Would Bank Mergers and Acquisitions Improve Technical Efficiency of Vietnamese Commercial Banks?

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Abstract

The Vietnamese banking system has experienced a period of restructuring. Trends such as globalisation, liberalisation and innovation of financial markets from 1990 to 2011 have affected not only the competitive viability of banks but also the nature of the intermediation business. Banks include mergers and acquisitions among the strategies they adopt to address the challenges of an increasingly competitive environment. This study investigates whether bank mergers would have improved efficiency of the Vietnamese banking system between 2007 and 2011, when the impact of the global financial crisis (GFC) (2007–08) is taken into account.

The synergy theory posits that efficiency gains resulting from bank mergers can be achieved through economies of scale and economies of scope, selective redeployment of assets and transfer of assets control to better quality managers. A bootstrap data envelopment analysis approach is used to pre-evaluate whether virtual bank mergers would generate technical efficiency gains. Accordingly, 136 virtual bank mergers are created as derived from the original sample of 21 Vietnamese commercial banks. The bias-corrected efficiency scores of banks in the sample are then calculated. The findings reveal that the exclusion of off-balance-sheet activities from output specification underestimates the technical efficiency of Vietnamese banks and reduces the number of possible combinations for virtual bank mergers. In addition, the study shows that, for virtual bank mergers that include a state-owned commercial bank, the post-GFC technical efficiency is higher than for virtual bank mergers that do not include a state-owned commercial bank, and for the pre-GFC technical efficiency of virtual bank mergers that include state-owned commercial banks and privately owned commercial banks. This suggests that mergers that include a state-owned commercial bank should be encouraged.

In addition, the study investigates the determinants of technical efficiency in Vietnamese commercial banks. The findings show that state-owned commercial banks are more efficient than privately owned commercial banks. This reinforces the earlier finding that mergers that include a state-owned commercial bank should be promoted. Furthermore, the findings indicate that banks that are more-diversified are more efficient than banks that are less-diversified. This suggests that Vietnamese banks should diversify by including non-traditional activities in order to improve their operating efficiency. The findings also confirm that banks with more capital are more efficient than those with less capital. This suggests that policy-makers could further increase the minimum charter capital requirement on banks in order to improve their ability to absorb losses and to enhance their efficiency. In fact, the current level of charter capital requirement in Vietnam is much lower than what is suggested in Basel III. Finally, it is found that banks that are better managed are more efficient than those that are poorly managed. This suggests that banks should implement superior management practices in their day-to-day operations and minimise their input usage.

Keywords: Data envelopment analysis, bootstrap technique, Vietnam-mergers and acquisitions, bank efficiency, global financial crisis

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List of abbreviations

ABB	An Binh Commercial Joint Stock Bank
ACB	Asia Commercial Joint Stock Bank
AGB	Bank for Agriculture and Rural Development
ATM	automated teller machine
BCVRS	bias-corrected variable returns to scale efficiency score
BIAS	bootstrap bias estimates
BIDV	Joint Stock Commercial Bank for Investment and Development of Vietnam
CAR	capital adequacy ratio
CEO	chief executive officer
Co-op Bank	Co-operative Bank of Vietnam
CRS	constant returns to scale
CTG	Vietnam Joint Stock Commercial Bank of Industry and Trade
DEA	data envelopment analysis
DFA	distribution free approach
DMU	decision-making unit
EAB	Dong A Joint Stock Commercial Bank
EIB	Vietnam Export Import Commercial Joint Stock Bank
EQUITY/TA	ratio of total equity to total assets
ESH	efficient structure hypothesis
FB	foreign bank
FDH	free disposal hull
GDP	gross domestic product
GFC	global financial crisis
HBB	Hanoi Building Commercial Joint Stock Bank
HDB	HoChiMinh Development Joint Stock Commercial Bank

HHI	Herfindahl-Hirschman Index
IAS	International Accounting Standards
IDG	International Data Group
IMAA	Institute of Mergers, Acquisitions and Alliances
IMF	International Monetary Fund
ISA	Inspection and Supervision Authority
POCB	privately owned commercial bank
JVB	joint-venture bank
LB	lower bound
LLP/TL	ratio of loan loss provisions to total loans
M&A	merger and acquisition
MB	Military Commercial Joint Stock Bank
MHB	Mekong Housing Bank
MOF	Ministry of Finance
MOS	mixed optimal strategy
MSB	Maritime Commercial Joint Stock Bank
NIE/TA	ratio of non-interest expenses to total assets
NII	non-interest income
NII/TA	ratio of non-interest income to total assets
NIM	net interest margin
NPL	non-performing loan
NVB	National Citizen Commercial Joint Stock Bank
OBS	off-balance-sheet
OceanBank	Ocean Commercial Joint Stock Bank
OLS	ordinary least square
PNB	Southern Commercial Joint Stock Bank
POCB	privately owned commercial bank

ROA	return on assets
ROE	return on equity
RQ	research question
SBV	State Bank of Vietnam
SD	standard deviation
SFA	stochastic frontier approach
SHB	Saigon-Hanoi Commercial Joint Stock Bank
SME	small and medium enterprises
SOCB	state-owned commercial bank
STB	Saigon Thuong Tin Commercial Joint Stock Bank
TA	total assets
TBTF	too-big-to-fail
TD	total deposits
TechcomBank	Vietnam Technological and Commercial Joint Stock Bank
TFA	thick frontier approach
UB	upper bound
VAS	Vietnamese Accounting Standards
VBSP	Vietnam Bank for Social Policies
VCB	Joint Stock Commercial Bank for Foreign Trade of Vietnam
VDB	Vietnam Development Bank
VietCapitalBank	Viet Capital Commercial Joint Stock Bank
VMB	virtual bank merger
VND	Vietnam Dong Currency
VPBank	Vietnam Commercial Joint Stock Bank for Private Enterprises
VRS	variable returns to scale
WB	The World Bank
WesternBank	Western Commercial Joint Stock Bank

WTO	World Trade Organization

Chapter 1 Introduction

Banks and the various important roles they play are critical to the financial system of any economy. Trends that have occurred over the past decade, such as globalisation, liberalisation and innovation of financial markets, affect not only the competitive viability of banks but also the nature of the intermediation business. Banks undertake mergers and acquisitions (M&As) as one of a range of strategies to address the difficulties they face in an increasingly competitive environment. The literature on bank mergers is dominated by studies from the US and Europe, where larger markets and higher numbers of banks have facilitated economic modelling. Prior studies have suggested that there is no consensus on the efficiency gains that can result from bank mergers. The situation is even less clear in Vietnam, because its limited number of banks – and therefore possible bank mergers – result in a small sample size which makes it difficult to conduct empirical research. Consequently, it is unclear whether bank mergers would have improved efficiency of the Vietnamese banking system.

The aim of this study is to investigate the impact of mergers on the efficiency of the merging banks and non-merging banks in a developing country. Vietnam provided an appropriate situation for this investigation because the Prime Minister of Vietnam on 1 March 2012 officially released Decision No. 254/QD-TT on restructuring the credit institutions system with the main focus on bank mergers (The Vietnamese Government 2012). Its key terms of reference included reassessing the financial health of credit institutions in terms of bad debt and capital requirements; scheduling the process of equitising state-owned commercial banks (SOCBs); regulation of the financial system; competition; and technological development. Accordingly, the State Bank of Vietnam (SBV), or the central bank, is responsible for supervising and promoting banks M&As. Since M&As are a relatively new phenomenon in the Vietnamese banking system, compared with the length of time other markets have been involved with M&As, this study has important implications for policy-makers working to

strengthen the banking sector in Vietnam. The study provides a strategic tool to enable Vietnamese authorities to pre-evaluate whether virtual bank mergers (VBMs) generate technical efficiency gains in Vietnamese banks between 2007 and 2011.

1.1 The background of the present study

This section first emphasises the role of the banking system in any economy, and then discusses the banking system in the Vietnamese economy. Then, an overview of bank mergers, both globally and locally, is presented.

1.1.1 Why study banks?

The financial sector plays an essential role in any economy. By compiling the theoretical and empirical evidence on the relationship between financial development and economic growth, Levine (2005) classified the functions of the financial sector into five categories:

- producing information ex-ante about possible investment and allocating capital
- monitoring investments and exerting corporate governance after providing finance
- facilitating the trading, diversification and management of risk
- mobilising and pooling savings
- easing the exchange of goods and services.

In developing economies, the role of the banking industry is even more important, due to the relatively undeveloped stock market (Levine 2005).

Allen and Carletti (2009) proposed that the banking industry, a critical component of the financial sector, has three specific roles. First, banks play an essential role in the channelling of funds between savers and borrowers as well as in solving various informational problems between them. Banks borrow via accepting deposits from individuals, businesses, financial institutions and governments with surplus funds (savings). The deposits and borrowed funds

are used to generate loans (to businesses, other financial institutions, individuals and governments) and make investments. Consequently, the lending function of banks is the means by which money is supplied in the economy. Furthermore, banks fulfil their intermediary functions by acting as a delegated monitor and offer the information necessary for the efficient allocation of resources (Boot & Thakor 1997; Diamond 1984). This may help reduce the information problems that can exist in the relationship between lenders and borrowers (Boot & Thakor 1997). Without financial intermediaries, lenders cannot obtain complete information about borrowers' future projects; conversely, lenders cannot observe whether borrowers intend to invest the funds in a risky or safe project unless they pay a fixed cost to monitor the borrower. In a financial market with many lenders, there is a free-rider issue. Small lenders may find that it is not worth paying this fixed cost. Instead, they free-ride – they leave it to someone else to bear the monitoring costs. This leads to a lack of monitoring, which allows borrowers to invest in a risky project (Allen & Carletti 2009). Banks can alleviate information problems between lenders and borrowers by monitoring the borrowers and ensuring the proper use of depositors' funds (Boot & Thakor 1997).

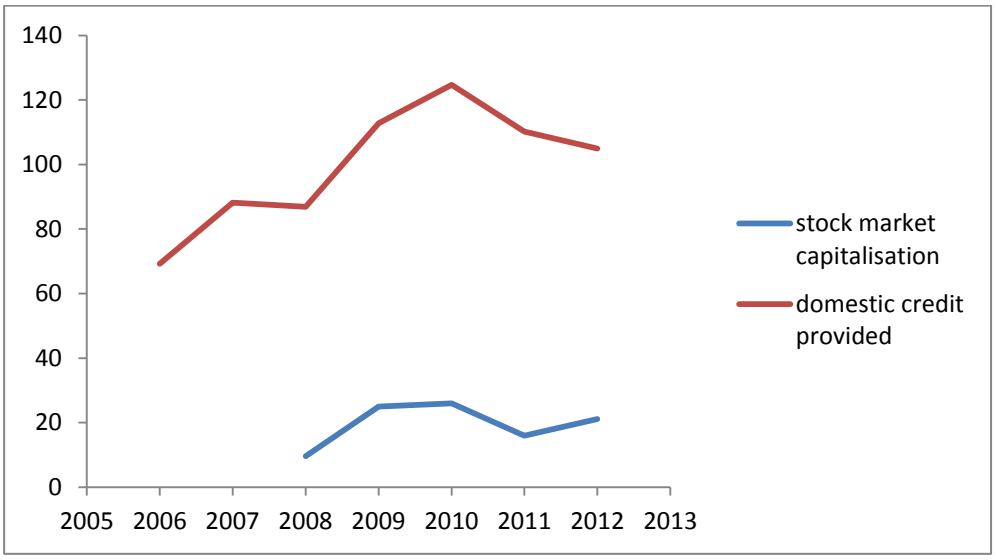
Second, banks contribute to economic growth by facilitating the investment that is critical to a growing market economy. The literature indicates that there are positive relationships between financial development, investment and growth (King & Levine 1993; Levine & Zervos 1998; Misati & Nyamongo 2011). When banking systems function well, they can ease the external financing constraints that impede firm and industrial growth. Banks can also reduce the cost of information, as discussed above. In addition, bank-based markets can enhance resource allocation efficiency, which positively impacts on savings, investment and economic growth.

Third, banks play a crucial role in sharing risk in the economy, by diversifying and smoothing fluctuations over time (Allen & Gale 1997). Intertemporal smoothing of risk can be averaged

over time in a way that mitigates their impact on individual welfare. Banks increase reserves when the returns on their assets are relatively high, and reduce reserves when the returns on their assets are relatively low. Consequently, banks can put aside a relatively consistent amount of reserves each period, thus minimising the risk on deposits.

The importance of the different roles of banks varies substantially across countries and times, but banks are always important to the financial system. In the context of Vietnam, the equity market is not sophisticated. Figure 1.1 compares the domestic credit provided by the Vietnamese banking sector with stock market capitalisation in Vietnam. It suggests that the Vietnamese stock market has been at the early stage of development. Consequently, the banking system is the main pillar of the Vietnamese financial system.

Figure 1.1 Comparison of domestic credit provided by the Vietnamese banking sector and market capitalisation in Vietnam, 2006 to 2012



Source: The World Bank database (WB 2012)

It is important to note that banks are fragile, especially when exposed to financial contagion. Thus the failure of one bank could have wide-ranging consequences for the economy. Indeed, changes in scale, and in the organisational and market structure, of the banking industry would have critical implications for not only the future evolution of financial markets but also

the implementation of monetary policies. M&As are an integral part of the dynamic market of organisational forms. Consequently, the impact of bank mergers is widely examined in the literature.

1.1.2 Why study Vietnam?

Because the capital market in Vietnam is not developed, this offers a unique context to study Vietnam given that prior studies mostly confined to developed countries. Since the implementation of 'doi moi' (Renovation Reforms) in 1986, Vietnam's economy has achieved remarkable growth and a rapid transformation in production structure. According to World Development Indicators (WB 2012), the growth rate of gross domestic product (GDP) averaged 6.2% between 2006 and 2012. Vietnam was recognised as having one of the highest economic growth rates in the world, just behind China (Nguyen, Roca & Sharma 2014). Consequently, it is considered that Vietnam will be Asia's next dragon. More specifically, within the Association of Southeast Asian Nations (ASEAN) region, Vietnam is one of leaders when it comes to economic performance (Abbott & Tarp 2012).

The Vietnamese banking system is a backbone of the Vietnamese economy (Stewart, Matousek & Nguyen 2016). When domestic credit supplied by commercial banks is expanding, consumers can borrow and spend more and businesses can borrow and invest more. Improving consumption and investment creates jobs and generates income and profits. In addition, the expansion of credit tends to increase the price of assets (shares and property), thus enhancing the net worth of households. For example, GDP growth rate reached a peak of 8.5% in 2007, when the credit growth rate was 51% (WB 2012). The lending balance of the banking sector in Vietnam is concentrated on manufacturing and processing (24%) and trading and motor repairing (21%), followed by other industries (19%), agriculture, forestry, aquaculture and mining (12%) and construction (10%) (KPMG 2013). Consequently, the efficiency of the Vietnamese banking system has received much attention from academic

researchers and practitioners (Minh, Long & Hung 2013; Nguyen & Simioni 2015; Nguyen, Roca & Sharma 2014). The efficiency of the banking system is affected by changes in scale and market structure, especially when M&A activities have taken place. Since M&As are a relatively new phenomenon in the Vietnamese banking system, compared with the length of time other markets have been involved with M&As, this study has important implications for policy-makers working to strengthen the banking sector in Vietnam. The study provides a strategic tool to enable Vietnamese authorities to pre-evaluate whether VBMs generate technical efficiency gains in Vietnamese banks between 2007 and 2011.

1.1.3 Overview of bank mergers

Before presenting an overview of bank mergers both globally and in Vietnam, it is useful to establish a background, beginning with basic terminology.

1.1.3.1 Terminology

'Merger' is defined as a combination of two firms in which only one firm survives; typically, the merged entity ceases to exist. In a merger, the acquirer receives the assets of the target and assumes its liabilities. A merger may also take place when two firms of the same size cease to exist after they are combined to create a new firm (Gaughan 2005). A merger is seen as a friendly combination: the parties meet to discuss the prospective deals, which are then taken to shareholders as a 'marriage of equals' (Alluru & Thomas 2016).

'Acquisition' refers to the outright purchase of a firm or a majority of that firm. The acquiring firm typically, but not always, remains the dominant force in the newly-combined business, and its directors fill critical management roles (White & Bruton 2010).

Some authors pointed out that the terms 'merger' and 'acquisition' are used differently in different contexts, due to the legal differences between the two terms (Narver 1967). Thus it is important that this study looks at how the terms are defined by legal entities in Vietnam.

The SBV defines ‘bank merger’ as an act whereby one or several banks transfer all of its/their property, rights, obligations and legitimate interests to another bank, and at the same time the existence of the merging banks is terminated. A ‘bank acquisition’ refers to an act whereby a bank acquires the whole of another bank, or a portion of its assets large enough to control or dominate all or one of the trades of the acquired bank (SBV 2010b).

Although they involve very different types of business activities, it is not easy to differentiate mergers from acquisitions in practical terms (White & Bruton 2010). In line with the views of Gaughan (2005) and Narver (1967), Connell (2008) argued that the terms ‘merger’ and ‘acquisition’ are generally used in similar ways in academic literature and trade press, and by M&A industry participants. Therefore, the terms are used interchangeably in this study to mean any transition that forms a new economic unit from two previously existing units.

This study is the first attempt to examine whether bank mergers would generate technical efficiency gains in Vietnam. Accordingly, it will be useful to define ‘technical efficiency’ as it relates to banks. Technical efficiency is defined as the ability of a bank to produce an existing level of output with minimal inputs (input-oriented), or to produce maximum output from a given set of inputs (output-oriented) (Coelli et al. 2005). In other words, Sathye (2001) suggested that the concept of technical efficiency is associated with productivity inputs.

1.1.3.2 Global bank mergers

Trends such as globalisation, liberalisation and innovation in financial markets, and other reforms and restructuring programs over the past decades have affected not only the competitive viability of banks but even the nature of the intermediation business per se (Vander Vennet 1996). During the late 1990s and early 2000s, the global banking system witnessed an acceleration in bank mergers, which was documented in two notable studies by DeYoung, Evanoff and Molyneux (2009) and Kolaric and Schiereck (2014). Bank mergers

between 2000 and 2010 were usually large and characterised by high transaction values. Most active deals took place in developed banking markets, such as the US and Europe. For example, mergers among US banks had a combined transaction value of more than US$375 billion, and the total value of intra-European transactions exceeded US$330 billion (Kolaric & Schiereck 2014). Unlike other markets, M&A activities in the Vietnamese banking system are relatively new. For instance, between 2011 and 2013 there were three mergers between financial institutions in Vietnam (SBV 2012, 2013).

As banking markets mature over time, it becomes difficult for acquiring banks to outperform their peers. In particular, the takeover market becomes competitive, and an acquirer might have to pay a high premium for an acquired bank. This leads to a more critical evaluation of the value of proposed transactions by capital markets and hampers the performance of the newly-formed institutions. Further, new regulations and a more competitive environment make it more essential than ever for financial institutions in Vietnam to understand what to expect from M&As, including which factors play a decisive role in successfully undertaking the transaction.

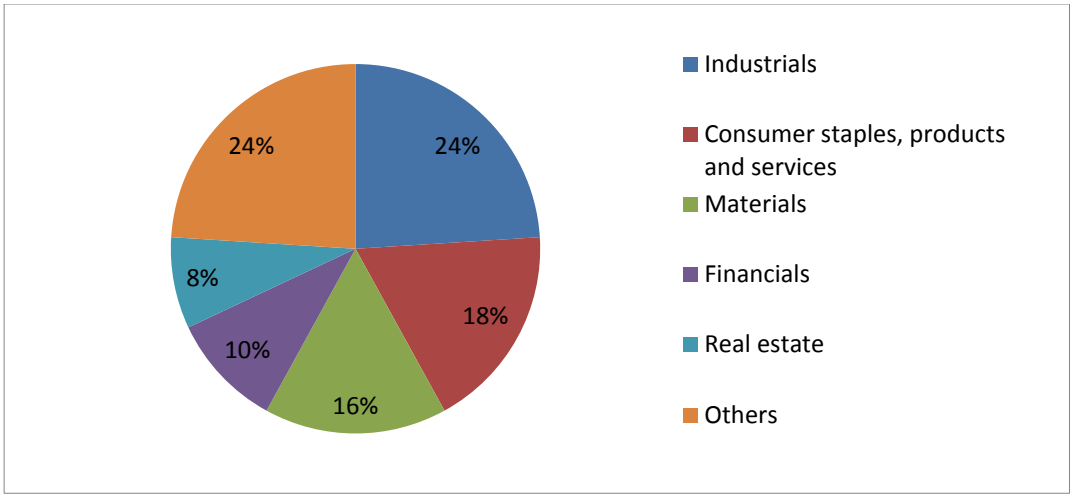
1.1.3.3 Mergers in Vietnam

In line with global trends, M&A activities in Vietnam have increased in terms of transaction volume and the value of the deals. The period 2003 to 2013 was considered to be the first wave of M&As in Vietnam, peaking between 2008 and 2013 with a total value of US$15 billion (The Business Times 2012). Specifically, 750 M&A transactions were completed between 2009 and 2011, with a total worth of US$6.89 billion. Unlike other markets in the Asia-Pacific region, which saw a decline in both transaction volume and deal value in 2010 and 2011, the number of M&A deals in Vietnam increased slightly, while the total value in 2011 was more than twice as much as it was in 2010. Consequently, Vietnam was ranked eighth in the most active M&A deals in the Asia-Pacific region (The Business Times 2012).

Upon close analysis, it can be seen that M&A activities have occurred in various industries in Vietnam. Figure 1.2 indicates that industrials accounted for 24% of transaction volumes in M&A activities, followed by consumer staples, products and services at 18%. In terms of the value of deals, Figure 1.3 shows that the financial sector accounted for 24% of deal values, followed by the media and entertainment sector at 20%. As can be seen, M&As in the financial sector were characterised by large transaction values, despite involving limited numbers of transactions.

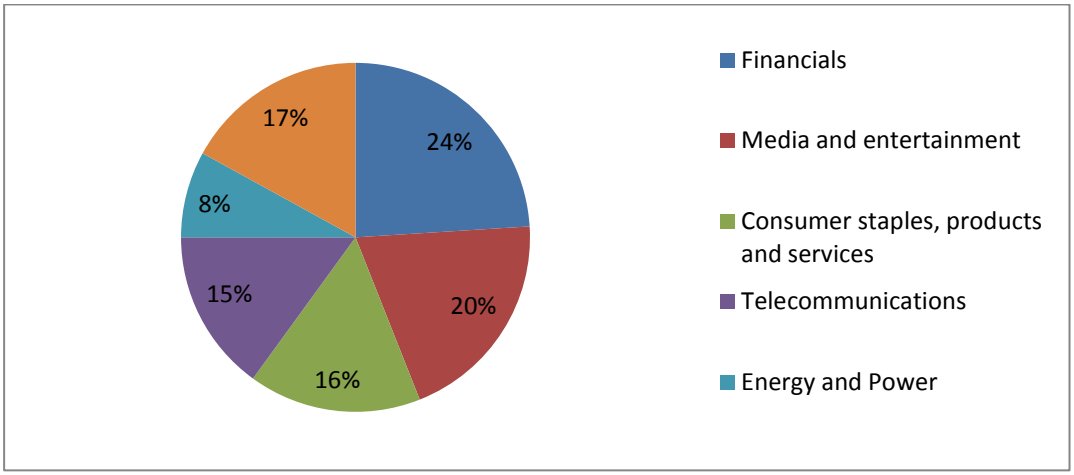
Domestic firms accounted for most of the M&As in 2011, at 77% of all transactions. However, foreign acquisitions played an important role in transaction values, accounting approximately two-thirds of total value in 2011 (IMAA 2012).

Figure 1.2 M&As in Vietnam by transaction volume, 2011



Source: Institute of Mergers, Acquisitions and Alliances (IMAA) (IMAA 2012)

Figure 1.3 M&As in Vietnam by transaction value, 2011



Source: IMAA (2012)

In response to the impact of the GFC (2007–08), the Vietnamese Government (2012) officially released a program for the restructuring of credit institutions, under Decision No. 254/QD-TT, with a focus on bank mergers. Its key terms of reference included reassessing the financial health of credit institutions in terms of bad debt and capital requirements; scheduling the process of equitising SOCBs; and regulating the financial system, competition and technological development. More importantly, the program also indicated that M&As between credit institutions should be encouraged in order to strengthen the banking system. Consequently, the second merger wave in Vietnam is expected to take place in the banking sector between 2015 and 2018.

In fact, the Vietnamese banking system between 2011 and 2013 witnessed three bank mergers. In general, the primary goals of these mergers were to (1) improve the efficiency and competitiveness of domestic banks (2) increase the charter capital to meet the minimum charter capital requirement of VND 3,000 billion and (3) improve the capital adequacy ratio in line with Basel III as proposed by the Basel Committee. The Basel Committee is the primary global standard-setter for prudential regulation of banks, and it provides a forum for cooperation on banking supervisory matters (BIS 2015).

In contrast with the views of bankers and policy-makers, the literature on bank mergers shows conflicting results (DeYoung, Evanoff & Molyneux 2009; Kolaric & Schiereck 2014). This raises concerns about whether bank mergers would have improved efficiency of the Vietnamese banking system. So far, no study has been done to examine the efficiency effect of bank mergers in Vietnam. This study is the first attempt to address this current gap in the empirical research and outline policy measures that could be implemented by the Vietnamese authorities in decision-making processes around bank mergers.

1.2 What is this study about?

Due to the limited number of banks and bank mergers in Vietnam, this study examines the efficiency effect of VBMs in Vietnam using an economic frontier approach rather than standard financial ratio analysis. This approach will result in a strategic tool that Vietnamese authorities can use in order to pre-evaluate whether bank mergers would generate technical efficiency gains.

1.2.1 Identifying research gaps

Four major research gaps were identified and addressed in this study.

First, prior studies investigating the efficiency effect of bank mergers have not taken into account off-balance-sheet (OBS) activities. Two comparable simulation studies, by Halkos and Tzeremes (2013) using Greek data and by Halkos, Matousek and Tzeremes (2014) using Japanese data, did not include OBS activities in their estimations. The OBS items are included in this study for a number of reasons. Banks around the world have been shifting away from traditional lending into OBS activities, such as fee-based activities (Drake & Hall 2003). OBS activities generally include loan commitments, non-financial guarantees, standby letters of credit, foreign exchange, securitisation, financial futures, forward contracts, options, interest rate swap contracts, and a rapidly expanding range of other derivative products (Board of

Governors of the Federal Reserve System 1997; Lieu, Yeh & Chiu 2005; Meisenzahl 2015). Increasing amounts of bank incomes are made up of OBS activities. For example, in US banks the income generated by OBS activities reached a peak of 44% of operating income in 2003, up from 35% in 1993 and 24% in 1983 (DeYoung & Torna 2013). Additionally, total assets grew from US$3 trillion in 1990 to approximately US$15.5 trillion in 2014 in the US banking system, while unused commitments expanded even faster, from about US$1 trillion in 1990 to US$8 trillion in 2007, and have substantially reduced in subsequent years. Financial standby letters of credit and foreign office guarantees in the US banking system escalated from about US$100 billion in 1990 to US$700 billion in 2014, while other letters of credit stayed steady at approximately US$100 billion over the past two decades (Meisenzahl 2015). The same trend can be observed for the evolution of OBS activities in the Vietnamese banking system. There was significant growth in OBS activities in the Vietnamese banking system between 2007 and 2012. For example, there was an approximate 200% increase in the nominal value of the OBS activities of the Vietnamese banking system between 2008 and 2011. In addition, prior studies in bank efficiency indicated that, if frontier estimation techniques do not account for OBS activities, bank efficiency will be understated (Lieu, Yeh & Chiu 2005; Rime & Stiroh 2003; Rogers 1998). Most studies examined the impact of OBS on cost and profit efficiency (Clark & Siems 2002; Rime & Stiroh 2003; Rogers 1998). Accordingly, the present study is the first attempt to assess the impact that including OBS activities has on the technical efficiency of Vietnamese commercial banks.

In contrast to prior studies, this study uses a different measure of OBS. A study by Clark and Siems (2002) suggested three alternative measures of a bank's aggregate OBS. The first measure is the total credit-equivalent amount of OBS transactions. The second measure is an aggregate measure of asset equivalent as suggested by Boyd and Gertler (1994). The third measure is non-interest income (NII). However, all three measures have disadvantages. The

first one may seriously understate the level of OBS (Boyd & Gertler 1994; Clark & Siems 2002). The second measure is revenue based and includes losses, which potentially distorts the measure of OBS. The measure of NII may overestimate the amount of OBS, since fees and commissions are also drawn from on-balance-sheet activities. In contrast, this study uses other income as a proxy for OBS activities. Other income contains charges for services, commission for providing guarantees, letters of credit, fiduciary activities and other income from fees and commissions. The use of other income in the study is a better proxy for OBS activities than the use of NII.

The second research gap identified concerns the effect of bank mergers on the efficiency of non-merging banks. Most studies have investigated the effect of bank mergers by comparing the post- and pre-merger efficiency levels of the merging banks. However, performance gains may extend well beyond the merging banks (DeYoung, Evanoff & Molyneux 2009). It is argued that non-merging banks may respond to a merger by decreasing costs and increasing cost efficiencies, as a result of increasing competition due to the entry of a new market player or the creation of a more viable local competitor. So far only one study, by Evanoff and Ors (2008) using US bank data, has investigated the effect that increased potential competition from M&As has had on the performance of non-merging banks. Accordingly, this study attempts to investigate the response of non-merging banks after VBMs have taken place.

In relation to the third research gap identified, the literature is dominated by studies from the US and Europe, where the larger markets and numbers of bank mergers have traditionally facilitated econometric modelling (DeYoung, Evanoff & Molyneux 2009; Kolaric & Schiereck 2014). However, it is unclear whether the empirical evidence on the US and European markets reflects the true efficiency effect of bank mergers in other markets (Dymski 2002). Because the regulatory and economic environments faced by banks are likely to differ across nations, and because the level and quality of service associated with deposits and loans

in different countries may differ, the effect of mergers on bank efficiency in other markets would also differ. Consequently, the experiences of developed economies cannot be automatically applied to the underdeveloped environment in general, particularly the banking system, because of the substantial differences that exist in institutional reality (Elumilade 2010). The few studies that have examined the efficiency effect of bank mergers in emerging countries specifically in the Asia-Pacific region include those by Sufian et al. (2012) on Malaysian banks; Lee, Liang and Huang (2013) on Taiwanese banks; and Hadad et al. (2013) on Indonesian banks. By providing the evidence of bank mergers in Vietnam, this study will be a forerunner for similar studies in future to increase external validity in relation to bank M&As in the Asia-Pacific region.

The last research gap that this study addresses is that so far no study has investigated the impact of mergers on bank efficiency in Vietnam. Based on my best knowledge, this study is the first attempt to fill to this gap in empirical research and provide recommendations for policy-makers with respect to bank mergers.

1.2.2 The importance of the present study

The mixed findings in the extant literature raise concerns about whether or not potential bank mergers in Vietnam would have improved efficiency of the merging parties. Thus, it is crucial to conduct an empirical investigation on the efficiency effect of bank mergers. This study is the first attempt to examine whether potential bank mergers would generate technical efficiency gains. Consequently, this will help the Vietnamese authorities to make decisions about whether bank mergers should be promoted. Policy measures drawn from the study could also be implemented in the decision-making process about bank consolidation through M&As in other developing countries which have banking structures similar to that in Vietnam.

1.2.2.1 Research questions

This study attempts to address three main research questions as follows.

