0.001)	(0.002)	(0.004)	(0.003)	(0.002)	(0.002)
BANKAGE	0.002	0.001	**0.030*** **	**0.023*** **	-0.003	0.001
	(0.002)	(0.004)	(0.009)	(0.007)	(0.002)	(0.005)
Observations	1064	1064	1064	1064	880	880
R-squared	0.0260	0.2204				
rho			0.3618	0.8710		
AR(1) test (p-value)					0.000	0.000
AR(2) test (p-value)					0.147	0.148
Hansen test of over-identification: (p-value)					0.505	0.441
Diff-in-Hansen test of exogeneity (p-value)					0.557	0.694

Table 2.7b. Coporate Governance and bank profit efficiency

In this table, the author report results from the estimation of the model:

$$ProfitEFF = f(ProfitEFF_{t-1}, Explanatory\ variables, Controls)$$

ProfitEFF is the cost efficiency score of a bank. Model (a) and (b) represents the results for Residual ProfitEFF and Overall ProfitEFF as dependent variables, respectively. Explanatory variables include FOREIGN, GOVT CEODUAL; BSIZE (the size of the board measured by the logarithm of the number of board members) and BINDEP. Control variables include BANKSIZE, BANKAGE and country dummies. The results are based on a sample of 175 ASEAN banks with data collected from 2007-2014.

*All t-statistics are based on robust standard errors. ***, ** and * present significance at 1%, 5% and 10% level, respectively. AR(1) and AR(2) are tests for first-order and second-order serial correlation in the first-differenced residuals with the null hypothesis of no serial correlation. The Hansen test of over-identification is under the null hypothesis that all instruments are valid. The Diff-in-Hansen test of exogeneity is under the null hypothesis that instruments used for the equations in levels are exogenous.*

	ProfitEFF					
	OLS		**Fixed-Effects**		**Dynamic System GMM**	
Regressor	**Resid. (4a)**	**Overall (4b)**	**Resid. (5a)**	**Overall (5b)**	**Resid. (6a)**	**Overall (6b)**
ProfitEFF (t-1)					0.286	0.054
					(0.282)	(0.324)
FOREIGN	-0.007	-0.012			-0.018	-0.007
	(0.011)	(0.009)			(0.027)	(0.024)
GOVT	-0.015	-0.016	-0.086	-0.037	0.019	-0.027
	(0.001)	(0.014)	(0.103)	(0.054)	(0.086)	(0.048)
CEO DUALITY	**0.050***	**0.142*****	0.065	**0.050***	-0.492	0.175
	(0.026)	(0.022)	(0.056)	(0.029)	(0.952)	(0.494)
BOARDSIZE	0.024	**0.033****	**0.072***	0.029	-0.440	-0.276
	(0.018)	(0.014)	(0.038)	(0.020)	(0.275)	(0.199)
BINDEP	-0.028	0.026	-0.069	-0.054	0.451	0.156
	(0.042)	(0.035)	(0.092)	(0.048)	(0.512)	(0.254)
BANKSIZE	0.002	-0.002	**0.038****	**0.022****	**0.050***	0.034
	(0.004)	(0.003)	(0.017)	(0.009)	(0.028)	(0.021)
BANKAGE	-0.004	**0.013***	**-0.122*****	**-0.079*****	0.020	**0.034***
	(0.008)	(0.006)	(0.037)	(0.019)	(0.030)	(0.020)
Observations	1064	1064	1064	1064	880	880
R-squared	0.0113	0.1097				
rho			0.3583	0.6866		
AR(1) test (p-value)					0.080	0.234
AR(2) test (p-value)					0.797	0.628
Hansen test of over-identification: (p-value)					0.288	0.480
Diff-in-Hansen test of exogeneity (p-value)					0.650	0.760

Table 2.8. The Durbin-Wu-Hausman test for endogeneity of regressors

	H_0: Regressors are exogenous			
	Resid. CostEFF	**Overall CostEFF**	**Resid. ProfitEFF**	**Overall ProfitEFF**
DWH Test Statistic	52.8939***	21.4269***	16.6913**	18.4385**
P-Value	0.0000	0.0036	0.0195	0.0101
Degrees of Freedom	7	7	7	7

, ** and * denote significance and the rejection of Ho at 10, 5 and 1 percent level, respectively. The test is based on the bank efficiency scores on corporate governance and control variables. The instruments are the lags of the differenced bank efficiency scores, corporate governance, and control variables. Lags 2 of the differenced corporate governance variables, lags 2 of the differenced control variables, lags 2 of the differenced bank efficiency scores are employed as instruments. The test is performed on the corporate governance and control variables. The test statistic follows a chi-squared distribution with p degrees of freedom, where p is the number of regressors tested for endogeneity. The null hypothesis states that all regressors are exogenous.*

CHAPTER 3

Diversification and bank efficiency in six ASEAN countries

3.1. Introduction

The presence of a robust banking system is essential for countries, and particularly developing countries, to achieve sustainable economic growth (Levin, 1997). An efficient banking system is characterized as being able to provide low-cost monetary payments and effectively mobilize and allocate funds to encourage investments and savings. To achieve those features, governments of developing countries have introduced significant policies and agendas focusing on financial market liberalization and financial sector reforms.

Due to their importance, not only for bankers and bank stakeholders but also for economic systems, banks' business models assume a critical role. The issue of optimal business models for banks has been discussed extensively in literature, with the central issue involving the question of whether banks should diversify across different products, assets, and sources of funding, or whether they should specialize instead (Berger et al., 2010).

Theory suggests conflicting predictions about the impact of diversification on bank performance, with evidence supporting two arguments. One argument supports diversification by suggesting that it helps banks to gain economies of scope by spreading fixed costs over different products (Laeven and Levin, 2007), leveraging management abilities and skills across different products and markets (Iskandar-Datta and McLaughlin, 2007), reducing risk of bankruptcy (Berger et al., 2010), and dealing with future uncertainty by acquiring in advance necessary skills to make efficient business decisions in the new areas (Elsas et al., 2010). In contrast, another line of argumentation does not support diversification, stating that it might negatively affect bank performance as it increases the agency problems between corporate insiders and small shareholders (Laeven and Levin, 2007); that it could dilute the comparative advantages of bank management by making managers go beyond their existing expertise (Klein and Saidenberg, 1998); that it might increase revenue volatility, leading to increased profit volatility (Berger, 2010); and that in an increased competitive market, it might exaggerate the costs and consequences of banks that do not successfully enter into a new sector (Winton, 1999).

Besides inconclusive predictions in theory, the literature also provides mixed empirical evidence. Furthermore, previous empirical studies have mainly been based on developed markets, such as the US and the EU (Curi et al., 2015; Elsas et al., 2010; Rossi et al., 2009; Mercieca et al., 2007; Baele et al., 2007; Stiroh and Rumble, 2006; Acharya et al., 2006). Very little research has focused on developing markets, such as Brazil (Tabak et al.,

2011), China (Berger et al., 2010), or the Philippines (Meslier et al., 2014). While numerous studies have explored the determinants of ASEAN bank performance, only a highly limited number of them have examined the impact of diversification on bank performance.

The ASEAN region is chosen as the focus of this paper for the following reason. Though the banking systems of different ASEAN countries are diverse with different models and paces of development, the current trend in these countries is banking sector consolidation. Most ASEAN countries are undergoing consolidation processes aiming to reduce the number of banks; this can be seen in Indonesia (aiming to decrease from over 120 banks to 70 before 2020) or Vietnam (from 37 banks to 20 before 2020). Some other countries have just completed the consolidation process and are focusing mainly on tightening bank regulations, such as Thailand and Malaysia, both of which completed their bank consolidations in 2010. In other countries, on the other hand, the banking system is in the development and expansion stages; this is the case in Cambodia. However, the regulators of Cambodia currently focus more on tightening regulations to ensure the soundness of their banking system. Consolidation and restructuring reduce the number of banks mainly through mergers and acquisitions. Since the banks created after mergers and acquisitions are normally larger in size and more complex than pre-merger banks, they tend to be more diversified. Furthermore, bank supervisors also have the tendency to encourage bank diversification to reduce risk. On the other hand, tightening regulations, particularly restrictions that limit banks in participating in investment or insurance activities, make banks more focused. Hence, research on the optimal bank business model in ASEAN countries is highly useful from both managerial and regulatory perspectives. Given the purpose of this study and the availability of data, banks from the following six ASEAN countries are included in the sample: Vietnam, Cambodia, Indonesia, Malaysia, the Philippines, and Thailand.

To examine the effects of diversification on bank efficiency, this paper examines ASEAN bank diversification in three dimensions: asset, funding, and income. Next, the paper measures the cost and profit efficiency of ASEAN banks using the stochastic frontier approach (SFA). Finally, the impact of diversification on bank efficiency is explored through OLS regressions. A robustness test is also carried out to control for the potential endogeneity problem, as diversification is likely a choice of banks.

The efficiency concept used in this paper is economic efficiency, which refers to the ability of a bank to minimize its costs (cost efficiency) or maximize its profits (profit efficiency). Moreover, this paper attempts to separate the efficiency term into persistent (long-

term) efficiency and time-varying (short-term) efficiency. This separation is helpful in further investigating the causes of bank inefficiency. Particularly in this paper, diversification can be explored as a possible impact factor of efficiency in the long and the short term. To determine the persistent and time-varying economic efficiency of ASEAN banks, Kumbhakar et al.'s (2014) SFA model is used.

In summary, this study contributes to existing literature in the following ways. Firstly, it attempts to fill the gap regarding bank diversification and performance, as the literature mainly focuses on developed countries. Secondly, the paper examines the impact of diversification on both long-term and short-term efficiency of banks. Thirdly, it presents evidence of the mitigating effects of foreign ownership and government ownership by assessing the relationship of diversification bank efficiency in ASEAN countries. Hence, the results of this paper could not only help to identify the optimal business models for banks in ASEAN countries but could also provide useful suggestions to policy makers and bank supervisors.

The remainder of this paper is structured as follows. Section 2 discusses different theories that explain the relationship between diversification and bank performance. This section also summarizes the empirical evidence and diversification experience in six ASEAN countries. Subsequently, section 3 presents the methodology, data, and descriptive statistics. Section 4 reports the results of diversification and efficiency estimations and the regression analysis of diversification as the determinant of bank efficiency in ASEAN countries. Finally, section 5 concludes the paper.

3.2. Literature review

3.2.1. Theoretical arguments

Different theories explain the impact of greater activity diversification on the performance of financial intermediaries (Laeven and Levin, 2007).

One of the most important arguments about the benefits of diversification on bank performance is that it leads to economies of scope. Unlike many firms from other sectors, banks have the tendency to maintain long-term contractual relationships with their clients (Elsas et al., 2010). Hence, over time, banks can acquire information about their customers during their service provisions and reuse that information in the process of providing additional services. For example, banks can gather information about their clients during the loan making process, which could assist the effective provisions of other financial services,

such as the underwriting of securities or insurance (Diamond, 1991; Rajan, 1992; Stein, 2002). In return, the information that banks could achieve from engaging in different financial activities, such as securities and insurance underwriting could later be used to improve loan making. Furthermore, Iskandar-Datta and McLaughlin (2007) suggest that diversified banks can benefit from leveraging managerial abilities and skills across different products and markets.

In addition, Boot and Schmeits (2000) point out that by spreading their operations across various products or markets, diversified banks can reduce their risk of bankruptcy. The authors argue that different business activities involve different degrees of risk-taking. Hence, if different business activities are integrated in one firm, the pooled funding cost of the firm only partially represents the risk characteristic of each activity, which means that the business activities co-insure each other. This results in more predictable returns for the firm and a lower possibility of default.

Furthermore, business diversification is one of the strategies that banks use to deal with uncertainty and might help to improve their future performance of banks (Elsas et al., 2010; Boot, 2003). As mentioned by Elsas et al. (2010), technological progress and deregulation trigger dramatic changes in the banking industries. Hence, if banks extend their activities to other business areas early, they could acquire the necessary skills required to make efficient business decisions in these new areas. Eventually, when a particular business area flourishes, banks could then be ready to compete and enjoy additional profits. In other words, this line of argument views diversification as skill-building investments that could help banks to seize future opportunities to create added value for their shareholders.

Regarding the costs of diversification, one of the most important disadvantages of bank diversification for performance is the increase in agency problems between corporate insiders and small shareholders, which might adversely impact the market's valuation of the firm. According to Laeven and Levine (2007), the more diversified the firm is, the more difficult it is to design efficient managerial incentive contracts, which in turn makes it more challenging to align the incentives of outsiders with those of insiders. Specifically, the bank insiders may proceed to widen the range of business activities if this diversification can help them to extract additional private benefits from the bank. Hence, according to Jensen and Meckling (1976), it does not matter if the diversification positively or negatively affects the firm performance and market valuation; the insiders will still diversify if their marginal

private benefits surpass the losses that they incur with the change in firm performance and market valuation.

Secondly, in contrast with the point made by Iskandar-Datta and McLaughlin (2007) about the leverage of managerial abilities across different products or markets, Klein and Saidenberg (1998) argue that banks can suffer from dilution of their management's comparative advantage by making them go beyond their existing expertise. In other words, by forcing managers to manage business areas that are not in their area of expertise, banks might perform less efficiently.

Thirdly, though diversification is considered to be the strategy that banks use to deal with uncertainty and greater competition, Winton (1999) states that increased competition may exaggerate the costs and consequences for banks that do not successfully enter into a new sector. Hence, the author suggests that if banks face increasing competition, it would be more reasonable and less costly to specialize.

3.2.2. Empirical literature

Studies on developed markets provide mixed results about the impact of diversification on bank performance. Some have reported evidence against the diversification benefits, such as those of Curi et al. (2015) and Baele et al. (2007).

Curi et al. (2015) assess the effects of focused and diversified business models on the efficiency of foreign banks in Luxembourg from 1995 to 2009. The authors investigate bank diversification using three business dimensions: assets, funding, and income. The bank efficiency level is measured using Data Envelopment Analysis (DEA). Curi et al. (2015) conclude that no unique business model exists for foreign banks in a financial center such as Luxembourg, and that the most efficient business model appears to be a focused asset, funding, and income strategy. Taking into account the impact of the global financial crisis of 2007-2008, the study reports that the positive impact of greater asset diversification on bank efficiency is only found during the consolidation period, whereas greater negative impacts on bank efficiency are found for income and funding diversification during the financial crisis.