The literature on banking efficiency suggests that the exclusion of OBS activities leads to underestimation of the technical efficiency of banks (Berger & Mester 1997; Casu & Girardone 2005; Lieu, Yeh & Chiu 2005). Most studies examined the impact of OBS activities on cost and profit efficiency (Clark & Siems 2002; Rime & Stiroh 2003; Rogers 1998). Two recent simulation studies, by Halkos and Tzeremes (2013) using Greek data and by Halkos, Matousek and Tzeremes (2014) using Japanese data, did not include OBS activities in their estimations. Accordingly, the present study is the first attempt to address the following question:

> Research question 1 (RQ1): What is the impact of the inclusion of off-balance-sheet activities on the technical efficiency of Vietnamese commercial banks?

In order to address RQ1, the study first estimates the technical efficiency of Vietnamese commercial banks over a five-year period using the efficiency frontier approach. Two models, A and B, are run. In Model A, the OBS activities, as proxied by 'other income', are included. In Model B, OBS activities are excluded. Then, the technical efficiency levels of banks within the two groups are compared using non-parametric tests.

The literature suggests that bank efficiency is a function of bank-specific and external determinants. Several studies that examined the impact of mergers on bank efficiency indicated mixed findings. Efficiency gains resulting from bank mergers are found in several studies such as DeYoung (1997) and Al-Sharkas, Hassan and Lawrence (2008) in the US, Halkos, Matousek and Tzeremes (2014) in Japan, and Liu and Tripe (2003) in New Zealand. However, opposite findings are indicated in several studies such as Wu (2008) in Australia, and Halkos and Tzeremes (2013) in Greece. In addition to the impact of bank mergers, bank

efficiency is also influenced by financial contagion (Andrieș & Ursu 2016; Vu & Turnell 2011); bank ownership (Nguyen, Roca & Sharma 2014; See & He 2015); bank size (Stewart, Matousek & Nguyen 2016; Sufian 2009); market concentration (Homma, Tsutsui & Uchida 2014; Koetter, Kolari & Spierdijk 2012); diversification (Alhassan 2015; Nguyen, Skully & Perera 2012; Sufian 2009); capital structure (Alhassan 2015; Gardener, Molyneux & Nguyen-Linh 2011); the quality of management (Bonin, Hasan & Wachtel 2005; Das & Ghosh 2006; Garza-García 2012; Sufian 2009); and risk (Nguyen & Nghiem 2015; Sathye & Sathye 2016). Accordingly, the present study attempts to address the following question:

Research question 2 (RQ2): What are determinants of banks' technical efficiency?

This research question is further divided into four subquestions relating to virtual bank mergers and the existing commercial banks which will be discussed in depth in chapters 4 and 5. In order to address these research questions, two-stage analysis is used. In the first stage, the efficiency scores of banks are estimated. In the second stage, these scores are regressed with control variables in a regression model.

Most previous studies examined the efficiency effect of bank mergers by comparing the pre- and post-merger efficiency levels of the merging banks (Halkos & Tzeremes 2013). However, Evanoff and Ors (2008) concluded that studies examining the impact of mergers on the efficiency of merging banks alone may overlook the most significant welfare-enhancing aspect of merger activity. Performance gains may well extend beyond the merging banks (DeYoung, Evanoff & Molyneux 2009). Accordingly, the present study attempts to answer the following question:

Research question 3 (RQ3): What is the technical efficiency of non-merging banks after virtual bank mergers have taken place?

To address RQ3, a two-stage approach of the economic frontier approach is proposed, as presented in chapter 5. Consequently, this allows us to evaluate whether bank mergers should serve as 'a wake-up call' to non-merging banks.

1.2.2.2 Contributions of the present study

By examining the efficiency effect of bank mergers and the determinants of Vietnamese commercial banks, this study has important public policy implications, particularly with respect to the principal aim of restructuring the banking sector. Consequently, the present study could help regulatory authorities in determining the future course of action to strengthen Vietnamese banking sector.

The present study contributes to the literature in several ways.

First, two recent simulation studies on bank mergers, by Halkos and Tzeremes (2013) in Greece and by Halkos, Matousek and Tzeremes (2014) in Japan, did not consider the OBS activities in their estimations. However, the literature on banking efficiency suggests that excluding OBS activities from output specification will underestimate the efficiency level of banks. In addition, most prior studies in banking efficiency examined the impact of including OBS activities on cost and profit efficiency of banks. The present study is the first attempt to assess what impact the inclusion of OBS activities has on the technical efficiency of Vietnamese commercial banks. In addition, the study examines whether the inclusion of OBS activities has an impact on the number of possible bank mergers that could be created.

Second, so far only one study, by Evanoff and Ors (2008), has assessed the effect of bank mergers in the US on the performance of non-merging banks. Most prior studies examined the effect of bank mergers only on merging banks. DeYoung, Evanoff and Molyneux (2009) suggested that the performance gains may extend well beyond the merging banks, to non-merging banks as well. Non-merging banks may respond to mergers of other banks by

reducing their costs and increasing their efficiency levels when a new player enters the market or a new, more viable local competitor is created. Consequently, this study attempts to investigate whether bank mergers can serve as a wake-up call to non-merging banks.

Third, the literature on bank mergers is dominated by studies from the US and Europe, where larger markets and greater numbers of bank mergers have traditionally facilitated economic modelling. However, the experiences of developed markets do not necessarily reflect the true effect of bank mergers in developing markets, because there are substantial differences in institutional reality (Dymski 2002; Elumilade 2010). The studies on the effect of bank mergers in emerging markets, in particular in the Asia-Pacific region, is limited to very few studies, such as those by Sufian et al. (2012) in Malaysia, Lee, Liang and Huang (2013) in Taiwan, and Hadad et al. (2013) in Indonesia. By examining the efficiency effect of bank mergers in Vietnam, this study strengthens the evidence on the effect of bank mergers in emerging markets.

Fourth, the present study is the first attempt to examine the efficiency effect of bank mergers in Vietnam. This study fills the gap in empirical research and outlines policy measures that could be implemented in decision-making processes about bank mergers in Vietnam and in other developing countries which have banking structures similar to those in Vietnam.

The present study makes three important contributions to policy.

First, this study provides an answer to the ongoing debate about whether mergers would have enhanced efficiency of the Vietnamese banking system, by addressing RQ2 as stated above.

Second, the present study provides evidence on the impact of ownership on the efficiency of bank mergers, by addressing the subquestions. Consequently, this will help the Vietnamese authorities make a decision on whether bank mergers that include SOCBs should be encouraged.

Third, the present study investigates the various impacts on the technical efficiency of Vietnamese commercial banks. This will enable policy-makers to have a better understanding of bank efficiency, so that appropriate policies can be implemented to improve the efficiency of the Vietnamese banking system.

The present study also makes an important contribution to practice. The SBV has identified 10 banks that need to be restructured. Of those 10, six are included in the analysis presented in this thesis. The findings will help Vietnamese authorities to make decisions on possible M&As concerning these banks. In addition, this study investigates the determinants of technical efficiency in Vietnamese commercial banks, which will help bank managers to improve their banks' operating efficiency.

1.3 Thesis outline

This thesis is structured into seven chapters. Chapter 1 presents an introduction to the study, beginning with a discussion of the importance of the banking industry in any economy, and particularly in Vietnam. In addition, the key terms are defined. The research objectives and research questions are specified, describing the research topic. The chapter finally discusses the present study's contributions to theory, policy and practice.

Chapter 2 provides an overview of the Vietnamese banking system. Chapter 3 provides a literature review on the efficiency effect of bank mergers and goes on to discuss the theory and evidence on the efficiency effect of bank mergers. In addition, the main determinants of bank efficiency are outlined. Finally, the existing gaps in the literature are identified. Chapter 4 presents a theoretical framework for the study, and outlines the development of hypotheses associated with the research questions. Chapter 5 describes the research methodology and data collection methods used in the study.

Chapter 6 presents the findings. First, the impact of the inclusion of OBS activities on technical efficiency in Vietnamese commercial banks is addressed. Second, the impact of the GFC on the technical efficiency of banks created via VBMs is examined. Third, the impact of ownership on the technical efficiency of banks created via VBMs is assessed. Fourth, the impact of interaction between ownership and GFC on the technical efficiency of banks created via VBMs is evaluated. Fifth, the determinants of the technical efficiency of Vietnamese commercial banks (the existing commercial banks) are investigated. Last, the technical efficiency of non-merging banks after VBMs have taken place is examined.

Chapter 7 begins with a discussion of the contributions of the study and goes on to present its limitations. Contributions are made to original academic research, policy and practice. Last, the limitations of the present study and directions for future research are discussed. The findings are offered as a benchmark to compare the findings of future research on actual bank mergers.

Chapter 2 An overview of the Vietnamese banking system

2.1 Introduction

Vietnam has taken various steps towards the liberalisation and reform of the formal financial sector in order to improve the stability and efficiency of the Vietnamese banking system. Therefore, the banking sector has experienced significant institutional and structural changes over the past decades. The main objective of Chapter 2 is to provide the background necessary for understanding the empirical analysis of the efficiency effect of bank mergers in Vietnam, as presented in the subsequent chapters. The chapter's introduction profiles the Vietnamese banking system's structure, as well as banking reforms, several restructuring programs, and the regulatory and supervisory framework. The main achievements of the Vietnamese banking system over the period 2006 to 2012, since the implementation of key reforms, are then highlighted. More specifically, the performance of banks in ownership is examined, according to bank ownership, size and market share. In addition, this chapter outlines several problems faced by the banking system that could severely affect the sustainability of the Vietnamese financial system as a whole. Last, the present study discusses the consolidation process in the Vietnamese banking system, as promoting bank mergers and acquisitions (M&As) is considered to be a possible solution to the difficulties faced by the banking system.

2.2 Profile of the Vietnamese banking system

Before discussing the development of the Vietnamese banking system, it is important to introduce the structure of the Vietnamese banking system. Key reforms are then highlighted, including the renovation reforms of 1986 and several restructuring programs implemented since Vietnam's entry into international trade and investment agreements. The regulatory and supervisory framework in the Vietnamese banking system is then discussed.

2.2.1 Structure of the Vietnamese banking system

Prior to the 1990s, the structure of the Vietnamese banking system was entirely based on a one-tier model, where the State Bank of Vietnam (SBV), or the central bank, was the sole bank in the country. Although the Joint Stock Commercial Bank for Investment and Development of Vietnam (BIDV) and the Joint-Stock Commercial Bank for Foreign Trade of Vietnam (VCB) were established in 1958 and 1963, respectively, they were actually subsidiaries of the SBV, thus maintaining the one-tier system. Under this model, the SBV controlled the volume, cost and allocation of credits in the economy.

Since the implementation of 'doi moi' (Renovation Reforms) in 1986, Vietnam's economy has achieved remarkable growth, with a rapid transformation in the production structure. Specifically, financial reforms that were codified in several 1990 ordinances on banks and financial institutions transformed the one-tier to a two-tier system. The SBV gradually shifted to more of a 'true' central bank and is responsible for controlling money, credit and banking operation networks throughout the country in order to stabilise the value of money. The direct lending function of the SBV to any individual, business or government entity was prohibited. Instead, the SBV governs and supervises the second-tier system; the commercial banks include state-owned commercial banks (SOCBs), privately owned commercial banks (POCBs), joint-venture banks (JVBs) and foreign banks (FBs). In this regulatory capacity, the SBV grants and withdraws operating licences, issues regulations and acts as a clearing house for financial institutions. Along with the Ministry of Finance (MOF), the SBV also takes responsibility for managing and implementing Vietnam's ambitious plans for a stock exchange (Dinh 1996).

2.2.1.1 State-owned commercial banks

After the implementation of financial reforms in 1990, the central bank transferred its lending and banking activities to five SOCBs in specific economic segments. SOCBs include the

Vietnam Bank for Agriculture and Rural Development (AGB), the BIDV, the VCB, the Vietnam Joint Stock Commercial Bank of Industry and Trade (CTG) and the Mekong Housing Bank. At the end of 2011, the four large SOCBs – or so-called 'big four' banks – accounted for up to approximately 50% of total assets (KPMG 2013).

The individual SOCBs are characterised as follows:

- AGB was established in 1988 in order to facilitate financial operations in the agricultural and rural segments. AGB is the leading and the largest commercial bank in Vietnam. In 2011 AGB had the largest operating network – 2,400 branches and units nationwide – and was Vietnam's largest bank, with total assets of VND 556.2 trillion and charter capital of VND 21.6 trillion (AGB 2011).
- CTG was established in 1988 with a focus on industry and commercial lending to state-owned enterprises (SOEs). In 2011, CTG was the second largest of the SOCBs in terms of total assets (VND 460.6 trillion) and had charter capital of VND 20 trillion. In 2009, CTG went public and listed on the Ho Chi Minh City Stock Exchange (HOSE). CTG also had second largest operating network, with 1,104 branches and units, after the AGB (CTG 2011).
- BIDV was founded in 1957 with a concentration on commercial loans to both SOEs and non-SOEs (Tran, Ong & Weldon 2015). In 2011, BIDV was the third largest bank in terms of total assets (VND 405.7 trillion) and had charter capital of VND 12.9 trillion. BIDV also had the third largest operating network, with 644 branches and units (BIDV 2011).
- VCB was established in 1963 with a specialisation in commercial loans to SOEs. In 2011, VCB was the fourth largest bank, with total assets of VND 366.7 trillion and charter capital of VND 19.6 trillion. In 2009, VCB decided to go to public and listed

on the HOSE. VCB had the fourth largest operating network, of 400 branches and units (VCB 2011).

- Mekong Housing Bank (MHB) was founded in 1997 with a main focus on providing personal and commercial loans (small and medium enterprises) in the Mekong Delta region. In 2011 MHB was the smallest bank, with total assets of VND 47.2 trillion and charter capital of VND 3.1 trillion. Among the SOCBs, MHB had the smallest operating network, of 230 branches and units.

2.2.1.2 Policy banks

Along with the establishment of SOCBs, two policy banks have proven to be efficient tools of the state in mobilising various resources, both domestically and internationally, to perform designated socio-political lending programs. The Vietnam Bank for Social Policies (VBSP) was founded in 2002, with a main focus on providing credits for the poor and other policy beneficiaries – that is, it has separate policy lending obligations to that of AGB. The Vietnam Development Bank (VDB) was established in 2006 to support the state's policy of development and investment, as well as of export credit.

Price controls and budgetary support for policy banks has enabled them to provide products to their clients at below-market interest rates, while remaining compliant with their mandate. More specifically, VBSP and AGB are the dominating lenders in rural regions. The combined total assets of the two policy banks have increased substantially, from VND 189.7 trillion in 2007 to VND 346.4 trillion in 2011 (WB 2014).

2.2.1.3 Credit cooperatives

In 2011, there were the Central People's Credit Fund and more than 1,000 local People's Credit Funds (PCFs) (SBV 2011). The Central People's Credit Fund, also known as the Co-operative Bank of Vietnam (the Co-op Bank), was established in 1995 with the main goal of

assisting and governing credit operative members. Credit operative members play an important role in the poverty reduction program of the government, by providing financial services for agricultural production, farmers and enterprises in rural areas. In order to enhance the effectiveness and efficiency of the rural operative members, the Co-op Bank provides information exchange as well as professional training, and offers consultancy services to its members. More importantly, the Co-op Bank takes responsibility for managing the people's credit fund system safely in accordance with the regulation of the SBV. The total assets of credit cooperatives rapidly increased from VND 19.1 trillion in 2007 to VND 46.4 trillion in 2011.

2.2.1.4 Privately owned commercial banks

Since the implementation of financial reforms, codified in several 1990 ordinances on banks and financial institutions, the Vietnamese banking system has been transformed from a one-tier to a two-tier system. Accordingly, POCBs, or joint-stock commercial banks, have been licensed to operate in the Vietnamese banking system. In 2011, the banking system included 37 POCBs. POCBs have had relatively smaller capital and deposit bases compared with SOCBs, mainly because POCBs have been engaged in banking activities for a shorter period. However, POCBs have been operating more actively. The total assets of POCBs have rapidly expanded, from VND 597.7 trillion in 2007 to VND 2285.8 trillion in 2011, while those of SOCBs increased from VND 931.5 trillion to VND 1912.3 trillion over the same period.

POCBs are allowed to provide universal banking services to small and medium enterprises (SMEs), newly-established firms and individual households. They have a smaller operating network of branches and units than SOCBs, since they primarily focus on serving consumers in particular regions.

In addition, POCBs have a more-diversified shareholding structure than SOCBs. The equity ownership of these banks is distributed among state, private and foreign investors. Table 2.1 shows the cross-ownership structure of POCBs in 2011. Since SOCBs are shareholders in the ownership of some POCBs, the SBV may have some interventions in the activities of POCBs if necessary. In addition, some POCBs – such as An Binh Commercial Joint Stock Bank (ABB) and Vietnam Export Import Commercial Joint Stock Bank (EIB) – introduced international strategic investors (often international commercial banks) in order to gain advanced management skills and new technology.

In order to enhance the management of their banks, POCBs are encouraged to list on the stock exchange to ensure additional external monitoring. In 2011, the six POCBs that had listed on the stock exchange included EIB, Asia Commercial Joint Stock Bank (ACB), Saigon Thuong Tin Commercial Joint Stock Bank (STB), Saigon-Hanoi Commercial Joint Stock Bank (SHB), Military Commercial Joint Stock Bank (MB) and National Citizen Commercial Joint Stock Bank (NCB). The issue of cross-ownership will be discussed in section 2.4.2.

Table 2.1 Ownership structure of POCBs (%), 2011

Banks	SOCBs[1]	POCBs[1]
Saigon Bank for Industry and Trade	14.36	
Orient Commercial Joint Stock Bank	4.6	
Ocean Commercial Joint Stock Bank	1	
Mekong Development Joint Stock Commercial Bank		10.2
Vietnam Prosperity Commercial Joint Stock Bank		1.53
Viet Capital Commercial Joint Stock Bank		3.5
Dai A Joint Stock Commercial Bank	1.53	10.8
Kien Long Commercial Joint Stock Bank		6.1
Saigon Thuong Tin Commercial Joint Stock Bank (STB)		9.7
Vietnam Export Import Commercial Joint Stock Bank (EIB)	8.2	1.5
Military Commercial Joint Stock Bank (MB)	9.8	9.4
Ho Chi Minh Development Joint Stock Commercial Bank	14.2	

Source: Tran, Ong and Weldon (2015).

[1, 2] This figure could represent more than one SOCB or more than one POCB in the ownership structure of a POCB. This does not count for foreign and other ownerships, due to the unavailability of data.

2.2.1.5 Foreign banks

FBs and JVBs have been operating in the Vietnamese banking system since 1990. The liberalisation process was further accelerated by Vietnam's entry into the World Trade Organization (WTO) in 2007, specifically under Decree No.22/2006/ND-CP on licensing wholly foreign-owned banks. In 2011, the banking system contained four JVBs, 50 FB branches and five wholly foreign-owned banks. The wholly foreign-owned banks were HSBC, Standard Chartered Bank, ANZ Bank, Shinhan Bank and Hong Leong Bank. The FBs' share of total commercial banking assets has remained small and stable, rising from 9.5% in 2007 to 10% in 2011 (WB 2014).

FBs are also allowed to take a stake in local banks in the form of strategic partnerships. However, the government imposes the condition that the total shares of foreign investors must not exceed 30% of the charter capital of a local bank. Therefore, the share of FBs in the ownership of local banks is still marginal.

2.2.1.6 Non-banking financial institutions

There are two major types of non-banking financial institutions: other credit institutions (finance and leasing companies), and investment banks and financial auxiliaries (securities brokers/dealers and foreign exchange houses). These institutions increased the amount of credit available in Vietnam's financial system and are also supervised and regulated by the SBV and the MOF. The combined total assets of these institutions improved from VND 138 trillion in 2007 to VND 264.5 trillion in 2011 (WB 2014).

2.2.2 Key reforms in the Vietnamese banking system

The literature on developing nations and the finance growth nexus suggests that the observed high growth rates of Vietnam's economy cannot continue indefinitely without significant reform of the banking system and the legal/financial infrastructure (Berger, Hasan & Zhou 2009). In 2011, foreign and private banks made up 90% of total banks in Vietnam. A study by Nguyen, Roca and Sharma (2014) examined the market concentration using the concentration ratio (the ratio of the three largest banks to the total) and found that concentration levels decreased from 87% in 1995 to 50% in 2011 because reforms encouraged significant private and foreign participation over that period.

Prior to the 1990s, the structure of the Vietnamese banking system was entirely based on a one-tier model, where the SBV acted as the central bank as well as a commercial bank. After 1990, a two-tier system was created, where SBV handed over all its commercial banking functions to the commercial banks, and shifted its role to more of a true central bank.

In addition, several banking reforms were implemented in Vietnam under a gradual approach towards deregulation. They were mainly motivated by the country's entry into international trade and investment agreements, especially the US–Vietnam Bilateral Trade Agreement in 2001 (WB 2002). A restructuring program was implemented for both SOCBs and POCBs.

The key objectives of this program were to (1) recapitalise banks, (2) replace and re-organise the work of their management boards, (3) improve employee skills, (4) enhance transparency in estimating the accurate level of non-performing loans (NPLs) and (5) phase out policy lending for state-owned banks (SOBs). As a consequence, the consolidation of small rural credit institutions occurred and the rate of NPLs was reduced. However, the achievements remained limited. First, the International Monetary Fund (IMF) (2002) asserted that there was a continuing big gap between estimated NPL in the Vietnamese Accounting Standards (VAS) and under the International Accounting Standards (IAS). Second, some regulatory discrimination between POCBs and SOCBs still existed. Unlike SOCBs, POCBs had not been allowed to open extensive branch networks. This constrained their operations, given that most POCBs concentrated on serving the private sector, especially individual consumers and SMEs, which require larger branch networks as distribution channels (IMF 2002).

In order to speed up the effect of the banking reforms, the Vietnamese Government launched the 'banking sector reform roadmap' program in 2005 (Vu & Turnell 2010). The main objectives of this program were to (1) accelerate the restructuring process of commercial banks, (2) gradually equitise SOCBs, (3) increase the capital adequacy ratio (CAR) according to the Basel framework suggested by the Bank for International Settlements, and (4) improve the competitiveness of POCBs. Accordingly, most banks made significant investments in banking technology in terms of the application of banking software to computerise transactions, the issuing of debit and credit cards, and the development of internet and electronic banking services. Indeed, the period 2007 to 2011 witnessed the rapid expansion of branch networks, transaction offices and automated teller machines (ATMs). For example, the number of ATMs rocketed from 1,800 in 2007 to 11,700 in 2010. Also, the number of bank cards issued significantly increased, doubling to 31.7 million in the period 2008 to 2010

(Vietcombank Securities Company 2011). This was mainly due to an increase in household income, thus a rising demand for retail banking.

2.2.3 Regulatory and supervisory framework

The regulatory and supervisory framework is divided among different agencies. The central bank or the SBV, through the Inspection and Supervision Authority (ISA), monitors credit institutions, while the MOF, via the Insurance Supervisory Authority and State Securities Commission, supervises the insurance sector and securities markets (WB 2014). Each supervisory agency concentrates on its sector but suffers from limited operational independence and does not carry out any supervision of financial groups. In addition, supervisors have faced a challenge in identifying the time and cross-sectional series of macro-prudential risk. This is due to the limited range of tools available for supervisors to measure the risk. This is also explained by the fact that no institution is responsible for assessing and managing the overall risk in the financial system because of a lack of legal framework for macro-prudential policy. Furthermore, due to gaps in the legal framework, inadequate enforcement and weak crisis management, a 'too-interconnected-to-fail' structure has emerged (WB 2014). It is important to note that the SBV is implicitly supposed to take functionally responsibility for managing systemic risk. However, the lack of a database and capacity makes it difficult to gauge emerging systemic risk.

2.2.3.1 Bank regulation and supervision

The level of compliance with the core of Basel Core Principles for Effective Banking Supervision (BCP) is relatively low. The merging of the prudential supervision function, focusing on the safety and soundness of the banking system, and the general inspectorate function, concentrating on policing violations of administrative procedures, has reduced the effectiveness of the core prudential supervision function performed by the SBV (WB 2014). More specifically, on-site inspections of SOCBs have not been conducted by the SBV for

several years, partly due to the avoidance of overlapping inspections by the General Inspectorate and State Audit Office. Meanwhile, off-site monitoring by the SBV is still in its initiation stage. In addition, the requirements on financial reporting and disclosure for commercial banks are very limited. The quality of financial information is relatively poor, and non-financial statement disclosure is practically non-existent (WB 2014). In the case of cross-border banking supervision, there is significant lack of supervision on overseas operations of domestic banks, although some provisions are included in the regulatory framework.

2.2.3.2 Bank governance

Despite the establishment of the two-tier system, SBV still plays critical roles in the Vietnamese banking system. Along with a weak regulatory and supervisory framework and low levels of transparency, policy mandates and directed lending have created a business setting with little or no accountability for bank boards and management (WB 2014). Due to the lack of well-defined governance structures, the SBV may carry out some responsibilities for SOCBs that are supposed to be conducted by a bank board. Indeed, this may reduce the incentives for these banks to take full responsibility and accountability for their businesses.

More importantly, across financial institutions a strong risk culture is lacking, and risk management is underdeveloped. Lax laws and regulations, has created complex shareholding structures in many POCBs (the so-called cross-ownership structure discussed in section 2.4.2). This raises concerns about conflicts of interest, especially in terms of imprudent channelling of funds to related parties or unrelated speculative ventures. In addition, the focus of current laws and regulations is mainly on detailing the mechanics of each administrative body rather than charging the parties for their performance in the best interest of the public trust and sector stakeholder. This results in a lack of primary parts of regulation, including a code of bank governance and risk management regulations.

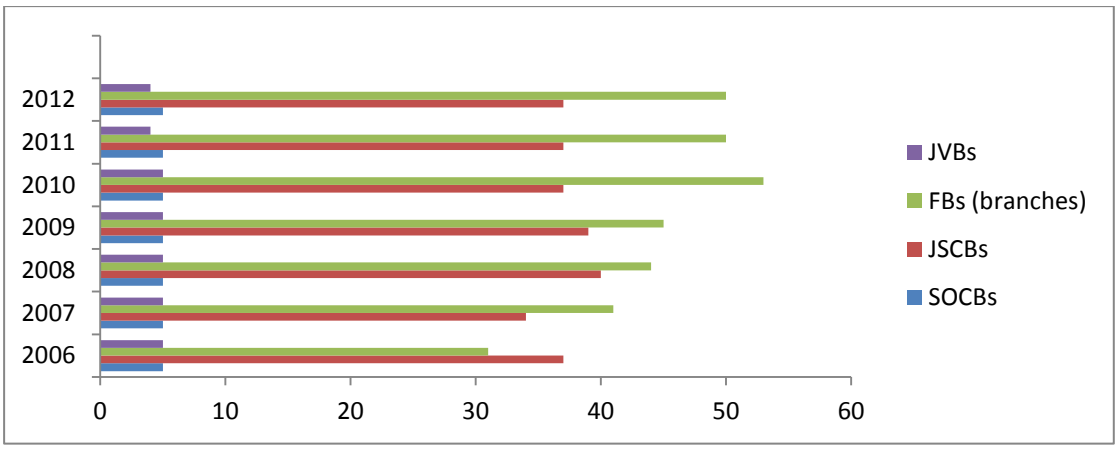
2.3 Performance of the Vietnamese banking system

Since the implementation of banking reforms, the Vietnamese banking system has made remarkable achievements. First, this section outlines the growth in banks' size and assets. Second, the performances of the different types of bank ownership in Vietnam are analysed in terms of deposit and credit market share. Third, the main sources of funding of Vietnamese banks are discussed. Fourth, the performances of Vietnamese banks in terms of bank profitability are investigated. The three main measures used are returns on assets (ROA), returns on equity (ROE) and net interest margin (NIM). This section further discusses the income structure of Vietnamese banks.

2.3.1 Bank size

Recently, the size of the Vietnamese banking system has significantly increased. Figure 2.1 shows the accelerating growth in the number of FBs, from 31 in 2006 to 50 in 2012, while there were marginal changes in other ownership types. In 2011, the Vietnamese banking system consisted of five SOCBs, 37 POCBs, four JVBs and 50 FBs (including branches, five wholly foreign-owned banks, and representative offices) (SBV 2011).

Figure 2.1 Number of banks in Vietnam, 2006 to 2012



Source: ADB (2015) and SBV (2012).

2.3.2 Bank assets

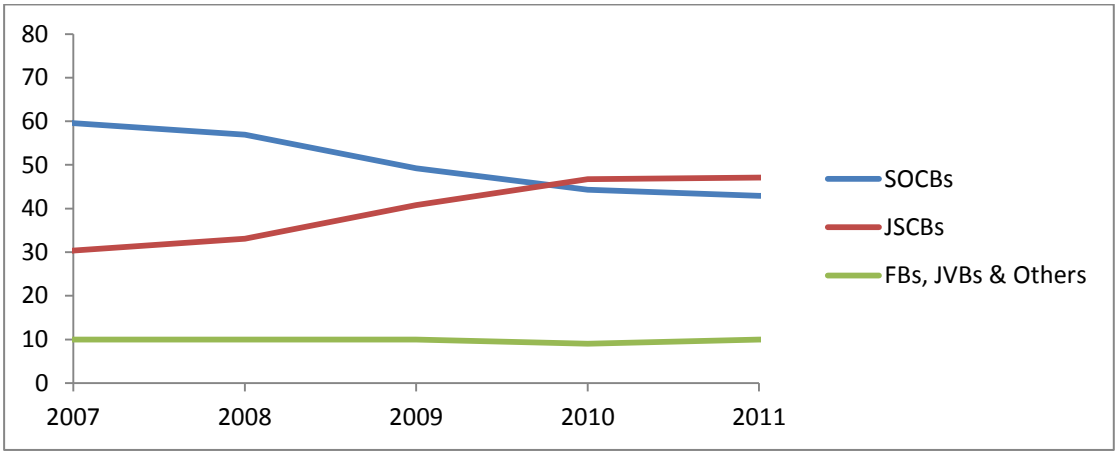
There was significant growth in bank assets over the period 2007 to 2011. More specifically, total assets of commercial banks (POCBs, FB and SOCBs) substantially expanded, from VND 1733.3 trillion in 2007 to VND 4,750 trillion in 2011 (WB 2014). In terms of bank assets' share of GDP, this ratio improved from 151.5% in 2007 to 170.9% in 2011. Consequently, the Vietnamese banking system was ranked in second position in the list of the fastest growth in total assets (Vietcombank Securities Company 2011).

Despite experiencing a rapid growth of total assets, the size of commercial banks in Vietnam, especially POCBs, was modest compared with that of their Asia-Pacific regional counterparts such as banks in China, Malaysia, India and Thailand (Vietcombank Securities Company 2011).

2.3.3 Bank market share

The Vietnamese banking system is dominated by four SOCBs. This is mainly because SOCBs have explicitly or implicitly received preferential treatment from the SBV (Dinh 2011). They are involved in all aspects of banking with their national branch network, and are primarily focused on serving large SOEs. However, POCBs have been operating more actively and have gradually gained a large market share in terms of both deposits and credit market shares, as indicated in Figure 2.2 and Figure 2.3, respectively. In fact, POCBs have mainly concentrated on providing universal banking services in particular regions, although some banks maintain large branch networks that allow them to operate on multi-regional or national bases. POCBs have served small SOEs, newly-established firms and individual households (Vu & Turnell 2010).