Using data on listed banks from 17 European countries over the period of 1989 to 2004, Baele et al. (2007) investigate the influences of functional diversification on bank returns and risk. They find that banks with a higher share of non-interest income in total income are associated with higher market values. In addition, diversification of revenue from

distinct financial activities increases banks' systematic risk and has a general negative influence on idiosyncratic risk.

In contrast, other studies have provided evidence that supports the benefits of bank diversification, including those of Elsas et al. (2010) and Stiroh and Rumble (2006). Elsas et al. (2010) use data from nine countries (Australia, Canada, France, Germany, Italy, the UK, the USA, Spain, and Switzerland) over the period of 1996 to 2008 to examine the effects of revenue diversification on bank value. They provide evidence that revenue diversification helps to improve bank profitability and hence bank market value. The results still hold during the financial crisis of 2007-2008. Stiroh and Rumble (2006) investigate the impact of income diversification on the performance of US financial holding companies (FHCs) over the years 1997 to 2002. Bank performance is measured using the risk-adjusted return. Stiroh and Rumble's (2006) main findings imply that benefits of diversification are found between FHCs, but these benefits are offset by the increased exposure to higher risk activities.

On the other hand, some studies have reported mixed results. Rossi et al. (2009) study the impact of bank diversification across industries and sizes on risk, cost efficiency, profit efficiency, and bank capitalization using a dataset of large Austrian commercial banks over the period of 1997 to 2003. The diversification is measured in two dimensions: the diversification of loans across different industries, and the diversification of loan portfolios across different sizes. Banks' cost and profit efficiency are measured using SFA. The overall findings show that diversification decreases cost efficiency, increases profit efficiency, reduces banks' realized risk, and has a positive impact on bank capitalization.

In another vein, a few studies have found no significant link between diversification and bank performance. Mercieca et al. (2007) use a sample of small European banks from 15 countries to examine the impact of diversification on bank performance. They find no direct link between diversification in income and loan portfolio on banks' risk-adjusted returns. Acharya et al. (2006) study the effects of loan portfolio diversification on the risk and returns of 105 Italian banks from 1993 to 1999. Acharya et al. (2006) find that diversification does not necessarily enhance performance and/or mean greater safety for Italian banks. Particularly in the case of high-risk banks, diversification reduces bank returns while producing riskier loans.

Though not many studies have examined developing countries, the empirical evidence is also conflicting regarding the relationships between diversification and bank performance.

Meslier et al. (2014) investigate the impact of income diversification on the profitability of Philippine banks from 1999 to 2005. The results show that income diversification enhances profitability, and the effect is significantly stronger for foreign banks compared to domestic banks.

Tabak et al. (2011) study the impacts of credit portfolio diversification on bank performance and risk in Brazil from 2003 to 2009. They find that bank loan portfolios in Brazil are moderately concentrated, especially compared to developed countries. Furthermore, their results show that foreign banks are more specialized than domestic banks. In addition, Tabak et al. (2011) report that loan portfolio concentration has a positive impact on both bank returns and risk of default. However, the positive influence of concentration on bank returns decreases with risk. That is, not only the returns but also the risk of high-risk banks decrease due to concentration. In the case of banks with low and moderate risk, the degree of concentration induces overall performance.

Berger et al. (2010) use data on Chinese banks during the period of 1996 to 2006 to examine the impact of focus and diversification on bank performance. They measure diversification in four dimensions: loans, deposits, assets, and geography. Bank performance is measured by the cost and profit efficiency scores using SFA. The authors find that all four diversification dimensions are associated with higher costs and reduced profits, which implies a negative relationship between diversification and bank performance. Furthermore, Berger et al. (2010) construct a new measure, economies of diversification, which is based on the framework of economies of scope. Profit scope economies refer to the proportional increase in profit when certain outputs are produced by joint producers instead of specialist firms. Similarly, cost scope economies refer to the proportional increase in costs when certain outputs are produced by specialist producer instead of joint firms. Berger et al. (2010) also find evidence of foreign ownership playing a mitigating role in diversification diseconomies. Specifically, banks with more foreign ownership and banks with conglomerate affiliation are found to suffer a smaller loss of profits or increase in costs as impacts of diversification.

3.2.3. ASEAN banking: diversification experience

Due to their importance in the financial systems, banking sectors are normally heavily regulated. Heavy regulations, in turn, may restrict banks' ability to diversify. This section reviews some of the characteristics of the ASEAN banking sectors and relevant regulations that might affect bank diversification.

Vietnam

At the end of 2014, the banking system of Vietnam consisted of 7 state-owned commercial banks (SOCBs), 28 joint stock commercial banks (JSCBs), 5 whole foreign-owned banks (WFOBs), 4 joint venture banks (JVBs), 49 foreign bank branches, and 3 other banks (SBV, 2015).

Vietnamese commercial banks are allowed to conduct the following activities: deposit taking, credit extension, via-account payment, capital contribution and share purchase, treasury bill and government bond trading, foreign exchange services, derivative provision, entrustment and agency, cash management, banking and financial consultancy, asset management, monetary brokerage services, and other business activities related to banking operations with written approval from the State Bank of Vietnam. However, foreign bank branches in Vietnam are not allowed to engage in capital contribution and share purchase or other non-licensed activities.

Although domestic commercial banks in Vietnam are eligible to contribute capital and purchase shares, considerable restrictions are placed on this activity. Moreover, commercial banks are eligible to establish or acquire subsidiaries or affiliated companies to conduct business, including securities, financial leasing, insurance, security asset management, currency trading, gold trading, factoring, and other consumer credit services. Banks can also purchase shares from enterprises that operate in these areas, except for financial leasing. This indicates that commercial banks are not allowed to directly engage in securities, financial leasing, or insurance business.

The case that commercial banks acquiring shares of other credit institutions is subjected to the limit of 11% of the acquired firm's chartered capital, and 40% of the acquirer's charter capital and reserve fund.

In addition to the limitations in investment activities, commercial banks may not deal in real estate, except if the real estate is used for bank operations or as the assets from debt handling processes. In the latter case, the bank must sell, transfer, or purchase the assets within 3 years. However, commercial banks can invest in fixed assets directly related to their operations at no more than 50% of their chartered capital and reserve fund.

Regarding credit extensions, a commercial bank's total outstanding credit extended to a single client must not exceed 15% of its own capital, and the total credit extended to a single client and affiliated person must not exceed 25% of its own capital.

In terms of capital adequacy, at the end of 2014, banks in Vietnam were required to maintain a minimum equity amount of 3,000 billion VND (133.7 million USD) and a capital adequacy ratio of 9%.

Cambodia

In 2014, the banking system in Cambodia comprised 36 commercial banks, 11 specialized banks, 7 representative offices, and 40 microfinance institutions (NBC, 2014).

Similar to banks in Vietnam, commercial banking operations mainly include credit extension, deposit taking, and via-account payments. If a credit institution carries out only one of these three basic activities, it is labeled as a "specialized" bank. However, Cambodian commercial banks can also conduct other activities similar to Vietnamese banks, such as foreign exchange operations, transaction in derivatives, and precious metal trading, among others. Also in line with their Vietnamese counterparts, they cannot engage in insurance business. However, in contrast with Vietnamese banks, Cambodian banks are allowed to provide securities services and participate in securities trading, which are subjected to the supervision of a special Commission.

Furthermore, banks can only acquire fixed assets if they are used directly for bank operations or if they are collaterals from lending contracts. The fixed assets used for a bank's operation must be less than 30% of its total net worth. The fixed assets with no direct link to the bank's operations must be liquidated within one year after they become the bank's properties.

In case of credit extensions, bank loans to related parties are capped at 10% of a bank's total net worth.

Regarding capital requirements, since 2008, banks in Cambodia have been required to maintain a minimum capital of 50 billion Riel (equivalent to 8.9 million USD in 2008) if they are owned by at least one influential shareholder that is a bank or a financial institution with an "investment grade" rating extended by a reputable rating agency. In other cases, commercial banks are required to have at least 150 billion Riel as the minimum chartered capital. In 2014, the capital adequacy ratio was required to be 15% at a minimum, which was substantially higher than the Vietnamese banking regulations.

Indonesia

At the end of 2014, the Indonesian banking system consisted of 4 state-owned banks and 114 private banks (including 26 regional development banks, 39 foreign exchange banks, 28 non-foreign exchange banks, and 21 foreign bank branches and joint-venture banks) (IMF, 2016).

Indonesian banks are eligible for activities similar to those of Vietnamese and Cambodian banks. In case of other activities, Indonesian commercial banks are allowed to conduct short-term securities trading activities. Commercial banks can only invest in other banks or institutions operating in financial services. Finally, they are prohibited from conducting business in insurance.

Regarding credit extensions, bank loans to related parties are limited to 10% of their chartered capital.

Banks in Indonesia are required to provide minimum capital in accordance with their risk profiles. The requirement of the capital adequacy ratio ranges from 8% to 14% depending on how risky banks are rated.

Malaysia

At the end of 2014, the banking sector of Malaysia comprised 27 commercial banks (8 domestic and 19 foreign banks), 19 Islamic banks, 11 investment banks, and 2 other financial institutions (BNM, 2015).

In Malaysia, there are three different banking licenses with different permitted and prohibited activities. Firstly, the "banking license" allows its holder to conduct business involving deposit taking, credit extensions, and via-account payments. Secondly, the "banking and finance company" license allows the holders to engage in both banking and finance company business. The permitted services of a finance company include the giving of credit facilities, asset leasing, the hire-purchase business, and acquiring rights and interest in a hire-purchase, leasing, or other similar transactions. Thirdly, the "merchant-banking license" allows holders to participate in: deposit taking, credit extending, investment consultancy and advisory services, and making or managing investments on behalf of clients.

Regarding equity investments, a commercial bank in Malaysia is not allowed to purchase shares in another commercial bank, but can do so in a merchant bank and vice versa.

Foreign bank participation in Malaysian-owned or controlled commercial banks and investment banks is limited to 30%.

Currently, the minimum capital requirement is 300 million RM for banks with more than 51% foreign ownership, 300 million RM for stand-alone investment banks, and 20 billion RM for other cases. Furthermore, all banking institutions are subjected to maintaining a minimum risk-weighted total capital ratio of 8%.

The Philippines

At the end of 2014, there were 648 banks in the sector, which consisted of 36 universal and commercial banks, 69 thrift banks, and 543 rural and cooperative banks (BSP, 2014).

Due to the focus of the present study, the following review only concerns universal and commercial banks. A commercial bank in the Philippines is allowed to participate in basic commercial banking activities including credit extensions, deposit taking, via-account payments, foreign exchange, precious metal trading, acquiring marketable bonds, and debt securities. A universal bank has the power to carry out activities allowed for commercial banks and to invest in equities of allied and non-allied companies. The invested entities can be financial or non-financial. However, the total investment in the equity of a universal bank is limited to 50% of its net worth, and the total equity investment in any one entity is capped at 25% of the bank's net worth.

A universal bank can invest up to 100% in a financial or a non-financial allied enterprise. Commercial banks can invest in their allied enterprises with a maximum ownership of 100%.

Regarding real estate investments, any bank can acquire real estate directly linked to its business operation. Nevertheless, the total outstanding amount of investment shall not exceed 50% of the bank's chartered capital. Furthermore, if a bank invests in equity of a company that engages primarily in real estate, the amount invested is considered as part of the bank's total real estate investments. In addition, Philippine banks are prohibited from engaging directly in insurance business as insurers.

With regard to credit extensions, the maximum amount of loan that a bank can grant to a single client cannot exceed 20% of the bank's total net worth.

For the research period, the risk-based capital adequacy ratio of commercial and universal banks shall be no less than 10%. The minimum capital requirement for universal banks is 4.95 billion PHP, and for commercial banks 2.4 billion PHP.

Under current regulation in the Philippines, a foreign bank is treated as equal to a domestic bank of the same category in every aspect of operation.

Thailand

At the end of 2014, the Thai banking sector consisted of 31 commercial banks, including 14 domestic banks, 1 retail bank, 4 foreign subsidiaries, and 12 foreign bank branches (BOT, 2014). A retail bank is a public limited company with the license to undertake commercial banking business with the main purpose of providing services to retail customers and small and medium enterprises.

Commercial banks in Thailand are licensed to undertake the activities of accepting deposits, granting credits, via-account payments, foreign exchange business, and trading bills of exchange or any other negotiable instruments.

In terms of equity investments, Thai banks can use up to 20% of their capital fund to buy shares from other companies, and the investment amount in a single entity cannot exceed 5% of the bank's total capital fund or 10% of the target company's capital. Furthermore, financial institutions are prohibited from holding shares of other financial institutions, except if the shares are acquired as a result of debt repayment or collateral in a loan contract. However, those shares must be sold within 6 months of the date of acquisition.

Thai commercial banks can purchase or hold fixed assets that are directly linked to their business operations and employee welfare purposes allowed by the Bank of Thailand. Furthermore, banks can also acquire fixed assets as the result of debt settlement or as collateral in the loan granting process. However, those fixed assets must be sold within 5 years of the date of acquisition.

During the research period, commercial banks in Thailand are required to maintain a minimum total capital ratio of 8.5%.

Summary

In summary, the regulations on the activities of banking sectors in the six ASEAN countries have many similarities but also some differences that could impact the ability of their commercial banks to diversify.

In terms of permitted banking activities, the common ones are deposit taking, credit granting, via-account payments, foreign exchange trading, precious metal trading, government and Treasury bond trading, and some other credit-related activities. The common prohibited activity is engaging in the insurance business. For other businesses including securities, equity, and real estate investments, some differences exist between the countries.

In terms of equity investments, Cambodia imposes very few restrictions on banks. Other countries only allow banks to acquire equities of other financial institutions with some conditions, such as Vietnam and Indonesia. In contrast, Thailand prohibits banks from acquiring equities from other financial companies, but allows them to invest in equities of non-financial companies with restrictions. In the Philippines and Malaysia, universal banks are allowed to invest in equities with greater relaxation compared to other countries, while their commercial banks also face some restrictions regarding equity investment activities.

In term of securities investments, this line of business is not allowed in Vietnam and Indonesia, while it is fully allowed in Cambodia. On the other hand, it is only permitted for certain types of banks in Malaysia (merchant banks) and the Philippines (universal banks).

Regarding real estate investments, the general requirement is that banks can only hold real estate that is directly used for their business operations or that is acquired as the result of debt settlements or as collateral in loan granting contracts. In the latter case, banks are required to sell the asset within a certain period of time from the date of acquisition. However, the length of time is imposed differently across the countries: for example, 3 years in Vietnam, 1 year in Cambodia, and 5 years in Thailand.