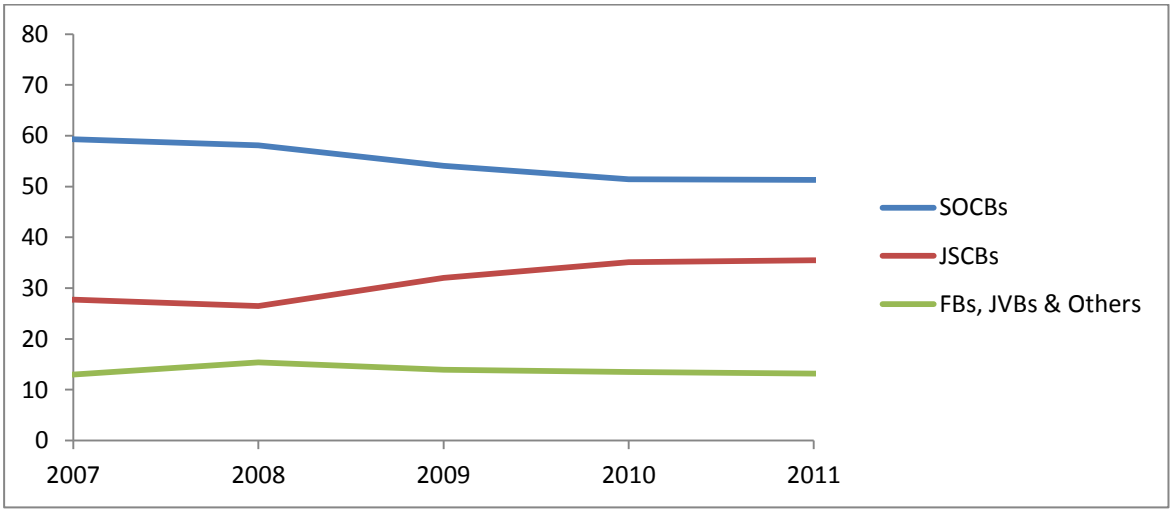
Figure 2.2 Deposits market share in Vietnam, 2007 to 2011 (%)



Sources: ADB (2015), Vietcombank Securities Company (2011)

Along with POCBs, wholly foreign-owned banks and JVBs have been permitted to accept local currency, thus gaining market share at the expense of the SOCBs (Leung 2009). Although their businesses are primarily geared to wholesale activities with a limited customer base and transaction points, POCBs, wholly foreign-owned banks and JVBs have a strong orientation on retail banking, offering high-quality and sophisticated products and services.

Figure 2.3 Credit market share in Vietnam, 2007 to 2011 (%)

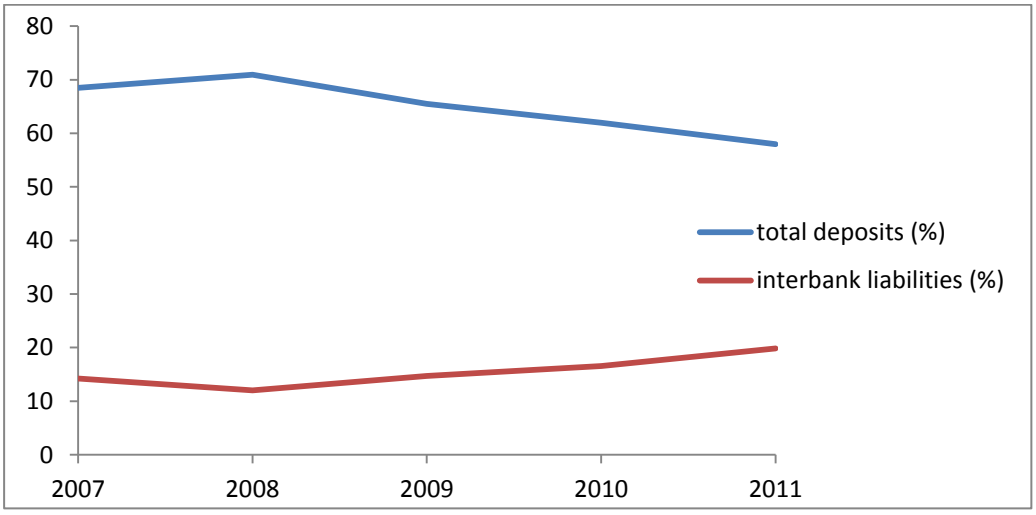


Sources: ADB (2015), Vietcombank Securities Company (2011)

2.3.4 Liquidity and funding of banks

The two main sources of capital mobilisation of Vietnamese commercial banks are total deposits and interbank liabilities. Figure 2.4 shows that capital mobilisation of commercial banks mainly comes from total deposits from individual households and businesses in the economy. Total deposits accounted for 66% of liquidity and funding of commercial banks between 2007 and 2011. Thus, Vietnamese banks competed aggressively on deposit rates but under the deposit rate ceiling imposed by the central bank to capture the massive amount of deposits, especially in cities and industrial zones.

Figure 2.4 Structure of liquidity and funding of Vietnamese commercial banks, 2007 to 2011 (%)



Source: Estimates based on the author's calculation. The estimates account for domestic commercial banks only since the data for foreign banks and joint-venture banks were unavailable. Data were manually collected from annual reports of banks.

In addition, between 2008 and 2011 there was an increasing trend in the number of interbank liabilities of banks, especially for smaller POCBs. However, the recent regulation by Circular No.1/2013/TT-NHNN further restricts credit institutions from engaging in interbank loans, since credit institutions can borrow only if they do not have more than 10 days of overdue debts with other credit institutions and FBs, unless they get approval from the central bank

(Tran, Ong & Weldon 2015). Thus, this may reduce the attractiveness of borrowing through the interbank market.

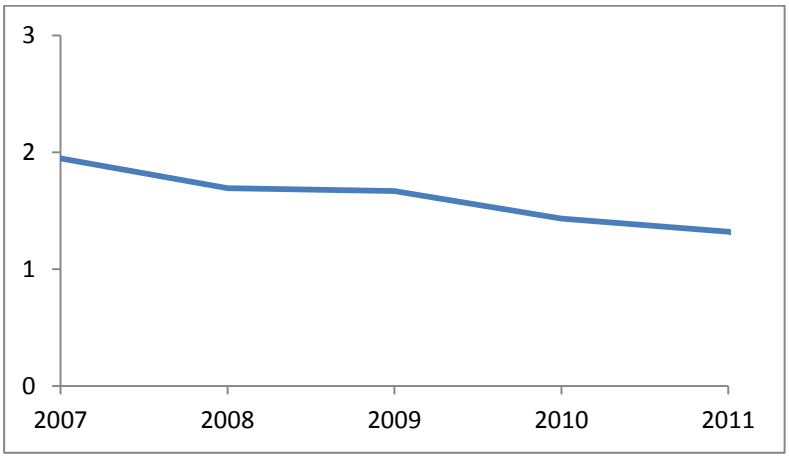
2.3.5 Bank profitability

The performance of the Vietnamese banks is also measured by bank profitability. Three main measures of bank profitability are ROA, ROE and NIM.

2.3.5.1 Returns on assets

A standard ROA ratio is used to measure bank profitability: higher ratios suggest better performance. ROA is the ratio of profit before tax to total assets (Le 2016b; Nguyen, Roca & Sharma 2014). Figure 2.5 indicates that there was a reduction in ROA over the examined period 2007 to 2011.

Figure 2.5 Returns on assets of Vietnamese commercial banks, 2007 to 2011 (%)



Source: Estimates based on the author's calculation, where ROA is the ratio of profit before tax to total assets. This does not account for the foreign banks and joint-venture banks, due to unavailability of data. Data were manually collected from annual reports of banks.

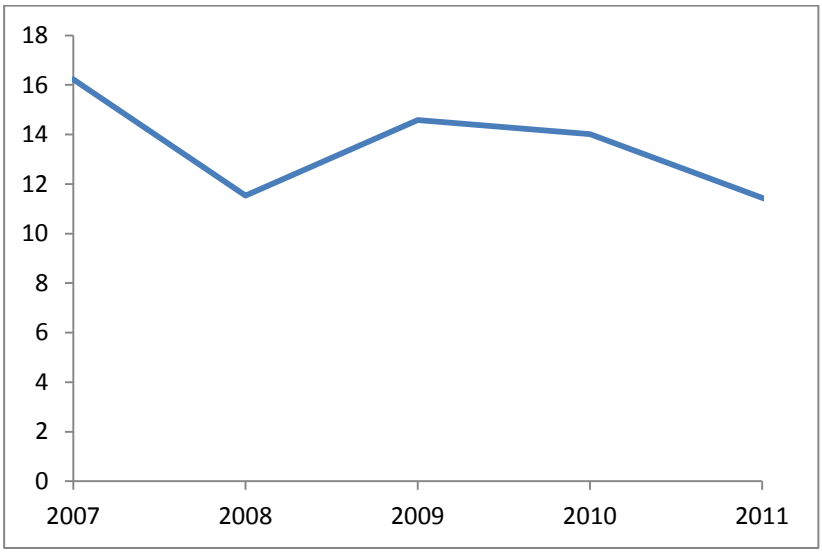
A lower ROA does not equate to reduced profitability for Vietnamese commercial banks, since the growth of total assets was much greater than the improvements in profits, especially between 2007 and 2010. In addition, due to the unfavourable condition of the economic environment as a result of the GFC (2007–08), the quality of the loan portfolio was

deteriorating (KPMG 2013). Therefore, commercial banks were required to set aside more provisions, further reducing bank accounting profitability in 2011.

2.3.5.2 Returns on equity

ROE is also used to investigate bank profitability in the Vietnamese banking system. ROE is the ratio of profits before tax to a bank's equity. Figure 2.6 presents evidence of a reduction in ROE between 2007 and 2011. This is consistent with the earlier analysis of ROA. More specifically, the significantly decreased ROE between 2009 and 2011 was primarily due to the substantial decrease in credit losses and operating expenses, and net interest income (as analysed in the next paragraph). As a result of the GFC (2007–08), increases in NPLs required the banks to maintain higher levels of provisions, reducing bank accounting profitability.

Figure 2.6 Returns on equity of Vietnamese commercial banks, 2007 to 2011 (%)

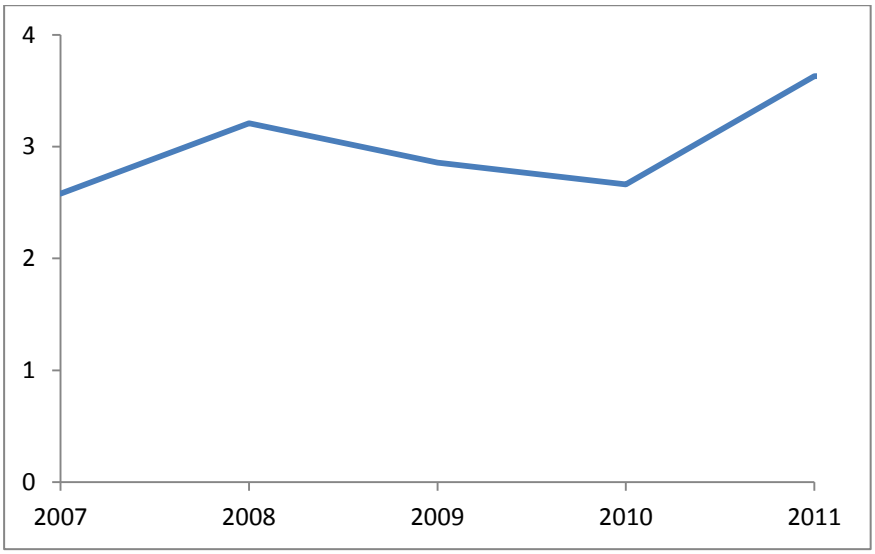


Source: Estimates based on the author's calculation, where ROA is the ratio of profit before tax to total equity. This does not account for the foreign banks and joint-venture banks, due to unavailability of data. Data were manually collected from annual reports of banks.

2.3.5.3 Net interest margin

NIM is also used to measure bank profitability. NIM is the ratio of net interest income to interest bearing assets, where interest bearing assets comprise cash and reserves, balance with the SBV, dues from financial institutions, trading and available for sale securities, and total loans (Halkos & Salamouris 2004; Le 2017). Figure 2.7 shows that there was a fluctuation in the NIM of Vietnamese commercial banks between 2007 and 2011, including a significant reduction in NIM between 2008 and 2010. This may be partly due to the fact that banks paid higher rates for depositors, since banks competed aggressively on deposit rates to capture the massive deposits in urban and industrial zones (Tran, Ong & Weldon 2015). Nonetheless, Nguyen, Roca and Sharma (2014) found there was an unclear trend in NIM, but it was relatively low, averaging around 3%. The authors suggested that, although the Vietnamese banking system appeared relatively efficient, the efficiency level was not enhanced between 1995 and 2011.

Figure 2.7 Net interest margin of Vietnamese commercial banks, 2007 to 2011 (%)



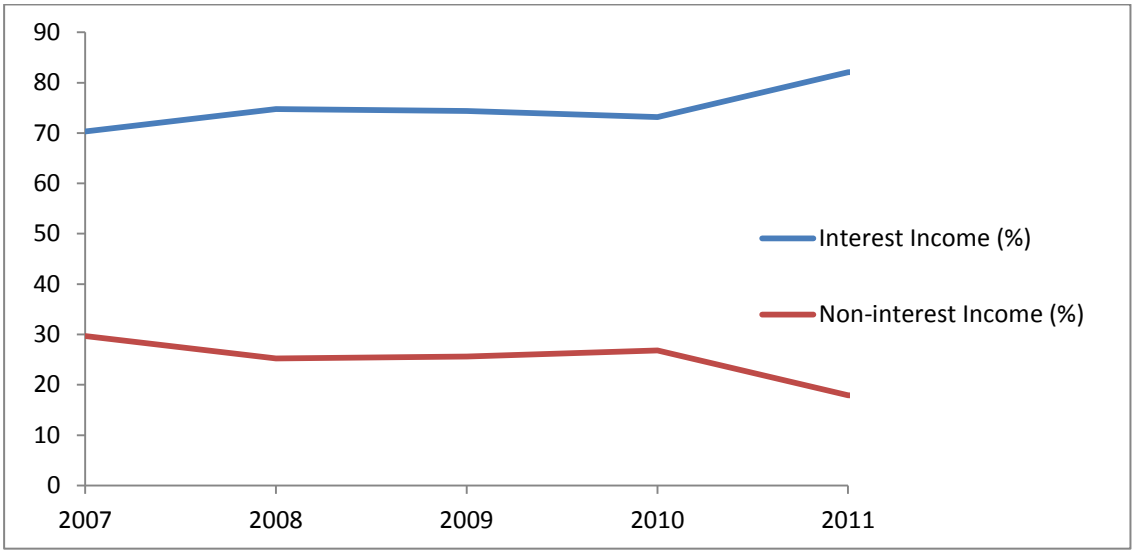
Source: Estimates based on the author's calculation, where NIM is the ratio of net interest income to interest bearing assets, and interest bearing assets include cash and reserves, balance with the SBV, dues from financial institutions, trading and available for sale securities, and total loans. This does not account for the foreign banks and joint-venture banks, due to unavailability of data. Data were manually collected from annual reports of banks.

2.3.5.4 The structure of bank income

Although NIM is an effective indicator of operational performance, this ratio does not comprehensively reflect bank profitability. A bank's profitability is influenced by a number of factors, including the nature of banks' activities, the composition of their customer base and their funding strategies. KPMG (2013) suggested that the greater and most favourable NIMs are found in banks focusing on traditional lending and deposit businesses. However, some SOCBs have operated effectively with lower NIMs, because of the size of their operations. In addition, NIM does not fully reflect the profitability of the Vietnamese banking system, since the ratio does not take into account the fee and commission income and other net operating income. Thus, it is necessary to examine the structure of bank income in Vietnam.

Figure 2.8 shows that interest income from traditional business activities is primarily the core income for most Vietnamese banks, accounting for approximately 70 to 80% over the examined period. In addition, there was a slight increase in non-interest income (NII) between 2007 and 2010, reaching a peak of 30% in 2007. However, NII significantly reduced to 18% in 2011. This could be due to the impact of the GFC (2007–08). More analytically, the large component of NII was net fees and commissions (KPMG 2013). Furthermore, KPMG (2013) reported that NII of the Vietnamese banking sector was relatively low compared with those of other countries in the Asia-Pacific region, such as Australia, Thailand and Singapore. This could be primarily because the Vietnamese banks are less engaged in retail banking. For instance, retail accounts are one of the main sources of fees for products (mortgages, credit cards and everyday accounts) but these products have not been widely used in Vietnam. Nonetheless, the low level of NII may provide opportunities for Vietnamese banks to diversify their income structure, thus possibly reducing bank risks (Tran, Ong & Weldon 2015).

Figure 2.8 Structure of commercial banks' income in Vietnam, 2007 to 2011

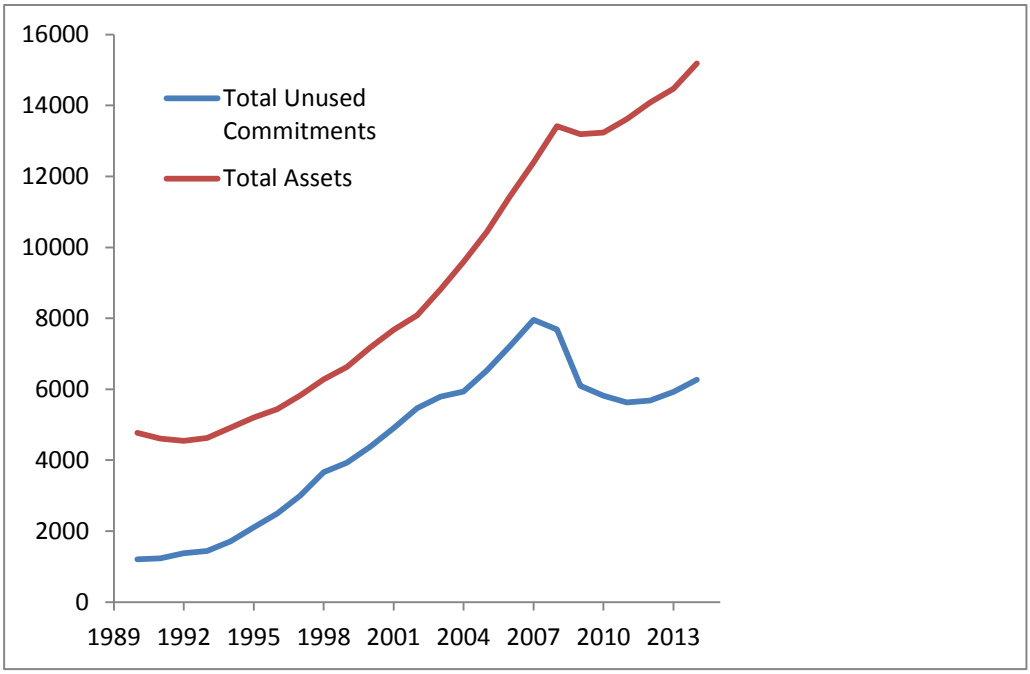


Source: Estimates based on authors' calculation. This does not account for the foreign banks and joint-venture banks, due to unavailability of data. Data were manually collected from annual reports of banks.

In addition, because of deregulation, Vietnam's integration into the global financial market, and technological advances, the Vietnamese banking industry faces a new and increasingly competitive environment. Commercial banks have been forced to respond to the challenges by changing their traditional business manners or creating new forms of intermediation, and by developing new products to attract new consumers and engaging in other fee-based activities. Meanwhile, banks also need to maintain their existing customers. Consequently, the traditional business of advancing loans by issuing deposits has declined in favour of a substantial growth in activities that are not typically captured on banks' balance sheets (Boyd & Gertler 1994; Rogers & Sinkey 1999). These OBS activities – which generally comprise loan commitments, non-financial guarantees, standby letters of credit, foreign exchange, securitisation, financial futures, forward contracts, options, interest rate swap contracts and other derivative products – have expanded rapidly (Board of Governors of the Federal Reserve System 1997; Lieu, Yeh & Chiu 2005; Meisenzahl 2015). Figure 2.9 shows there

was significant growth in the total value of unused commitments of US banks between 1990 and 2007. However, unused commitments reduced significantly during the financial crisis.

Figure 2.9 Total assets and total commitments of depository institutions in the US (US$ billions)

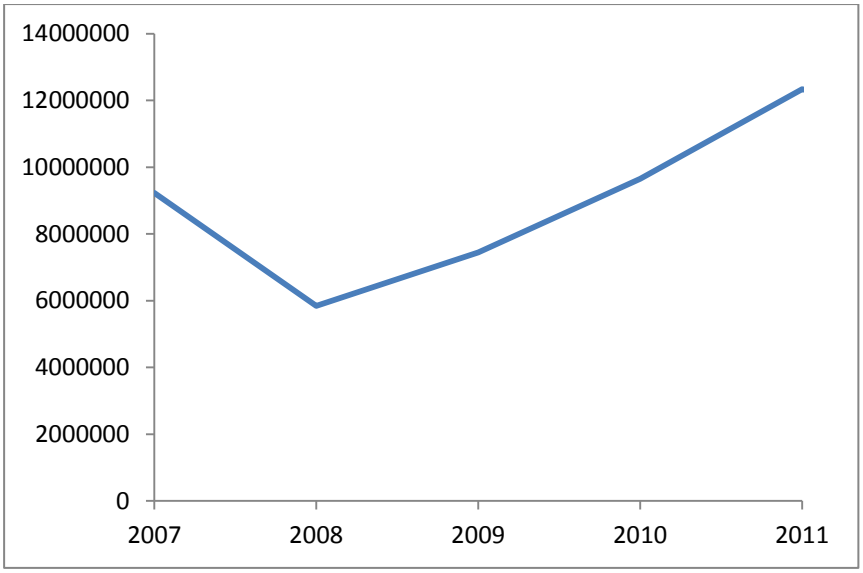


Source: Meisenzahl (2015)

In addition, the total value of financial standby letters of credit and foreign office guarantees in the US banking system in 2014 surged seven times as much as that in 1990, while other letters of credit maintained steady over the past decades (Meisenzahl 2015).

The same trend can been observed on the evolution of OBS activities in the Vietnamese banking system. Figure 2.10 indicates that there was an approximate 200% increase in the nominal value of the OBS activities of the Vietnamese banking system from 2008 to 2011.

Figure 2.10 Evolution of nominal value of off-balance-sheet in Vietnam, 2007 to 2011 (VND million)



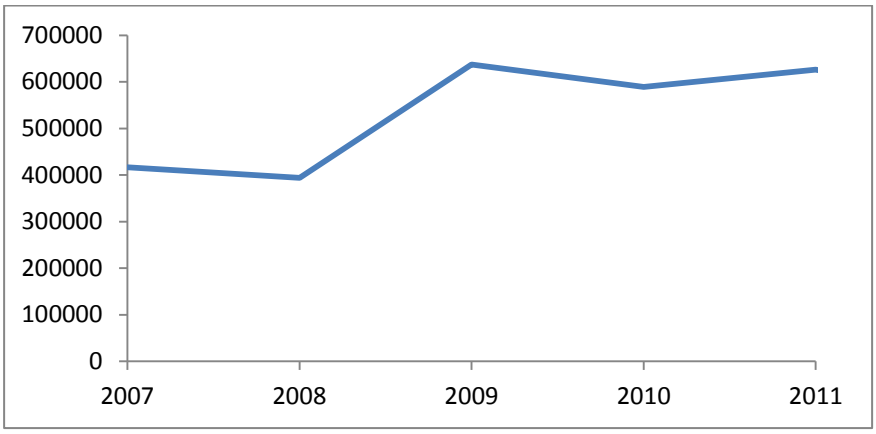
Source: Estimates based on author's calculation. This does not account for the foreign banks and joint-venture banks, due to the unavailability of data. Data were manually collected from annual reports of banks.

Vietnamese commercial banks are required to disclose OBS contingencies and commitments according to Vietnamese Accounting Standard 22 (MOF 2005). Most Vietnamese banks have engaged in OBS activities, mainly financial guarantees, commercial at sight letters of credit, standby letters of credit and other guarantees and commitments, and foreign exchange transactions. Financial guarantees are conditional commitments issued by a bank to commit the performance of a customer to a third party, including guarantee for borrowings, settlement, and performing contracts and bidding. Commercial at sight letters of credit refer to a financing transaction by a bank to its customer where the customer is usually the buyer/importer of goods and the beneficiary is typically the seller/exporter. Standby letters of credit provide for payment to the beneficiary by the issuing bank in the event of default by the account party upon the presentation of a draft or documentation required in the letter of credit (ABB 2007; Board of Governors of the Federal Reserve System 1997). Foreign exchange contracts are contracts to exchange one currency for another as of a specified data and time at

a specific rate of exchange (price). Delivery of the currency may be spot (two or less business days) or forward (more than two business days) (Board of Governors of the Federal Reserve System 1997).

In addition, the expansion of OBS activities reflects an increasing growth in NII, as indicated in Figure 2.11.

Figure 2.11 Evolution of non-interest income of Vietnamese commercial banks, 2007 to 2011 (VND million)



Source: Estimates based on author's calculation. This does not account for the foreign banks and joint-venture banks, due to data unavailability. Data were manually collected from annual reports of banks.

The importance of OBS activities in the Vietnamese banking system should not be neglected. Banks engaging in non-traditional OBS activities could gain important diversification benefits, with an enhancement in their risk-return trade-off. Portfolio theory suggests the shift from interest to non-traditional OBS activities should reduce total risk if it is imperfectly correlated with the traditional interest income business (Gallo, Apilado & Kolari 1996; Kwast 1989; Zhou 2014). A study by Froot and Stein (1998) suggested that diversification is a hedge against insolvency risk and reduces the effect of costly financial distress. Therefore, including OBS activities in the research of the efficiency effect of bank mergers has become an important topic in the Vietnamese banking system, given that the banking business structure

has changed from one that mainly involves traditional lending patterns to one that involves increasing numbers of innovative OBS activities.

2.4 Current problems

Despite making several remarkable achievements, the banking system faces some constraints, as presented in this section.

2.4.1 Restrictions on the presence of foreign banks

As a result of deregulation, FBs have taken major steps in expanding their operating networks in main cities or industrial zones. For instance, Citibank and Standard Chartered officially launched their retail banking services in Hanoi in 2010, while HSBC operated two branches, in Da Nang and Can Tho. Although in recent times it has become easier for FBs to operate in the Vietnamese banking market, they face restrictions in several areas.

First, the share of foreign ownership in any JVBs is limited to 49% of equity capital. This restricts their scale, which may result in additional costs. Since JVBs are not allowed to mobilise extra funds from their foreign counterparts to expand their operations, they must borrow from the Vietnamese market at high interest rates. However, this measure will hypothetically be relaxed when wholly foreign-owned banks are allowed to co-exist in the market (WTO 2007). Second, the Vietnamese government continues to impose a cap of 30% on foreign purchases of shares in any domestic bank. This prevents the threat foreign counterparts acquiring local banks (SBV 1993). Third, onshore FB branches are not allowed to open additional transaction points outside their head offices, except wholly foreign-owned banks (WTO 2007). Fourth, until 2011, FBs were still prohibited to accept local currency deposits in excess of 1,000% of their charter capital from Vietnamese residents with whom they have no credit relationship (WTO 2007). Fifth, a number of restrictions are imposed on the temporary movement of natural persons. More specifically, at least 20% of managers,

executives and specialists in JVBs must be Vietnamese people (WTO 2007). These conditions somewhat limit the business operations of FBs in the market.

2.4.2 Cross-ownership issue

The Vietnamese banking system witnessed a dramatic increase in the cross-ownership of POCBs between 2006 and 2011. According to Decision No.141/2006/ND-CP on regulating the minimum requirement on charter capital, POCBs must achieve at least VND 1,000 billion in charter capital in 2008, and VND 3,000 billion in 2010. The use of cross-ownership may generate virtual charter capital in order to deal with this minimum requirement in the short run. More analytically, shareholders of one bank may implicitly borrow money from another bank and then invest back into the original bank, and vice versa. This would affect the stability of the Vietnamese banking system.

Tran, Ong and Weldon (2015) documented six different types of cross-ownership of banks in Vietnam:

- SOCBs owning shares in POCBs
- POCBs owning shares in POCBs
- ownership of SOCBs and FBs in the form of JVBs
- strategic partnerships between FBs and POCBs
- investment funds owning shares in commercial banks
- SOEs, private corporations and individuals owning shares in POCBs.

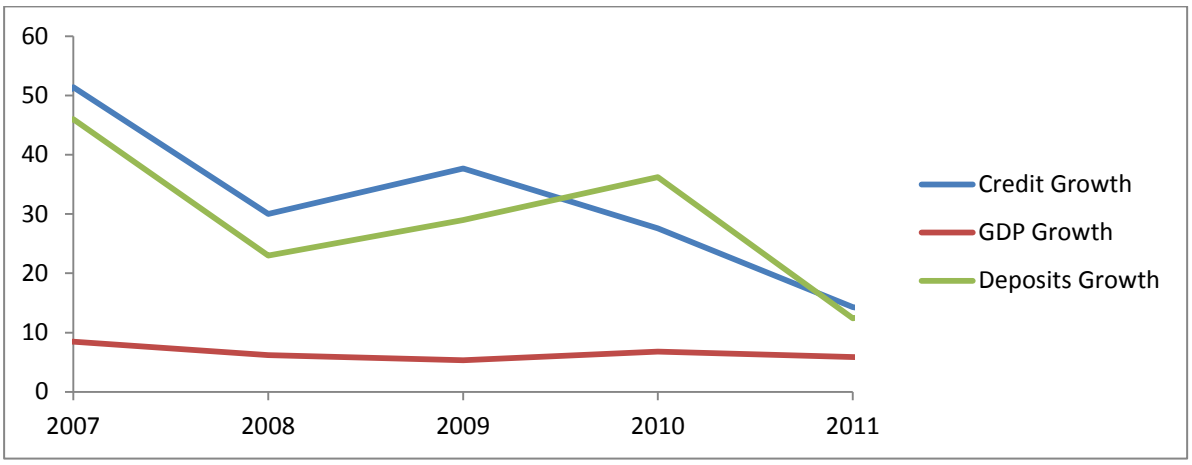
In theory, cross-ownership may allow for mutual support of funds, technology and expertise. However, this may cause several problems. First, cross-ownership can make it difficult to measure actual NPLs, since loan classification and provisioning can be falsified by the cross-ownership. Second, the sector may become more concentrated due to larger banks having share of ownership in many smaller banks, thus increasing the systemic risk. Last, the

increase in cross-ownership may reduce competition in the Vietnamese banking system, which may reduce the efficiency level of the banking system (Tran, Ong & Weldon 2015).

2.4.3 Bank credit risk

The Vietnamese banking system witnessed accelerating growth in credit and deposits between 2007 and 2011, as indicated in Figure 2.12. As can be seen, the average growth of credit and deposits reached a peak in 2007. This suggests there was an improvement in the intermediation efficiency of commercial banks. However, when average credit growth exceeds the average growth of deposits and GDP, this could potentially expose the banking sector to higher liquidity risk.

Figure 2.12 Growth of credit, deposits and GDP, 2007 to 2011 (%)

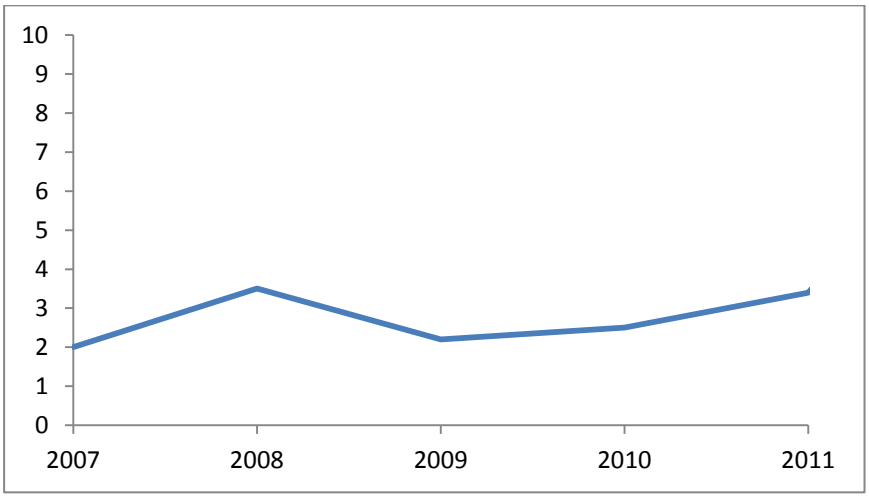


Source: SBV annual reports (2007b, 2008, 2009, 2010a, 2011, 2012).

Despite a rapid growth of credit and total deposits, the banking system faced a significant increase in NPLs, especially between 2007 and 2008, as presented in Figure 2.13. However, several reports suggested that the actual figures of NPLs would be higher than what was reported by the SBV (WB 2014). The NPLs caused by loans to SOEs have not been comprehensively included in the estimates made by the SBV (Phuong Nam Securities Company 2013). In addition, VAS are still behind the IAS, thus the underestimation of the level of NPLs (Nguyen & Gong 2012). For example, some banks took advantage of loan

rescheduling as a way to lower their actual NPLs, since rescheduled loans were not considered to be NPLs (VPBank Securities Company 2014).

Figure 2.13 Non-performing loans in Vietnam, 2007 to 2011 (%)



Sources: SBV annual reports (2007b, 2008, 2009, 2010a, 2011, 2012) and Phuong Nam Securities Company (2013)

The proliferation of NPLs between 2007 and 2011 could be explained by the following reasons. First, in response to the lax regulatory environment, SBV licensed, inter alia, rural banks to operate in urban areas, where demand for credit was booming. This led to significant credit growth among commercial banks, reaching a peak in 2007. Along with inefficient credit management of POCBs, significant portions of loans were invested into speculative activities in the booming real estate and stock markets rather than into productive investments. In addition, SOCBs that accounted for more than 50% of market share continued providing directed and often subsidised credit to selected industries. These advances often supported the cash needs of less productive SOEs while crowding out the legitimate credit needs of the private sector. The GFC (2007–08), and the subsequent decline in the stock market index by some 60% and in housing market prices by approximately 50%, resulted in significant increases in NPLs in banks as mortgages were renewed (ADB 2009; Leung 2009). Second, the cross-ownership issue contributed to this problem faced by the banking system.

Under pressure from major shareholders, POCBs were required to advance loans to high-risk investments where the controlling shareholders had commercial interests (ADB 2014).

In response, the SBV put in place several stabilisation measures to strengthen the banking system and improve its competitiveness and resilience against the GFC, especially the imposition of minimum charter capital and CAR following the Basel framework. Accordingly, POCBs were required to increase their charter capital to VND 1,000 billion no later than 31 December 2008 and to at least VND 3,000 billion by the end of 2010 (SBV 2011). Also, SOCBs were required to increase their charter capital to VND 3,000 billion no later than 31 December 2008. Coupled with this, commercial banks were required to achieve at least 9% of CAR by the end of 2010.

It was seemingly not difficult for SOCBs to meet the new regulations on both charter capital and CAR, since they received strong lifetime support from the government. In fact, four out of five SOCBs already met the requirements when they were officially announced. This implies that the government seems to pick the winners, rather than letting the market decide (Dinh 2011).

In contrast, the tight deadline created some problems for POCBs. First, some POCBs had to sell their shares at prices lower than par value in return for capital. This may have caused a loss to their shareholders, at least in the short term, which in turn created the possibility of peculation issues in the stock market (Dinh 2011). Second, some POCBs borrowed at high interest rates in the informal market to improve their capital. This situation arose when those banks were unable to recapitalise by issuing new shares to both existing and new shareholders, due to the unfavourable condition of the stock market. Third, there was a moral hazard effect. The high demand for recapitalisation resulted in an increase in the market interest rate. This limited banks to mobilising funds and generating loans. In turn, newly

recapitalised banks searched for high profit investments with excessive risk-taking (Dinh 2011). Therefore, an increase in regulatory capital may have forced POCBs to squeeze their operations relatively more than SOBs had to, although they appear to have been more active and to have outperformed than their counterparts. M&As are considered to be a possible solution for POCBs, especially small and medium banks. So far, banks' activities have been restricted due to a lack of capital and accumulated NPLs. The consolidation process is expected to restore not only the intermediary function of banks but also to improve the efficient allocation of credits in the economy.

2.5 Bank mergers

In order to address the issues faced by the banking system outlined above, the Vietnamese government (2012) officially released a program to restructure the credit institutions, under Decision No. 254/QD-TTg. Accordingly, the SBV and the MOF have responsibility for supervising and providing appropriate guidance for credit institutions in order to accomplish goals as per the schedule. The fundamental purpose of this program is to develop a modern, safe, efficient and sustainable financial system by 2020, thus providing better banking products and services to satisfy the demands of individual households and businesses, and the economy as a whole. More specifically, this program emphasises that bank M&As should be promoted in order to (1) achieve healthy financial conditions, since their charter capital will improve and the management capability of merging banks will enhance and (2) strengthen bank efficiency and performance in an increasingly competitive environment.

In the same vein, Than (2010) and Vu (2013) suggested that bank mergers should be encouraged on a voluntary basis. In addition, 10 POCBs were targeted by the SBV to be restructured, due to their poorly financial and management conditions (The Vietnamese Government 2012). Merging these target banks with other banks was considered a possible solution.

After introduction of the program to restructure credit institutions, the Vietnamese banking system had witnessed the consolidation of three banks in one merger in 2011: Saigon Commercial Joint Stock Bank, Vietnam Tin Nghia Commercial Joint Stock Bank and the First Joint Stock Commercial Bank. The newly-formed bank had total assets of VND 154 trillion and a charter capital of VND 10.6 trillion. Therefore, the SBV expects more mergers among small and medium banks in Vietnam.

In contrast to the expectations of industry participants and policy-makers, the extant literature shows mixed results. Several studies reported that bank mergers resulted in efficiency gains and cost reductions (Akhavein, Berger & Humphrey 1997; Berger & Dick 2007; Shaffer 1993). However, others indicated the opposite (Berger & Humphrey 1992a; Lee, Liang & Huang 2013; Montgomery, Harimaya & Takahashi 2014; Rhoades 1993, 1998; Shih 2003). Accordingly, this raises concerns about whether bank mergers in Vietnam would bring benefits to the merging parties or to the public – this is one reason that it is crucial to conduct an empirical research on the effect of bank mergers. So far, no prior study has been conducted to examine the efficiency effect of bank mergers in Vietnam. The present study is the first attempt to fill to this gap in empirical research and to outline policy measures that could be used in the decision-making process about bank mergers. Furthermore, the target banks as identified in the restructuring program are included in the analysis.

2.6 Summary

This chapter provided an overview of the Vietnamese banking system. First, the profile of the Vietnamese banking system was discussed. This began with an introduction to the structure of the Vietnamese banking system and then highlighted key reforms, including financial reforms in 1990 and several restructuring programs that took place after Vietnam's entry into world agreements. Thereafter, the chapter emphasised some issues in relation to the regulatory and supervisory framework in Vietnam.

Second, the performance of the Vietnamese banking system over the period 2007 to 2011 was discussed in terms of bank size, bank assets, bank market share, liquidity and funding sources, and bank profitability. More analytically, the performance of different types of ownership was analysed. The Vietnamese banking system is dominated by SOCBs, which account for 50% of total assets in the market. However, POCBs have operated more actively and have gradually gained a large market share in terms of both deposits and credit market shares. Also, FBs and JVBs have been allowed to accept domestic currency deposits, thus gaining the deposits market share at the expense of SOCBs. Despite their successful operations, the capital size of POCBs is much smaller than that of SOCBs.

In addition, the main sources of funding of commercial banks were discussed. In order to make loans and other investments, Vietnamese banks are mainly based on funds collected from individual households and other economic entities rather than from the interbank market. The income structure of Vietnamese banks was also explored. Over the examined period, Vietnamese banks have been diversifying, at the margin, away from traditional lending businesses and into non-traditional activities, including OBS activities. Nonetheless, the NII of banks was lower than that of banks in the Asia-Pacific region, such as in Australia, Singapore and Thailand. This could be mainly due to the fact that the Vietnamese banks were less engaged in retail banking. Nonetheless, the low level of NII may provide opportunities for Vietnamese banks to diversify their income structures in order to reduce their risks.

Third, the current problems faced by the banking system were discussed, especially a significant increase in NPLs between 2007 and 2011. The proliferation of NPLs was due to inefficient credit management and targeted lending policies with significant portions of loans in speculative activities such as real estate and the stock market. As a result of the GFC (2007–08), a stagnating economy, a crash in real estate, and a deep fall in the stock market index resulted in an increase in business insolvencies, thus exacerbating NPLs.

Last, the chapter discussed M&A activities in Vietnam. M&A activities were one of the key strategies adopted by businesses in order to address the difficulties of an increasingly competitive environment. Accordingly, bank mergers resulted in not only a restoration of the intermediary function of banks but also improvements in the efficient allocation of credit in the economy. The present study is the first attempt to investigate the efficiency effect of bank mergers in Vietnam, which will provide a strategic tool for policy-makers to enable them to pre-evaluate whether bank mergers would generate technical efficiency gains. Also, this will help Vietnamese authorities target banks in suitable for future M&As.

Chapter 3 Literature review

3.1 Introduction

Chapter 2 gave an overview of the Vietnamese banking system and the evolution of bank mergers, and this chapter reviews the literature on bank efficiency, especially the efficiency effect of bank mergers. Chapter 3 begins with an introduction to the bank merger causes, and goes on to discuss relevant theories. Next, the methodologies used in previous studies are discussed, as well as the findings of empirical studies on the efficiency effect of bank mergers. In addition, the various impacts on bank efficiency are outlined. The chapter concludes by identifying the gaps in the literature.

3.2 Bank merger causes

The wave of M&As in the global banking system during the past decades has received a good deal of attention, but most of the academic and public discussion has been devoted to the consequences of the mergers. It is important to also explore the motives behind these mergers.

Prior studies have proposed a range of different motives for mergers. Chatterjee (1986) indicated three motives of mergers: the attainment of operative, financial and collusive synergies. Synergies arise when a new formed bank can perform better than two separate, competitive entities. Operative synergies are related to cost of production, while financial and collusive gains are associated with cost of capital and price, respectively. These gains are generated by 'horizontal mergers', defined as mergers between firms in the same industry (Farrell & Shapiro 1990) or between firms in the same local market (in-market mergers) where there is a significant overlap by the merging parties (Avkiran 1999; Rhoades 1993). Krishnan, Hitt and Park (2007) suggested three motives: the attainment of market power, cost reduction and diversification. Next, Devos, Kadapakkam and Krishnamurthy (2009) and Houston, James and Ryngaert (2001) demonstrated there were two main motives behind

mergers: operative synergies (increased operating profits or reduced investments) and market power gains.

With respect to these prior studies, the following sections discuss three main motives of bank mergers: the value-maximisation motive, the non-value-maximisation motive and diversification. Thereafter, this study identifies three types of changes in the economic environment that may have led to the accelerating pace of bank mergers.

3.2.1 Value-maximisation motive

Banks can maximise value via M&A activities, either by increasing their market power in setting prices or by improving their efficiency (Berger, Demsetz & Strahan 1999; Devos, Krishnamurthy & Narayanan 2016).

3.2.1.1 Market power

As per the market power hypothesis, greater market power allows the consolidated bank to charge higher prices (higher interests) and decrease quantities, thus earning greater margins via the appropriation of consumer surplus (Weitzel & McCarthy 2011). Market power also increases barriers for potential entrants in the market (Motta 2004), which in turn allows larger banks to gain a significant premium (Gugler et al. 2003). Enhanced market power sometimes refers to increased size, which increases access to safety net subsidies. Consequently, this may enable the newly-combined bank to expand into riskier activities (Devos, Krishnamurthy & Narayanan 2016).

It is not easy to determine the goals of M&A participants, but there is evidence that in-market mergers enable merging banks to exercise market power on their customers (Devos, Krishnamurthy & Narayanan 2016). A similar result was found in the case of a US mega-merger that included two very large merging banks with in excess of US$1 billion in total assets (Berger 1995). In addition, several studies indicated that bank mergers resulted in

diminished economic conditions (Kahn, Pennacchi & Sopranzetti 2005), higher real estate loan rates (Garmaise & Moskowitz 2006) and lower interest rates paid to depositors (Prager & Hannan 1998). Therefore, bank mergers that are associated with increased market power need to be approached in caution.

3.2.1.2 Efficiency improvements

A per the theory of synergy gains, mergers have the potential to generate three types of synergies: operative synergies, allocative synergies, or collusive synergies (Chatterjee 1986; Trautwein 1990). Operative synergies, or efficiency gains, can be achieved through scale and scope economies (Haynes & Thompson 1999). As per the corporate control hypothesis, in an efficient merger market operative gains can be generated when a superior firm or a superior management team is willing to acquire an underperforming firm, thus improving the performance and efficiency of the consolidated banks (DeYoung 1997; Weston, Mitchell & Mulherin 2004).

Several studies showed that financial gains resulting from mergers included cost reductions (Kwan & Wilcox 2002), profit gains (Knapp, Gart & Chaudhry 2006) or revenue efficiency improvements (Cornett, McNutt & Tehranian 2006). Recently, Hagendorff and Keasey (2009) suggested that US bank mergers tended to focus on revenue generation in the post-merger period, although this did not always improve performance, because the revenue enhancement can be offset by an increase in costs.

3.2.1.3 Shareholder wealth

As per the theory of efficiency, mergers only occur when the deal benefits both parties. In other words, a 'friendly' merger that can generate positive returns to both the bidder and the target should be proposed and approved (Weitzel & McCarthy 2011).

Several studies have investigated whether bank mergers bring benefits to shareholder wealth (Al-Sharkas & Hassan 2010; Goddard, Molyneux & Zhou 2012; Kolaric & Schiereck 2013). A review study by Kolaric and Schiereck (2014) pointed out that bank mergers in the US were more successful from a bidder shareholder perspective in the 1970s and early 1980s, but that success diminished from the late 1980s onwards. The same phenomenon can be observed for bank mergers in European markets. However, the evidence in Latin America and Asia showed that positive returns were found for both merging parties (Ekkayokkaya, Holmes & Paudyal 2009; Kolaric & Schiereck 2013; Lensink & Maslennikova 2008).

3.2.2 Non-value-maximisation motive

The lack of consistency in efficiency gains resulting from M&As has encouraged researchers to study alternative explanations, and to pay particular attention to managerial motives (DeYoung, Evanoff & Molyneux 2009). There are two main views on non-value-maximisation motives: the maximisation of managers' personal utility and the status of a too-big-to-fail (TBTF) organisation.

3.2.2.1 Utility maximisation

As per the theory of managerial entrenchment, managers who pursue growth-by-acquisition strategies do not put effort into maximising firm value, but rather entrench themselves by increasing their individual value to the firm. Accordingly, they may primarily make specific investments that make it much too costly for shareholders to replace them. As per the theory of empire building, entrenchment not only secures the manager's position in the firm but also allows them to extract more wealth, power, reputation and fame (Ravenscraft & Scherer 1987). This strategy could include maximising the remuneration of the chief executive officer (CEOs) and choosing a quiet life or building a personal empire (Hadlock, Houston & Ryngaert 1999; Vander Vennet 1996).

A study by Rosen (2005) suggested that, since higher CEO compensation was linked to increased firm size via M&As, managers tended to engage in extended merger programs. In addition, Anderson, Becher and Campbell (2004), using US data, found that post-merger CEO compensation was positively related to performance gains from M&As and suggested that CEO compensation packages were used to provide incentives for managerial productivity. Their findings somewhat conflict with the findings of Bliss and Rosen (2001), who found that increased CEO remuneration was considered to be evidence of managerial empire building irrespective of value creation or productivity enhancements.

Furthermore, prior studies have found a negative relationship between firm value and increased size via M&As. Roll (1986) suggested that managers may have good intentions to maximise firm value, but, being overconfident, may overestimate their ability to generate synergies. Overconfidence may not only cause the higher probability of overpaying (Martynova & Renneboog 2008) but also result in a higher probability of failure (Dong et al. 2006). In addition, Jensen (1986) and Rau and Vermaelen (1998) demonstrated that stakeholders of the firm may approve M&A plans on the basis of fuzzy and subjective concepts that include 'managerial instincts', 'gut feelings' and 'intuition' based on high past and current cashflows. Therefore, they tend to make strategic decisions without prudent analysis and more quickly than their cash-strapped peers. Furthermore, greater levels of liquidity also increase managerial discretion, which may induce managers to select poor acquisitions when they run out of good options (Martynova & Renneboog 2008).

In addition, a study by Berger and Hannan (1998) indicated that if the managers of larger bank size via M&As (higher levels of concentration) is pursuing a quiet life, they will not put their efforts into minimising costs. Similarly, studies by Hughes et al. (2003) and Gupta and Misra (2007) indicated that acquisitions undertaken by bank managers acting based on agency problems had lower shareholder returns than those by bank managers with value-enhancing

goals. Agency theory suggests that the managers may select actions (i.e. payment of excessive salaries to managers, resistance to value-increasing takeover bids, and outright shirking) to maximise their personal utility (Denis, Denis & Sarin 1999). Consequently, this raises the possibility of conflicts of interest between managers and shareholders.

3.2.2.2 Safety net subsidies and systematic risk

The global banking system witnessed bailouts of large banks during the GFC (2007–08), after which they became extremely large and were considered TBTF or too-big-to-discipline adequately. This may provide an opportunity for them to utilise safety net subsidies (DeYoung, Evanoff & Molyneux 2009; Kane 2000; Mishkin 2006).

A study by Ennis and Malek (2005) suggested that TBTF subsidies were likely to be significant, although it was difficult to measure these subsidies. TBTF banks can take advantage over their rivals because they can pay less for funds than do smaller banks, and operate with lower capitalisation rates (Shull & Hanweck 2001). In addition, a study by Penas and Unal (2004) found that bank mergers can lead to bondholder gains when they attain TBTF status. In addition, Schmid and Walter (2009) found that substantial premiums as an indicator of the safety net subsidy were paid in very large conglomerate deals in the US. Similarly, Brewer and Jagtiani (2007) indicated higher premiums for acquired banks over a critical size.

Furthermore, several studies have investigated the relationship between M&As and safety net subsidies, by examining systematic risk. ‘Systematic risk’ is defined as the risk that the insolvency of one large or a very few crucial financial institutions may cause financial losses in and insolvencies of other entities, thus leading to a system-wide financial disturbance and potential macroeconomic disruption (DeYoung, Evanoff & Molyneux 2009). A study by Nicoló et al. (2004) demonstrated that trends in international consolidation and

conglomeration may increase risks for large complex financial institutions. D'Souza and Lai (2006) also noted that an increase in financial sector consolidation can lead to increased liquidity in the money market, and this influence is dependent on the post-merger allocation of capital within merging entities.

3.2.3 Diversification

The trend in financial sector consolidation is accompanied by greater geographic and product diversification (McCarthy & Weitzel 2012). Expanding into new geographic markets or new product lines has the potential to improve risk-adjusted returns via diversification.

As per portfolio theory, diversifying away from traditional business activities towards non-interest income (NII) could increase bank revenue and enhance the risk-return trade-off if NII is negatively or only weakly correlated with interest income (Stiroh 2004). In addition, diversification may reduce the cyclical variation in bank profits and revenue (Amihud & Lev 1981; Stiroh 2004) and mitigate the likelihood of bankruptcy and liquidation (Shleifer & Vishny 1992).

As per diversification theory, diversification enables the redistribution of funds among divisions and also encourages internal capital markets that can alleviate financial constraints and improve efficiency (Campa & Kedia 2002). By informing an internal capital market where internally generated cashflows can be pooled, diversified firms can allocate resources to their best use (Li & Li 1996).

3.2.3.1 Product diversification

'Product diversification' is defined as a merger that expands the acquirer's portfolio of products and services. Due to the fact that regulations have long prevented banks from diversifying across product lines, several studies using US data examined whether hypothetical mergers between banks and non-bank financial firms generated diversification

benefits. Studies by Lown et al. (2000) and Estrella (2001) suggested that potential reduction in risk resulted from diversification benefits in potential mergers between banks and insurance providers. Wall, Reichert and Liang (2008) concluded that significant risk-return improvements were found when merging banks with firms from the construction, retail, or wholesale sectors. However, Allen and Jagtiani (2000) indicated that hypothetical diversification of banks into insurance and/or securities businesses mitigated the overall firm risk but increased systematic market risk. Therefore, diversification benefits are not realised when banks expand their businesses in these areas.

Another strand of literature that examined the impact of product diversification resulting from actual M&As showed opposite results. Cornett et al. (2003) and DeLong (2003) indicated that US bank mergers in which the acquiring banks improved their product line resulted in higher stock market reactions. However, a study by Rime and Stiroh (2003) found that scope or scale economies do not exist at large Swiss banks and that no evidence of cost efficiencies was found at any of the banks. Their findings are in line with those of Hayden, Porath and Westernhagen (2007) in Germany and Hendershott, Lee and Tompkins (2002) in the US..

The mixed results could be explained by a cost-less strategy of diversification. First, diversified firms may incur substantial costs because they will invest too much in lines of business with poor investment opportunities. Stulz (1990) demonstrated that when divisions have diverse resources and opportunities, it may be too costly or even impossible to obtain cooperation, even through the allocation of funds. In addition, this may increase not only the direct costs of internal lobbying and the costs of misallocations of resources (Meyer, Milgrom & Roberts 1992) but also control and co-ordination costs (Jones & Hill 1988). Second, bargaining problems may arise within the diversified firm (Rajan, Servaes & Zingales 2000). While managers attempt to gain power through self-serving investments, headquarters of banks cannot bribe them privately to take the right investment, because investment cannot be

contracted on. Also, headquarters are willing to channel larger capital budgets to divisions with poor opportunities simply in order to avoid even larger costs from divisions choosing poor investments. Therefore, funds are allocated towards the most inefficient divisions, thus increase costs for diversified firms. Third, as per the managerial theories, diversification allows managers to (1) entrench and reduce their human capital risk, (2) increase their discretion and (3) build empires, power and prestige (DeYoung, Evanoff & Molyneux 2009; Kolaric & Schiereck 2014) as presented in section 3.2.2.1. . In sum, the pursuit of a product diversification strategy via mergers should be undertaken cautiously by weighing the incurring costs and the resultant benefits.

3.2.3.2 Geographic diversification

'Geographic expansion' is defined as a merger that expands the acquirer's presence into a new city, state, or geographic region (DeYoung, Evanoff & Molyneux 2009). Domestically geographic expansions allow for the realisation of efficiencies in scale economies and for a reduction in management, finance, research and development, marketing and production costs (Buch & DeLong 2004). In addition, cross-border mergers can enhance the competitive standing of the firm because geographically diverse operations can bring benefits from local specialisation, improved capacity utilisation and technical efficiency. Therefore, geographic expansion is expected to result in improvement in the firm's revenue or a reduction in costs (Besanko et al. 2009).

However, there is lack of consistency in the views on the benefits of geographic diversification resulting from bank mergers. Several studies on cross-country European bank mergers found that focused mergers performed better than diversifying mergers in terms of shareholder returns (Beitel, Schiereck & Wahrenburg 2004). However, others suggested opposite results (Ekkayokkaya, Holmes & Paudyal 2009; Lepetit, Patry & Rous 2004). Nonetheless, Buch and DeLong (2004) argued that banks make domestic over-investment and

could then realise potential diversification benefits from further international expansion when comparing actual versus optimal cross-border portfolios for banks.

Several studies in the US reported that geographic diversification via M&As resulted in little or no cost efficiency improvements (Berger & DeYoung 2001; Vander Vennet & Gropp 2003), although there was some evidence for profit efficiency gains and accounting returns (Elsas, Hackethal & Holzhäuser 2010; Vander Vennet & Gropp 2003). Notably, studies by Berger and DeYoung (2001, 2006) found that increased geographic expansion via consolidation resulted in higher operational inefficiency due to managerial incapability and the effect of multi-market contact. As per mutual forbearance hypothesis or linked oligopoly theory, diversified firms may not have aggressive attitudes towards their multi-market rivals, due to the fear of multipoint attacks from them (Edwards 1955). Consequently, there is less incentive for them to operate efficiently.

The mixed results of geographic diversification resulting from M&As could be explained as follows. Like product diversification, geographic expansion may include a substantial 'diversification discount'. Along with the possible agency problems, there is the added complexity and uncertainty of entering new markets where the firm has no geographic core competence, which together may destroy shareholder value (McCarthy & Weitzel 2012).

In sum, prior studies suggested that attainment of such operating gains is a prominent motive behind bank mergers (Devos, Kadapakkam & Krishnamurthy 2009; Lee, Liang & Huang 2013; Montgomery, Harimaya & Takahashi 2014). Cost efficiency can be used as an antitrust defence in the case of the US banking industry (Berger & Humphrey 1992a). In addition, achievement of cost reduction is often easier than that of revenue improvements (Carey 2000). Cost savings can be easily achieved by eliminating redundancies and duplication in

related operations such as labour and offices (Akhavein, Berger & Humphrey 1997; Berger & Humphrey 1992a; DeYoung 1997).

More importantly, operating gains resulting from bank mergers are consistent with the aim of the Vietnamese Government's program to restructure credit institutions (2012). Accordingly, mergers are expected to improve the efficiency and performance of banks, thus enhancing banking stability. Consequently, the present study is the first attempt to investigate the effect of mergers on the technical efficiency of Vietnamese banks, since technical efficiency reflects the ability of banks to control costs.

3.2.4 Why is consolidation accelerating?

The pace of consolidation is primarily determined by changes in economic environments that alter the constraints that banks face. A relaxation of constraints may allow consolidations that increase shareholder value or facilitate managers to pursue their own goals through M&As. Three key elements that have accelerated the pace of bank mergers include globalisation, technological progress and deregulation.

3.2.4.1 Globalisation

Globalisation is seen as a process that removes restrictions and leads to increased trade and economic growth and financial integration (Aizenman & Jinjarak 2009; Stiglitz 2002). Accordingly, the transfer of securities, goods and services in international markets creates demands for currency, deposits, loans and other services provided by international financial institutions. Thus, the globalisation has likely contributed to cross-border mergers (Berger, Demsetz & Strahan 1999; Dymski 2002). This allows foreign banks (FBs) (usually megabanks seeking global scale of their investment banking activities) to participate in other potential markets by merging with or acquiring existing domestic banks in the host country.

3.2.4.2 Technological progress

Consolidations have occurred as a result of the financial and technological innovations that led to banks altering their functions and optimising their productivity. Technological progress revolutionised back-office processing, front-office delivery systems and payments systems (Berger 2003; Humphrey et al. 2006). For instance, some new delivery methods for depositor services, such as phone centres, ATMs and online banking, may lead to greater economies of scale than traditional branching networks (Radecki, Wenninger & Orlow 1997). This generates faster processing and improves real-time access to potential consumers in various markets. In addition, financial innovations included, but were not limited to, financial engineering and new risk management tools, larger and more sophisticated derivative markets (such as assets-backed securities, swaps and derivative contracts), and the ability of large and mid-sized business to float their own debt securities. These new tools of financial engineering may be more efficiently produced by larger institutions. Therefore, these innovations have significantly changed the competitive and strategic conditions faced by banks. More importantly, technological progress may have increased economies of scale in delivering banking services as well as providing opportunities to improve efficiency and increase value through mergers (Berger, Demsetz & Strahan 1999).

3.2.4.3 Deregulation

A wave of financial deregulation is the enabling force that is necessary for banks to take full advantage of the new production processes (DeYoung, Evanoff & Molyneux 2009). The geographic restrictions on competition may have allowed some inefficient banks to continue to survive. However, the removal of this constraint may have forced inefficient banks to become more efficient by acquiring another institution, by being acquired, or by improving management practices internally. In addition, the changes in deregulation have allowed commercial banks to expand – almost always via mergers – into geographic and product

markets that had previously been off-limits (Becher & Campbell 2005). A study by Lozano-Vivas, Meléndez-Jiménez and Morales (2016) suggested that loosening geographic constraints increased merger activities in the US, irrespective of value-maximising motives. Their findings are in line with those of Lozano-Vivas, Meléndez-Jiménez and Morales (2011) that the complete removal of geographic constraints in Spain led inter-regional mergers of savings banks to be optimal whenever economies of scale relating to M&As were low.

The Vietnamese Government (2012) officially released a program to restructure the credit institutions, with the main focus on M&As of commercial banks. Accordingly, the SBV creates more favourable conditions for banks that intend to merge. So far, no study has been conducted to investigate the effect of mergers on bank efficiency in Vietnam.

3.3 Theoretical framework

The theory of synergies proposed by Trautwein (1990) has been adopted by the present study. Accordingly, potential efficiency gains resulting from bank mergers can be achieved through economies of scale and economies of scope, and selective redeployment of assets. Hereafter, x-efficiency is discussed.

3.3.1 Economies of scale and scope

This section begins by defining ‘economies of scale’ and ‘economies of scope’, and then discusses the findings of empirical studies on these effects.

3.3.1.1 Economies of scale

Economies of scale may arise when consolidated banks achieve the control of cost-saving technologies or spread their fixed costs over a larger volume of output, thus reducing their average cost and increasing efficiency.

First, economies of scale can be achieved when an increase in the volume of productions results in a reduction in the cost of production per unit. Scale economies might be a

consequence of higher efficiency resulting from high-capital equipment. Small banks have less incentive to invest in expensive technologies (i.e. credit scoring systems, internet banking) in order to reduce marginal costs, as such investments incur additional capital costs, or may even exceed the resulted benefits. For newly-combined firms, it may be profitable to invest in technologies that reduce marginal costs, because the investment costs are spread over a larger output. Although these capital investments are costly, such investments are somewhat beneficial if this increase is smaller than the reduction in operating costs per unit of output (Silberston 1972).

Second, fixed expenses can potentially be lowered through a merger by eliminating overlapping branches or offices, or duplication of indivisible tasks within the post-merger organisation (DeYoung 1997; Haynes & Thompson 1999). Indivisibility arises when it is technically impossible to reduce an input below a certain minimum size, even when the level of output is relatively small. In addition, a merger may help to expand the volume of production, without a corresponding increase in fixed costs. Thus, this can reduce the unit cost of production. More importantly, spreading these fixed costs may be feasible whether both firms produce identical or different products and services (Dash 2010).

In contrast, the empirical studies such as Berger and Humphrey (1992a) and McAllister and McManus (1993) in the US, and Altunbas and Molyneux (1996) in Europe showed that there are few or no cost savings to be generated simply by expanding bank size via M&As.

3.3.1.2 Economies of scope

'Economies of scope is defined as reductions in per-unit costs due to synergies involved in producing multiple products within the same firm (Goldstein & Gronberg 1984). Economies of scope may arise when merging banks enter new markets and cross-selling their products to existing customers by sharing inputs or when pooled assets from them can be utilised in the

most productive way by one single entity. Therefore, costs associated with a bank merger may be reduced if the consolidated bank can offer several products at a lower cost than separate banks each providing individual products (Pilloff & Santomero 1998).