The dissimilarities in banking activity restrictions between the six ASEAN countries are predicted to significantly affect the diversification of banks in terms of income and assets. The countries with more diversified banks are likely to be Cambodia, the Philippines, and Malaysia.

In addition to activities restrictions, regulations on minimum capital requirement could also affect the ability of ASEAN banks to diversify in terms of funding. The common minimum capital adequacy ratio requirement is about 8% to 10%, except for Cambodia (15%) and Indonesia (8-14%).

3.3. Methodology

To evaluate the effect of diversification on bank efficiency in ASEAN countries, this study is divided into three steps: first, measuring the degree of diversification at the bank

level; second, measuring the cost and profit efficiency of banks; and third, explaining differences between the efficiency levels of banks in ASEAN countries by looking at their diversification characteristics.

3.3.1. Measurement of bank diversification

Following the works of Elsas et al. (2010) and Curi et al. (2015), this paper measures asset, funding, and income diversification using a modified Herfindahl-Hirschman Index (HHI). The diversification index is constructed by subtracting HHI from 1, so that the index increases with the degree of diversification.

For asset diversification (ADIV), the paper focuses on the most important categories of bank assets, including customer loans (CLOAN), interbank loans (IBLOAN), securities (SEC), and other earning assets (OTHEREA). Therefore, for each bank i at time t, the asset diversification index is calculated as:

$$ADIV_{i,t} = 1 - \left(\left(\frac{CLOAN_{i,t}}{EA_{i,t}}\right)^2 + \left(\frac{IBLOAN_{i,t}}{EA_{i,t}}\right)^2 + \left(\frac{SEC_{i,t}}{EA_{i,t}}\right)^2 + \left(\frac{OTHEREA_{i,t}}{EA_{i,t}}\right)^2\right) \quad (3.1)$$

where earning assets (EA) is the sum of the five numerators.

For funding diversification (FDIV), the paper examines equity (EQUI); short-term interbank deposits (IBDEP); deposits from customers (CDEP); long-term market funding, such as subordinated debts (LDEBT); and short-term market funding, such as certifications of deposit (SDEBT). Hence, for each bank i at time t, the funding diversification index is calculated as:

$$FDIV_{i,t} = 1 - \left(\left(\frac{EQUI_{i,t}}{FUND_{i,t}}\right)^2 + \left(\frac{IBDET_{i,t}}{FUND_{i,t}}\right)^2 + \left(\frac{CDEP_{i,t}}{FUND_{i,t}}\right)^2 + \left(\frac{LDEBT_{i,t}}{FUND_{i,t}}\right)^2 + \left(\frac{SDEBT_{i,t}}{FUND_{i,t}}\right)^2\right) \quad (3.2)$$

where FUND is the sum of the five numerators.

Similarly, for income diversification (IDIV), this paper also follows Curi et al.'s (2015) approach by considering interest income (II), commission income (CI), net profit from other operations (NPFO), and other non-interest income (ONII).

$$IDIV_{i,t} = 1 - \left(\left(\frac{II_{i,t}}{TOI_{i,t}}\right)^2 + \left(\frac{CI_{i,t}}{TOI_{i,t}}\right)^2 + \left(\frac{NPFO_{i,t}}{TOI_{i,t}}\right)^2 + \left(\frac{ONII_{i,t}}{TOI_{i,t}}\right)^2\right) \quad (3.3)$$

where TOI is the sum of absolute values of the four numerators. As noted by Elsas et al. (2010), unlike assets and funding, the components of total income (TOI) might take negative values, which would lead to negative shares for some streams of income and a share greater than one for other income streams. To avoid this problem, the absolute values of the four income components are used to calculate TOI.

3.3.2. Measurement of bank efficiency

This paper aims to measure banks' economic efficiency by comparing the relative performance of a bank to that of the best-practice bank. Economic efficiency, as defined by Aigner et al. (1997), refers to a bank's ability to minimize its cost or maximize its profit. Using the same approach as Berger and Mester (1997) do, this paper measures a bank's cost efficiency by determining how close that bank's actual cost is to what a best-practice bank's cost would be to produce the same outputs. Similarly, profit efficiency is determined based on how its profit compares to what the best-practice bank would produce given the same bundle of inputs.

The literature on bank efficiency estimation is dominated by two econometric techniques: the non-parametric and parametric techniques. Two of the most widely used methods for each technique are DEA and SFA, respectively. The use of the two methods is mixed in the ASEAN banking efficiency literature. DEA is usually adopted as the main estimation method in earlier research (e.g. Montinola and Moreno, 2001; Nguyen and DeBorger, 2008; Chansarn, 2008; Sufian, 2009; Garderner et al., 2011; Chan et al., 2016). However, SFA has started to gain in popularity in recent years and has become as extensively used as DEA (e.g. Manlagnit, 2011; Muazroh et al., 2012; Nalm and Vu, 2013; Chan and Karim, 2016; Lin et al., 2016).

Though both methods are widely used in the literature, the parametric techniques are considered to be preferable to measure economic efficiency as they generally correspond well with the cost and profit efficiency concepts proposed by Aigner et al. (1977) and Berger and Mester (1997). Furthermore, the non-parametric techniques face two major drawbacks: firstly, according to Vennet (2002), non-parametric techniques assume no statistical measurement error as a factor that can affect outcomes, which could lead to inaccurate measurement of bank efficiency; and secondly, non-parametric techniques generally ignore the prices of bank inputs and outputs, which makes them more suitable for measuring technological rather than economic efficiency. Therefore, the present study uses the SFA proposed by Aigner et al. (1997) to measure the cost and profit efficiency of banks in ASEAN countries.

To specify the inputs and outputs of banks for the efficiency estimation, this paper follows the intermediation approach, which views banks as collectors of funds that are then intermediated to loans and other assets (Zaim, 1995). Alternatively, under the productional approach, a bank can be viewed as the producer of deposits and loans using labor, capital, and materials (Zaim, 1995). The intermediation approach is chosen here as it is more suitable for measuring efficiency at the firm level, while the productional approach is more suitable at the bank branch level (Berger and Humphrey, 1997).

To model the bank cost and profit functions, banks in the sample are classified as multi-product, three-output, three-input firms. The dependent variables are total cost (TC) and pre-tax profit (PP), and the independent variables are input prices and output quantities. The outputs are the amounts of loans to customers (Q_1), interbank loans (Q_2), and other earning assets (Q_3). The inputs are labor (L), which is the personnel expenses; capital (K), which is total fixed assets, and deposits (D), which are deposits from banks and customers. The prices of input are P_L (the ratio of personnel expenses to total assets), P_D (the ratio of total interest paid to deposits), and P_K (the ratio of other administrative expenses to total fixed assets), respectively. The choices of inputs and outputs are consistent with previous studies by Berger et al. (2010), Ncube (2009), Kraft et al.(2002), and Vivas (1997). Following Berger and Mester's (1997) approach, this paper normalizes the dependent variables and input price variables by P_L to impose linear homogeneity on the model.

Furthermore, the study controls for the risk preference of bank managers by including the bank's level of capital, which is measured by the ratio of equity to total asset. As Casteuble (2015) argues, risk-neutral banks could appear to be more cost efficient than risk-averse banks, as risk-averse banks tend to incur more cost in risk reduction. However, according to Berger and DeYoung (1997), as the capital ratio of risk-averse banks is higher, their bad loan levels are lower, which makes the loan recovering cost unnecessary. As a result, risk-averse banks can appear to be more cost efficient than risk-neutral banks are.

In addition, when comparing the efficiency levels of banks from different countries, it is essential to account for different environmental factors that might affect bank performance (Berger, 2007). Following previous studies, this study includes the following four environment control variables.

+ The labor productivity growth rate (*prod.growth*): the ratio measured by the changes in the amount of GDP per person employed for each country. According to Lozano-Vivas et al.

(2002), when a country's labor productivity growth rate increases, banking costs are believed to decrease, which makes banks more cost efficient.

+ The branch density of the banking sector (*branch.dens*): measured by the number of bank branches per 100,000 inhabitants. The impact of branch density on bank efficiency is still indecisive. On the one hand, high branch density might help to improve bank efficiency as the population has easier access to financial services. On the other hand, higher branch density levels might imply higher costs for banks, as the capacity of some bank branches might be underutilized, in turn making banks less efficient.

+ Inflation rate (*infl*): the influence of inflation on bank efficiency depends on the bank's ability to accurately anticipate future inflation changes. According to Sufian and Habibullah (2012), if banks can fully anticipate the inflation rate, they can adjust their interest rates to increase revenue, thereby leading to higher profits. Conversely, if the future inflation rate is unsuccessfully forecast, banks could incur higher costs (Perry, 1992).

+ Banking industry concentration (*concentration*): measured by the share of assets held by the three largest banks in an economy. Two main hypotheses have been proposed to explain the relationship between market concentration and bank efficiency. The first one is the structure-conduct-performance hypothesis, which states that more concentrated markets are characterized by high-power but less efficient firms, as banks tend to increase their market power and reduce competition in the market (Molyneux et al., 1996). Second, the efficient structure hypothesis suggests that more concentrated markets are characterized by high market power and more efficient firms, as banks with higher cost efficiency levels will outperform other banks and eventually dominate the market (Berger, 1995; Goldberg and Rai, 1996). Finally, year dummy variables are added to the cost and profit frontier to account for technical changes over time for banks in the sample (Berger et al., 2010).

Using a Cobb-Douglas translog functional form, the profit frontier is specified as follows:

$$\ln\left(\frac{PP}{P_L}\right) = \beta_0 + \sum_{i=1}^{2}\alpha_i \ln\frac{P_i}{P_L} + 0.5\sum_{i=1}^{2}\sum_{j=1}^{2}\alpha_{ij}\ln\frac{P_i}{P_L}\ln\frac{P_j}{P_L} + \sum_{k=1}^{3}\gamma_k lnQ_K + 0.5\sum_{k=1}^{3}\sum_{m=1}^{3}\gamma_{km}lnQ_K lnQ_M + 0.5\sum_{i=1}^{2}\sum_{m=1}^{3}\delta_{im}\ln\frac{P_i}{P_L}lnQ_M + \theta\ln\frac{NPI}{P_L} + \lambda_n controls - U_{it} + V_{it} \quad (3.4)$$

where PP is the pre-tax profit; Q is the vector of output quantities. P is the vector of input prices; i and t represent cross-sectional; U_{it} is the inefficiency term; and V_{it} is the random error. $U_{it} \geq 0$, and zero is the value of the most profit-efficient firm, so the higher the value, the less profit efficient the bank is. Controls include the level of capital (E.ratio), productivity growth (*prod.growth*), bank branch density (*branch.dens*), inflation rate (*infl*), industry concentration (*concentration*), and year dummies.

Adopting Bos and Koetter's (2009) approach, NPI is the Negative Profit Indicator and is used as a proxy to control for negative profits. PP takes the value of 1 if banks incur zero or negative profit, and takes the value of PP for banks with positive profits. NPI is assigned the value of 1 for banks with positive profits, and the value of absolute PP for banks with negative profits. This approach is chosen as it does not change the error term structure, preserves all the observations, and still accounts for bank losses by adding the NPI variable.

To estimate the profit function, Kumbhakar et al.'s (2014) SFA model is employed. According to Kumbhakar et al. (2014), the error term of the function is separated into four components: the firm effects (μ_i), the persistent inefficiency (η_i), the residual (or time-varying) inefficiency (u_{it}), and the random error (v_{it}). Equation (3.4) becomes:

$$\ln\left(\frac{PP}{P_L}\right) = \beta_0 + \sum_{i=1}^{2} \alpha_i \ln\frac{P_i}{P_L} + 0.5\sum_{i=1}^{2}\sum_{j=1}^{2} \alpha_{ij} \ln\frac{P_i}{P_L}\ln\frac{P_j}{P_L} + \sum_{k=1}^{3} \gamma_k lnQ_K + 0.5\sum_{k=1}^{3}\sum_{m=1}^{3} \gamma_{km} lnQ_K lnQ_M + 0.5\sum_{i=1}^{2}\sum_{m=1}^{3} \delta_{im} \ln\frac{P_i}{P_L} lnQ_M + \theta \ln\frac{NPI}{P_L} + \lambda_n controls + \mu_i - \eta_i - u_{it} + v_{it} \quad (3.5)$$

Kumbhakar et al. (2014) put distributional assumptions on the error terms ($v_{it} \sim N(0, \sigma_v^2)$, $u_{it} \sim N^+(0, \sigma_u^2)$, $\eta_i \sim N^+(0, \sigma_\eta^2)$ and $\mu_i \sim N^+(0, \sigma_\mu^2)$), and then estimate the inefficiency terms (η_i and u_{it}) using Maximum Likelihood. Similarly, the cost frontier is specified as:

$$\ln\left(\frac{TC}{P_L}\right) = \beta_0 + \sum_{i=1}^{2} \alpha_i \ln\frac{P_i}{P_L} + 0.5\sum_{i=1}^{2}\sum_{j=1}^{2} \alpha_{ij} \ln\frac{P_i}{P_L}\ln\frac{P_j}{P_L} + \sum_{k=1}^{3} \gamma_k lnQ_K + 0.5\sum_{k=1}^{3}\sum_{m=1}^{3} \gamma_{km} lnQ_K lnQ_M + 0.5\sum_{i=1}^{2}\sum_{m=1}^{3} \delta_{im} \ln\frac{P_i}{P_L} lnQ_M + \lambda_n controls + \mu_i + \eta_i + u_{it} + v_{it} \quad (3.6)$$

where the error term of the cost function is also separated into four components, similar to the profit function. The estimation of the cost function is similar to that of the profit function by employing Kumbhakar et al.'s (2014) SFA model.

Kumbhakar et al. (2014) argue that the inefficiency term of a firm comprises two factors: the persistent inefficiency component, and the time-varying or short-term inefficiency component. According to Kumbhakar et al. (2014), the separation of persistent inefficiency from short-term inefficiency is crucial, as it leads to different policy and management implications, especially for short panel data. Persistent inefficiency reflects the impact of inputs such as management, which is not likely to change over a short period of time, while time-varying inefficiency might vary over time even when there is no change in bank operations. Furthermore, Kumbhakar et al. (2014) highlight the importance of separating firm heterogeneity that does not affect performance from firm inefficiency by including the firm effect component μ_i in the function. In other words, some of the firm heterogeneity is considered as part of bank inefficiency, and some is not. Kumbhakar et al.'s (2014) model is by far the most preferred one, as it improves on the weaknesses of older SFA models. For example, the models of Battese and Coelli (1992), Kumbhakar (1990), and Kumbhakar and Wang (2005) consider the total firm heterogeneity as a component of bank inefficiency, which leads to overestimation of the inefficiency scores. On the other hand, Greene's (2005) True Fixed Effects and True Random Effects models consider firm heterogeneity as unrelated to the inefficiency term, which leads to underestimation of inefficiency scores. Finally, Kumbhakar and Heshmati's (1995) model separates persistent inefficiency and time-varying inefficiency, but it considers the entire firm effects as the persistent inefficiency term, which again leads to overestimation of bank inefficiency levels.