However, the empirical studies such as Berger and Humphrey (1987) and Berger and Humphrey (1992a) in the US indicated little or no support for cost reductions by changing the mix of bank products offered. Their findings also highlighted that cost savings resulting from economies of scope seem to be significantly irrelevant for bank mergers where both merging parties generally produce the full range of bank outputs.

In sum, the limited existence of such economies is explained by several reasons. In terms of scale economies, many studies investigating economies of scale assumed that banks produce their services with same degrees of efficiency. However, this assumption is incorrect because of significant variations in operating costs exist among merging banks of similar size. In addition, it may be possible to achieve these cost savings when most efficient banks acquire less efficient banks, but they are not the consequence of realising scale economies. If economies of scale exist, these savings would be in addition to any savings from such economies (General Accounting Office 1995). Furthermore, the translog cost function used to estimate scale economies generates a poor approximation when banks of 'assorted sizes' are used (Avkiran 1999). In addition, scale economies on and off the efficient frontier show only slight differences. Hence, this potential problem seems to be of little practical importance (Berger & Humphrey 1991).

Regarding scope economies, McAllister and McManus (1993) emphasised that the comparison revealed substantial differences on and off the frontier, invalidating the product mix results of conventional cost studies. In addition, Berger and Humphrey (1991) contended that conclusions on scope economies are mainly claimed on the extrapolation of the estimated

cost function well outside the actual practice of banking, as reflected in the sample on which findings are based.

3.3.2 Selective redeployment of assets

Efficiency gains resulting from bank mergers could be explained by the effect of selective redeployment of assets (Haynes & Thompson 1999). Prior studies suggested that in market mergers may give rise to economies where under-utilisation allows selective retirement of assets (Rhoades 1993). As discussed above, prior studies found little or no support for the realisation of economies of scale from consolidation.

3.3.3. Transfer of asset control to better quality managers

If the acquisition process leads to assets passing from the stewardship of less able or less diligent managers to the control of their more efficient acquiring banks, as per the market for corporate control hypothesis, x-efficiency gains would be expected (Haynes & Thompson 1999). Several studies support this view (Avkiran 1999; Kohers, Huang & Kohers 2000). However, as per the learning by doing hypothesis, a significant reduction in x-efficiency depends more on the opportunities facing management than the difference in management quality between acquired and acquiring banks (DeYoung 1997). Similarly, a study by Valverde and Humphrey (2004) using Spanish data found that x-efficiency improvements that resulted from mergers between savings banks could be created by the effect of learning by doing in banks engaging in more than one merger. The following section discusses x-efficiency and its components.

3.3.3.1 X-efficiency

While M&As have some limited potential to improve performance via economies of scale and economies of scope, as discussed in section 3.3.1, whether or not these gains are captured depends on the control of x-inefficiency (Haynes & Thompson 1999). Prior studies on

banking efficiency confirmed that x-efficiency is significant and dominant over economies of scale and scope (Avkiran 1999). Berger and Humphrey (1991) and Ferrier and Lovell (1990) found that the average x-inefficiencies banks were approximately 20% or higher for virtually all size classes of banks, while findings for scale and product mix economies amounted to 5% or less, except for the smallest size classes. Therefore, the literature has shifted to examine the impact of mergers on x-efficiency of banks.

3.3.3.2 Explanation of x-efficiency concept

The efficiency of a bank can be also determined by whether cost minimisation or profit maximisation is achieved. This depends on the role of management regarding its pursuit of these objectives in order to maximise shareholder value. However, it is not an easy task, because the competitive condition of the market, internal and external factors as well as the application of the level of technology, may prevent firms from achieving higher efficiency. Managers face the challenge of using quantity and quality of inputs to produce the appropriate quantity and quality of outputs while maintaining cost minimisation. It is also analogous to the case of maximising profit, where managers face the challenge of achieving optimal quantity and quality of produced outputs.

Depending upon the inputs used, a bank will operate on or outside of the production frontier of other banks that produce the maximum quantity of output, all other things being equal. In terms of the outputs produced, a bank will operate on or outside the frontier of other banks that use the minimum inputs, all other things being equal. In other words, the banks that operate on the production frontier obtain the highest productive efficiency – they are the so-called ‘best’ banks in practice. Therefore, the differences in managerial competence to control costs or maximise profits are attributed to x-efficiency (Avkiran 1999). It is similar to the concept of x-efficiency as proposed by Leibenstein (1966).

3.3.3.3 Composition of x-efficiency

The x-efficiency of a bank is divided into technical efficiency and allocative efficiency (Coelli et al. 2005). Technical efficiency refers to the ability of a firm to produce its existing level of output with the minimum inputs (input-oriented), or to produce maximum output from a given set of inputs (output-oriented). 'Allocative efficiency' is defined as the choice of an optimum combination of inputs consistent with the relative factor prices to produce a given level of outputs.

The x-efficiency of a bank can be theoretically estimated by how close its input requirements are to the best-practice or fully efficient firm within a sample, holding constant the effects of scale, scope economies, input prices and other exogenous factors affecting bank costs. The best-practice bank here is not the same as the best possible practice in reality (Coelli et al. 2005).

3.3.3.4 Categories of bank efficiency

Three concepts of bank efficiency are cost efficiency, revenue efficiency and profit efficiency. For convenience, in the rest of this thesis 'revenue', 'cost' and 'profit efficiency' refer to revenue x-efficiency, cost x-efficiency and profit x-efficiency, respectively.

'Revenue inefficiency' refers to a firm's failure to produce the highest value of output from a given set of input quantities and output prices. A bank may be revenue inefficient if it produces too few outputs for the given set of inputs or is inside the best-practice frontier. A firm may be also revenue inefficient if it responds poorly to relative prices and produces too little of a high-priced output and too much of a low-priced output, even if it is on the best-practice frontier (Akhavein, Berger & Humphrey 1997).

Similar to revenue inefficiency, the 'cost inefficiency' of a firm is defined as the use of too many inputs in order to produce the given outputs. A firm may be also cost inefficient if it

uses too much of a relatively high-priced input (Akhavein, Berger & Humphrey 1997). Therefore, revenue inefficiencies are absolutely analogous to cost inefficiencies – both count for a net loss of real value; they just differ as to whether the loss is in terms of a lower value of output produced or a higher value of inputs consumed (English et al. 1993).

Profit efficiency is a more inclusive concept than cost efficiency since it counts for the cost and revenue effects of the choice of the output vector, which is used in the measurement of cost efficiency (Akhavein, Berger & Humphrey 1997). A merger could increase profit efficiency without enhancing cost efficiency if the reconfiguration of outputs in relation to the merger improves revenues more than it increases costs, or if it reduces costs more than it reduces revenues. Consequently, profit efficiency may be more appropriate for the investigation of bank mergers than cost efficiency, since outputs typically change significantly after the merger (Akhavein, Berger & Humphrey 1997; Sufian et al. 2012).

3.4 Main strands of examining the effect of bank mergers

Over the past decades, an increasing number of studies have examined the effect of mergers in the banking sector. The literature in this field can be divided into two main strands, as follows (Aggarwal, Akhigbe & McNulty 2006).

The first strand uses event study methodology to assess the reactions of stock or bond markets to merger announcements (Al-Sharkas & Hassan 2010; Antoniadis, Alexandridis & Sariannidis 2014; Asimakopoulos & Athanasoglou 2013; Higgins 2013; Kolaric & Schiereck 2013; Pasioura et al. 2013; Rani, Yadav & Jain 2012). The event studies assume that the combined effects of the abnormal returns to shareholders of both bidder and target banks in reaction to the merger announcement reflect the market's perception of the value generated or destroyed by that merger. Such abnormal return is defined as the amount by which an actual

stock price exceeds the stock price predicted by an asset-pricing model (DeYoung, Evanoff & Molyneux 2009).

In the context of the Vietnamese banking system, where the equity market and the number of listed banks are limited, it is difficult to conduct empirical research on the market reaction to M&A announcements. For instance, there were only eight listed commercial banks in 2011 (Vietcombank Securities Company 2011). Consequently, the present study focuses on the second strand of research that investigates the efficiency effect of bank mergers.

The second strand of research examines operating gains resulting from bank mergers, that are based on realisation of scale and scope economies and other efficiency gains generated by the consolidated banks (Craig & Dinger 2009; Lin et al. 2013). Accordingly, the second strand has attempted to evaluate the effect of bank mergers on cost efficiency (Al-Khasawneh 2013; Lee, Liang & Huang 2013; Montgomery, Harimaya & Takahashi 2014), profit efficiency (Al-Sharkas, Hassan & Lawrence 2008; Sufian et al. 2012) and technical efficiency (Halkos, Matousek & Tzeremes 2014; Halkos & Tzeremes 2013; Rezitis 2008).

3.4.1 Empirical studies on efficiency effect of bank mergers

Before discussing the findings of empirical studies on bank mergers, it is important to explore how bank efficiency is measured.

3.4.1.1 Efficiency estimation methods

Methods that can be used to examine the efficiency effect of bank mergers include the accounting ratios method and the frontier economic method.

- The accounting ratios method

Accounting ratios used to examine bank efficiency include bank credit to bank deposits, net interest margin (NIM), overhead costs, and cost to income ratios (Nguyen, Roca & Sharma

2014; Rhoades 1998). This approach is easy to access the information from the financial statements as periodically reported by individual banks. However, these ratios cannot fully take into account the complexity of the banking industry and capture the fact that multiple inputs-outputs are interacting and have trade-offs (Nguyen, Roca & Sharma 2014). Therefore, this measure does not provide any information of efficiency relative to that of the best-practice bank in the particular sample (Zhu 2003). In order to overcome the deficiencies of accounting ratios, econometric methods are preferred for estimating bank efficiency.

- The frontier economic method

Two primary approaches used to measure bank x-efficiency include parametric and non-parametric (Berger & Humphrey 1997).

  - The parametric approach

The three main parametric approaches include the stochastic frontier approach (SFA), the distribution free approach (DFA) and the thick frontier approach (TFA).

SFA requires a large dataset and a specification form for cost, profit, or production functions that shows relationships among inputs, outputs and environmental factors. SFA assumes a composed error model, where inefficiencies follow an asymmetric distribution, often the half-normal, while random errors follow a symmetric distribution, usually the standard normal. Both the inefficiencies and the errors are assumed to be orthogonal to the specifications of input, output, or environmental variables in the determined equation. The computed inefficiency for any firm is taken as the conditional mean or mode of the distribution of the inefficiency term, given the observation of the composed error term (Berger & Humphrey 1997). The SFA approach is used to examine the effect of bank mergers on cost and profit efficiency in several studies such as Al-Sharkas, Hassan and Lawrence (2008) in the US and Montgomery, Harimaya and Takahashi (2014) in Japan..

DFA specifies a functional form for the frontier but separates the inefficiencies from random error in a different way. First, DFA makes no strong assumptions for the specific distributions of the inefficiencies or random errors. DFA posits that the efficiency of each bank is constant over time, whereas random error tends to average out to zero over time in SFA. The inefficiency of each firm in a panel dataset is then estimated by the difference between its average residual and the average residual of the firm on the frontier, with some truncation performed to account for the failure of the random error to average out to zero fully. Accordingly, inefficiencies derived from DFA can follow almost any distribution, even one that is fairly close to symmetric, as long as the inefficiencies are non-negative. However, if efficiency is shifting over time due to technical efficiency change, regulatory reform, the interest rate cycle, or other influences, DFA illustrates the average deviation of each firm from the best average-practice frontier, rather than the efficiency at any point in time (Berger & Humphrey 1997).

Similar to the frontier approaches mentioned above, TFA also specifies a functional form. However, TFA assumes that deviations from predicted performance values within the highest and lowest performance quartiles of observations (stratified by size class) refer to random error. Deviations in predicted performance between the highest and lowest quartiles represent inefficiencies. TFA imposes no distributional assumptions on either inefficiency or random error except to assume that inefficiencies differ between the highest and lowest quartiles and that random error exists within these quartiles. TFA per se does not indicate point estimates of efficiency for each bank, but it intends to provide an estimate of the general level of overall efficiency. In addition, TFA mitigates the effect of extreme points in data, as does DFA, when the extreme average residuals are truncated (Berger & Humphrey 1997).

The TFA approach is used to investigate the efficiency effect of bank mergers in several studies such as Peristiani (1997) in the US between 1980 and 1990 and DeYoung (1997) in the US between 1987 and 1988.

Similar to studies using SFA, TFA studies also require a large dataset and a specification of cost function. However, DFA sorts the data into arbitrarily chosen groups of firms. While SFA results depend on a priori distributional assumption, DFA heavily relies on the strong assumption that x-efficiency is constant over time. If there are changes in x-efficiency, then only average inefficiency over the past for a specific firm can be predicted. Consequently, results drawn from traditional TFA should be interpreted with caution as the average production inefficiency within the sector will usually be biased downward, such that the efficiency will be overstated (Wagenvoort & Schure 2006).

There are inherent disadvantages to parametric approaches. They require a particular functional form, with associated behavioural assumptions that presuppose the shape of the frontier. If the functional form is mis-specified, measured efficiency may be confounded with the specification errors (Drake & Hall 2003; Nguyen, Roca & Sharma 2014). In addition, SFA requires a large dataset of bank mergers to provide a good picture for analysis. Therefore, it may be not applicable to emerging markets, in which there are small markets and limited numbers of bank mergers.

- The non-parametric approach

The non-parametric approach includes the data envelopment analysis (DEA), free disposal hull (FDH) and mixed optimal strategy (MOS) approaches. In MOS, the most efficient 'parts' of different banks are combined and used as a frontier, in contrast to DEA and FDH, where all parts of an individual bank define the frontier. MOS is the least commonly employed

approach in the banking industry (Berger & Humphrey 1997). Therefore, the rest of the discussion about the non-parametric approach focuses on DEA and FDH.

The DEA frontier is constructed as the piecewise linear combinations that link the set of these best-practice observations thus generating a convex production possibilities set (Coelli et al. 2005). As such, DEA does not require the explicit specification of the form of the underlying production relationship. Several studies have used the DEA technique to examine the efficiency effect of bank mergers in developed markets covering the US and Europe (Figueira & Nellis 2009; Halkos & Tzeremes 2013; Kohers, Huang & Kohers 2000; Rezitis 2008) and in developing markets such as Malaysia (Sufian et al. 2012).

FDH does not allow such linear input substitution. Thus, the isoquant is represented by a step function through the observed input combinations (Drake 2003). In addition, Berger and Humphrey (1997, p. 177) state:

> 'The FDH is a special case of the DEA model where the points on lines connecting the DEA vertices are not included in the frontier. Instead, production possibilities set of the FDH is composed only of the DEA vertices and the FDH points interior to these vertices'.

Because the FDH frontier is either congruent with or interior to the DEA frontier, FDH will typically generate larger estimates of average efficiency than DEA (Tulkens 1993). Nonetheless, DEA is the most prominent approach among non-parametric techniques in the banking efficiency studies (Banker, Cummins & Klumpes 2010), for the following reasons. First, DEA can be used with small sample sizes (Drake & Hall 2003; Evanoff & Israilevich 1991). Second, Sathye (2003) suggests that DEA is sensitive to the choice of input-output variables. Accordingly, DEA is able to reveal which of the input-output variables need to be closely monitored by bank management in order to enhance their operating efficiency.

Consequently, information on peer group is relatively helpful for managerial purposes, since banks may enhance their efficiency by learning from their more efficient competitors. In addition, DEA imposes very little structure on the efficiency frontier and does not require the maintained assumption that all banks face the same unknown production technology (Drake & Hall 2003; Paradi & Zhu 2013).

The DEA measure is often criticised for lacking a statistical basis. Assaf, Barros and Matousek (2011) argued that the DEA approach is unable to conduct statistical inference. However, Simar and Wilson (1998, 2000) propose a bootstrap DEA to mitigate the main drawback of DEA. Therefore, the bootstrap DEA is adopted in the present study.

In short, the above parametric and non-parametric approaches differ primarily in the distributional assumptions imposed on the random error and inefficiency. There is more restrictive functional form of the best-practice frontier for a parametric approach and a less restrictive form for a non-parametric approach.

Although there are differences in making assumptions between these approaches, the efficiency estimates from these frontier methods are similar (Berger & Humphrey 1997; Resti 1997). Berger and Mester (1997) suggested that the choices made regarding measurement techniques, functional forms, and other variables often make very little difference in terms of either average industry efficiency or the rankings of individual firms. Another study by Bauer et al. (1998) demonstrated that the efficiency estimates derived from the four different techniques should be consistent in the distribution of efficiency levels, the rank order correlation of efficiency levels should be very high, and the identification of best- and worst-practice firms should be similar. Another study by Weill (2004) claimed that the efficiency scores calculated by all three techniques (SFA, DFA and DEA) are quite similar in terms of standard measures of performance, suggesting that these techniques provide efficiency

estimates that do not much depend on the assumptions needed for the frontier efficiency technique.

Empirical studies on the comparison of frontier efficiency techniques suggested that neither the non-parametric nor parametric method has an absolute advantage over the other. Nevertheless, in certain specific situations, the choice of these approaches to measure frontier efficiency seemingly depends on the characteristics of the data and the purpose of the study. The 'characteristics of the data' here mean the number of units in the sample, or the amount of noise and inefficiency in the data. For the purpose of the study, for instance, the non-parametric methods generally account for technical efficiency in using too many inputs or producing too few outputs (Drake & Hall 2003). In the case of available data on input prices, however, the DEA can also be used to estimate the efficiency costs. In contrast, the parametric techniques are primarily preferred in the banking studies on cost and profit efficiency (Berger & Mester 1997).

3.4.2 Evidence on the effect of mergers on efficiency of merging banks

As mentioned above, the evidence of efficiency gains as a result of mergers comes from banks' financial statements: either straight accounting ratio analysis or efficiency frontier analysis.

3.4.2.1 Accounting ratio analysis

The effect of bank mergers can be captured using accounting cost ratios (Gayle & DeYoung 2007; Hannan & Pilloff 2009; Rhoades 1993) and profitability ratios (Berger & Humphrey 1992a; Rhoades 1998). Prior studies indicated mixed findings. A study by Hannan and Pilloff (2009) indicated that cost-efficient bidders in the US tend to acquire more inefficient targets using a hazard function approach. These findings are in line with those of Kwan and Wilcox (2002), who found significant cost reductions only after adjusting data for merger accounting

standard rules. Profit gains resulting from bank mergers were also found in several studies, such as those by Knapp, Gart and Chaudhry (2006) and Cornett, McNutt and Tehranian (2006) in the US. However, Hagendorff and Keasey (2009) concluded that the European banks tended to pursue a cost-cutting strategy while the US banks tended to focus on revenue generation.

3.4.2.2 Efficiency frontier analysis

As discussed above, the literature has shifted to x-efficiencies (Avkiran 1999). Improvements in x-efficiency as a result of mergers can be tested using frontier economic approaches, as indicated in section 3.4.1.1. Empirical studies on the efficiency effect of bank mergers can be divided into three parts: studies on cost efficiency (DeYoung 1997; Figueira & Nellis 2009; Lee, Liang & Huang 2013; Peng & Wang 2004; Rezitis 2008), studies on profit efficiency (Akhavein, Berger & Humphrey 1997; Al-Sharkas & Hassan 2010; Kohers, Huang & Kohers 2000; Sufian et al. 2012) and simulation studies (Hadad et al. 2013; Halkos, Matousek & Tzeremes 2014; Halkos & Tzeremes 2013; Shaffer 1993).

- Effect of bank mergers on cost efficiency

The literature on banking efficiency suggests that average cost inefficiency was close to 20% above the observed best practice (Berger, Hunter & Timme 1993). Accordingly, a successful bank merger could contribute to cost savings and hence improve bank performance (Kohers, Huang & Kohers 2000). Consequently, the search for cost efficiency gains may be a common motivation behind bank mergers.

  - Post-merger performance regarding cost efficiency in the United States

Prior studies indicated mixed findings. A study by Berger and Humphrey (1992a) suggested that on average no significant gains in cost efficiency resulted from mega-mergers and post-merger efficiency gains are not associated with the amount of market overlap and the

difference in the efficiency level between the acquirer and the target. These findings are in line with those of Peristiani (1997) and Rhoades (1993) that bank mergers were unable to improve cost efficiency, even in the case of in-market mergers. . In addition, Rhoades (1998) claimed acquiring banks in nine merger cases that were more efficient than or as efficient as the target was insufficient to ensure efficiency gains.

However, several studies indicated bank mergers resulted in cost efficiency gains. A study by DeYoung (1997) showed that cost efficiency gains were found most often when both the acquiring and the acquired banks were relatively cost inefficient. This suggests that a reduction in costs depends more on the opportunities facing management than the difference in the management quality between the acquiring and target banks. In addition, Al-Sharkas, Hassan and Lawrence (2008) revealed that bank mergers resulted in increased cost efficiency, and that small bank mergers generated greater cost efficiency improvements than mergers formed by large banks.

- Post-merger performance regarding cost efficiency outside the United States

A growing volume of studies recently on European bank mergers provide compelling evidence of efficiency enhancements. A study by Rezitis (2008) demonstrated that mergers impacted negatively on the technical efficiency of Greek banks. However, other studies reported opposite results. Figueira and Nellis (2009) indicated that there were slight improvements in the technical efficiency of banks after mergers in five European countries. Their results also suggested that country-specific characteristics contributed a crucial role to explain bank efficiency gains. Their findings are in line with those of Vander Vennet (1996), who indicated that cost efficiency gains were found for domestic mergers among equal-sized partners and for cross-border mergers.

In addition, it is useful to examine the post-merger performance of merging banks as compared with non-merging banks. A study of Spanish data indicated that merged firms were more efficient than non-merged firms (Cuesta & Orea 2002). These findings are in line with those of Valverde and Humphrey (2004) . More importantly, Valverde and Humphrey (2004) emphasised that efficiency gains were generated by the effect of learning by doing in banks engaging in more than one merger.

Outside the US and Europe markets, few studies have attempted to examine the efficiency effect of bank mergers in other developed banking systems. Again, the studies had mixed findings. A study by Avkiran (1999) found that acquiring banks were more efficient than the target banks in Australia. However, the acquiring banks did not always maintain their pre-merger efficiency. Using similar methodology, a study by Liu and Tripe (2003) suggested that efficiency gains were associated with bank mergers in New Zealand. However, a study by Wu (2008) contended that mergers among the Australian 'big four' banks may result in a less efficient banking sector and acquiring banks were larger, more aggressive and less efficient than the target banks. In addition, a study using Japanese data found that bank mergers significantly lowered banks' cost efficiency after controlling for the effect of market power (Montgomery, Harimaya & Takahashi 2014).

In contrast, few studies attempted to investigate the efficiency effect of bank mergers in emerging markets, due to their small market size and the difficulty of conducting empirical research with small sample sizes. A study by Lee, Liang and Huang (2013) found that cost efficiency for most banks in Taiwan significantly decreased in the post-merger year. This suggests that it takes time for the acquiring bank to integrate and enhance efficiency.

- Efficiency of bank mergers on profit efficiency

In addition to cost reduction, maximising shareholders' value or wealth by maximising profits is also another motive behind bank mergers. Mergers could result in improved profits in any of three major ways. First, they could enhance cost efficiency, thus reducing costs per unit of output for a given set of output quantities and input prices. Second, mergers may enhance profits by increasing additional market power in setting prices. An increase in market concentration may allow a newly-combined bank to charge higher rates for the products and services it produces, raising profits by extracting more surplus from consumers, without any improvement in efficiency. Last, the bank could raise profits through profit efficiency gains that include superior combinations of inputs and outputs. Profit efficiency gains could be generated without improving cost efficiency if the combination of outputs related to the mergers increases revenue more than additional costs incurred, or if it decreases costs more than it reduces revenues.

As explained in section 3.3.3.4, prior studies suggested that profit efficiency is more appropriate for the investigation of mergers than cost efficiency. However, there is the limited number of studies that examined the effect of bank mergers on profit efficiency.

- Post-merger performance regarding profit efficiency in the United States

A study by Al-Sharkas, Hassan and Lawrence (2008) indicated that the mergers in the US improved profit efficiency for both large and small banks. Their findings are in line with those of Akhavein, Berger and Humphrey (1997), who found that, on average, mega-mergers significantly improved profit efficiency. More importantly, Akhavein, Berger and Humphrey (1997) claimed that greater efficiency gains are found when either or both merging firms have poor performance prior to the merger. This supports the view of DeYoung (1997), suggesting improvements in efficiency depend more on the opportunities facing management than the difference in management quality between acquiring and target banks. This somewhat

conflicts the findings of Kohers, Huang and Kohers (2000), who asserted that acquiring bank holding companies were slightly more profit efficient as compared with their targets.

- Post-merger performance regarding profit efficiency outside the United States

There is also some evidence from outside the US of mergers resulting in profit efficiency improvements. A study by Sufian et al. (2012)found that revenue efficiency of merged banks in Malaysia did not significantly improve after forced bank mergers. This is due to the fact that the level of cost efficiency is higher than profit efficiency. Although cost and profit efficiencies have improved, banks may face revenue inefficiency resulting from producing a small number of outputs, producing too much of a cheaper or expensive output, and selling it inefficiently. However, a study by Hosono, Sakai and Tsuru (2006) indicated evidence of significant post-merger profit efficiency improvements in Japan, although the capital positions of the acquiring banks tended to weaken.

To sum up, there is a consensus view that bank mergers could lead to profit efficiency improvements by using either financial ratios or economic frontier modelling. Meanwhile, cost efficiency gains resulting from bank mergers are elusive. The mixed results on cost efficiency enhancements reflect different methodologies used in the previous studies. All estimations in efficiency studies are based on accounting data. However, such studies have several drawbacks. Beitel (as cited in Kolaric & Schiereck 2014) argued that it is the most complicated methodology and that, because it requires a number of accounting variables and approximations, it is more prone to error. Furthermore, there is a longstanding debate on whether deposits should be treated as inputs or outputs of the production function of bank. Deposits have input characteristics since they are paid for in part by interest payments, and the funds raised provide the bank with the raw material of investible funds. However, deposits also have output features as they are related to a significant amount of liquidity, preservation

and payments services provided to depositors. Any results achieved by these studies should therefore be carefully examined, but the overall results seem to only partially depend on the way deposits are treated (Berger & Humphrey 1997).

In addition, it is argued that the post-merger time period is insufficiently long to capture the gains (Halkos & Tzeremes 2013). The consolidation process includes transaction costs, which may disguise operating gains achieved shortly after merger completion. Many performance gains may take time either to be achieved or to be reflected in financial reports. Sufian et al. (2012) suggest that observing post-merger performance of consolidated banks in the longer post-merger period may capture efficiency gains resulting from M&As. However, this solution involves its own problems. Measured changes between the pre- and post-merger period may not be solely due to the merger. Other events may have occurred during the investigated period which may more accurately account for the observable performance changes. Failing to account for such extraneous events may lead to improper conclusions regarding merger-related changes (Pilloff & Santomero 1998).

- Simulation studies in bank mergers

A number of studies have used the simulation technique. Efficiency studies permit the simulation of hypothetical bank mergers. This allows examining whether possible efficiency gains are theoretically generated, thus making recommendations on which target banks should actually merge in the future (Kolaric & Schiereck 2014). However, prior simulation studies showed conflicting results.

Using simulation modelling, Shaffer (1993) found that the US mega-mergers, especially in the case of in-market mergers could generate significant cost savings when the acquiring banks were more efficient than their targets. . Their findings also indicated that the potential for scale efficiency gains from mega-mergers is negligible, but large x-efficiency gains are

possible. Similarly, McIntosh (2002) revealed potential benefits from large economies of scale in Canadian bank mergers. However, Altunbas, Molyneux and Thornton (1997) indicated that mergers of big banks in Europe are more likely to result in increased total costs. However, their findings claimed that mergers between German and Italian banks appeared to have the greatest opportunities for cost savings, while mergers between French and German banks resulted in substantial cost increases.

The simulation studies outlined above ignored any prior information about the pairings. These studies assumed no premiums or merger costs and no further synergies resulted from, for example, closures of overlapped branches and offices or a restructuring of the product mix. Nonetheless, the earlier studies suggested that potential cost efficiency gains can be generated if the acquiring bank can maintain its pre-merger efficiency.

Recently, several studies put more restricted requirements on pairings when simulating bank mergers, with mixed results. A study by Lin and Huang (2009) contended that the mergers in Taiwan would improve overall efficiency and reduce the probability of financial distress. Similarly, a study by Hadad et al. (2013) reported hypothetical mergers of Indonesia commercial banks that could generate significant cost savings and economies of scale were only found for the largest and smallest banks. In addition, a study by Halkos, Matousek and Tzeremes (2014) asserted that hypothetical bank mergers formed by smaller banks in Japan outperform those formed by larger banks. In contrast, a study by Halkos and Tzeremes (2013) using Greek data indicated that possible bank mergers formed by two cost-efficient banks did not result in operating efficiency gains. Their findings also showed that the majority of possible bank mergers were unable to create operating efficiency gains one year after, and one year before, the start of the Greek fiscal crisis (2008–09).

- Importance of off-balance-sheet activities to banks

Two recent simulation studies, by Halkos and Tzeremes (2013) in Greece and by Halkos, Matousek and Tzeremes (2014) in Japan, did not consider OBS activities in their estimation models. This would fail to capture all the business operations of modern banks, because banks have been shifting away from traditional financial intermediation business and into OBS activities, such as fee-based activities (Drake & Hall 2003).

Income generated from OBS activities accounted for approximately half of the total operating income of US banks and contributed a significant amount to total income of banks in other markets (DeYoung & Torna 2013; Nguyen 2012). OBS activities – generally including loan commitments, non-financial guarantees, standby letters of credit, foreign exchange, securitisation, financial futures, forward contracts, options, interest rate swap contracts and other derivative products – have expanded rapidly (Board of Governors of the Federal Reserve System 1997; Lieu, Yeh & Chiu 2005; Meisenzahl 2015)**.**

Given the importance of OBS activities to bank income, the literature on banking efficiency indicates that, if frontier estimation techniques do not account for OBS activities, bank efficiency will be understated (Lieu, Yeh & Chiu 2005). Studies by Rogers (1998) and Clark and Siems (2002) found that US banks demonstrated higher estimated cost efficiency when OBS activities (NII output as a proxy) were included in the model. Their findings are in line with those of Rime and Stiroh (2003) in Switzerland, Tortosa-Ausina (2003) in Spain and Lieu, Yeh and Chiu (2005) in Taiwan. Consequently, prior studies in bank mergers that exclude OBS activities from output specification would result in a mis-specification of banks' output, and thus may lead to biased conclusions.

3.4.3 Effect of bank mergers on the performance of non-merging banks

Merger-induced improvements in operational efficiency can be investigated directly by comparing the pre- and post-merger operational efficiency of merging banks. However,

performance gains may extend well beyond the merging firms (DeYoung, Evanoff & Molyneux 2009). So far, one study, by Evanoff and Ors (2008) using US bank merger data, has found that non-merging banks respond to consolidation in the market by improving their efficiency. Their findings suggest that increases in potential bank mergers should serve as a wake-up call to non-merging banks and place competitive pressure on them to improve their operations in order to remain a viable competitor.

3.5 Determinants of bank efficiency

Along with the effect of bank mergers, as discussed above, there are various other factors that are likely to influence bank efficiency. External variables account for the economic and legal environment in which the bank operates. In addition, bank-specific variables include bank ownership, bank size, capital structure, the pursuit of a diversification strategy and risk management capacity. It is important to note that the present study only discusses the main determinants of bank efficiency that have been found frequently in the literature.