3.3.3. Estimating the relationship between bank diversification and efficiency

a. The dependent variables

OLS regressions are employed to estimate the impact of bank diversification on efficiency. The dependent variables are the cost and profit efficiency scores of ASEAN banks measured using Kumbhakar et al.'s (2014) SFA model. For both cost and profit efficiency, two types of efficiency scores are included in the models: overall efficiency scores (Overall CostEFF and Overall ProfitEFF) and time-varying efficiency scores (Residual CostEFF and Residual ProfitEFF).

b. Independent variables

The independent variables are three measures of bank diversification: asset diversification (ADIV), funding diversification (FDIV), and income diversification (IDIV).

c. Controls

Some firm- and industry-specific factors might have a significant influence on bank diversification and efficiency. Adopting approaches from previous studies, this paper includes the following controls.

+ Bank size

According to Demsetz and Strahan (1997), diversification is positively associated with bank asset size, as larger banks have access to a wider deposit base and a broader variety of borrowers. Hence the logarithm of total assets is included in the regression as the proxy to measure bank size. Moreover, the study adopts the same approach as Curi et al. (2015) and Berger et al. (2010): the variable size squared is also included to control for a possible non-linear relationship between size and efficiency.

Furthermore, the impact of bank size on efficiency has been widely debated in the literature. MacAllister and McManus (1993) argue that larger banks enjoy economies of scope and scale, and have more opportunities to diversify their risk compared to smaller banks. Hence, large banks' funding expenses are likely to be lower, which leads to higher profitability (Goddard et al., 2004). On the other hand, Vallascas and Keasy (2012) argue that large banks are normally perceived as "too big to fail"; hence, they could have more incentive to carry out riskier investment strategies, as they would eventually be bailed out by the government. Thus, larger banks might be less efficient than smaller banks.

+ Four largest banks

This paper follows the approach of Curi et al. (2015) and Berger et al. (2010) of including a dummy variable of BIGFOUR to identify the four largest banks in terms of their total assets. According to Curi et al. (2015), the largest banks in a banking system are normally global players and have privileged access to money markets and international capital.

+ Ownership

According to Saghi-Zedek (2016), ownership has an important impact on banks' diversification abilities as bank owners can be the sources of advanced technologies,

knowledge, and expertise, allowing banks to efficiently manage diverse activities. Saghi-Zedek (2016) states that state-owned banks can be unsuccessfully diversified as the states can lack the experience to manage diversified activities. Furthermore, in developing countries such as the ASEAN countries, foreign banks are considered to have greater technology, knowledge, and expertise, which make them more capable of diversifying. However, regulations may impose some limits, on which activities foreign banks can conduct, which in turn reduce their diversification abilities. Some recent studies have assessed the effects of diversification on bank performance and taken into account their ownership structures, and they have produced various results. For instance, Berger et al. (2010) find significant evidence of greater diversification discounts for domestic banks compared to foreign banks in China from 1996 to 2006. Meslier, Tacneng, and Tarazi (2014) study Philippine banks from 1999 to 2005 and find positive effects of income diversification on bank profitability, with stronger effects found for foreign banks than for domestic ones. Moreover, Saghi-Zedek's (2016) study on Western European banks from 2002 to 2010 also reveals positive links between bank diversification and profitability, with weaker effects found for banks with the states as controlling shareholders.

To control for the effect of ownership on bank diversification and performance, two dummy variables (FOREIGN and GOVT) are included in the present study. FOREIGN takes the value of 1 if a bank has foreign ownership greater than 50%, and 0 otherwise. GOVT takes the value of 1 if a bank has government ownership greater than 50%, and 0 otherwise.

Furthermore, the interactive variables of the diversification index and ownership are also included to assess the mitigating role of ownership in the relationship between diversification and efficiency.

+ Regulation variable

As reviewed in section 3.2.3, government regulation is one of the factors affecting bank diversification abilities. Two particular aspects of regulation are significantly different between the ASEAN countries: equity investments and securities investments. As it was impossible in this study to obtain data from merchant banks in Malaysia, the restrictions imposed on banks in the sample are essentially the same for both equity and securities investment activities. To account for the regulatory restrictions, the dummy variable REG is included. REG takes the value of 0 if there is very little regulatory restriction on bank activities of equity and securities investment; this is the case for banks in Cambodia and for

universal banks in the Philippines. Conversely, REG takes the value of 1 if substantial restrictions exist on these activities, which is the case for the rest of the sample.

3.3.4. Data

The sample of this study consists of 175 banks from six ASEAN countries: Vietnam, Cambodia, Indonesia, Malaysia, the Philippines, and Thailand. The data cover the period of 2007 to 2014.

To measure bank diversification indices and bank efficiency scores, data are collected mainly from audited financial reports and annual statements of banks in the sample over the period of 2007 to 2014. The information collected for each bank includes:

- Interest expenses and similar expenses
- Total operating expenses
- Personnel expenses
- Profit before tax
- Loans to customers
- Interbank loans
- Securities investments
- Other earning assets
- Total assets
- Total fixed assets
- Equity
- Short-term interbank deposits
- Customer deposits
- Long-term market funding
- Short-term market funding
- Interest income
- Commission income
- Net profit from other operations
- Other non-interest incomes

Data on the rest of the variables are collected from the following sources:

- Data on productivity growth, bank branch density, and inflation rate are obtained from the World Bank website.

- Data on industry concentration are obtained using information from annual supervision reports of each country's state bank or central bank.

- Data on bank ownership are collected from the Bankscope database and from annual reports of banks.

Tables 3.1, 3.2, 3.3a, 3.3b, 3.4a, 3.4b, and 3.4c present the descriptive statistics of the diversification indices and input and output variables used to estimate cost and profit efficiency.

Table 3.1 provides the definitions of input prices, output quantities, and control variables of the cost and profit functions. Table 3.2 presents the sample distribution by country. The total number of banks in the sample is 175, with Indonesia as the largest contributor (50 banks), followed by Vietnam (36 banks), with the four other countries contributing from 20 to 25 banks each. The differences in the number of banks in each country are due to the differences in their banking sector structures, as reported in table 3.2.

Table 3.3a provides the descriptive statistics of input prices, output quantities, and control variables used to estimate the efficiency scores. As presented in table 3.3a, the bank data are relatively widespread in terms of total cost, pre-tax profit, input prices, and output quantities.

Table 3.3b reports the descriptive statistics of output, input, and control variables used in the cost and profit functions by country. Based on the data on pre-tax profit and total cost, banks from Malaysia and Thailand incur the highest levels of cost and pre-tax profit, followed by Indonesian and Philippine banks. Vietnamese banks incur relatively small and Cambodian banks very small cost and profit amounts. Among banks from the six ASEAN countries, Vietnamese banks incur the highest level of total cost relative to profit, while Cambodian banks incur the lowest level. In terms of outputs produced, Thai and Malaysian banks show the highest levels, followed by the Philippines, Indonesia, Vietnam, and Cambodia. On the other hand, there are variations in the combination of the three input prices, which makes it highly difficult to determine which group of banks has the overall lower prices. Banks from Vietnam have the lowest price of labor (0.0073) and price of capital (1.734), but the highest price of funds (0.074). Banks from the Philippines have the lowest price of funds (0.0196) and the second lowest price of capital (1.879), but a relatively high price of labor (0.011). Thai, Malaysian, and Cambodian banks have very high prices of capital (5.496, 2.834, and 2.231) but relatively low prices of funds and labor. Finally, Indonesian banks have a medium capital price, the second highest price of funds (0.059), and the highest price of labor (0.019).

In terms of control variables, banks from Vietnam, Malaysia, and the Philippines demonstrate relatively low levels of risk aversion, while banks from Cambodia exhibit very high levels of this. The productivity growth rates in Vietnam, Cambodia, and Indonesia are higher than in the other three countries. The bank branch density levels are vastly different between the six countries, which demonstrates their different levels of financial service accessibility. The country with the highest level of bank branch density is Indonesia, with more than 13 branches per 100,000 inhabitants, followed by Malaysia and Thailand with

more than 11 branches, the Philippines with 8 branches, and Cambodia and Vietnam with 3 to 4 branches. In another vein, Thailand and Malaysia have the lowest inflation rate, while the country with the highest rate is Vietnam. Finally, Vietnam and Indonesia have the least concentrated banking markets, while Malaysia has the highest industry concentration.

To summarize, there are large differences in the inputs, outputs, and environmental factors that affect the levels of efficiency between banks from ASEAN countries. Hence, it is highly difficult to forecast which groups of banks will be more efficient than other. However, if only the levels of total cost and pre-tax profit are taken into account, given the combination of input prices and output quantities, Malaysian and Philippine banks appear to have better combinations, while Indonesian banks appear to have the least favorable combinations.

Table 3.4a presents the descriptive statistics of bank characteristics that are used to compute the diversification index and some bank-level characteristics used in the OLS regressions. Regarding asset decomposition of ASEAN banks, on average, customer loans account for the highest proportion of loans (55.06%), followed by other earning assets (18.51%), securities (15.75%), and interbank loans (10.68%). Concerning funding decomposition for an average ASEAN bank, customer deposits make up the largest proportion (75.07%), followed by equity (10.46%), short-term interbank deposits (7.63%), long-term market funding (4.17%), and short-term market funding (2.67%). With regard to the income decomposition for an average ASEAN bank, interest income comprises the largest share (67.54%), followed by commission income (14.99%), net profit from other operations (12.73%), and other non-interest income (4.74%). In terms of bank characteristics as controls, the average total assets of an ASEAN bank are 10 billion USD, and there is a significant level of foreign ownership, a low level of government ownership, and high regulation restrictions on investment activities.

Table 3.4b reports the components of assets, funding, and income as well as controlled characteristics of ASEAN banks by country. Regarding asset composition, Cambodian banks have the highest share of customer loans and interbank loans (97.60%) and the lowest share of securities and other earning assets (2.40%), while Malaysian and Philippine banks have the lowest shares of customer loans and interbank loans (more than 58%) and the highest shares of securities and other earning assets (less than 42%). For the three other countries, the share of loans is about 70%, while the share of non-traditional bank assets is about 30%. Regarding the funding decomposition, Malaysian, Philippine, and Thai banks have similar shares of equity (9-11%), short-term interbank deposits (6-8%), and customer deposits (72-76%).

Vietnamese banks have the lowest share of customer deposits (66.29%) but the highest share of short-term interbank deposits (17.88%) and an average share of equity (8.12%), which indicates that these banks rely more on the interbank market for their funding compared to banks in other countries. Indonesian banks have the highest share of customer deposits (79.95%), the lowest share of short-term interbank deposits (2.23%), and an average share of equity (11.93%), implying that these banks rely more on the retail market for their funding compared to banks in other countries. Finally, Cambodian banks have a lower share of customer deposits (67.89%), an average share of short-term interbank deposits (8.10%), and the highest share of equity (17.64%), which suggests that these banks rely more on equity as their source of funding compared to banks in other countries. In terms of long-term and short-term market funding sources, the largest share can be seen in Thai banks (10%), while the shares of other countries' banks range from 6 to 7%. Concerning income decomposition, Cambodian banks have the largest share of interest income (77.59%) and commission income (18.75%), while Philippine banks have the lowest share of interest income (54.08%) and a low share of commission income (11.15%). Moreover, Philippine and Thai banks have very high shares of net profit from other operations and other non-interest incomes (34.77% and 22.94%, respectively). Regarding bank characteristics, banks from Malaysia and Thailand are the largest, while those in Vietnam, Indonesia, and the Philippines are average in size, and those in Cambodia are the smallest. Banks in Cambodia and Malaysia have the highest levels of foreign ownership, while Vietnamese banks have the lowest levels. Banks from Indonesia and the Philippines have the highest levels of government ownership, while these levels are very low in the other countries. Finally, regulation restrictions on banks' investment activities are imposed in Vietnam, Indonesia, Malaysia, and Thailand. Cambodia has very few restrictions, and the Philippines only has significant restrictions for commercial banks, while very few are imposed on universal banks.

Table 3.4c decomposes the sample by ownership and bank size and reports the descriptive statistics for the components of assets, funding, and income, as well as several bank characteristics. Regarding ownership, similar asset and funding decompositions are found for foreign, government-owned, and private banks. However, in terms of income decomposition, government-owned banks have the highest share of interest income (73.71%), the lowest share of commission income (12.33%), and an average share of other income (13.97%). On the other hand, foreign banks have a high share of interest income (71.36%), the highest share of commission income (17.17%), and the lowest share of other incomes

(11.48%). Moreover, private banks have a very low share of interest income (62.99%), an average share of commission income (15.53%), and the highest share of other income (21.48%). Hence, though all three types of banks rely heavily on interest income, foreign banks earn more income from commissions, while private banks earn more from other operations and other non-interest income. Moreover, government-owned banks are very large in size, while private banks are of average size and foreign banks are relatively small.

Regarding size, this study decomposes the sample into SMALL banks (total assets of less than 1 billion USD), MEDIUM banks (total assets of 1-10 billion USD), and LARGE banks (total assets of more than 10 billion USD). In terms of asset decomposition, small banks rely heavily on loans (80%) while medium and large banks have lower loan shares of 62 to 66%. In terms of funding decomposition, large banks have the highest share of customer deposits and the lowest share of interbank deposits (76.89% and 6.70%), while small and medium banks have only 66% of their funding from customer deposits and very high shares of interbank deposits (12%). Furthermore, small banks rely more heavily on equity as their source of funding (18.07%) compared to medium (12.91%) and large banks (9.87%). Concerning income decomposition, small banks have the highest share of interest income (74.93%), medium banks have the highest share of other income (20.67%), and large banks have the highest share of commission income (15.85%). Furthermore, small banks have the highest level of foreign ownership, while large banks have the highest level of government ownership, which is consistent with the results yielded by decomposing the sample by ownership.