3.5.1 Economic and legal environment

3.5.1.1 Financial contagion

Prior studies have attempted to examine the impact of financial contagion, especially the recent GFC (2007–08), on bank efficiency. Several studies in developed markets have documented that there is obvious evidence of the impact of the GFC on bank efficiency. A cross-country study by Andrieș and Ursu (2016) shows that the GFC had a significantly negative impact on both cost and profit efficiency of European commercial banks. This is in line with those of Vu and Turnell (2011) in Australia. In contrast, one may argue that banks in emerging markets may be less or not affected by the GFC because they are less integrated in the global financial market and have benefited from government subsidies.

Nonetheless, prior studies in emerging markets have indicated mixed results. Several studies, such as that by Řepková (2015) in Czech Republic and by Gulati and Kumar (2016) in India, suggest that the GFC had no long-lasting adverse effect on banking efficiency, due to the effectiveness of accommodative macro policies in which sufficient liquidity was injected in the system. On the other hand, other studies report that the GFC impacted negatively on bank efficiency in Romania (Popovici 2014), Brazil (Wolters, Barbosa Do Couto & Felício 2014) and Bangladesh (Kamarudin, Sufian & Nassir 2016).

Given the impact of financial crises, several studies have investigated whether possible bank mergers would enhance bank efficiency. Shih (2003) suggests that mergers that included relatively healthy banks were less likely to fail during the Asian financial crisis (1997–98). However, Halkos and Tzeremes (2013) found that the majority of possible bank mergers that included two efficient banks were unable to generate technical efficiency gains within one year after the Greek fiscal crisis.

In short, prior studies have indicated mixed findings of the impact of financial contagion on bank efficiency. This study is the first attempt to assess what impact the GFC (2007–08) has on the technical efficiency of bank mergers in Vietnam. Consequently, this will help Vietnamese authorities to pre-evaluate whether bank mergers could be a solution for the Vietnamese banking sector in light of the recent GFC.

3.5.1.2 Other business environment factors

The literature also suggests that bank efficiency is significantly influenced by other factors in the business environment, such as the legal, political and other conditions in which banks operate. A study by Bos and Kool (2006) found that local market factors can explain at the most 10% of the efficiency of local Dutch banks. In addition, a cross-country study by Dietsch and Lozano-Vivas (2000) indicated that without environmental variables, the cost

efficiency scores of Spanish banks are lower than those of French banks. When incorporating these variables into the common frontier, the differences in efficiency are significantly reduced. Thus, their findings suggested that neglecting the environmental variables results in an significant mis-specification of the common frontier and overestimates inefficiency. However, Carbó Valverde, Humphrey and López del Paso (2007) claimed that large banks across 10 European countries were approximately equally efficient after controlling for differences in business environment, banking costs and bank productivity.

3.5.2 Bank ownership

Prior studies have indicated that ownership is one of the key factors that determine the way banks should operate, thus influencing bank efficiency. As per public choice theory and the principle agent framework, different types of ownership have different impacts on bank efficiency.

Several studies found that state-ownership has a positive impact on bank efficiency. A study by See and He (2015) claimed that state-owned commercial banks (SOCBs) in China are more efficient than privately owned commercial banks (POCBs). Their findings are in line with those of Nguyen, Roca and Sharma (2014) in Vietnam, and Gardener, Molyneux and Nguyen-Linh (2011) in the South-East Asia region. However, opposite results were found in several studies, such as those by Berger, Hasan and Zhou (2009) and Lin and Zhang (2009) in China, Yang and Liu (2012) in Taiwan, and Perera, Skully and Wickramanayake (2007) in the South Asian region.

In addition, several studies have investigated the impact of foreign ownership on bank efficiency and found mixed results. Berger, Hasan and Zhou (2009) asserted that FBs are the most efficient, and minority foreign ownership is associated with significantly improved efficiency. These findings are in line with those by Bonin, Hasan and Wachtel (2005), who

asserted that FBs bring state-of-the-art technology and human capital to the banks and that this may explain their superior performance over domestic banks. However, other studies made opposite findings. A study by Chan et al. (2015) reported that greater foreign ownership in the ASEAN-5 does not significantly affect bank efficiency. In the same vein, Semih Yildirim and Philippatos (2007) contended that FBs in 12 transition countries in Central and Eastern Europe are not profitable and efficient compared with both the private domestic banks and SOCBs.

3.5.3 Bank size

As per the structure-conduct-performance paradigm, bank size is expected to have a positive effect on bank efficiency, purely because of economies of scale. Several studies found that larger banks are more efficient than smaller banks (Stewart, Matousek & Nguyen 2016; Sufian 2009). Studies such as those by Arora (2014) and Sathye and Sathye (2016) claimed that there was no conclusive evidence of a relationship between size and bank efficiency in India. However, the U-shape relationship between size and banking efficiency suggests that a bank faces a challenge in terms of determining what the optimal size is to maintain the high level of its efficiency (Berger & Humphrey 1991). If a bank is too large, its size could be a disadvantage as it could lead to bureaucracy and other management downsides, such as the deterioration or disappearance of personal relationships with customers (Berger & Humphrey 1991; Kwan & Eisenbeis 1997; Nguyen & Nghiem 2015). Sun and Chang (2011) showed that size impacts negatively on efficiency.

3.5.4 Market concentration (market power)

As per the structure-conduct-performance framework, the market structure influences banks' pricing conduct and ultimately its performance. The market power hypothesis posits that the increased market power of the bank may enable it to earn higher profits by raising loan rates and lowering deposit rates (Bain 1956; Pilloff & Santomero 1998). However, 'the quiet life'

hypothesis predicts that, when banks enjoy greater market power and concentration, they have less incentive to minimise costs (Berger & Hannan 1998; Homma, Tsutsui & Uchida 2014; Sathye 2001).

This could be explained by the following reasons. First, the difference between the actual price charged and the competitive price may provide a 'cushion', or comfort zone. In the absence of other disciplining mechanisms, managers may permit unit costs to increase to take up part of this cushion while achieving economic rents for the firm's owner without the full effort of cost minimisation (Shepherd 1985). Second, greater market power may allow managers to pursue their own goals rather than maximising shareholder value (expense preference behaviour) (Berger & Hannan 1998). Third, in a non-competitive situation, managers may utilise resources to achieve and maintain market power, leading to additional costs for banks and a reduction in cost efficiency (Posner 1975). For instance, banks may expend resources on lobbying efforts to limit the number of bank charters or to maintain geographic restrictions on branch networks in order to preserve barriers to entry. Such expenditures increase cost inefficiency because extra costs are incurred, although this could raise profits. Last, the price cushion generated by greater market power may simply allow inefficient managers to continue to be employed, without any intention to pursue the goal of maximising shareholder value. The lack of market discipline in concentrated markets may simply weaken economic signals that often force changes in management to maintain low costs (Berger & Hannan 1998).

The empirical studies showed mixed results. A negative relationship between market power and bank efficiency is found in several studies, such as those by Berger and Hannan (1998) in the US and Delis and Tsionas (2009) in the US and Europe; Homma, Tsutsui and Uchida (2014) in Japan; Sathye (2001) in Australia; and Sufian (2009) in Malaysia. However, the positive relationship between market power and efficiency is also found in several studies,

such as those by Koetter, Kolari and Spierdijk (2012) in the US; Maudos and de Guevara (2007) in Europe; and Williams (2012) in the Latin America. Recently, Alhassan, Tetteh and Brobbey (2016) found no relationship between market power and bank efficiency in Ghana.

3.5.5 Diversification

As per the conglomeration hypothesis, diversification towards non-interest activities has a positive impact on bank efficiency. Diversified banks can benefit from leveraging managerial skills and abilities across products and services (Iskandar-Datta & McLaughlin 2005). Also, they can gain economies of scope through spreading fixed costs over multiple products (Drucker & Puri 2009). A study by Hughes et al. (1999) showed that bank efficiency in the US is positively associated with diversification. Their findings are in line with those of Bos and Kolari (2005) in a sample of large US and European banks, and evidence in emerging banking systems (Alhassan 2015; Nguyen, Skully & Perera 2012; Sufian 2009).

As per the monitoring hypothesis, internal or regulatory framework may prescribe some level of monitoring independent of the level of diversification. A diversified portfolio with a large number of customers in different industries causes additional monitoring costs for banks, thus increasing cost inefficiency. The monitoring hypothesis could furthermore be supported by the fact that managers may be more risk averse. Thus, they may be willing to take additional costs for seeking a high-quality loan portfolio and for monitoring its performance in order to reduce risks. A study by Rossi, Schwaiger and Winkler (2009) found a negative relationship between loan portfolio diversification and bank cost efficiency in Austria, thus supporting the monitoring hypothesis. Their findings are in line with those of Mercieca, Schaeck and Wolfe (2007), who reported no direct diversification benefits within and across business lines, and an inverse association between NII and bank performance.

3.5.6 Capital structure

Theory offers opposing views on the impact of bank capital on bank efficiency. The higher level of capital may help a bank to reduce its moral hazard between shareholders and debtholders. Because of the limited liability of shareholders, banks with low capital ratios tend to take on excessive risk. This behaviour is reinforced by explicit or implicit government guarantees of deposits. Therefore, a higher capital ratio reduces risk-shifting, and increases shareholders' incentive to monitor and control to ensure the bank operates efficiently. The positive impact of capital on bank efficiency is found in several studies, such as those by Alhassan (2015) in Ghana; Perera, Skully and Wickramanayake (2007) in the South Asia; Gardener, Molyneux and Nguyen-Linh (2011) in the South-East Asia; Fiordelisi, Marques-Ibanez and Molyneux (2011) in Europe; and Le (2016b) in Vietnam. However, as per corporate governance theory, agency costs between managers and shareholders tend to inflate when capital ratio becomes relatively high and further increases due to the disciplines rendered by debt repayment on managers' behaviour (Calomiris & Kahn 1991). Studies such as those by Berger and Bonaccorsi di Patti (2006) in the US and Vu and Turnell (2011) in Australia found that lower capital ratios are associated with higher efficiency.

3.5.7 Quality of management

As per the bad management hypothesis of Berger and DeYoung (1997), low efficiency scores are a signal of poor senior management practices, which apply to input-usage, day-to-day operations and loan portfolios. Subpar managers do not sufficiently monitor and control the bank's operating expenses. Several studies found that banks that have managers with skills in risk management and superior corporate governance are more efficient (Bonin, Hasan & Wachtel 2005; Das & Ghosh 2006; Garza-García 2012; Sufian 2009). However, a study by Vu and Turnell (2011) found that higher administration costs will not necessarily reduce bank efficiency in Australia.

3.5.8 Risk

As per the bad management hypothesis, inadequate loan monitoring and bad debt control can result in lower interest income. Also, the bad luck hypothesis posits that, as a result of an increased credit risk, a bank will begin to expend additional managerial effort and expense to deal with these problem loans. The combined effect can lead to reduced bank efficiency. The negative relationship between credit risk and bank efficiency was found in several studies, such as those by Berger and DeYoung (1997) in the US; Nguyen and Nghiem (2015) and Sathye and Sathye (2016) in India; Bonin, Hasan and Wachtel (2005) in the Western Europe; and Le (2016b) in Vietnam. However, a study by Altunbas et al. (2007) using European data did not indicate a strong relationship between inefficiency and bank risk-taking.

3.6 Studies on banking efficiency in Vietnam

Several studies have examined the efficiency of the Vietnamese banking system. A study by Nguyen (2007) suggested that bank inefficiency was mainly due to technical inefficiency rather than allocative inefficiency. Those findings somewhat conflict with those of Nahm and Vu (2013) that the main source of low profit efficiency was allocative inefficiency rather than technical inefficiency, implying that banks were poor in selecting input and output combinations to maximise profits.

In addition, a study by Minh, Long and Hung (2013) suggested that there would be room for these banks to improve their production efficiency and that large banks did not perform with high super-efficiency in comparison with small banks. Their findings somewhat conflict with those of Stewart, Matousek and Nguyen (2016), who showed that large and very large banks are more efficient than their small and medium-sized counterparts.

Several studies have examined whether different types of ownership have impacted on the efficiency of banks. Nguyen, Roca and Sharma (2014) suggested that SOCBs were more cost

and profit efficient than POCBs. However, the gap in efficiency between the two was reduced towards the end of their examined period. Their findings are in line with those of Vu and Turnell (2010), who found a significant gap in allocative efficiency between large SOCBs and other types of banks, and that POCBs were the least profit efficient banks in the Vietnamese banking industry.

3.7 Summary

To sum up, four gaps in the literature on the efficiency effect of bank mergers are identified.

First, prior studies have not taken into account OBS activities when investigating the efficiency effect of bank mergers. The US and Vietnamese data emphasise that income generated from OBS activities (as indicated in Chapter 2) contributed significantly to bank income. Empirical studies in bank efficiency also confirm that exclusion of OBS activities from output specification leads to understatement of bank efficiency. Most studies examined the impact of OBS activities on cost and profit efficiency (Clark & Siems 2002; Rime & Stiroh 2003; Rogers 1998). Two recent simulation studies, by Halkos and Tzeremes (2013) in Greece and by Halkos, Matousek and Tzeremes (2014) in Japan, did not include OBS activities in their estimations. Accordingly, the present study is the first attempt to assess what impact the inclusion of OBS activities has on the technical efficiency of Vietnamese commercial banks.

In addition, a different measure of OBS activities is used in this study. Clark and Siems (2002) suggested three alternative measures of a bank's aggregate OBS. The first measure is the total credit-equivalent amount of OBS transactions, second is an aggregate measure of asset equivalent as proposed by Boyd and Gertler (1994), and the third is NII. However, all three measures have their disadvantages. The first measure may seriously understate the level of OBS activities (Boyd & Gertler 1994; Clark & Siems 2002). The second is a revenue based

measure that includes losses. Accordingly, this has the potential to distort the measure of OBS activities. Last, NII may overestimate the amount of OBS activities, since fees and commissions are also drawn from on-balance-sheet activities (Casu & Girardone 2005). In contrast, this study uses other income as a proxy for OBS activities of Vietnamese commercial banks. Other income includes charges for services, commissions for providing guarantees, letters of credit, fiduciary activities and other net non-interest operating income. The use of other income in the present study is a somewhat better proxy for OBS activities instead of using NII.

Second, the effect of bank mergers on the efficiency of non-merging banks has not received much attention in the literature. Most studies have investigated the effect of bank mergers directly on merging banks. However, performance gains may extend well beyond the merging banks (DeYoung, Evanoff & Molyneux 2009). It is argued that non-merging banks may respond to mergers of other banks by decreasing costs and increasing their level of cost efficiency, since the level of competition will increase as a result of the market entry of a new player or the creation of a more viable local competitor. So far only one study, by Evanoff and Ors (2008) using US bank data, has examined the effect that increased competition resulting from M&As has had on the performance of non-merging banks. Consequently, this study attempts to investigate the technical efficiency of non-merging banks after bank mergers have taken place.

Third, the literature is dominated by studies from the US and Europe, where the larger market and numbers of banks mergers have traditionally facilitated econometric modelling (DeYoung, Evanoff & Molyneux 2009; Kolaric & Schiereck 2014). However, it is unclear whether the empirical evidence in developed markets reflects the true efficiency effect of bank mergers in other markets (Dymski 2002). Because the regulatory and economic environments faced by banks are likely to differ across nations, and because the level and

quality of service associated with deposits and loans in different countries may differ, the effect of mergers on bank efficiency in other markets would be different. For this reason, the experiences of developed economies cannot be automatically applied to the developing economies in general, and particularly to the banking system, because of the substantial differences in institutional reality (Elumilade 2010). In addition, only a few studies have examined the efficiency effect of bank mergers in emerging countries, especially in the Asia-Pacific region – studies include those by Sufian et al. (2012) in Malaysia; Lee, Liang and Huang (2013) in Taiwan; and Hadad et al. (2013) in Indonesia. By examining the efficiency effect of bank mergers in Vietnam, this will increase external validity in relation with bank M&As in the Asia-Pacific region.

Fourth, so far no study has examined the impact of mergers on bank efficiency in Vietnam. This study fills the current gaps in empirical research by providing an answer to the debate on whether bank mergers would have improved efficiency of the Vietnamese banking system. In addition, the study strives to provide an answer to whether or not future mergers that involve SOCBs should be promoted. Consequently, the study outlines policy measures that could be implemented in the decision-making process about bank consolidation through M&As in Vietnam and in other developing countries with a similar banking structure.

Chapter 4 Theoretical framework and hypothesis development

4.1 Introduction

Chapter 3 provided a literature review on the determinants of bank efficiency, especially the impact of bank mergers. This chapter presents the theoretical framework and hypothesis development for this study.

4.2 Theoretical framework of the study

Why do banks merge? Several theories have been developed over the years to answer this question. These include the theory of efficiency, market power theory, the value destroying theories and the theory of synergy gains which are discussed in detail in chapter 3.

The present study investigates the impact of mergers on technical efficiency of Vietnamese banks. Since the synergy theory proposed by Trautwein (1990) posits that efficiency gains can be achieved through scale and scope economies, and transfer of asset control to better quality managers, the synergy theory is appropriate for the study. Prior studies also suggested that operating efficiency is the most important source of gains (Devos, Kadapakkam & Krishnamurthy 2009; Houston, James & Ryngaert 2001). This is consistent with the aim of the Vietnamese Government's program to restructure credit institutions (The Vietnamese Government 2012). Accordingly, bank mergers in Vietnam are encouraged to improve the efficiency and performance of merging banks, thus enhancing banking stability. Consequently, this study is the first attempt to investigate whether bank mergers in Vietnam would generate operating efficiency gains using the theoretical framework of the theory of synergy gains.

4.2.1 Efficiency effect of virtual bank mergers

As mentioned above, mergers have the potential to improve bank efficiency through economies of scale and scope (Craig & Dinger 2009). However, the literature on banking

efficiency has suggested that mergers have limited potential to enhance the efficiency of banks through scale and scope economies, as discussed in Chapter 3. Whether or not efficiency gains are captured depends on the control of technical inefficiency (Haynes & Thompson 1999). Technical efficiency refers to the ability of bank managers to control costs and is measured by how close its costs are to those of a fully efficient bank when the effects of factors that may affect banking costs – such as scale, product mix and other exogenous variables – are considered (Coelli et al. 2005). Due to the limited number of banks and bank mergers in Vietnam, this study attempts to investigate whether virtual bank mergers (VBMs) in Vietnam would generate technical efficiency gains.

4.3 Development of hypotheses

Following the explanation of the proposed theoretical framework of the study, the hypotheses associated with the research questions are developed below.

4.3.1 Impact of inclusion of off-balance-sheet activities on the technical efficiency of Vietnamese commercial banks (RQ1)

As discussed above, technical efficiency is the main source of gains from M&As. Accordingly, several studies have attempted to measure the technical efficiency of banks using economic frontier approaches, as indicated in Chapter 3. Two recent simulation studies on bank mergers, by Halkos and Tzeremes (2013) using Greek data and by Halkos, Matousek and Tzeremes (2014) using Japanese data, did not include off-balance-sheet (OBS) activities in their estimations. This would result in a failure to capture all the business operations of modern banks, because banks have been shifting away from traditional financial intermediation business towards OBS and business that generates income from fees (as discussed in Chapter 2) (Berger & Humphrey 1997; Berger & Mester 1997; Drake & Hall 2003). In other words, the bank efficiency measures in these simulation studies that exclude

OBS items from output specification would become less accurate indicators of true bank efficiency.

In addition, the literature on banking efficiency suggests that omitting OBS activities underestimated the efficiency levels of banks. Studies by Rogers (1998) and Clark and Siems (2002) in the US banking system concluded that exclusion of OBS activities from the cost and profit efficiency models understated bank efficiency. These findings are in line with the findings of Rime and Stiroh (2003) in the Swiss banking system, Tortosa-Ausina (2003) in the Spanish banking system, Casu and Girardone (2005) in the European banking system and Lieu, Yeh and Chiu (2005) in the Taiwanese banking system. However, Lozano-Vivas and Pasiouras (2010) indicated that the cost efficiency of public banks in 87 countries increased irrespective of whether OBS was included in the output specification. Most studies have examined the impact of OBS activities on cost and profit efficiency and the productivity change. Accordingly, this study is the first attempt to assess what impact the inclusion of OBS activities has on the technical efficiency of Vietnamese commercial banks. Following prior studies by Rogers (1998) and Clark and Siems (2002), it is anticipated that the inclusion of OBS activities will have a positive impact on the technical efficiency of Vietnamese commercial banks. The following hypotheses relating to RQ1 will be tested:

> $H1_0$: There is no difference in the technical efficiency of banks when OBS activities are included in the output specification.
>
> $H1_1$: The technical efficiency of banks is higher when OBS activities are included than without the inclusion of OBS activities.

In order to test the above hypotheses, the study will first estimate the technical efficiency of Vietnamese commercial banks over five years, using the economic frontier approach. Two models, A and B, are run. In Model A, the OBS activities as proxied by 'other income' are

included. In Model B, OBS activities are excluded. Then, the non-parametric tests are used to test for the null hypothesis. These tests have been widely used in the literature on banking efficiency (Casu & Girardone 2005; Lieu, Yeh & Chiu 2005). In addition, these tests are appropriate for studies that have used the non-parametric approach to estimate the efficiency scores of banks.

4.3.2 Determinants of banks' technical efficiency (RQ2)

The literature suggests that bank efficiency is influenced by various factors as discussed in chapter 3. Therefore, the study attempts to address following subquestions (SQs) relating to virtual bank mergers and the existing commercial banks:

SQ1: What is the impact of global financial crisis on the technical efficiency of banks created via virtual bank mergers?

SQ2: What is the impact of ownership on the technical efficiency of banks created via virtual bank mergers?

SQ3: What is the impact of interaction between ownership and global financial crisis on the technical efficiency of banks created via virtual bank mergers?

SQ4: What are determinants of technical efficiency of Vietnamese commercial banks?

4.3.2.1 Impact of global financial crisis on the technical efficiency of banks created via virtual bank mergers (SQ1)

As per synergy theory, bank mergers have the potential to improve the technical efficiency of banks. Bank mergers are expected to restore the intermediation functions of banks and to improve the efficiency of banks, given the impact of financial contagion (Halkos, Matousek & Tzeremes 2014). Several studies have attempted to examine whether possible bank mergers would enhance bank efficiency and performance. Shih (2003) proposed a theoretical model to

assess whether bank mergers could be used as a solution for the Asian banking sector to the results of the Asian financial crisis (1997–98). His findings suggested that mergers that include relatively healthy banks were less likely to fail. However, Halkos and Tzeremes (2013) demonstrated that the majority of possible bank mergers that include two efficient banks were unable to generate operating efficiency gains in the year after the Greek fiscal crisis.

Furthermore, not all countries were affected by the recent GFC (2007–08) in the same way. Prior studies in developed markets have documented that there was obvious evidence of the impact of the GFC on banking efficiency. A study by Andrieș and Ursu (2016) using European bank data found that the GFC had a negative impact on bank efficiency in terms of both cost and profit efficiency. Their findings are in line with the findings of Vu and Turnell (2011) in the Australian banking system. However, the evidence of the impact of GFC in emerging banks is unclear. Several studies reported that GFC did not have a significant impact on bank efficiency in the Czech Republic (Řepková 2015) and in India (Gulati & Kumar 2016), mainly because sufficient liquidity was injected in the banking system. On the other hand, the adverse impact of GFC on the efficiency of banks was found in several studies, such as those by Popovici (2014) in Romania; Wolters, Barbosa Do Couto and Felício (2014) in Brazil; and Kamarudin, Sufian and Nassir (2016) in Bangladesh.

In the context of Vietnam, the banking system has also been affected by the GFC. An increase in non-performing loans (NPLs) may reduce the efficiency of Vietnamese commercial banks, as indicated in Chapter 2. Consequently, banks need to expend additional managerial efforts and expenses to deal with these problem loans, thus reducing their efficiency. Empirical studies on Vietnamese banking also confirmed the impact of GFC. Nguyen and Simioni (2015) concluded that there was a reduction in the overall productive efficiency of Vietnamese banks over the post-GFC period. In response to the GFC, the Vietnamese

Government (2012) officially released a program to restructure credit institutions, with a main focus on bank mergers. Accordingly, bank mergers would result in improvements in the efficiency of Vietnamese banks. This necessitates investigating the relationship between GFC and technical efficiency in banks after VBMs in Vietnam. In short, the GFC had a negative impact on bank efficiency in Vietnam. Following the prior studies by Halkos and Tzeremes (2013), the majority of possible bank mergers were unable to generate operating efficiency gains a year after the Greek fiscal crisis. It is anticipated that a merger alone may not be able to offset the massive impact of GFC which is caused by a bank's exposure to various types of investments and traditional lending. The following hypotheses relating to RQ2 will be tested:

$H2_o$: The post-GFC technical efficiency of banks created via VBMs is not different from their pre-GFC technical efficiency.

$H2_1$: The post-GFC technical efficiency of banks created via VBMs is lower than their pre-GFC technical efficiency.

In order to test the above hypotheses, two-stage analysis will be used. In the first stage, the efficiency scores of VBMs will be estimated. In the second stage, these scores will be used as a dependent variable in an ordinary least square (OLS) regression. The independent variable GFC is a dummy variable which takes the value of 1 for post-GFC, and 0 otherwise. Following prior studies, ownership and bank size will be used as control variables.

4.3.2.2 Impact of ownership on the technical efficiency of banks created via virtual bank mergers (SQ2)

As per the synergy theory, bank mergers have the potential to result in technical efficiency gains. In addition, prior studies in banking efficiency have suggested that ownership type exerts significant influence on banking efficiency. Consequently, bank mergers that include ownership types may generate technical efficiency gains in different ways.

As per public choice theory and the principle agent framework, different types of ownership impact on efficiency in different ways. Accordingly, a lack of capital market discipline weakens owners' control over management, which enables the latter to pursue their own interests and gives fewer incentives to operate efficiently (Das & Ghosh 2006). Few studies have examined the impact of ownership on the efficiency of bank mergers. A study by Hadad et al. (2013) using Indonesian data between 2004 and 2009 showed that the cost reductions resulting from hypothetical mergers were mainly found when the merged entity included a SOCB. This can be explained by the fact that SOCBs have an advantage in terms of the support they receive from the government (there is an implicit subsidy in the government funding). Accordingly, the merged entity which includes a SOCB acquires a cost advantage. This is similar in Vietnam, where SOCBs have received long-term support from the government. Consequently, it is anticipated that VBMs that include a SOCB are more efficient than those that do not include a SOCB. The following hypotheses relating to RQ3 will be tested:

> $H3_0$: The technical efficiency of banks created via VBMs that include a SOCB is not different from that of banks created via VBMs that do not include a SOCB.
>
> $H3_1$: The technical efficiency of banks created via VBMs that include a SOCB is higher than that of banks created via VBMs that do not include a SOCB.

In order to test the above hypotheses, the same procedure that is used to address RQ2 will be employed. In the same regression model, the independent variable OWNERSHIP is a dummy variable which takes the value of 1 if one of the merging banks is a SOCB and 0 otherwise.

4.3.2.3 Impact of the interaction between ownership and GFC on the technical efficiency of banks created via VBMs (SQ3)

As per the theory of synergy gains, bank mergers that include different types of ownership may generate technical efficiency gains in different ways, as discussed above. Given the negative impact of the GFC (2007–08) as expected, an examination will be made of whether the interaction between ownership and GFC affects the technical efficiency of banks created via VBMs. In the context of Vietnam, SOCBs have an advantage in terms of the support they received from the government (there is an implicit subsidy in the government funding) during the GFC. Accordingly, the merged entity which includes a SOCB acquires a cost advantage. Consequently, it is anticipated that the interaction between state-ownership and GFC will have a positive impact on the technical efficiency of banks created via VBMs. The following hypotheses will be tested:

> $H4_0$: The post-GFC technical efficiency of banks created via VBMs that include a SOCB is not different from that of banks created via VBMs that do not include a SOCB and the pre-GFC technical efficiency of banks created via VBMs that include SOCBs and POCBs.
>
> $H4_1$: The post-GFC technical efficiency of banks created via VBMs that include a SOCB is higher than that of banks created via VBMs that do not include a SOCB and the pre-GFC technical efficiency of banks created via VBMs that include SOCBs and POCBs.

In order to test the above hypotheses, the regression model used to address RQ2 and RQ3 will be modified by incorporating the interaction term OWNERSHIP*GFC into the model.

4.3.2.4 Determinants of technical efficiency of Vietnamese commercial banks (SQ4)

Besides the impact of mergers on banking efficiency, prior studies have found various other impacts on bank efficiency, as discussed in Chapter 3. Accordingly, this study only considers factors that are likely to influence the technical efficiency of Vietnamese commercial banks. These are similar, but not identical, to those adopted in prior studies, so as to better reflect the Vietnamese institutional and regulatory framework.

- Impact of bank size on the technical efficiency of Vietnamese commercial banks

As per the structure-conduct-performance paradigm, large banks are more technically efficient than small banks, for the following reasons. First, large banks can exploit economies of scale and scope. There may be increasing returns to scale via allocating fixed costs over a higher volume of products and services (Hauner 2005). Second, large banks may have more professional or specialised management teams which have greater abilities to control costs. Third, large banks may be more flexible in financial markets and more able to diversify credit risk in an uncertain environment (Cole & Gunther 1995). Last, if the size is positively associated with market power, large banks may pay less for their inputs than do small banks (Hauner 2005).

However, the literature on banking efficiency has indicated mixed findings. No conclusive evidence on the relationship between size and bank efficiency in the Indian banking system was found in the studies by Arora (2014) and Sathye and Sathye (2016). Even, Sun and Chang (2011), Das and Ghosh (2006) and Gardener, Molyneux and Nguyen-Linh (2011) found that size had a negative impact on bank efficiency. However, several studies showed a positive relationship between size and bank efficiency (Sufian 2009). Bautista Mesa, Molina Sánchez and Ramírez Sobrino (2014) indicated that there was a positive relationship between bank size and efficiency, but this relationship was not significant for very large banks. In the

context of Vietnam, a study by Stewart, Matousek and Nguyen (2016) suggested that large banks were more efficient than small banks. Accordingly, it is anticipated that bank size will have a positive influence on the technical efficiency of Vietnamese commercial banks.

- Impact of ownership on the technical efficiency of Vietnamese commercial banks

Ownership is one of the major factors used to determine the way that banks should operate, thus influencing bank efficiency. As per public choice theory and the principal agent framework, different types of ownership impact on bank efficiency in different ways. As discussed in Chapter 3, prior studies have found that state-ownership influences bank efficiency. Several studies, such as by See and He (2015) in the Chinese banking system, reported that state-ownership had a positive impact on bank efficiency. However, opposite findings were shown in several studies, such as those by Berger, Hasan and Zhou (2009) and Lin and Zhang (2009) in China; Yang and Liu (2012) in Taiwan; and Perera, Skully and Wickramanayake (2007) in South Asia. In addition, prior studies in Vietnamese banking documented that SOCBs were more efficient than POCBs (Gardener, Molyneux & Nguyen-Linh 2011; Nguyen, Roca & Sharma 2014; Vu & Turnell 2010). Consequently, it is anticipated that state-ownership has a positive impact on the technical efficiency of Vietnamese commercial banks.

- Impact of market power on the technical efficiency of Vietnamese commercial banks

As per the structure-conduct-performance hypothesis, market structure influences banks' pricing conduct and ultimately their performance. Accordingly, the increased market power of the bank may enable it to pay deposit rates, thus improving efficiency (Pilloff & Santomero 1998). However, 'the quiet life' hypothesis predicts that, since banks enjoy greater market power and concentration, inefficiency may follow not because of non-competitive pricing but

because of a relaxed environment without any incentive to minimise costs (Berger & Hannan 1998; Homma, Tsutsui & Uchida 2014; Sathye 2001).