3.4. Results and discussion

3.4.1. Analysis of bank diversification in ASEAN countries

Table 3.5 reports the asset, funding, and income diversification indices by country, ownership type, and bank size. By country, Philippine banks have the highest levels of asset and income diversification (0.612 and 0.548), but a very low funding diversification level (0.356). Furthermore, Vietnamese banks have a very high level of asset diversification (0.542), the highest level of funding diversification (0.536), but very low income diversification (0.353). On the other hand, Cambodian banks have very low levels of asset and income diversification (0.427 and 0.353) and an average level of funding diversification (0.438). Indonesian banks have an average level of asset diversification (0.484) but the lowest levels of funding and income diversification (0.328 and 0.274). Malaysian banks have average levels of asset, funding, and income diversification (0.431, 0.444 and 0.481). Finally,

Thai banks have very high levels of asset, funding, and income diversification (0.506, 0.510 and 0.513). Hence, Thai banks can be considered to be the most diversified, while Cambodia and Indonesia banks are the least diversified.

Regarding ownership type, all three types of banks have similar levels of income diversification. However, government-owned and private banks have similarly high asset diversification levels (0.517), while foreign banks have lower levels (0.455). On the other hand, foreign banks have the highest degree of funding diversification (0.439) compared to two other types of banks.

In terms of bank size, small banks have the lowest levels of asset and income diversification (0.461 and 0.313) and an average level of funding diversification (0.417). Medium banks have the highest levels of asset diversification and funding (0.540 and 0.464) and an average level of income diversification (0.405). In contrast, large banks have average levels of asset and income diversification (0.480 and 0.463) and the lowest level of funding diversification (0.387). Hence, large banks are the least diversified, while medium banks are the most diversified in the sample.

3.4.2. Analysis of bank efficiency in ASEAN countries

Table 3.6 presents the parameter estimations of the cost and profit functions. According to the results in table 3.6, bank costs are explained by both input price and output quantity variables, while bank profits are mainly explained by output quantity variables.

Tables 3.7a, 3.7b, 3.7c, and 3.7d present the efficiency scores by year, country, ownership type, and bank size. The results include the persistent, residual, and overall scores for both cost and profit efficiency. The scores for both cost and profit efficiency of banks are less than one, with a score of 1 representing a bank with the optimal cost or profit. For example, if a bank's cost efficiency score is 0.70, this means that compared to the best-practice bank in the sample, it can save 30% of its costs without changing its inputs or outputs. Similarly, if a bank scores 0.60% for profit efficiency, this indicates that compared to the best-practice bank in the sample, it can increase its profit by 40%.

By year, the scores tend to fluctuate over time. The overall cost efficiency of the sample is 0.7734, with the largest contribution of inefficiency coming from the persistent component. The average profit efficiency score of the entire sample is 0.3084, with similar contributions from both persistent and residual components.

By country, Indonesian banks are the most cost efficient (0.8071), while Malaysian and Philippine banks are the least cost efficient (0.7062 and 0.7421). Other countries have similar scores of cost efficiency (0.76-0.78). In contrast, Indonesian banks are the least profit efficient (0.2778), while Malaysian banks are the most profit efficient (0.3486). Cambodian banks have a very high average level of profit efficiency (0.3481), followed by the Philippines (0.3223), Thailand (0.3024), and Vietnam (0.2996). Cambodian banks' high level of profit efficiency despite their small sizes could be due to the fact that the Cambodian banking sectors are currently in the expansion process, while other countries' banking sectors are in the consolidation stage. Hence, while Cambodian banks are not as cost efficient as banks from other countries, they are more profit efficient as they might enjoy higher profit margins. Combined with the average results of the diversification measurements, it is challenging to forecast whether diversification negatively or positively impacts bank efficiency. However, as Indonesian banks are the least diversified in the sample, it can be predicted that diversification might have a positive impact on cost efficiency but a negative impact on profit efficiency.

By ownership type, government-owned banks are the most cost efficient but the least profit efficient, while foreign banks are the least cost efficient but the most profit efficient. Private banks have average levels of both cost and profit efficiency. The results hold for all types of efficiency scores (persistent, residual, and overall). As suggested in the diversification index results, foreign banks are the most diversified banks in terms of funding and income, but the least diversified in terms of assets. Hence, it can be predicted that funding and income diversification could negatively affect cost efficiency but positively affect profit efficiency of ASEAN banks. On the other hand, asset diversification might positively affect their cost efficiency but negatively affect their profit efficiency scores.

Regarding size, small banks are the most cost efficient, while medium banks are the least cost efficient. On the other hand, medium banks are the most profit efficient, and large banks are the least cost efficient. As mentioned earlier, large banks are the least diversified and medium banks are the most diversified in the sample. This suggests that diversification might positively influence profit efficiency but could negatively influence cost efficiency.

In summary, conflicting predictions are made by only observing the average efficiency scores and diversification indexes. The next section presents the regression results to examine the more accurate relationship of diversification and bank efficiency.

3.4.3. Regression analysis

Tables 3.8a and 3.8b present the OLS regressions of bank residual and overall efficiency scores on diversification indexes and other bank-specific and control variables.

3.4.3.1. Diversification and cost efficiency

According to the results in table 3.8a, asset and funding diversification have no significant impact, while income diversification has a significant negative impact on residual cost efficiency scores. In terms of the effect of bank diversification on overall cost efficiency scores, negative relationships are found, but only significant for asset and income diversification. In most cases, no significant relationship is found for interactive variables (DIV x BIGFOUR, DIV x FOREIGN and DIV x GOVT) and cost efficiency levels. Only a significant positive relationship is found for FDIV x GOVT and overall cost efficiency, which indicates that funding-diversified banks associated with government ownership enjoy higher levels of overall cost efficiency. Berger et al. (2010) report opposite results for Chinese banks, finding that asset-focused banks associated with government ownership enjoy higher levels of cost efficiency. On the other hand, the finding of the negative impact of asset diversification on cost efficiency is consistent with Rossi et al.'s (2009) study on large Austrian commercial banks.

For the control variables, negative relationships are found between BIGFOUR and bank cost efficiency, although significant relationships are only found when FDIV and ADIV are independent variables and overall cost efficiency score is the dependent variable. This indicates that the four largest banks suffer from lower overall cost efficiency levels on the asset and funding diversification dimensions. This finding is consistent with that of Curi et al. (2015) and Berger et al. (2010).

Negative impacts are also found for the FOREIGN and GOVT dummies on both residual and overall cost efficiency scores, although these impacts are mostly statistically insignificant. This shows that foreign and government ownership alone have little effect on banks' cost efficiency levels. In contrast, Berger et al. (2010) find strong significant negative impacts of foreign and government ownership on bank cost efficiency.

Significant positive relationships are found between REG (regulation restrictions) and residual and overall cost efficiency scores for all three diversification dimensions. In other words, banks facing substantial restrictions on investment activities are found to be more cost efficient than banks that face very few restrictions.

In terms of bank size, significant negative relationships are found between bank size and both cost efficiency scores for all three diversification dimensions. This suggests that smaller banks are more cost efficient than larger banks. However, a strong significant positive relationship found between bank size squared and cost efficiency indicates a non-linear correlation between bank size and bank cost efficiency. This result confirms the descriptive statistics in table 3.7d, which show that small and large banks are more cost efficient than medium banks. This result is in contrast with Berger et al.'s (2010) finding of positive effects of both bank size and bank size squared on cost efficiency, which suggest that larger banks are more cost efficient than smaller banks. Curi et al. (2015) also examine the relationship between bank size and bank size squared and efficiency, but their results are mixed.

3.4.3.2. Diversification and profit efficiency

The results in table 3.8b show that diversification is positively associated with bank profit efficiency in general, but those significant associations are only found for some diversification dimensions. Asset diversification has no significant impact on residual profit efficiency but a significant positive impact on overall profit efficiency scores, which suggests that asset diversification only helps banks to improve their persistent and not time-varying profit efficiency. Moreover, funding diversification has significant positive impacts on both residual and overall profit efficiency levels, which implies that banks with higher funding diversification enjoy higher levels of profit efficiency in both the long and short term. On the other hand, no significant relationship is found between income diversification and bank profit efficiency levels. These results differ substantially from those of Berger et al. (2010), who report that more focused banks have higher levels of profit efficiency. Meslier et al. (2014) find a positive impact of income diversification on the profitability of Philippine banks. On the other hand, the positive impact of asset diversification on profit efficiency is consistent with the findings of Rossi et al. (2009).

Examining the impact of interactive variables and profit efficiency scores yields some highly interesting results. No significant impact of asset diversification in association with BIGFOUR, FOREIGN, or GOVT is found on residual profit efficiency, which is similar to the case of the asset diversification index alone. In contrast, although asset diversification has a general significant positive impact on overall profit efficiency scores, a negative significant relationship is found for ADIV x FOREIGN. A similar result is found for FDIV x FOREIGN and overall profit efficiency levels. These results indicate that foreign banks associated with higher levels of asset and funding diversification exhibit lower levels of overall profit

efficiency. Furthermore, significant negative impacts of FDIV x FOREIGN and FDIV x GOVT are found on residual profit efficiency, while significant positive impacts are found for the funding diversification index (FDIV) alone. This suggests that although banks with higher levels of funding diversification associate with higher degrees of residual profit efficiency, funding-diversified foreign- and government-owned banks are in fact less profit efficient in the short term. On the other hand, Berger et al. (2010) find that asset-focused banks associated with government ownership are less profit efficient. Moreover, loan-, deposit-, and asset-focused banks associated with foreign ownership are also less profit efficient. This result is also different from Meslier et al.'s (2014) findings regarding Philippine banks, that more income-diversified banks are more profitable.

No significant relationship is found between BIGFOUR and GOVT dummies and bank profit efficiency. This implies that the four largest banks and government-owned banks are not necessarily less or more profit efficient than other banks. Significant positive effects of foreign ownership are found for residual profit efficiency on the funding diversification dimension, and for overall profit efficiency on the asset diversification dimension. In support of some of the results of this study, Berger et al. (2010) find a significant negative impact of BIGFOUR, no significant impact of GOVT, and a significant positive impact of FOREIGN on profit efficiency.

Significant negative impacts are found for REG (regulation restrictions) on both residual and overall profit efficiency scores on most of the diversification dimensions. This indicates that banks facing more regulation restrictions on investment activities are less profit efficient than banks facing fewer restrictions.

Regarding bank size and bank size squared, no significant relationship is found between the two variables and residual profit efficiency. However, significant positive relationships are found between bank size and overall profit efficiency on all three diversification dimensions, which indicates that smaller banks are less efficient than larger ones. Furthermore, the significant negative relationship between bank size squared and overall profit efficiency indicates a non-linear correlation. This is confirmed by the descriptive statistics in table 3.7d, which imply that medium banks are more efficient than small and large banks. These results contrast those of Berger et al. (2010), who find significant negative effects of both bank size and bank size squared on profit efficiency levels, indicating that smaller banks are more profit efficient than larger banks. Furthermore, Curi et

al. (2015) report mixed results for the relationships between bank size and bank size squared, and bank efficiency.

3.4.3.3. Discussion

In summary, this study provides evidence that diversification negatively affects cost efficiency but positively affects profit efficiency of ASEAN banks. Funding-diversified banks associated with government ownership exhibit higher levels of overall cost efficiency but lower levels of residual profit efficiency. Funding- and asset-diversified banks associated with foreign ownership exhibit higher levels of profit efficiency. Banks facing substantial regulation restrictions on investment activities are more cost efficient but less profit efficient compared to banks that face very few restrictions. Medium banks are less cost efficient but more profit efficient than small and large banks, which indicates a non-linear relationship between size and efficiency.

The negative effects of diversification on cost efficiency do not support Elsas et al.'s (2010) argument of economies of scope as one of the important benefits of diversification. However, this finding does support the arguments that bank diversification increases agency cost (Leaven and Levein, 2007, Jensen and Meckling, 1976) and that diversification in an increasingly competitive market may exaggerate the costs of banks when entering into a new sector (Winton, 1999). As banks in ASEAN countries are going through their consolidation processes, market competition is high; hence, it would be less costly for banks to specialize. Nevertheless, as negative impacts are mostly found for income and asset diversification on bank cost efficiency, ASEAN banks only need to be less diversified in terms of asset and income to be more cost efficient.

On the other hand, the positive effects of diversification on profit efficiency support the argument that diversification helps to reduce risk (Berger et al., 2010) and that diversification is a means for banks to deal with future uncertainty and to be profitable in the longer term (Elsas et al., 2010). Nonetheless, as significant positive impacts are mostly found for asset and funding diversification, ASEAN banks can concentrate only on further diversifying in terms of funding and assets to be more profit efficient.

The finding that regulatory restrictions on investment activities have a positive effect on bank cost efficiency but a negative effect on profit efficiency is consistent with the results of the diversification index and the efficiency scores. As diversification decreases cost efficiency, it is reasonable that regulatory restrictions would increase it. Similarly, as

diversification increases profit efficiency, it is expected that regulatory restrictions would reduce this factor.

The finding that medium banks are less cost efficient than small and large banks supports MacAllister and McManus's (1997) argument that larger banks enjoy economies of scope and scale and have more opportunities to diversify their risk. However, in the case of ASEAN banks, they need to reach a certain size to enjoy those benefits.

Finally, the finding that medium banks are more profit efficient than small and large banks supports Vallascas and Keasy's (2012) argument that larger banks tend to follow riskier investment strategies as they expect ultimate bail-outs from the government, which makes them less efficient than smaller banks. However, in the case of ASEAN banks, they need to reach a certain size threshold to be profit efficient, as both small and large banks are less profit efficient than medium ones.

3.4.4. Robustness test

According to Laeven and Levine (2007), since banks can choose whether or not to diversify, the endogeneity issue of diversification and bank performance is regularly discussed in the literature (Curi et al., 2015; Elsas et al., 2010; Berger et al., 2010).

Hence, this study attempts to test the robustness of the results by controlling for possible endogeneity problem. The paper follows Elsas et al.'s (2010) approach by treating bank diversification and efficiency as endogenous variables and identifying appropriate instrumental variables to control for the endogeneity issue. According to Elsas et al. (2010), a common procedure in econometrics is to use lagged variables as instruments. Although lagged variables are not fully exogenous, they are predetermined. To be valid instruments, these variables must be correlated with one endogenous variable (diversification) but not the other (bank efficiency).

Tables 3.9a and 3.9b show the estimation results when using lagged diversifications as the instrumental variables for current diversifications, and employing a two-stage least squares (2SLS) estimator. Furthermore, the tables also present the results of the Durbin-Wu-Hausman test for endogeneity (Durbin, 1954; Wu, 1973, Hausman, 1978). According to Schultz, Tan, and Walsh (2010), the existence of endogeneity would make OLS parameter estimates biased, and other estimators would need to be used. On the other hand, if endogeneity does not exist, estimators that deal with endogeneity such as the 2SLS would be less efficient than OLS. As the Durbin-Wu-Hausman results in tables 3.9a and 3.9b cannot

reject the null hypothesis that all regressors are exogenous at the 5% level, there is a lack of evidence regarding the endogeneity issue between bank diversification and efficiency.

3.5. Conclusion

This study examined the effect of diversification on the cost and profit efficiency of banks from six ASEAN countries over the period of 2007 to 2014.

Using Kumbhakar et al.'s (2014) SFA model for efficiency estimation, the study yielded average cost efficiency scores of 0.7062 to 0.8071 and average profit efficiency scores of 0.2778 to 0.3486. Indonesia was the nation with the most cost-efficient but the least profit-efficient banking sector, while Malaysia is the country with least cost efficient but most profit efficient banking industry.

To explain the differences in bank efficiency across the six ASEAN countries, this study examined their business models, and specifically bank diversification. The latter was analyzed using three dimensions: asset, funding, and income. Then, OLS regressions were employed to investigate the relationship between bank diversification and efficiency.

In terms of diversification and cost efficiency, the findings showed that more income-diversified banks were associated with lower cost efficiency, while more asset-diversified banks were only associated with lower persistent cost efficiency. On the other hand, results regarding the relationship between diversification and profit efficiency showed that more funding-diversified banks enjoyed higher levels of profit efficiency, while more asset-diversified banks only enjoyed higher levels of persistent profit efficiency. This has important implications for banks and bank regulators: for ASEAN banks, the optimal business model could be income-focused and funding-diversified; and for bank regulators, any regulatory restrictions or relaxations need to be considered in relation to their effects on banks' income and funding diversification.

Examining the mitigating role of ownership in the relationship between diversification and efficiency yielded some interesting results. Funding-diversified banks with government ownership were associated with higher levels of persistent cost efficiency but lower levels of residual profit efficiency scores. Furthermore, though diversification had a generally positive impact on profit efficiency, funding-diversified banks with foreign ownership actually exhibited lower profit efficiency scores. Similarly, asset-diversified banks with foreign ownership also enjoyed lower persistent profit efficiency levels. In other words, funding diversification could help government-owned banks to be more cost efficient but less profit

efficient. In addition, funding and asset diversification could make foreign-owned banks less profit efficient.

Important results were also found for control variables. It was concluded that regulatory restrictions on investment activities in ASEAN countries had a positive effect on bank cost efficiency but a negative one on bank profit efficiency, which is consistent with the results of diversification and efficiency scores. Furthermore, medium banks were found to be less cost efficient but more profit efficient than small and large banks, indicating non-linear relationships between bank size and efficiency.

Overall, by examining different aspects of diversification, this study identified the optimal business model for ASEAN banks, which is essential for both bank managers and bank regulators as the process of bank restructuring in the region is still on-going to create better-functioning banking sectors.

APPENDICES

Table 3.1. Variables used to estimate the cost and profit functions

This table gives descriptions and detail measurements of the dependent variables (TC and PP) and independent variables (outputs, inputs, input prices, and controls) that are used to estimate bank profit efficiency.

Variable	Variable name	Description
TC	Total costs	Interest expenses and operating expenses
PP	Pre-tax Profit	Profit before taxation
Outputs		
Q_1	Loans to customers	Loans issued by the bank to retail clients
Q_2	Interbank loans	Loans issued by the bank to other credit institutions
Q_3	Other earning assets	Other earning assets
Inputs		
P_1	Labor	Number of full-time employees
P_2	Capital	Fixed assets
P_3	Funds	Deposits from customers and banks
Input prices		
P_L	Labor	Personnel expenses/Total assets
P_K	Capital	Other administrative expenses/Book value of fixed assets
P_D	Funds	Interest expenses/Funds
Controls		
E.ratio	Equity ratio	Equity/Total assets
Prod.growth	Productivity	Growth of GDP per person employed
Branch.dens	Branch density	Number of bank branches per 100,000 inhabitants
Infl	Inflation	Inflation rate
Concentration	Industry concentration	Share of assets of 3 largest banks in a banking sector

Table 3.2. Sample distribution

This table presents the distribution of the sample by country in the period from 2007-2014. The "The sample" column refers to the number of banks included in the sample. The second column refers to the total number of conventional commercial banks in the banking system of each country in the sample. The "Sample contribution" column is calculated by taking the number of banks from each country and divided by the total number of banks in the sample.

Country	Total number of conventional Commercial banks	The sample	Sample contribution
Vietnam	45	36	21%
Cambodia	36	25	14%
Indonesia	103	50	29%
Malaysia	27	23	13%
Philippines	40	20	11%
Thailand	30	21	12%
Total	**281**	**175**	**100%**

Table 3.3a. Summary statistics of dependent and independent variables

This table reports descriptive statistics (obs, mean, std. dev., min, and max) for dependent and independent variables used to estimate bank efficiency scores. Obs is the number of observations Std. dev. is the standard deviation of each variable.

Variable description	Variables	Obs	Mean	Std. Dev.	Min	Max
Total cost ($000)	TC	1064	477,000	758,000	329	4,760,000
Pre-tax profit ($000)	PP	1064	178,000	382,000	-106,000	2,670,000
Loans to customers ($000)	Q_1	1064	5,980,000	11,500,000	1	80,200,000
Interbank loans ($000)	Q_2	1064	1,150,000	2,060,000	1	16,400,000
Other earning assets ($000)	Q_3	1064	2,010,000	3,850,000	1	36,700,000
Price of capital	P_K	1064	2.498	4.162	0.096	68.287
Price of funds	P_D	1064	0.045	0.030	0.001	0.182
Price of labor	P_L	1064	0.012	0.008	0.001	0.079
Equity ratio	E.ratio	1064	0.157	0.131	0.040	0.994
Productivity growth	Prod.growth	1064	0.033	0.020	-0.029	0.069
Bank branch density	Branch.dens	1064	8.838	4.798	3	17.9
Inflation rate	Infl	1064	0.057	0.048	-0.008	0.25
Industry concentration	Concentration	1064	0.430	0.067	0.287	0.562

Table 3.3b. Variable distribution by country

This table reports the mean values of input, output, and control variables used to calculate the cost and profit efficiency scores, for different countries. The variables are defined in Table 3.1.

Country		Vietnam	Cambodia	Indonesia	Malaysia	Philippines	Thailand
Total cost ($000)	TC	400,000	16,300	509,000	832,000	363,000	777,000
Pre-tax profit ($000)	PP	61,300	8,942	200,000	385,000	131,000	337,000
Loans to customers ($000)	Q_1	3,020,000	208,000	4,380,000	15,100,000	4,120,000	13,100,000
Interbank loans ($000)	Q_2	1,020,000	108,000	1,120,000	918,000	1,630,000	2,470,000
Other earning assets ($000)	Q_3	871,000	6,223	1,420,000	5,250,000	2,220,000	3,900,000
Price of capital	P_K	1.734	2.231	1.972	2.843	1.897	5.496
Price of funds	P_D	0.074	0.023	0.059	0.022	0.0196	0.031
Price of labor	P_L	0.0073	0.012	0.019	0.0075	0.011	0.0085
Equity ratio	E.ratio	0.122	0.306	0.134	0.123	0.125	0.165
Productivity growth	Prod. growth	0.040	0.037	0.037	0.022	0.028	0.022
Bank branch density	Branch. dens	3.441	4.273	13.417	11.035	7.978	11.543
Inflation Rate	Infl	0,106	0.055	0.057	0.024	0.041	0.026
Industry concentration	Concent ration	0.371	0.474	0.386	0.521	0.458	0.462

Table 3.4a. Descriptive statistics of bank characteristics used to compute diversification index

This table presents summary statistics of decomposition of assets, funding, and income and also some bank-level characteristics that are used in the OLS regression, including: size, ownership and regulation variables. BANKSIZE is measured by the logarithm of total asset, BANKSIZESQ is the square of BANKSIZE. BANKSIZE is also expressed in billion USD. FOREIGN is one if the foreign shareholdings in the banks is 50% and above, zero otherwise. GOVT is one if the government shareholdings in the banks is 50% and above, zero otherwise. REG is one if the restriction on investment activities are imposed on the bank, zero if very few restrictions imposed. All financial items under asset, funding and income decomposition are in millions of USD.

Variables		Obs.	Mean	Std. Dev.	Min.	Max.
Asset decomposition						
Customer loans	CLOAN	1064	5,980	11,500	0	80,200
Interbank loans	IBLOAN	1064	1,160	2,060	0	16,400
Securities	SEC	1064	1,710	3,310	0	29,000
Other earning assets	OTHEREA	1064	2,010	3,850	0	36,700
Funding decomposition						
Equity	EQUI	1064	1,000	1,800	8.091	14,000
Short-term interbank deposit	IBDEP	1064	730	1,380	0	14.400
Customer deposits	CDEP	1064	7,180	13,400	0.156	93,000
Long-term market funding	LDEBT	1064	399	1,010	0	8,950
Short-term market funding	SDEBT	1064	255	594	0	8,330
Income decomposition						
Interest income	II	1064	305	586	-10.3	4,340
Commission income	CI	1064	67.7	147	-112	1,040
Net profit from other operations	NPFO	1064	57.5	185	-83.6	2,510
Other non-interest incomes	ONII	1064	21.4	55.2	-61.5	519
Control variables						
Bank size (log)	BANKSIZE	1064	21.532	1.984	16.451	25.644
Bank size ($mil.)		1064	10,000	18,300	13,9	137,000
Bank size squared	BANKSIZESQ	1064	467.546	84.769	270.630	657.628
Foreign ownership	FOREIGN	1064	0.299	0.458	0	1
Government ownership	GOVT	1064	0.077	0.267	0	1
Regulation restriction	REG	1064	0.784	0.412	0	1

Table 3.4b. Descriptive statistics bank characteristics used to compute diversification index by country

This table reports the mean values of bank characteristic variables used to compute diversification index by country. The definitions of variables are given in Table 3.4a. All financial items under asset, funding, and income decomposition are in millions of USD.

Variables	Vietnam	Cambodia	Indonesia	Malaysia	Philippines	Thailand
Asset decomposition						
Customer loans	3,020	208	4,380	15,100	4,120	13,100
Interbank loans	2,010	108	1,130	918	1,640	2,470
Securities	837	1.535	1,180	4,510	1,900	3,200
Other earning assets	871	6.223	1,420	5,250	2,220	3,900
Funding decomposition						
Equity	420	64.7	834	2,160	927	2,280
Short-term interbank deposit	925	29.7	156	2,080	575	1,190
Customer deposits	3,430	249	5,590	18,200	6,410	13,900
Long-term market funding	157	21.3	226	1,240	117	986
Short-term market funding	242	2.068	186	333	549	817
Income decomposition						
Interest income	146	15.3	376	561	226	541
Commission income	16.3	3.697	66.6	128	46.6	186
Net profit from other operations	12.3	0.592	25.6	80.2	115	199
Other non-interest incomes	12.2	0.131	16.8	64.5	30.3	17.4
Control variables						
Bank size (log)	21.718	19.039	21.056	22.91	22.268	22.977
Bank size ($mil.)	5,380	376	7,310	25,100	8,470	20,600
Bank size squared	473.095	363.938	447.419	528.328	497.216	529.721
Foreign ownership	0.013	0.581	0.292	0.546	0.174	0.336
Government ownership	0.092	0.000	0.123	0.057	0.139	0
Regulation restriction	1	0	1	1	0.286	1
Number of observations	228	148	301	141	115	131

Table 3.4c. Descriptive statistics bank characteristics used to compute diversification index by ownership and size

This table reports the mean values of bank characteristic variables used to compute diversification index by ownership and size. The definitions of variables are given in Table 3.4a. FOREIGN denotes foreign-owned banks, GOVT denotes government-owned banks and PRIVATE denotes domestic private banks. SMALL denotes banks with total assets of less than 1 billion USD, MEDIUM denotes banks with total assets between 1 – 10 billion USD, LARGE denotes banks with total asset more than 10 billion USD. All financial items under asset, funding, and income decomposition are in millions of USD.

Variables	OWNERSHIP			SIZE		
	FOREIGN	*GOVT*	*PRIVATE*	*SMALL*	*MEDIUM*	*LARGE*
Asset decomposition						
Customer loans	3,420	18,800	5,630	196	2,010	20,100
Interbank loans	598	3,860	1,090	78.5	714	3,310
Securities	859	5,630	1,630	34.9	743	5,510
Other earning assets	1,080	6,630	1,880	41.0	917	6,370
Funding decomposition						
Equity	630	3,090	921	63.4	485	3,080
Short-term interbank deposit	359	2,240	722	42.3	458	2,090
Customer deposits	4,060	22,900	6,730	233	2,490	24,000
Long-term market funding	185	1,410	376	6.837	128	1,360
Short-term market funding	171	578	256	5.321	197	684
Income decomposition						
Interest income	212	1,190	241	13.1	120	994
Commission income	51.0	199	59.4	1.455	19.4	234
Net profit from other operations	23.0	143	63.5	1.921	28.1	179
Other non-interest incomes	11.1	82.5	18.7	1.007	8.213	69.7
Control variables						
Bank size (log)	21.132	23.733	21.451	19.292	21.876	23.984
Bank size ($mil.)	5,690	31,700	9,460	260	3,970	32,800
Bank size squared	450.228	564.258	463.895	373.196	479.030	575.671
Foreign ownership	1	0	0	0.351	0.287	0.248
Government ownership	0	1	0	0	0.039	0.241
Regulation restriction	0.708	0.805	0.818	0.635	0.845	0.885
Number of observations	318	82	664	362	432	270

Table 3.5. Diversification index by country, ownership type and size

This table reports the mean values of bank diversification index by country, ownership type and size. ADIV denotes asset diversification, FDIV denotes funding diversification and IDIV denotes income diversification. The data in brackets are the standard deviations. FOREIGN denotes foreign-owned banks, GOVT denotes government-owned banks and PRIVATE denotes domestic private banks. SMALL denotes banks with total assets of less than 1 billion USD, MEDIUM denotes banks with total assets between 1 – 10 billion USD, LARGE denotes banks with total asset more than 10 billion USD.