Empirical studies on banking efficiency have indicated mixed findings. A positive relationship between market power and efficiency was indicated in several studies, such as those by Koetter, Kolari and Spierdijk (2012) in the US, Maudos and de Guevara (2007) in Europe, and Williams (2012) in Latin America. Recently, Alhassan, Tetteh and Brobbey (2016) found no relationship between market power and bank efficiency in the Ghanaian banking system. However, a negative relationship between market power and bank efficiency was found in several studies, such as those by Berger and Hannan (1998) in the US; Delis and Tsionas (2009) in the US and Europe; Homma, Tsutsui and Uchida (2014) in Japan; Sathye (2001) in Australia; and Sufian (2009) in Malaysia. Consequently, it is anticipated that market power has a negative influence on the technical efficiency of Vietnamese commercial banks.

- Impact of diversification on the technical efficiency of Vietnamese commercial banks

The inclusion of OBS activities in the output specification first allows the capture of accurate indicators of true bank efficiency. Thereafter, it is important to assess whether diversification towards non-traditional activities is one of the main determinants of the technical efficiency of Vietnamese commercial banks. As per the conglomeration hypothesis, diversification towards non-interest activities has a positive impact on bank efficiency. Diversified banks can leverage managerial skills and abilities across products and services (Iskandar-Datta & McLaughlin 2005). Also, they can gain economies of scope by spreading fixed costs over multiple products (Drucker & Puri 2009).

Several studies in emerging banking systems found that income diversification had a positive impact on bank efficiency (Alhassan 2015; Nguyen, Skully & Perera 2012; Sufian 2009). However, a study by Nguyen and Nghiem (2015) using Indian bank data showed opposite

results. Their findings suggested that the expenses for non-traditional products were greater than those for traditional lending products. In the context of the Vietnamese banking system, as discussed in Chapter 2, domestic banks are less engaged in retail banking. There are substantial opportunities for banks to diversify their income structure, thus improving their sources of income without adjusting their capital structure. It is anticipated that more-diversified banks are more efficient than less-diversified banks. The following hypotheses will be tested:

$H5_0$: Income diversification has no impact on the technical efficiency of Vietnamese commercial banks.

$H5_1$: Income diversification has a positive impact on the technical efficiency of Vietnamese commercial banks.

- Impact of bank capital on technical efficiency of Vietnamese commercial banks

There are opposing views on the impact of bank capital on bank efficiency. Accordingly, a higher level of capital may help banks to reduce the moral hazard between shareholders and debtholders. Because of the limited liability of shareholders, banks with a low capital ratio tend to take on excessive risk. This behaviour is reinforced by explicit or implicit government guarantees of deposits. Therefore, a higher capital ratio reduces risk-shifting, and increases shareholders' incentive to monitor and control to ensure the bank operates efficiently.

The positive impact of capital on bank efficiency was found in several studies, such as those by Alhassan (2015) in Ghana; Perera, Skully and Wickramanayake (2007) in South Asia; Gardener, Molyneux and Nguyen-Linh (2011) in South-East Asia; and Fiordelisi, Marques-Ibanez and Molyneux (2011) in Europe. However, as per corporate governance theory, agency costs between managers and shareholders tend to inflate when capital ratio becomes relatively high and further increases due to the disciplines rendered by debt repayment on

managers' behaviour (Calomiris & Kahn 1991). Studies such as those by Berger and Bonaccorsi di Patti (2006) in the US and Vu and Turnell (2011) in Australia found that lower capital ratios were associated with higher efficiency. In the context of Vietnamese banking, a study by Le (2016b) found that banks with more capital operated more efficiently than those with less capital. Consequently, it is anticipated that bank capital has a positive impact on the technical efficiency of Vietnamese commercial banks. The following hypotheses will be tested:

$H6_0$: Bank capital has no impact on the technical efficiency of Vietnamese commercial banks.

$H6_1$: Bank capital has a positive impact on the technical efficiency of Vietnamese commercial banks.

- Impact of the management quality on the technical efficiency of Vietnamese commercial banks

As per the bad management hypothesis of Berger and DeYoung (1997), low measured efficiency is a sign of poor senior management practices that apply to input-usage and day-to-day operations. Poor managers do not sufficiently monitor and control the bank's operating expenses. Prior studies have indicated mixed findings. A study by Vu and Turnell (2011) showed that higher administration costs (poor quality of management) did not necessarily cause a reduction in efficiency. However, several studies found a negative relationship between poor management quality and bank efficiency (Das & Ghosh 2006; Garza-García 2012; Sufian 2009). Consequently, it is anticipated that, the higher the quality of the bank management, the more efficient that bank. The following hypotheses will be tested:

$H7_0$: The technical efficiency of banks with better management quality is not different from that of those with poor management quality.

$H7_1$: The technical efficiency of banks with better management quality is higher than that of those with poor management quality.

- Impact of risk on the technical efficiency of Vietnamese commercial banks

As per the bad management hypothesis, inadequate loan monitoring and bad debt control can result in lower interest income. As a result of increased risk, a bank will begin to expend additional managerial effort and expense (monitoring, negotiating workout arrangements, seizing and disposing of collateral and so on) to deal with these problem loans. The combined effect would lead to reduced bank efficiency. Prior studies on banking efficiency found that, as risk increases, efficiency becomes lower (Berger & DeYoung 1997; Nguyen & Nghiem 2015; Sathye & Sathye 2016). However, risk was found to have no impact on bank efficiency in several studies, such as those by Sufian (2009) in Malaysia and by Stewart, Matousek and Nguyen (2016) in Vietnam. Recently, a study by Le (2016b) showed a negative relationship between risk and bank efficiency. Consequently, it is anticipated that risk has a negative impact on the technical efficiency of banks.

In order to test the above hypotheses, a two-stage framework will be used. In the first stage, the efficiency scores of banks will be estimated. In the second stage, an OLS regression will be used, where these scores are used as dependent variables. Seven independent variables will be used, and their measurements will be discussed in Chapter 5.

4.3.3 Investigation of the technical efficiency of non-merging banks after virtual bank mergers have taken place (RQ3)

Most of the prior studies examined the efficiency effect of bank mergers by comparing the efficiency levels of merging banks in the pre- and post-merger periods (Halkos & Tzeremes

2013). However, performance gains may well extend beyond the merging banks – that is, the efficiency of non-merging banks may change as other banks merge. (DeYoung, Evanoff & Molyneux 2009). Theoretically, higher market concentration that creates more viable competition that will generate competitive pressure for non-merging banks to improve their efficiency. Accordingly, bank mergers can serve as a 'wake-up call' to non-merging banks, because they will need to make significant efforts to remain viable in the new post-merger competitive environment.

So far, only one study has examined the impact of potentially increased competition resulting from bank mergers on the performance of non-merging banks. A study by Evanoff and Ors (2008) using the US data indicated that non-merging banks responded to the consolidation process by enhancing their cost efficiency. Consequently, it is anticipated that there will be improvements in the technical efficiency of non-merging banks after VBMs have taken place. The following hypotheses relating to RQ3 will be tested:

> $H8_0$: The post-merger technical efficiency of non-merging banks is not different from their pre-merger technical efficiency.
>
> $H8_1$: The post-merger technical efficiency of non-merging banks is higher than their pre-merger technical efficiency.

In order to test the above hypothesis, the study first estimates the pre- and post-merger technical efficiency of non-merging banks. Thereafter, non-parametric tests are used to test the null hypothesis. These tests have been widely used in the literature on banking efficiency (Casu & Girardone 2005; Lieu, Yeh & Chiu 2005). In addition, these tests are more appropriate for studies that have used the non-parametric approach to estimate the efficiency scores of banks.

4.4 Summary

This chapter first presented the development of the theoretical framework for the study. Potential improvements could stem primarily from economies of scale or scope. However, while bank mergers have some limited potential to improve performance via economies of scale and economies of scope, whether or not these gains are captured depends on controlling technical inefficiency. Consequently, the study examines whether VBMs generate technical efficiency gains.

Second, the study addresses research questions and the corresponding hypotheses, summarised in Table 4.1 below.

Table 4.1 Research questions and corresponding hypotheses

Research questions	Corresponding hypotheses
RQ1: What is the impact of the inclusion of off-balance-sheet activities on the technical efficiency of Vietnamese commercial banks?	$H1_0$: There is no difference in the technical efficiency of banks when OBS activities are included in the output specification. $H1_1$: The technical efficiency of banks is higher when OBS activities are included than without the inclusion of OBS activities.
SQ1: What is the impact of global financial crisis on the technical efficiency of banks created via virtual bank mergers?	$H2_0$: The post-GFC technical efficiency of banks created via VBMs is not different from their pre-GFC technical efficiency. $H2_1$: The post-GFC technical efficiency of banks created via VBMs is lower than their pre-GFC technical efficiency.
SQ2: What is the impact of ownership on the technical efficiency of banks created via virtual bank mergers?	$H3_0$: The technical efficiency of banks created via VBMs that include a SOCB is not different from that of banks created via VBMs that do not include a SOCB.

	$H3_1$: The technical efficiency of banks created via VBMs that include a SOCB is higher than that of banks created via VBMs that do not include a SOCB.
SQ3: What is the impact of interaction between ownership and global financial crisis on the technical efficiency of banks created via virtual bank mergers?	$H4_0$: The post-GFC technical efficiency of banks created via VBMs that include a SOCB is not different from that of banks created via VBMs that do not include a SOCB and the pre-GFC technical efficiency of banks created via VBMs that include SOCBs and POCBs. $H4_1$: The post-GFC technical efficiency of banks created via VBMs that include a SOCB is higher than that of banks created via VBMs that do not include SOCB and the pre-GFC technical efficiency of banks created via VBMs that include SOCBs and POCBs.
SQ4: What are determinants of technical efficiency of Vietnamese commercial banks?	$H5_0$: Income diversification has no impact on the technical efficiency of Vietnamese commercial banks. $H5_1$: Income diversification has a positive impact on the technical efficiency of Vietnamese commercial banks.
	$H6_0$: Bank capital has no impact on the technical efficiency of Vietnamese commercial banks. $H6_1$: Bank capital has a positive impact on the technical efficiency of Vietnamese commercial banks.
	$H7_0$: The technical efficiency of banks with better management quality is not different from that of banks with poor management quality. $H7_1$: The technical efficiency of banks with better management quality is higher than that of banks with poor management quality.

RQ3: What is the technical efficiency of non-merging banks after virtual bank mergers have taken place?	$H8_0$: The post-merger technical efficiency of non-merging banks is not different from their pre-merger technical efficiency. $H8_1$: The post-merger technical efficiency of non-merging banks is higher than their pre-merger technical efficiency.

Chapter 5 Method

5.1 Introduction

Chapter 4 proposed the theoretical framework for the study and explained the development of the hypotheses. This chapter introduces the methodology used in the study. It begins with definitions of key terms. Then, data envelopment analysis (DEA) is justified as the preferred method for the study. Thereafter, a two-step DEA procedure is proposed to create virtual bank mergers (VBMs). Next, the two-stage framework is adopted to address RQ2 (indicated in Chapter 4). In the first stage, the bootstrap DEA is used to estimate bias-corrected efficiency scores of banks. In the second stage, these scores are regressed with control variables in order to examine the various impacts on the technical efficiency of banks. In addition, the non-parametric tests for comparing two populations are used to address RQ1 and RQ3. Finally, data used in the study are introduced.

5.2 Definitions of key terms used in the study

5.2.1 Technical efficiency

'Technical efficiency' reflects the ability of a bank to produce its existing level of output with the minimum inputs (input-oriented), or to produce maximum output from a given set of inputs (output-oriented) (Farrell 1957). The technical efficiency of a firm in relation to a panel data model with time-invariant firm effects is represented by the ratio of its mean production given its level of inputs and its realised firm effect to the corresponding mean production if the firm effect had a value of zero, meaning the firm was considered to be fully efficient (Battese & Coelli 1988). Battese (1992) represents the technical efficiency of an individual firm as the ratio of the observed output to the corresponding frontier output, given the levels of inputs used by that firm. In addition, Sathye (2001) suggests that the concept of technical

efficiency is related to the productivity of inputs. This study focuses on the input-oriented measure of technical efficiency based on Farrell's definition.

5.2.2 Bank ownership in Vietnam

This study only considers state and private ownership. In the context of Vietnam, state-owned commercial banks (SOCBs) and privately owned commercial banks (POCBs) are key players in the banking system. A SOCB is a commercial bank in which the government owns more than 50% of the charter capital (SBV 2000). According to article 4.6 of the Law on Enterprises, the charter capital of a bank is the amount of capital that is contributed or undertaken to be contributed by shareholders to the bank in a certain period. Also, this capital will be stated in the charter of the bank (The Vietnamese Government 2005). A POCB is a commercial bank that has been established using funds from individuals, businesses or corporations obtained by issuing shares in the bank. Consequently, bank shareholders have a right to vote at annual general meetings that can influence general bank policies, and are entitled to receive dividends (SBV 2000).

5.3 Methodology

This section first introduces the main econometric frontier approaches used in the banking literature. Then, they are compared in order to choose the appropriate method for study. Thereafter, the various methods which have been proposed to address the corresponding research questions are presented.

5.3.1 Economic frontier approaches

As discussed in Chapter 3, two common efficiency frontier techniques include parametric and non-parametric approaches (Berger & Humphrey 1997). Parametric approaches involve stochastic frontier approach (SFA), thick frontier approach (TFA), and distribution free approach (DFA). SFA specifies a functional form for cost relationships among inputs, outputs

and environmental factors, and allows for random error. It assumes that inefficiencies observe an asymmetric half-normal distribution, random errors are normally distributed, and both are orthogonal to the cost function's exogenous variables (Bauer et al. 1998). Similarly, TFA specifies a functional form but assumes that deviation from estimated costs within the highest and lowest quartiles of observations represent random error, while divergence in predicted costs between the highest and lowest quartiles define x-efficiencies. TFA imposes no distributional assumptions on either inefficiency or random error except to assume that inefficiencies differ between the highest and lowest quartiles and that random error exists within these quartiles. Consequently, TFA does not give point estimates of efficiency for individual firms, instead providing an estimate of the general level of overall efficiency (Berger & Humphrey 1991). DFA also specifies a functional form for the frontier, but it separates the inefficiencies from random error in a different way. DFA makes no strong assumptions about the underlying distribution of inefficiencies or random errors, but instead assumes that changes in efficiency are constant over time and that random error averages out over time (Berger & Mester 1997). Among these parametric approaches, SFA is widely used by most studies on the efficiency effect of bank mergers (Al-Sharkas, Hassan & Lawrence 2008; Hadad et al. 2013; Montgomery, Harimaya & Takahashi 2014).

Non-parametric approaches include DEA and free disposable hull analysis (FDH) (Garden & Ralston 1999). DEA is a linear programming technique where the set of best-practice or frontier observations are those for which no other decision-making unit (DMU) or linear combination of units has as much or more of each of the outputs (given inputs) or as little or less of every input (given outputs). The DEA frontier is constructed as the piecewise linear combinations that link the set of these best-practice observations, thus generating a convex production possibilities set (Coelli et al. 2005). As such, DEA does not require the explicit specification of the form of the underlying production relationship. FDH does not allow such

linear input substitution. Thus, the isoquant is represented by a step function through the observed input combinations (Drake 2003). Among non-parametric techniques, DEA is widely used by most studies on the efficiency effect of bank mergers (DeYoung, Evanoff & Molyneux 2009; Drake & Hall 2003; Kolaric & Schiereck 2014).

5.3.2 Justification of the choice of data envelopment analysis

The literature on banking efficiency has shown no consensus on the preferred method for determining the best-practice frontier against which relative efficiencies are measured (Berger, Hunter & Timme 1993; Drake & Hall 2003). Of the two most common approaches (DEA versus SFA), DEA is the preferred technique for the study for the following reasons.

The first reason is the availability of data and contextual information. As mentioned in Chapter 3, SFA requires the specification of a cost function. Accordingly, input prices of data are required. In the case of missing data on the number of employees, the accuracy measurement of SFA may be compromised by the lack of an accurate input price for labour. In addition, SFA measures x-efficiency, which includes both technical efficiency and allocative efficiency, while this study primarily focuses on technical efficiency.

The second reason that DEA is used for this study is that it can be used with small sample sizes, while SFA generally requires a large dataset to provide a good picture for analysis (Evanoff & Israilevich 1991). Accordingly, use of DEA enables the researcher to reveal which of the input-output variables need to be closely monitored by bank management to enhance efficiency. Consequently, information on peer groups is relatively helpful for managerial objectives, since banks could improve their efficiency by learning from their fully efficient counterparts.

The third reason for choosing DEA is that the problem of functional form dependence regarding SFA is especially pertinent in the context of the study, given the wide diversity

across Vietnamese banks in respect of business mix. Mester (1997) argued that the failure to adequately consider bank heterogeneity can result in an inaccurate calculation of bank efficiency. On the other hand, DEA imposes very little structure on the efficiency frontier and does not require the maintained assumption that all banks face the same unknown production technology (Drake & Hall 2003; Paradi & Zhu 2013). When a specification of inputs and outputs is given, DEA simply requires the existence of an input/output correspondence to measure relative efficiency scores.

The fourth reason is the issue of random error in SFA. The decomposition of the combined error term into the random error and inefficiency components requires an assumption concerning the appropriate distribution of the latter. Bauer et al. (1998) argue that any distributional assumptions that are simply imposed without basis are in fact quite arbitrary. This may result in significant error in estimating efficiencies of individual firms in the particular sample. However, DEA assumes no random error, which suggests that all deviations from the measured efficient frontier actually represent technical inefficiencies (Avkiran 1999; Resti 1997).

5.3.3 Introduction of data envelopment analysis

DEA is a linear mathematical programming approach that allows decomposing relative efficiency performance into categories. This approach was initially suggested by Farrell (1957), developed by Charnes, Cooper and Rhodes (1978), and later elaborated by Banker, Charnes and Cooper (1984).

The term ‘DEA’ was coined by Charnes, Cooper and Rhodes (1978) to measure the efficiency scores of DMUs, obtained as a maximum ratio of weighted outputs to weighted inputs. This is based on the view that the more outputs produced from a given set of inputs, the more efficient the production. Accordingly, this approach constructs the frontier of the observed

input-output ratios by linear programming techniques, so as to be able to compute efficiencies relative to this surface. DEA assumes that the linear substitution is possible between observed input combinations on an isoquant (the same quantity of output is produced while changing the quantities of two or more inputs). The constructed relative efficiency frontiers are non-statistical or non-parametric in the sense that they are constructed through the envelopment of DMUs, with the best-practice DMUs forming the non-parametric frontier.

Extending the work of Farrell (1957), Charnes, Cooper and Rhodes (1978) proposed the constant returns to scale (CRS) model, used to identify the frontier and estimate efficiency scores of DMUs. Accordingly, the CRS assumption is only relevant when all DMUs are operating at an optimal scale. However, imperfect competition of the market and financial constraints would cause a DMU be unable to operate at the optimal scale (Coelli et al. 2005). Consequently, given that not all DMUs operate at the optimal scale, the use of the CRS specification will lead measures of technical efficiency to be confounded by scale efficiency. Furthermore, the CRS model in DEA was extended by Banker, Charnes and Cooper (1984) to account for variable returns to scale (VRS) situations. The use of the VRS specification will permit the calculation of technical efficiency devoid of these scale efficiency effects (Coelli et al. 2005). Consequently, the VRS assumption in DEA is used in the present study.

5.3.3.1 Economic model of efficiency measurement

Given a bank with a set of input p and a set of output q, a production set Ψ can be defined in the Euclidean space R_+^{p+q} as:

$$\Psi = \{(x,y)|x \in R_+^p, y \in R_+^q, (x,y)\ is\ \text{feasible}\} \quad (1)$$

Where x and y are additional input and output vectors and feasibility, the considered bank can produce output quantities given the input quantities. Accordingly, the input requirement set is determined as follows:

$$\mathrm{C(y)} = \{\mathrm{x} \in R_{+}^{p} | (\mathrm{x,y}) \in \Psi\} \quad (2)$$

Consequently, the following production set Ψ of a bank can be estimated by:

$$\Psi = \{(x,y) | x \in C(y), \mathrm{y} \in R_{+}^{q}\} \quad (3)$$

Following Farrell (1957) concept, the efficient boundaries of Ψ in the input space can be defined as:

$$\partial C(y) = \{x | x \in C(y), \theta\, \mathrm{x} \notin C(\mathrm{y}), \forall\, \theta\,, 0 < \theta < 1\} \quad (4)$$

$$\theta(x_0, y_0) = \inf\{\theta | \theta x_0 \in C(y_0)\} = \inf\{\theta | (\theta x_0, y_0) \in \Psi\} \quad (5)$$

Thereafter, the following DEA estimator under the VRS assumption as proposed by Banker, Charnes and Cooper (1984) is measured as:

$$\hat{\theta}_{DEA}(x_{0,}y_0) = \min\begin{Bmatrix} \theta | y_0 \leq \sum_{i=1}^{n} \gamma_i Y_i\,; \theta x_0 \geq \sum_{i=1}^{n} \gamma_i X_i\,;\ \theta > 0; \\ \sum_{i=1}^{n} \gamma_i = 1;\ \gamma_i \geq 0, i = 1, \ldots, n \end{Bmatrix} \quad (6)$$

Equation (6) measures the input-oriented efficiency score of a bank, $\hat{\theta}_{DEA}(x_{0,}y_0)$ by calculating the radial distance between $(x_{0,}y_0)$ and $(\hat{x}^{\partial}(x_0|y_o, y_0))$. Accordingly, the level of the inputs that the bank should operate with, close to the efficient boundary with the same level of output and the same proportion of inputs, is indicated by $(\hat{x}^{\partial}(x_0|y_o))$. In other words, $\hat{x}^{\partial}(x_0|y_o) = \hat{\theta}(x_{0,}y_0)x_o$.

Consequently, the value of $\hat{\theta}_{DEA}(x_{0,}y_0)$ will be bounded by 0 and 1. The bank that obtains a score of 1 is considered to be technically efficient since it operates on the boundary of its production set (Daraio & Simar 2007).

5.3.3.2 Bootstrap data envelopment analysis

DEA measure is often criticised as lacking a statistical basis. Assaf, Barros and Matousek (2011) argue that one of the main disadvantages of DEA formulations is the inability to conduct statistical inference. In addition, Simar and Wilson (2000) make the criticism that DEA estimators are biased by construction. Accordingly, the true efficiency score $\hat{\theta}$ in equation (6) is not observed directly; rather, it is empirically estimated. The empirical estimates of the efficiency frontier are obtained on the selected sample, thereby ruling out some efficiency production possibilities not observed in the sample. Consequently, the empirical estimates are upwardly biased (Simar & Wilson 2007).

In order address this issue, a bootstrap DEA was introduced by Simar and Wilson (1998, 2000). This procedure can produce confidence limits on the efficiencies of the units to capture the true efficiency frontier within the specified interval (Dyson & Shale 2010). The following bootstrap procedure is divided into five steps:

Step 1: Transforming the input and output vectors from the original efficiency estimates:

$$\{\hat{\theta}_{in,}i = 1, \dots, n\}\ as\ (\hat{\theta}_i^l, y_i) = (x_i.\hat{\theta}_{in}, y_i) \quad (7)$$

Step 2: Generating smoothed resampled pseudo-efficiencies γ_i^* as follows:

Step 2.1. Given a set of estimated efficiencies $\{\hat{\theta}_{in}\}$, following the suggestion by Silverman (1986), the bandwidth parameter is determined as $h = 0.9n^{1/5}\min\{\hat{\sigma}_{\hat{\theta}}, R_{13}/1.34\}$,

where $\hat{\sigma}_{\hat{\theta}}$ is the standard deviation of $\{\hat{\theta}_{in}\}$ and R_{13} is the interquartile range of the empirical distribution of $\{\hat{\theta}_{in}\}$.

Step 2.2. Generating $\{\delta_i^*\}$ by replacing, with replacement, from the empirical distribution of $\{\hat{\theta}_{in}\}$ of the estimated efficiencies.

Step 2.3. Generating the sequence $\{\tilde{\delta}_i^*\}$ by using:

$$\tilde{\delta}_i^* = \begin{cases} \tilde{\delta}_i^* + h\varepsilon_i^* & \text{if } \tilde{\delta}_i^* + h\varepsilon_i^* \leq 1 \\ 2 - (\tilde{\delta}_i^* + h\varepsilon_i^*) & \text{otherwise} \end{cases} \quad (8)$$

where ε_i^* is drawn independent and identically distributed from a standard normal distribution.

Step 2.4. Generating the smoothed pseudo-efficiencies $\{\gamma_i^*\}$ by using the following formula:

$$\gamma_i^* = \frac{\bar{\delta}_i^*(\tilde{\delta}_1^* - \bar{\delta}_i^*)}{\sqrt{1+h^2/\hat{\sigma}_\theta^2}} \quad (9)$$

Where $\bar{\delta}_i^* = \sum_{i=1}^n \delta_i^*/n$, this is the average of the resampled original efficiencies.

Step 3: Let the pseudo-data be given by:

$$(X_i^*, Y_i^*) = (\frac{\hat{X}_i^l}{\gamma_i^*}, Y_i) \quad (10)$$

Step 4: Computing the bootstrapped efficiency score using the pseudo-data:

$$\hat{\theta}_{in}^{SW*} = \min_{\theta,z}\{\theta: y_i \leq Y_Z\,, \theta x_i \geq X^* z, \sum_{i=1}^n z_i = 1, z \in R_+^n\} \quad (11)$$

Step 5: Repeating steps (2) to (4) with B times to generate a set of B bank-specific bootstrapped efficiency estimates:

$$\hat{\theta}_{in}^{SW*b}, i = 1, \dots., n\ ;\ b = 1, \dots., n \tag{12}$$

Along with others, Simar and Wilson (1998, 2000) and Stewart, Matousek and Nguyen (2016) indicate a B value of 2,000 replications.

Once the bootstrap values $\hat{\theta}^*_{DEA,b}(x_0, y_0), b = 1 \dots B$ are obtained, the bootstrapped bias estimates for the original DEA estimator $\hat{\theta}_{DEA}(x_o, y_0)$ is computed as:

$$\widehat{BIAS}_B\left(\hat{\theta}_{DEA}(x_o, y_0)\right) = B^{-1}\sum_{b=1}^{B}\hat{\theta}^*_{DEA,b}(x_0, y_0) - \hat{\theta}_{DEA}(x_0, y_0) \tag{13}$$

The bias-corrected estimator of $\theta(x_0, y_0)$ can be calculated by:

$$\hat{\hat{\theta}}_{DEA}(x_0, y_0) = \hat{\theta}_{DEA}(x_0, y_0) - \widehat{BIAS}_B\left(\hat{\theta}_{DEA}(x_0, y_0)\right)$$

$$= 2\,\hat{\theta}_{DEA}(x_0, y_0) - B^{-1}\sum_{b=1}^{B}\hat{\theta}^*_{DEA,b}(x_0, y_0) \tag{14}$$

where $\hat{\theta}^*_{DEA,b}(x_0, y_0)$ is a bootstrapped value; B is 2,000 replications.

Also, the bias correction in equation (14) should not be applied unless:

$$\frac{|\widehat{BIAS}_B\left(\hat{\theta}_{DEA}(x_o, y_0)\right)|}{\hat{\sigma}} > \frac{1}{\sqrt{3}} \tag{15}$$

However, Simar and Wilson (2000) indicate that this bias correction may create additional noise. Consequently, the sample variance of the bootstrap value $\hat{\theta}^*_{DEA,b}(x_0, y_0)$ needs to be estimated. The variance of the bootstrap values can be calculated by:

$$\hat{\sigma}^2 = B^{-1} \sum_{b=1}^{B} \left[\hat{\theta}^*_{DEA,b}(x_0, y_0) - B^{-1} \sum_{b=1}^{B} \hat{\theta}^*_{DEA,b}(x_0, y_{0)}\right]^2 \quad (16)$$

In addition, following the input distance function suggested by Shephard (1970), input-oriented efficiency can be expressed as:

$$\hat{\delta}_{DEA}(x_0, y_0) \equiv \frac{1}{\hat{\theta}_{DEA}(x_0 y_0)}$$

The bootstrap confidence intervals for $\hat{\delta}_{DEA}(x_0, y_0)$ can be constructed as follows:

$$\left[\hat{\delta}_{DEA}(x_0, y_0) - \hat{\alpha}_{1-a/2}, \hat{\delta}_{DEA}(x_0, y_o) - \hat{\alpha}_{a/2}\right] \quad (17)$$

A number of software options are available for running DEA. The present study employs the Frontier Efficiency Analysis with R (FEAR) package, as introduced by Wilson (2008), to estimate the technical efficiencies scores of DMUs. FEAR is a very flexible, extensible package unlike any current package available for the estimation of productivity and efficiency.

It is important to note that efficiency estimates produced by the FEAR package are the reciprocals of Farrell's input efficiency measures (Wilson 2008). Therefore, the VRS

efficiency score of a DMU can be estimated as $\frac{1}{\hat{\theta}_{DEA}(x_{0,}y_0)}$ where $\hat{\theta}_{DEA}(x_{0,}y_0)$ is produced by running FEAR. The bias-corrected VRS efficiency score (BCVRS) of a DMU can be computed as $\frac{1}{\hat{\hat{\theta}}_{DEA}(x_0,y_0)}$ where $\hat{\hat{\theta}}_{DEA}(x_0, y_0)$ is produced by running FEAR.

5.3.4 Procedure to create virtual bank mergers

Due to the limited number of banks in Vietnam, this study is the first attempt to investigate whether VBMs in Vietnam generate technical efficiency gains in banks. Accordingly, VBMs can be created using the following two-step procedure of DEA:

Step 1: Identifying technically efficient banks in the sample.

Efficiency is calculated using DEA under the VRS assumption, as discussed above. Accordingly, a bank that obtains a DEA score of 1 is considered to be efficient (Coelli et al. 2005).

Step 2: Creating VBMs.

Given the technically efficient banks as derived from step 1, a VBM is performed by combining the inputs and outputs of two efficient banks, following theorem 14.1 in Cooper, Seiford and Tone (2007) and the suggestion of Halkos and Tzeremes (2013). Accordingly, all possible combinations between the efficient banks are created.

When performing a VBM, it is assumed that VBMs are able to generate the following synergy gains. The first type is financial synergy (allocative or collusive synergies), which results from lowering capital cost. In addition, financial synergies can be achieved by possessing superior information, thus generating an efficient allocation of capital. The second type is operational synergy, which can be realised through the combination of operations of different units. In addition, operational synergy gains are also associated with management that can

implement superior planning and control processes. Consequently, costs are reduced and different products and services are produced.

5.3.5 Procedure to investigate technical efficiency of non-merging banks after virtual bank mergers have taken place (RQ3)

In order to address RQ3, the two-step procedure of bootstrap DEA is used, as follows.

Step 1: Identifying the non-merging banks and calculating their pre-merger BCVRS scores.

As stated in step 1 of the procedure of creating VBMs (section 5.3.4), the identified efficient banks will undergo VBMs, leaving inefficient banks (non-merging banks) out of the existing list. Accordingly, the pre-merger BCVRS of these non-merging banks are obtained using the bootstrap DEA after running the input-oriented VRS model for the original sample (existing banks).

Step 2: Estimating the post-merger BCVRS scores of non-merging banks.