Variables	Obs.	ADIV	FDIV	IDIV
By country				
Vietnam	228	0.542	0.536	0.353
		(0.115)	(0.113)	(0.146)
Cambodia	148	0.427	0.438	0.353
		(0.121)	(0.169)	(0.113)
Indonesia	301	0.484	0.328	0.274
		(0.092)	(0.108)	(0.139)
Malaysia	141	0.431	0.444	0.481
		(0.120)	(0.110)	(0.103)
Philippines	115	0.612	0.356	0.548
		(0.071)	(0.109)	(0.087)
Thailand	131	0.506	0.510	0.513
		(0.130)	(0.125)	(0.107)
By ownership types				
FOREIGN	318	0.455	0.439	0392
		(0.132)	(0.160)	(0.152)
GOVT	82	0.517	0.411	0.387
		(0.117)	(0.136)	(0.134)
PRIVATE	664	0.517	0.426	0.386
		(0.113)	(0.141)	(0.169)
By sizes				
SMALL	362	0.461	0.417	0.313
		(0.126)	(0.162)	(0.167)
MEDIUM	432	0.540	0.464	0.405
		(0.120)	(0.154)	(0.158)
LARGE	270	0.480	0.387	0.463
		(0.098)	(0.099)	(0.109)
Whole sample	1064	0.498	0.429	0.388
		(0.122)	(0.147)	(0.161)

Table 3.6. The frontier parameter estimates for ASEAN commercial banks (2007-2014).

This table reports the cost and profit frontier parameter estimates for the sample using the SFA model of Kumbhakar et al. (2014). The "" symbol refers to the significant level of each estimation (* significant at 10% level, ** significant at 5% level, *** significant at 1% level).*

Parameter	Variable	Cost Function		Profit Function	
		Estimates	Std.Err	Estimates	Std. Err.
α_1	ln (P_K/P_L)	0.406***	0.099	1.455***	0.553
α_2	ln (P_D/P_L)	0.102	0.110	1.655**	0.639
α_{11}	$0.5\times [ln(P_K/P_L)]^2$	0.041***	0.008	0.094*	0.048
α_{22}	$0.5\times[ln(P_D/P_L)]^2$	0.230***	0.016	0.133	0.094
α_{12}	$ln(P_K/P_L)\times ln(P_D/P_L)$	-0.054***	0.009	-0.050	0.054
γ_1	lnQ_1	0.099**	0.053	0.164	0.304
γ_2	lnQ_2	0.389***	0.056	1.106***	0.313
γ_3	lnQ_3	-0.121***	0.030	0.052	0.172
γ_{11}	$0.5\times(lnQ_1)^2$	0.037***	0.002	0.073***	0.013
γ_{22}	$0.5\times(lnQ_2)^2$	0.018***	0.011	0.041***	0.006
γ_{33}	$0.5\times(lnQ_3)^2$	0.013***	0.001	0.018***	0.005
γ_{12}	$lnQ_1\times lnQ_2$	-0.017***	0.003	-0.051***	0.017
γ_{13}	$lnQ_1\times lnQ_3$	0.005***	0.001	-0.006	0.008
γ_{23}	$lnQ_2\times lnQ_3$	-0.008***	0.001	-0.002	0.008
δ_{11}	$ln(P_K/P_L)\times lnQ_1$	-0.020***	0.005	0.019	0.027
δ_{12}	$ln(P_K/P_L)\times lnQ_2$	-0.015***	0.005	-0.083***	0.020
δ_{13}	$ln(P_K/P_L)\times lnQ_3$	0.016***	0.002	-0.019**	0.009
δ_{21}	$ln(P_D/P_L)\times lnQ_1$	0.019***	0.006	-0.020	0.033
δ_{22}	$ln(P_D/P_L)\times lnQ_2$	-0.001	0.005	-0.044**	0.030
δ_{23}	$ln(P_D/P_L)\times lnQ_3$	-0.002	0.002	0.021	0.014
λ_1	E.ratio	-1.120***	0.104	-0.589	0.575
λ_2	Prod.growth	0.621*	0.350	6.585***	2.11
λ_3	Branch.dens	-0.006**	0.002	-0.031**	0.012
λ_4	Infl	0.043	0.193	0.741	1.155
λ_5	Concentration	-0.224*	0.133	7.322***	0.768
λ_6	NPI			-0.991***	0.123

Table 3.7a, 3.7b, 3.7c, 3.7d. Persistent, time-varying and overall efficiency scores of ASEAN commercials banks over the period of 2007-2014

Table 3.7a, 3.7b, 3.7c, and 3.7b report the average value persistent, residual, and overall efficiency scores of ASEAN banks by year, country, ownership type, and bank size, respectively. The scores are estimated using the Kumbhakar et al. (2014) model. The efficiency score of 1 represents the most efficient bank in the sample in term of both cost and profit. The higher the score, the more cost efficient or profit efficient a bank is.

Table 3.7a. Efficiency scores by year

Year	*Cost efficiency scores*			*Profit efficiency scores*		
	Pers.	*Resid.*	*Overall*	*Pers.*	*Resid.*	*Overall*
2007	*0.8382*	*0.9124*	*0.7649*	*0.5783*	*0.5429*	*0.3158*
2008	*0.8433*	*0.9147*	*0.7724*	*0.5627*	*0.5628*	*0.3242*
2009	*0.8432*	*0.9143*	*0.7717*	*0.5663*	*0.5510*	*0.3196*
2010	*0.8483*	*0.9145*	*0.7766*	*0.5562*	*0.5489*	*0.3076*
2011	*0.8454*	*0.9143*	*0.7744*	*0.5603*	*0.5356*	*0.3028*
2012	*0.8461*	*0.9161*	*0.7755*	*0.5556*	*0.5439*	*0.3063*
2013	*0.8454*	*0.9155*	*0.7746*	*0.5572*	*0.5406*	*0.3045*
2014	*0.8433*	*0.9147*	*0.7710*	*0.5542*	*0.5387*	*0.3006*
Mean	***0.8448***	***0.9148***	***0.7734***	***0.5596***	***0.5444***	***0.3084***

Table 3.7b. Efficiency scores by country

Country	*Cost efficiency scores*			*Profit efficiency scores*		
	Pers.	*Resid.*	*Overall*	*Pers.*	*Resid.*	*Overall*
Vietnam	*0.8515*	*0.9156*	*0.7798*	*0.5452*	*0.5434*	*0.2996*
Cambodia	*0.8453*	*0.9099*	*0.7695*	*0.6204*	*0.5502*	*0.3481*
Indonesia	*0.8768*	*0.9204*	*0.8071*	*0.5132*	*0.5327*	*0.2778*
Malaysia	*0.7762*	*0.9076*	*0.7062*	*0.6247*	*0.5549*	*0.3486*
Philippines	*0.8105*	*0.9153*	*0.7421*	*0.5648*	*0.476*	*0.3223*
Thailand	*0.8627*	*0.9133*	*0.7888*	*0.5475*	*0.5522*	*0.3024*
Mean	***0.8448***	***0.9148***	***0.7734***	***0.5596***	***0.5444***	***0.3084***

Table 3.7c. Efficiency scores by ownership type

Year	*Cost efficiency scores*			*Profit efficiency scores*		
	Pers.	*Resid.*	*Overall*	*Pers.*	*Resid.*	*Overall*
FOREIGN	*0.8305*	*0.9116*	*0.7582*	*0.5620*	*0.5421*	*0.3103*
GOVT	*0.8654*	*0.9196*	*0.7959*	*0.5450*	*0.5379*	*0.2969*
PRIVATE	*0.8490*	*0.9157*	*0.7779*	*0.5602*	*0.5463*	*0.3089*
Mean	***0.8448***	***0.9148***	***0.7734***	***0.5596***	***0.5444***	***0.3084***

Table 3.7d. Efficiency scores by bank size

Country	*Cost efficiency scores*			*Profit efficiency scores*		
	Pers.	*Resid.*	*Overall*	*Pers.*	*Resid.*	*Overall*
SMALL	*0.8633*	*0.9151*	*0.7907*	*0.5610*	*0.5365*	*0.3083*
MEDIUM	*0.8310*	*0.9123*	*0.7590*	*0.5699*	*0.5479*	*0.3152*
LARGE	*0.8419*	*0.9184*	*0.7732*	*0.5411*	*0.5494*	*0.2976*
Mean	***0.8448***	***0.9148***	***0.7734***	***0.5596***	***0.5444***	***0.3084***

Table 3.8a. OLS regressions of bank cost efficiency on diversification index

*Table 3.8a presents the ordinary least squares (OLS) regressions of cost efficiency on diversification index and bank-specific variables. DIV denotes diversification index, ADIV is asset diversification index, FDIV is funding diversification index and IDIV is income diversification. DIV x BIGFOUR, DIV x FOREIGN and DIV x GOVT represent the interaction terms between diversification index and dummy variables representing four biggest banks in a country and bank ownership structures. Other control variables include BIGFOUR dummy, ownership structure (FOREIGN and GOVT dummies), regulation restrictions (REG dummy), banksize (logarithm of total asset), banksize squared, year dummies, and countries dummies. Standard errors are presented in brackets. All t-statistics are based on clustered standard errors at bank level. ***, **, and * present significance at 1%, 5%, and 10% level, respectively.*

Dependent variables	**Residual Cost EFF**			**Overall Cost EFF**		
	ADIV	**FDIV**	**IDIV**	**ADIV**	**FDIV**	**IDIV**
DIV	0.018	-0.003	-0.019*	-0.080*	-0.055	-0.080**
	(0.013)	(0.014)	(0.011)	(0.041)	(0.055)	(0.031)
DIV x BIGFOUR	0.042	0.014	0.008	0.150	0.126	-0.060
	(0.056)	(0.022)	(0.014)	(0.101)	(0.082)	(0.094)
DIV x FOREIGN	0.030	0.014	0.023	0.123	0.080	0.004
	(0.025)	(0.019)	(0.017)	(0.083)	(0.080)	(0.074)
DIV x GOVT	-0.018	0.009	0.011	-0.010	0.182**	0.058
	(0.036)	(0.017)	(0.013)	(0.097)	(0.079)	(0.086)
BIGFOUR	-0.024	-0.008	-0.008	-0.107**	-0.078**	-0008
	(0.030)	(0.009)	(0.007)	(0.053)	(0.029)	(0.045)
FOREIGN	-0.015	-0.007	-0.010	-0.066*	-0.037	-0.008
	(0.012)	(0.007)	(0.007)	(0.038)	(0.030)	(0.028)
GOVT	0.007	-0.005	-0.006	0.024	-0.056	-0.005
	(0.018)	(0.007)	(0.005)	(0.050)	(0.041)	(0.037)
REG	0.006**	0.004*	0.004**	0.071***	0063**	0.067***
	(0.003)	(0.002)	(0.002)	(0.022)	(0.025)	(0.025)
Banksize	-0.036***	-0.033***	-0.033**	-0.236***	-0.246***	-0.0241***
	(0.013)	(0.012)	(0.013)	(0.059)	(0.059)	(0.060)
Banksizesq	0.001***	0.001***	0.001***	0.006***	0.006***	0.006***
	(0.0003)	(0.0002)	(0.0003)	(0.001)	(0.001)	(0.001)
Observations	1064	1064	1064	1064	1064	1064
R-square	0.0384	0.0265	0.0349	0.2957	0.2990	0.3008
F-statistics	2.82	3.16	4.07	5.31	6.45	5.48
(p-value)	(0.0001)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)

Table 3.8b. OLS regressions of bank profit efficiency on diversification index

*Table 3.8b presents the ordinary least squares (OLS) regressions of profit efficiency on diversification index and bank-specific variables. DIV denotes diversification index, ADIV is asset diversification index, FDIV is funding diversification index and IDIV is income diversification. DIV x BIGFOUR, DIV x FOREIGN and DIV x GOVT represent the interaction terms between diversification index and dummy variables representing four biggest banks in a country and banks' ownership structures. Other control variables includes BIGFOUR dummy, ownership structure (FOREIGN and GOVT dummies), regulation restrictions (REG dummy), banksize (logarithm of total asset), banksize squared, year dummies, and countries dummies. Standard errors are presented in brackets. All t-statistics are based on clustered standard errors at bank level. ***, **, and * present significance at 1%, 5%, and 10% level, respectively.*

Dependent variables	**Residual Profit EFF**			**Overall Profit EFF**		
	ADIV	**FDIV**	**IDIV**	**ADIV**	**FDIV**	**IDIV**
DIV	-0.008	0.194***	0.022	0.159**	0.204***	-0.002
	(0.050)	(0.046)	(0.047)	(0.064)	(0.063)	(0.055)
DIV x BIGFOUR	-0.074	-0.035	-0.074	0.139	-0.163	0.065
	(0.101)	(0.081)	(0.076)	(0.181)	(0.199)	(0.175)
DIV x FOREIGN	-0.061	-0.156**	0.010	-0.228**	-0.183*	0.063
	(0.076)	(0.063)	(0.052)	(0.102)	(0.104)	(0.084)
DIV x GOVT	-0.020	-0.150**	0.049	-0.049	-0.105	-0.049
	(0.177)	(0.064)	(0.074)	(0.284)	(0.142)	(0.141)
BIGFOUR	0.025	0.010	0.021	-0.042	0.090	-0.009
	(0.049)	(0.032)	(0.033)	(0.096)	(0.084)	(0.084)
FOREIGN	0.019	0.050*	-0.013	0.087*	0.047	-0.047
	(0.037)	(0.030)	(0.022)	(0.050)	(0.045)	(0.038)
GOVT	0.004	0.045	-0.029	0.021	0.035	0.019
	(0.095)	(0.030)	(0.033)	(0.156)	(0.069)	(0.066)
REG	-0.035***	-0.019	-0.034***	-0.108***	-0.099***	-0.116***
	(0.009)	(0.011)	(0.008)	(0.028)	(0.030)	(0.028)
Banksize	0.025	0.023	0.010	0.247***	0.242**	0.235**
	(0.052)	(0.052)	(0.054)	(0.090)	(0.097)	(0.094)
Banksizesq	-0.001	-0.0004	-0.0002	-0.006***	-0.006**	-0.006**
	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)
Observations	1064	1064	1064	1064	1064	1064
R-square	0.0102	0.0215	0.0094	0.1119	0.1176	0.0976
F-statistics	3.43	2.70	2.86	3.44	2.79	2.45
(p-value)	(0.0000)	(0.0002)	(0.0001)	(0.0000)	(0.0001)	(0.0007)

Table 3.9a. 2SLS regressions of bank cost efficiency on diversification index

Table 3.9a presents the two-stage least squares (2SLS) regressions of cost efficiency on diversification index and bank-specific variables.

The Durbin-Wu-Hausman test is also indicated. The instruments are lags 2 of diversification index (DIV) and interactive variables (DIV x BIGFOUR, DIV x FOREIGN, DIV x GOVT). The null hypothesis states that all regressors are exogenous.

****, **, and * present significance at 1%, 5%, and 10% level, respectively.*

Dependent variables	**Residual Cost EFF**			**Overall Cost EFF**		
	ADIV	**FDIV**	**IDIV**	**ADIV**	**FDIV**	**IDIV**
DIV	0.027	0.009	-0.240	-0.039	-0.125	-0.132
	(0.128)	(0.176)	(0.954)	(0.261)	(0.314)	(0.893)
DIV x BIGFOUR	0.453	-0.045	-0.140	-0.562	0.298	0.867
	(0.625)	(0.226)	(1.563)	(1.272)	(0.402)	(1.463)
DIV x FOREIGN	0.017	0.256	1.276	0.498	0.492	0804
	(0.271)	(0.253)	(1.472)	(0.552)	(0.452)	(1.377)
DIV x GOVT	0.061	-0.156	-0.313	-0.280	0.026	0.021
	(0.235)	(0.405)	(1.252)	(0.480)	(0.721)	(1.172)
BIGFOUR	-0.221	0.014	0.032	0.223	-0.194	-0.480
	(0.301)	(0.110)	(0.758)	(0.614)	(0.196)	(0.709)
FOREIGN	-0.013	-0.118	-0.591	-0.227	-0.234	-0.380
	(0.125)	(0.120)	(0.696)	(0.255)	(0.214)	(0.651)
GOVT	-0.042	0.075	0.153	0.169	-0.001	-0.010
	(0.123)	(0.201)	(0.636)	(0.251)	(0.359)	(0.595)
REG	0.024	-0.003	-0.030	0.040	0.078**	0.094
	(0.027)	(0.021)	(0.087)	(0.055)	(0.038)	(0.081)
Banksize	-0.047	-0.100***	-0.226	-0.395***	-0.349***	-0.387**
	(0.057)	(0.036)	(0.199)	(0.116)	(0.064)	(0.186)
Banksizesq	0.001	0.002***	0.005	0.009***	0.008***	0.009**
	(0.001)	(0.001)	(0.005)	(0.003)	(0.001)	(0.004)
Observations	533	533	533	533	533	533
Durbin-Wu-Hausman (p-value)	0.876	2.939	8.242	2.036	2.529	2.157
	(0.9279)	(0.5681)	(0.083)	(0.7291)	(0.6395)	(0.7069)

Table 3.9b. 2SLS regressions of bank profit efficiency on diversification index

Table 3.9b presents the two-stage least squares (2SLS) regressions of profit efficiency on diversification index and bank-specific variables.

The Durbin-Wu-Hausman test is also indicated. The instruments are lags 2 of diversification index (DIV) and interactive variables (DIV x BIGFOUR, DIV x FOREIGN, DIV x GOVT). The null hypothesis states that all regressors are exogenous.

****, **, and * present significance at 1%, 5%, and 10% level, respectively.*

Dependent variables	**Residual Profit EFF**			**Overall Profit EFF**		
	ADIV	**FDIV**	**IDIV**	**ADIV**	**FDIV**	**IDIV**
DIV	-0.623	-0.772	3.714	-0.219	0.047	2.230
	(0.764)	(0.880)	(3.938)	(0.658)	(0.748)	(2.381)
DIV x BIGFOUR	1.069	0.512	-2.580	1.988	0.274	01.823
	(3.722)	(1.127)	(6.455)	(3.207)	(0.958)	(3.902)
DIV x FOREIGN	-1.479	-0.373	-2.31	-1.571	-0.970	-2.869
	(1.615)	(1.264)	(6.077)	(1.391)	(1.075)	(3.674)
DIV x GOVT	0.669	1.607	-1.467	0.851	2.150	-0.905
	(1.405)	(2.019)	(5.169)	(1.211)	(1.712)	(3.125)
BIGFOUR	-0.456	-0.231	1.253	-0.878	-0.090	0.968
	(1.795)	(0.549)	(3.129)	(1.547)	(0.466)	(1.892)
FOREIGN	0.652	0.144	1.201	0.681	0.424	1.383
	(0.340)	(0.600)	(2.873)	(0.642)	(0.510)	(1.737)
GOVT	-0.318	-0.776	0.858	-0.435	-1.046	0.537
	(0.736)	(1.006)	(2.625)	(0.634)	(0.855)	(1.587)
REG	0.022	0.020	-0.025	-0.010	-0.020	-0.109
	(0.161)	(0.106)	(0.358)	(0.138)	(0.090)	(0.217)
Banksize	0.652*	0.480***	-0.347	0.768***	0.557***	0.302
	(0.340)	(0.178)	(0.822)	(0.292)	(0.151)	(0497)
Banksizesq	-0.015*	-0.011***	0.008	-0.018***	-0.013***	-0.007
	(0.008)	(0.004)	(0.019)	(0.007)	(0.004)	(0.012)
Observations	533	533	533	533	533	533
Durbin-Wu-Hausman (p-value)	5.532 (0.2369)	5.260 (0.2617)	6.679 (0.1539)	6.825 (0.1454)	5.860 (0.2098)	3.031 (0.5527)

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GENERAL CONCLUSION

Over the past decades, ASEAN banks have faced substantial changes occurring in the banking industry. Specifically, the processes of banking consolidation and regulatory tightening have essentially affected bank operations. Hence, determining the efficiency of ASEAN bank operations is highly important to evaluate the effectiveness of the current bank restructuring progress. In addition to the aforementioned external factors, specific bank characteristics are also important factors affecting bank efficiency. As banks are characterized as generally more opaque and heavily intervened by the government, it is more difficult for banks to achieve their aims of maximizing shareholder interests. Hence, effective corporate governance mechanisms are crucial to ensure bank efficiency. In addition, bank business model is also considered to be a key factor that influences bank efficiency by both bank managements and regulators. Due to banks' important roles in the economy, bank supervisors tend to encourage banks to diversify to reduce risks. Furthermore, the consolidation process also makes banks more diversified as it results in newly merged banks that are normally larger and more complex than pre-merger banks. On the other hand, tightening regulations limit banks to participate in non-traditional activities, which makes them less diversified. Thus, conflicting policies on bank diversification suggest that research on the optimal bank business model for ASEAN banks is highly essential.

The aim of this thesis is therefore to determine the efficiency level of ASEAN banks and examining corporate governance and diversification as potential determinants of banks. This conclusion summarizes the main results and contributions of the three previous chapters.

The purpose of the first chapter is to accurately measure the economic efficiency levels of ASEAN commercial banks from 2007 to 2014. The SFA model of Kumbhakar et al. (2014) is employed to estimate the cost and profit efficiency of ASEAN commercial banks in both long term and short term. The sample comprised 175 commercial banks from six countries: Vietnam, Cambodia, Indonesia, Malaysia, the Philippines, and Thailand. The results show that ASEAN banks are largely cost efficient but highly profit inefficient. The average permanent, residual, and overall cost efficiency scores are 0.8448, 0.9148, and 0.7734, respectively. On the other hand, the average permanent, residual, and overall profit efficiency scores are relatively low at 0.5596, 0.5444, and 0.3084, respectively. Regarding the general trend, the cost and profit efficiency scores are found to be generally unchanged for the whole sample during the sample period. The stable trend could be explained by the impacts of consolidation processes accompanied by tightening regulation in individual countries. In terms of ranking, Indonesian banks are the most cost efficient but the least profit efficiency,

while Malaysian banks are the least cost efficient but the most profit efficient. The difference in efficiency ranking is partly explained using general knowledge of ASEAN banking sectors, such as the levels of productivity growth, bank branch density or industry concentration.

The second chapter of this thesis examines the impact of corporate governance on cost and profit efficiency of ASEAN banks in both long term and short term. Various aspects of corporate governance are explored for ASEAN banks, including: ownership structure (government ownership and foreign ownership) and board structure (board size, board independence, and CEO duality). This chapter has addressed for the endogeneity problem, which is extensively discussed in the literature when estimating the relationship between corporate governance and bank performance. By employing the estimation model of Dynamic System GMM, three different type of endogeneity problem between bank performance and corporate governance are accounted for, including: dynamic endogeneity, simultaneity, and unobserved heterogeneity. Different models (OLS and Fixed Effects Model) are also employed to demonstrate the impacts of endogeneity on estimation results. In terms of corporate governance and cost efficiency, the results show that government-owned banks are more cost efficient than private and foreign banks, which could be justified by their access to cheaper inputs. Furthermore, banks with lower board independence levels are associated with higher cost efficiency scores. Moreover, no significant impact of foreign ownership, board size, and CEO duality on cost efficiency is found. In terms of corporate governance and profit efficiency, ownership structure and board structure are found to have no significant impacts on banks' abilities to maximize their profits. The results support the argument of stewardship theory that outside directors have limited abilities to contribute to bank operations as they are less informed and have less understanding of the business compared to inside directors (Donaldson, 1990, Petra, 2005).

The third chapter evaluates the effect of bank diversification on their cost and profit efficiency. Bank diversification is analyzed using three dimensions: asset, funding, and income. To investigate the relationship between diversification and bank efficiency, OLS regressions are employed. The general findings suggest a negative relationship between diversification and bank cost efficiency, but a positive relationship between diversification and bank profit efficiency. Specifically, the results highlight that more income-diversified banks are linked to lower cost efficiency levels in both long term and short term, while more asset-diversified banks are only associated with lower cost efficiency scores in long term. In addition, the results also indicate that more funding-diversified banks are more profit efficient

in both long term and short term, while more asset-diversified banks are only more profit efficient in long term. Furthermore, the chapter also takes into account the mitigating role of ownership when estimating the diversification-efficiency relationship. The regression outcomes show that funding-diversified banks associated with government ownership enjoy higher levels of cost efficiency in long term but suffer from lower levels of profit efficiency in short term. Furthermore, funding-diversified banks associated with foreign ownership exhibit lower levels of profit efficiency scores in both long term and short term, while asset-diversified foreign banks have lower long-term profit efficiency scores. In other words, diversification demonstrates significant negative impacts on foreign banks' profit efficiency levels.

Overall, this thesis emphasizes several challenges for both banks and bank regulators. First, the results that ASEAN banks demonstrate stable high cost efficiency scores but very low profit efficiency scores over the sample period, have raised questions regarding the effectiveness of bank restructuring process in the examined countries. Apparently, consolidation and restrictive regulations have helped banks to maintain high cost efficiency levels but also prevented banks from achieving higher profit efficiency.

Second, the results confirm that government ownership and board independence are determinants of bank cost efficiency while bank profit efficiency is not significantly affected by any ownership or board structure elements. This suggests bank managers and regulators take into account government ownership and the fraction of outside directors in the board when trying to reduce bank cost. Furthermore, ownership and board structure are not necessary to be taken into account when considering enhancing bank profit.

Finally, the previous results suggest that positive effects of diversification on both cost and profit efficiency of ASEAN banks. However, significant negative impacts on cost efficiency are only found for income- and asset-diversification dimensions. Significant positive impacts on profit efficiency are only found for funding- and asset-diversification dimensions. Furthermore, when ownership is taken into consideration, opposite results are found for diversification and efficiency. Specifically, diversification positively affects government-owned banks' cost efficiency but negatively affects their profit efficiency. Moreover, diversification also has negative impacts on foreign banks' profit efficiency. Hence, different bank business models or different diversification-related policies must be accounted for when dealing with each efficiency perspective and each group of bank.

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Gouvernance d'entreprise, diversification et efficience des banques de six pays de l'ASEAN

Résumé

Cette thèse est construite autour de trois essais empiriques examinant les niveaux d'efficience et les effets de la gouvernance d'entreprise et de la diversification sur l'efficience des banques de l'ASEAN. Avec le premier essai, le modèle AFS de Kumbhakar et al. (2014) est utilisé pour mesurer les niveaux d'efficience des banques commerciales de l'ASEAN. Les résultats font apparaître que les banques de l'ASEAN sont très économiques mais peu rentables. Les banques malaisiennes sont les plus rentables mais les moins économiques, alors que les banques indonésiennes sont les moins rentables mais les plus économiques. Aucune tendance générale à la progression ou au recul du niveau d'efficience ne se dégage sur l'ensemble de l'échantillon. Le second essai utilise le modèle Dynamic System GMM pour estimer les effets de différents aspects de la gouvernance d'entreprise sur l'efficience des banques, afin de vérifier toutes les formes d'endogénéité. Il en ressort que les banques ayant les plus fortes participations de l'État et la plus faible indépendance de l'organe de direction ont un meilleur rapport coût-efficience. En outre, on ne trouve pas d'élément de preuve déterminant quant aux effets de la structure de proprieté et des caractéristiques du conseil sur l'efficience profits. Le dernier essai estime l'influence de la diversification sur l'efficience des banques. Les résultats généraux font apparaître une relation positive entre diversification et rapport coût-efficience, mais une relation négative entre diversification et rentabilité. D'autre part, les banques ayant un financement diversifié et une participation de l'État ont un meilleur rapport coût-efficience mais une rentabilité inférieure à celle des autres banques. De plus, la diversification des financements et des actifs pourrait rendre les banques étrangères moins rentables.

Mots clefs français : efficience des banques, ASEAN, AFS, structure actionnariale, structure de l'organe de direction, diversification

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Corporate governance, diversification, and bank efficiency in six ASEAN countries

Abstract

This thesis consists of three empirical essays examining the efficiency levels and the effects of corporate governance and diversification on efficiency of ASEAN banks. Chapter 1 uses Kumbhakar et al.'s (2014) SFA to measure the efficiency levels of ASEAN commercial banks. The results show that ASEAN banks are highly cost efficient but very low profit efficient. Malaysian banks are found to be the most profit efficient but the least cost efficient, while Indonesian banks are the least profit efficient but the most cost efficient. No general trend of increasing or decreasing in efficiency levels is found for the whole sample. In chapter 2, to estimate the impacts of various aspects of corporate governance on bank efficiency, the Dynamic System GMM is used with the purpose of control for all forms of endogeneity. The results suggest that banks with higher degrees of government ownership and lower levels of board independence exhibit higher levels of cost efficiency. In addition, no significant evidence is found for the effects of ownership structure and board characteristics on profit efficiency. Chapter 3 estimates the influence of diversification on bank efficiency. The general findings suggest a positive relationship between diversification and cost efficiency but a negative relationship between diversification and profit efficiency. On the other hand, funding-diversified banks associated with government ownership demonstrate higher cost efficiency but lower profit efficiency compared to other banks. While, funding and asset diversification could make foreign banks less profit efficient.

Keywords : bank efficiency, ASEAN, SFA, ownership, board structure, diversification

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