To compare the technical efficiency of these non-merging banks as above in the post-merger scenario, the following procedure is used. First, the VRS scores of virtually merged banks are calculated. Thereafter, banks that have been virtually merged have scores of less than 1; will be excluded from the list. In the remaining list of VBMs, the original non-merging banks, as derived from step 1, are added. Then, efficiency is calculated for banks in the list, using the bootstrap DEA. The resultant scores of non-merging banks in the group are compared with the non-merging banks in the original group (step 1), using two non-parametric tests (discussed in the next section).

5.3.6 Purpose of non-parametric tests for the examination of the difference between two populations

In order to address RQ1 and RQ3, as indicated in Chapter 4, the Wilcoxon signed-rank and Mann-Whitney rank-sum tests are used to verify whether there is significant difference in the median technical efficiency of banks in two groups. These non-parametric tests are widely used in many prior studies, such as those by Casu and Girardone (2005) and Lieu, Yeh and Chiu (2005), that use a non-parametric approach with DEA to calculate technical efficiency scores of banks.

5.3.6.1 Mann-Whitney rank-sum test

- Introduction to the Mann-Whitney rank-sum test

The non-parametric method, the Mann-Whitney rank-sum test, or the so-called Wilcoxon rank-sum test, can be used to determine whether a difference exists between two populations. Anderson, Sweeney and Williams (2008) suggested that both the Mann-Whitney and Wilcoxon versions of this test are analogous. For convenience, the present study refers to it as the Mann-Whitney test. Unlike the Wilcoxon signed-rank test, the Mann-Whitney test is not based on a matched sample. Two independent samples are used – one from each population.

In addition, the Mann-Whitney test does not require interval data or the assumption that the populations are normally distributed. The only requirement of the Man-Whitney test is that the measurement scale for the data is at least ordinal. Therefore, the Mann-Whitney test is used to investigate whether two populations are identical instead of testing the difference between the means of two populations (Anderson, Sweeney & Williams 2008). The null hypothesis and alternative hypothesis of the Mann-Whitney test are presented as follows:

H_0: The two populations are identical.

H_1: The two populations are not identical.

- Calculation of the Mann-Whitney test

The Mann-Whitney test can be applied for either small or large sample sizes. Thus, the present study discusses them separately.

  - Small sample case

A small sample is considered to exist when both sample sizes are less than or equal to 10. The first step of the Mann-Whitney test is to rank the combined data from two samples from low to high. The second step is to sum the ranks for each sample separately. Then the Mann-Whitney test can use the sum of the ranks for either sample. Let T represent the sum of the ranks for the used sample. Critical values of the test T statistic are provided in the following table for cases in which both sample sizes are small.

Table 5.1 T_L values for the Mann-Whitney test

		n_2								
α=0.05		2	3	4	5	6	7	8	9	10
	2	3	3	3	3	3	3	4	4	4
	3	6	6	6	7	8	8	9	9	10
	4	10	10	11	12	13	14	15	15	16
	5	15	16	17	18	19	21	22	23	24
n_1	6	21	23	24	25	27	28	30	32	33
	7	28	30	32	34	35	37	39	41	43
	8	37	39	41	43	45	47	50	52	54
	9	46	48	50	53	56	58	61	63	66
	10	56	59	61	64	67	70	73	76	79

Source: Anderson, Sweeney and Williams (2008), p.945

The value of T_U is estimated from the following equation:

$$T_U = n_1(n_1 + n_2 + 1) - T_L \quad (18)$$

The value of T_L can be obtained directly from Table 5.1. Anderson, Sweeney and Williams (2008) provided T_L values for the Mann-Whitney test in terms of the 5% and 10% level of significance. However, the studies by Casu and Girardone (2005) and Lieu, Yeh and Chiu (2005) examined the impact of OBS activities on the efficiency of banks by using the 5% level of significance. Therefore, the present study only presents the 0.05 level of significance. In the table, n_1 denotes the sample size corresponding to the sample whose rank-sum is used in the test.

The null hypothesis H_0 of identical populations can be rejected if $T < T_L$ or $T > T_U$.

- Large sample size

When both sample sizes are greater than 10, a normal approximation of the distribution of T can be used to perform the analysis for the Mann-Whitney test. The first step is to rank the combined data from the lowest to the highest values. The second step is to sum the ranks for each sample. The test procedure can be based on the sum of ranks for either sample (Anderson, Sweeney & Williams 2008). Given the sample sizes, the appropriate sampling distribution of T for identical populations is given by the following equations:

Mean: $\mu_T = \frac{1}{2} n_1(n_1 + n_2 + 1)$

Standard deviation: $\sigma_T = \sqrt{\frac{1}{12} n_1 n_2 (n_1 + n_2 + 1)}$

Distribution form: approximately normal provided $n_1 \; and \; n_2 \geq 10$

Given the values of T, μ_T andσ_T, the $Z - value$ can be estimated using the following equation:

$$Z = \frac{T - \mu_T}{\sigma_T} \qquad (19)$$

According to the estimated $Z - value$, two-tailed $p - value$ can be obtained using the standard normal probability table.

If $p - value \leq \alpha = 0.05$, the null hypothesis H_0 can be rejected, thus the two populations are not identical.

If $p = value > \alpha = 0.05$, the null hypothesis H_0 cannot be rejected, thus two populations are identical.

5.3.6.2 Wilcoxon signed-rank test

- Introduction to the Wilcoxon signed-rank test

The Wilcoxon signed-rank test is the non-parametric alternative to the parametric matched-sample test. In the matched-sample situation, each experimental unit creates two pairs – one from population 1 and one from population 2. The difference between the matched observations provides insight about the differences between the two populations. The Wilcoxon signed-rank test examines the following hypotheses:

H_0: The two populations are identical.

H_1: The two populations are not identical.

- Calculation of the Wilcoxon signed-rank test

The Wilcoxon signed-rank test requires a ranking of the absolute value of the differences between two populations. After eliminating any differences of zero, the test ranks the remaining absolute differences from lowest to highest. Once the ranks of the absolute differences are determined, the ranks are given the sign of the original difference in the data. Then this arrives at the sum of signed-rank values. Finally, the Wilcoxon signed-rank test

examines whether the computed sum of signed ranks is significantly different from zero (Anderson, Sweeney & Williams 2008).

Let T represent the sum of the signed-rank values in a Wilcoxon signed-rank test. If the two populations are identical and the number of matched pairs of data is at least 10, the sampling distribution of T can be approximated by a normal distribution as follows:

Mean $\mu_T = 0$

Standard deviation: $\sigma_T = \sqrt{\frac{n(n+1)(2n+1)}{6}}$

Distribution form: approximately normal provided $n \geq 10$.

Value for the test statistic: $z = \frac{T-\mu_T}{\sigma_T}$

According to the value of z, the two-tailed $p - value$ is computed using the standard normal probability table. If $p - \text{value} \leq \alpha = 0.05$, the null hypothesis H_0 can be rejected, thus the two populations are not identical.

5.3.7 The two-stage analysis: data envelopment analysis and regression

Following prior studies (Garza-García 2012; Sufian 2009), the two-stage framework is used in the study to address SQs 2 to 4 (as stated in Chapter 4). In the first stage, bootstrap DEA is used to calculate the BCVRS scores of banks. In the second stage, these BCVRS scores are regressed control variables in order to examine the various impacts on bank efficiency. Several studies preferred a censored Tobit regression to an OLS regression (Gardener, Molyneux & Nguyen-Linh 2011; Garza-García 2012; Sufian 2009). This is because the Tobit regression takes into account the censored nature of the dependent variable – that is, efficiency scores are constrained between 0 and 1. However, McDonald (2009) proved that Tobit estimates are often similar to OLS estimates and suggested that the considered

advantage of OLS is that it is familiar and easy to compute. Consequently, an OLS regression model is used in the study. It is important to note that the regression model will be modified in order to address the corresponding research question. The study only considers factors that are likely to influence the technical efficiency of Vietnamese banks. These are similar, but not identical to, those adopted in many prior studies, so as to better reflect the Vietnamese institutional and regulatory framework.

5.3.7.1 A regression model used to address SQ1

In order to address SQ1, the following OLS regression model is used. Following from prior studies, ownership and size have been used as control variables:

$$EFFICIENCY_{i,t} = \beta_0 + \beta_1 GFC + \beta_2 OWNERSHIP_i + \beta_3 SIZE_{i,t} + \varepsilon_{i,t} \qquad (20)$$

The dependent variable $EFFICIENCY_{i,t}$ is the BCVRS score of the i^{th} virtually merged bank in year t. The BCVRS score of the virtually merged banks can be obtained using the bootstrap DEA as introduced by Simar and Wilson (1998, 2000) after running an input-oriented VRS model for the sample of VBMs. In terms of independent variables, GFC is a dummy variable which takes the value of 1 for post-GFC, and 0 otherwise, and OWNERSHIP is a dummy variable which takes the value of 1 if one of the merging banks is a SOCB, and 0 otherwise.

As mentioned in Sathye and Sathye (2016) paper, prior studies have used deposits, loans, numbers of automated teller machines (ATMs), numbers of employees, numbers of branch offices, the amount of total assets, and the natural logarithm of total assets as measures of size. We use the natural logarithm of total assets as a measure of SIZE since the relationship between bank size and bank efficiency is non-linear (Beccalli & Frantz 2009; Delis & Papanikolaou 2009; Sufian 2009; Wheelock & Wilson 2004). As per the procedure adopted in this study, total assets of a bank after a VBM are measured by combining the total assets of two merging banks.

5.3.7.2 A regression model used to address SQ2

The above OLS regression model (equation 20) is also used to address SQ2. Accordingly, GFC and SIZE are now used as control variables.

5.3.7.3 A regression model used to address SQ3

As expected, ownership and GFC have an impact on the technical efficiency of VBMs. We further examine the impact of the interaction between ownership and GFC on the technical efficiency of banks created via VBMs. In order to address this question, the OLS regression model (20) is modified as follows:

$$EFFICIENCY_{i,t} = \beta_0 + \beta_1 GFC + \beta_2 OWNERSHIP_i + \beta_3 SIZE_{i,t} + \beta_4 OWNERSHIP_i * GFC + \varepsilon_{i,t} \quad (21)$$

The independent variable OWNER*GFC is an interaction term between OWNERSHIP and GFC. The other variables are discussed above.

The summary of independent variables (equations 20 and 21) and their hypothesised relationship with efficiency (Chapter 4) are indicated in Table 5.2 below.

Table 5.2 Variables used to examine the impact of GFC and ownership, and the interaction between GFC and ownership on the technical efficiency of banks created via VBMs

Variables	Descriptions	Predicted signs	Remarks (as presented in Chapter 4)
GFC	A dummy variable which takes the value of 1 for post-GFC, and 0 otherwise	-	We expect that a priori this variable will have a negative sign.
OWNERSHIP	A dummy variable which takes the value of 1 if one of the merging banks is a SOCB, and 0 otherwise	+	We expect that a priori this variable will have a positive sign. Consequently, VBMs that include a SOCB are more efficient than those that do not include a SOCB.
GFC* OWNERSHIP	An interaction term between OWNERSHIP and GFC	+	We expect that a priori this variable will have a positive sign. Consequently, the post-GFC technical efficiency of banks created via VBMs that include a SOCB is higher than that of banks created via VBMs that do not include a SOCB, and the pre-GFC technical efficiency of banks created via VBMs that include SOCBs and POCBs.

5.3.7.4 A regression model used to address SQ4

In order to address SQ4, the following OLS regression model is used:

$$EFFICIENCY_{i,t} = \beta_0 + \beta_1 SIZE_{i,t} + \beta_2 OWNER_i + \beta_3 MARKET\ POWER_{i,t} + \beta_4 DIVERSIFICATION_{i,t} + \beta_5 CAPITAL_{i,t} + \beta_6 MANAGEMENT_{i,t} + \beta_7 RISK_{i,t} + \varepsilon_{i,t} \quad (22)$$

The dependent variable $EFFICIENCY_{i,t}$ is the BCVRS score of the i^{th} bank (the existing commercial bank) in year t. The BCVRS of the bank can be obtained using bootstrapped DEA as introduced by Simar and Wilson (1998, 2000) after running an input-oriented VRS model for the original sample of banks.

As discussed above, SIZE is measured by the natural logarithm of total assets. OWNER is used as a proxy for ownership. OWNER is a dummy variable which takes the value of 1 for a SOCB, and 0 otherwise.

Prior studies have used concentration ratio (Ngoc Nguyen & Stewart 2013), Herfindahl-Hirschman Index (HHI) (Berger & Hannan 1998; Maudos & de Guevara 2007; Park & Weber 2006), Lerner indices (conventional Lerner index and efficiency-adjusted Lerner index) (Fungáčová, Pessarossi & Weill 2013; Koetter, Kolari & Spierdijk 2012), H-statistic (Prasad & Ghosh 2007) and log of total deposits as measures of market power. We use the natural logarithm of total deposits as a measure of MARKET POWER.

Prior studies have used HHI of bank income (Elyasiani & Wang 2012; Laeven & Levine 2007), the ratio of non-interest income (NII) to total assets (Garza-García 2012; Sufian 2009), and the ratio of NII to total income (Le 2016c, 2016a; Nguyen & Nghiem 2015) as measures of income diversification. We use the ratio of NII to total assets as a measure of DIVERSIFICATION.

Following prior studies (Gardener, Molyneux & Nguyen-Linh 2011; Skully & Perera 2012; Vu & Turnell 2011), we use the ratio of book value of equity to total assets as a measure of CAPITAL.

Following prior studies (Das & Ghosh 2006; Sufian 2009; Vu & Turnell 2011), we use the ratio of non-interest expenses to total assets as a proxy for the quality of management (MANAGEMENT).

Prior studies have used the ratio of non-performing loans (NPLs) to net loans (Sathye & Sathye 2016), the natural logarithm of NPLs (Stewart, Matousek & Nguyen 2016), the ratio of loan loss provisions to total loans (Lepetit et al. 2008; Tan & Floros 2013) and the ratio of loan loss reserves to total assets (Altunbas et al. 2007) as measures of risk. We use the ratio of loan loss provisions to total loans as a proxy for risk (RISK) because there was substantial missing data for NPLs in our sample.

The summary of independent variables (equation 22) and their hypothesised relationship with efficiency are indicated in Table 5.3.

Table 5.3 Variables used to examine the determinants of technical efficiency of Vietnamese commercial banks

Variables	Descriptions	Predicted signs	Remarks (as presented in Chapter 4)
SIZE	Natural logarithm of total assets	+	We expect that a priori this variable will have a positive sign. Consequently, large banks are more efficient than their small counterparts.
OWNER	A dummy variable that takes the value of 1 for SOCBs, and 0 otherwise	+	We expect that a priori this variable will have a positive sign. Consequently, SOCBs are more efficient than POCBs.
MARKET POWER	Natural logarithm of total assets	-	We expect that a priori this variable will have a negative sign.
DIVERSIFICATION	The ratio of non-interest income to total assets	+	We expect that a priori this variable will have a positive sign. Consequently, more-diversified banks are more efficient than less-diversified banks.
CAPITAL	The ratio of total equity to total assets	+	We expect that a prior this variable will have a positive sign. Consequently, banks with a higher level of capital are more efficient than those with a lower level of capital.
MANAGEMENT	The ratio of non-interest expenses to total assets	-	We expect that a priori this variable will have a negative sign because banks that have better management quality can achieve lower administrative costs.
RISK	The ratio of loan loss provisions to total loans	-	We expect that a priori this variable will have a negative sign because, as risk increases, efficiency will be lower.

5.4 Data

This section first discusses the specification of inputs and outputs in DEA and then introduces the source of data and discusses sampling techniques used in the study. Finally, the data for variables used in the regression model are presented.

5.4.1 The specification of inputs and outputs

This section first discusses the specification of inputs and outputs used in the DEA model. Then data for inputs and outputs, as well as for variables used in the regression model (equation 22), are presented.

5.4.1.1 Measurements of bank inputs and outputs

A definition of banking activity and the various functions of banks play an important role in selecting inputs and outputs used in the efficiency estimation. Five approaches that are classified in the specification of inputs and outputs include the production approach , the intermediation approach , the asset approach , the user cost approach and the value-added approach (Favero & Papi 1995; Sufian 2009). However, two approaches (the user cost approach and the value-added approach) are generally not related to macroeconomic functions performed by banks (Favero & Papi 1995). As per the user cost approach, the net contribution to bank revenue determines the nature of inputs and outputs. However, the disadvantages of this approach are the difficulties in obtaining accurate data and the practice of subsidisation that may imply low reliability of prices and available revenue. As per the value-added approach, the specification of inputs or outputs is based on the share of value added. Indeed, balance sheet categories such as loans and deposits with a main share of value added are considered outputs (Drake, Hall & Simper 2006). Therefore, these two approaches have received much less attention in empirical studies on banking efficiency.

However, the first three approaches are associated with some functions carried out by banks. As per the asset approach, banks are considered only as financial intermediaries between

liability holders and those who receive bank funds. Loans and other assets are treated as outputs, while total deposits and other bank liabilities are considered inputs. This may be true in the case of large banks that mainly purchase their funds from other banks and large depositors, and transform those funds into loans. However, most banks operate beyond the purchase of their funds, and they also provide various services to depositors, but these services are not counted as outputs. In addition, as per current institutional arrangements, the use of the asset approach to measure banking outputs often results in contradictions (Favero & Papi 1995). An example is a bank that produces deposits and sells virtually all its funds to a second bank, which generates commercial loans with these funds. If the two banks merge, there is no change in total banking output, ceteris paribus. However, if both commercial and interbank loans are considered outputs, then measured output would be diminished by the merger because there would be no more interbank lending. If only commercial loans are considered outputs, then the bank that sells funds has no measured outputs, even though it provides deposit services and the second bank values the funds purchased. Consequently, the asset approach is appropriate only for limited purposes (Berger & Humphrey 1992b).

It is commonly acknowledged that the banking literature is dominated by two approaches: the production approach and the intermediation approach (Avkiran 1999; Berger & Humphrey 1997; Nguyen & Simioni 2015; Sathye 2001; Sufian 2009). As per the production approach, a bank is defined as producing demand deposits, time and saving deposits, and loans by utilising capital, labour and materials (Benston 1965). Accordingly, the number of accounts or related transactions is the best measure of output, while the number of employees and physical capital are used as inputs (Ferrier & Lovell 1990). More specifically, the number of accounts and loans outstanding are considered to be appropriate measures of bank outputs, and total costs include all operating costs incurred in the production of outputs. However, there are some disadvantages to this approach. First, such detailed transaction flow data is

typically proprietary and generally unavailable to collect (Berger & Humphrey 1997). Second, this approach ignores the interest expenses that are mainly used to produce outputs. Consequently, the production approach is not appropriate for studies that examine cost efficiency, as interest expenses accounted for one-half to two-thirds of total costs (Berger & Humphrey 1997). Nonetheless, this approach seems to be more appropriate for comparing efficiency among branches within a bank.

Therefore, the intermediation approach is adopted for use in this study for the following reasons. Accordingly, banks are considered as collectors of funds which are then intermediated into loans and other assets (Ferrier & Lovell 1990). This is consistent with the function of banks as written into law – as outlined in Chapter 2, article 1 of Decree No. 49/2000/ND-CP (The Vietnamese Government 2000). Consequently, banks are purchasing labour, materials and deposit funds to produce outputs such as loans and investments.

It is important to note that the choice of input and output variables is very important because this significantly influences the accurate efficiency scores of banks (Nguyen & Nghiem 2015). Following prior studies (Drake & Hall 2003; Sathye 2001; Sealey & Lindley 1977), three inputs (X) and three outputs (Y) are selected in the study as follows:

Inputs

(X_1) Labour costs

(X_2) Capital (premises and equipment),

(X_3) Loanable funds,

Outputs

(Y_1) Loans,

(Y_2) Other earning assets,

(Y_3) Other income,

5.4.1.2 Specification of inputs

General and administrative expenses are typically dominated by labour costs (X_1). Salaries and payables to employees accounted for around 50% of total operational costs of Vietnamese banks and were the largest component of operational expenses (KPMG 2013). The use of this proxy is necessitated due to the unavailability of data on the numbers of employees across banks in the sample. A study by Drake and Hall (2003) demonstrated that the use of personnel expenses rather than employee numbers may lead to some bias against those banks which hire high-quality employees and thus pay relatively high costs for those employees. However, this potential bias could be alleviated given those banks with higher quality staff should expect to receive some benefits in output terms. Thus, providing that the high-quality labour is sufficiently productive, such banks will not be disadvantaged from a relative efficiency perspective. The use of labour costs is consistent with prior studies such as those by Nguyen, Roca and Sharma (2014) and Vu and Turnell (2010).

The second input used is physical capital (X_2) as measured by the level of fixed assets, which represents the value of fixed assets after taking out depreciation value. The third input used is loanable funds (X_3) that include retail and wholesale deposits and other borrowed funds. This is consistent with prior studies, such as those by Aly et al. (1990), Drake and Hall (2003), Halkos and Tzeremes (2013) and Sathye (2001).

5.4.1.3 Specification of outputs

As per the intermediation approach, the first output is loans *(Y_1)* that include customer loans (total loans for the corporate and private sectors and other loans). This is consistent with a study by Stewart, Matousek and Nguyen (2016).

The second output is other earning assets *(Y_2)* that include balances with the SBV and other credit institutions, investments into securities, and equity investments (long-term investments). This is consistent with earlier studies, such as those by Lozano-Vivas and Pasiouras (2010) and Nguyen, Roca and Sharma (2014).

The third output is other income *(Y_3)* as a proxy for OBS activities, for the following reasons. Three alternative measures of a bank's aggregate OBS include credit-equivalent measure, asset equivalent measure and NII measure (Clark & Siems 2002). The first measure is the total credit-equivalent amount of OBS transactions according to Basel guidelines. The second is an aggregate measure of asset equivalent that utilises the rate of return on-balance-sheet items to capitalise the NII from OBS activities. These two measures have some disadvantages. Boyd and Gertler (1994) argued that the first measure may seriously understate the level of OBS. The second measure is revenue based and involves losses. Consequently, this may potentially distort the measure of OBS. Also, Clark and Siems (2002) suggested that derivatives may be used for hedging other OBS risks; therefore, the symmetry assumption of equal profitability between on-balance-sheet items and OBS items could also reduce the accuracy of this measure.

The use of NII as a measure of OBS is based on the assumption that OBS activities are mainly undertaken by larger banks (Casu & Girardone 2005). NII is defined as the sum of income from fiduciary activities; service charges on deposit accounts; trading fees and gains or losses from foreign transactions; trading account gains or losses; fee income; and all other NII (Clark & Siems 2002). However, NII may overstate the amount of OBS, because fees and commissions are also drawn from on-balance-sheet activities, and this would be already captured in other earning assets, leading to a double counting in the model (Lozano-Vivas & Pasiouras 2010). Especially, service charges on deposit accounts cause NII to overstate the contribution to revenue of OBS activities since these charges are a part of the input pricing

decision of various sources of funds along with minimum balance requirements, and interest rates. In order to mitigate this issue, service charges on deposits should be subtracted from the calculation as service charges on deposits are a part of the input pricing decision of various sources of funds along with minimum balance requirements and interest rates.

Instead, the present study uses other income as a proxy for OBS activities. Accordingly, other income includes net fee and commission income, and other net non-interest operating income (Drake & Hall 2003). Net fee and commission income is generated from OBS activities such as charges for services, commission for providing guarantees, commitments, standby letters of credit, and fiduciary activities (MOF 2005; Nguyen & Gong 2012). It is acknowledged that other net non-interest operating income may be drawn from some on-balance-sheet activities, which in turn may distort the accuracy of this measure of OBS activities. However, the data availability as presented in banks' annual reports does not allow distinguishing net fee and commission income (generated from OBS activities) from other net operating income. In addition, the proportion of other net operating income is relatively small. Nonetheless, other income is a somewhat better measure of OBS for the study.

Three outputs used in the study are consistent with prior studies on banking efficiency, such as those by Drake and Hall (2003); Vu and Turnell (2010), Casu and Girardone (2005); Lieu, Yeh and Chiu (2005); Tortosa-Ausina (2003).

5.4.2 Source and reliability of data

Data are derived from the published financial reports of individual Vietnamese banks. The information on financial data was collected from the official websites of individual banks and the Vietstock database. According to article 14 under Decision No. 16/2007/QD-NHNN and Circular No.49/2014/TT-NHNN, all financial institutions must announce their annual

financial statements, which must be audited by independent accounting companies (SBV 2007a).

However, the annual reports of some banks in particular years could not be obtained from their official websites. Missing data were alternatively collected from the Vietstock database. According to International Data Group (IDG), the Vietstock database is owned by Tai Viet Corporation in cooperation with its strategic partner, International Data Group Ventures Vietnam (IDG 2007). The Vietstock database was launched in 2001 and has become the pioneer in providing information services on financial and securities markets in Vietnam (Vietstock 2016). It has provided comprehensive information on financial markets nationally and internationally over the last 10 years (IDG 2007). Therefore, the data provided by the Vietstock database is reliable for the study.

5.4.3 Sample selection

This section first gives an overview of sampling techniques used in social research, especially in several studies on bank mergers. Thereafter, several criteria that are imposed on the process of data collection in the study are discussed.

5.4.3.1 Sampling methods in social research

Two main types of sampling methods used in social research include probability and non-probability sampling (Babbie 2010; Daniel 2012).

- Probability sampling

Probability sampling is the primary method of choosing large and representative samples for social research, because this technique is based on probability theory (Babbie 2010). In probability sampling, a random sample from the population is selected. Consequently, probability sampling can be representative of the whole population.

The probability sampling method has two important advantages. First, a probability sample is more representative than a non-probability sample. In fact, a probability sample is more likely to be representative of the population from which it is selected. Second, probability theory makes it possible to estimate the representativeness or accuracy of the sample (Babbie 2010).

- Non-probability sampling

Non-probability sampling would be more appropriate for the purpose of research that aims to obtain a general idea about the nature of the problem of the topic to be investigated, and to generate hypotheses (Daniel 2012). The four techniques of non-probability sampling in social research include reliance on available subjects, quota sampling, snowball sampling, and purposive and judgement sampling. Consequently, non-probability sampling is adopted by the study for following reasons. The choice of a non-probability sample is relevant to the purpose of the study and to investigate the hypotheses. The main motivation of the study is to investigate whether bank mergers that involve a SOCB are more efficient than those that do not involve a SOCB, thus providing further recommendations on the Vietnamese Government's program to restructure the credit institutions system over the period 2011 to 2015.

- Sample selection in previous studies

Prior studies have resulted in mixed findings, due to the data used and the time period under investigation (DeYoung, Evanoff & Molyneux 2009). Chamberlain (1998) demonstrated that the sample selection has an important role in a merger study because it can influence the findings of the study. Indeed, in simulation studies in the literature, the samples are not randomly selected.

A study by Shaffer (1993) examined the cost efficiency of bank mergers by simulating mergers between pairs of US commercial banks with assets exceeding US$1 billion, because the mergers of these banks were expected to lead to cost savings. In addition, a study by Hadad et al. (2013) used two important criteria in selecting its sample of Indonesian banks. First, for a bank to be included in the sample estimation period, the bank had to be operating in each year. Second, any bank that merged with another was excluded to avoid double merger counting. In another study, by Halkos, Matousek and Tzeremes (2014) using Japanese data, the sample selection was taken from the population of regional banks, as the purpose of their study was to provide evidence of VBMs on the technical efficiency of regional banks – thus, a selective policy on the consolidation of regional banks was able to be proposed to the government.

Consequently, the objective of this study is the most important factor in deciding on the sample selection to be analysed.

5.4.3.2 Sample selection in the study

The main motivation of the study is that the central bank promotes mergers of domestic commercial banks because they have played a key role in the Vietnamese banking system. Consequently, this study focuses on domestic commercial banks. At the end of 2011, the Vietnamese banking industry include five SOCBs and 34 POCBs (SBV 2012).

Because this study investigates whether VBMs generate technical efficiency gains, two criteria on data collection are imposed. First, a bank that is selected in the sample has to have been operating in each individual year. The study examines the Vietnamese banking system over five-year period (2007 to 2011), and the GFC (2007–08) is taken into account. Consequently, three POCBs were excluded from the sample because they were established in 2008. Second, the availability of the data dictated the selection of the years and the inclusion

of the banks in the sample. Due to the missing data on the labour costs of banks[1] between 2007 and 2011, one SOCB and 14 POCBs are excluded from the sample. Consequently, a balanced panel data of 21 commercial banks was obtained, as indicated in Table 5.4 below. This includes four SOCBs, or the 'big four' banks, and 17 POCBs. The big four banks together controlled approximately 50% of the total assets of the Vietnamese banking system (KPMG 2013). Thus, the sample used in the study is sufficient to represent the Vietnamese banking system.

[1] The study also considers number of employees. However, there was substantial missing data on the numbers of employees of most banks over the examined period.

Table 5.4 A sample selection of 21 banks for this study

Full name of bank	Abbreviation
State-owned commercial banks	SOCBs
Vietnam Bank for Agriculture and Rural Development	AGB
Joint Stock Commercial Bank for Investment and Development of Vietnam	BIDV
Joint Stock Commercial Bank for Foreign Trade of Vietnam	VCB
Vietnam Joint Stock Commercial Bank of Industry and Trade	CTG
Joint stock commercial banks	JSCBs
An Binh Commercial Joint Stock Bank	ABB
Asia Commercial Joint Stock Bank	ACB
Dong A Joint Stock Commercial Bank	EAB
Vietnam Export Import Commercial Joint Stock Bank	EIB
Maritime Commercial Joint Stock Bank	MSB
Military Commercial Joint Stock Bank	MB
National Citizen Commercial Joint Stock Bank	NVB
Ocean Commercial Joint Stock Bank	OceanBank
Saigon Thuong Tin Commercial Joint Stock Bank	STB
Southern Commercial Joint Stock Bank	PNB
Vietnam Technological and Commercial Joint Stock Bank	TechcomBank
Viet Capital Commercial Joint Stock Bank	VietCapitalBank
Vietnam Commercial Joint Stock Bank for Private Enterprises	VPBank
Saigon-Hanoi Commercial Joint Stock Bank	SHB
Hanoi Building Commercial Joint Stock Bank	HBB
HoChiMinh Development Joint Stock Commercial Bank	HDB
Western Commercial Joint Stock Bank	WesternBank

Source: Vietstock (2016)

It is acknowledged that banks could present their financial information following either a consolidated or an unconsolidated report. The data from consolidated financial statements

include the combined information from banks and their subsidiaries, such as their financial companies. The data from consolidated financial statements are used in this study for the following reasons. First, data from unconsolidated financial statements were unavailable in most cases in the sample. According to article 14 of Decision No.16/2007/QD-NHNN released by SBV (2007a), the contents of financial reports must include at least audited annual financial reports (balance sheet statement, income statement and cashflow statement), an independent auditors report and consolidated financial reports. Accordingly, banks are not required to publish the unconsolidated financial reports, except for a few listed banks in only particular years over the examined period. Consequently, the consolidated financial reports are analysed for this study in order to maintain consistency in data between 2007 and 2011.

5.4.4 Data of employed inputs and outputs

Table 5.5 provides descriptive statistics of the employed inputs and outputs in DEA. These inputs and outputs are measured in millions of VND.

Table 5.5 Descriptive statistics of inputs and outputs used in DEA

	2011	2010	2009	2008	2007
Labour costs (VND millions)					
Mean	1569373.1	1088172.3	764427.1	725541.29	434564.57
SD	2395065.7	1699397.9	1195222.2	1361354.1	856251.22
Min.	89744	55705	36448	20162	7978
Max.	10292535	6753006	4907936	5754280	3676307
Physical capitals (VND millions)					
Mean	1626735.9	1300580.7	1033109.3	832718.57	527721.57
SD	1482047.1	1384083.6	1163511.2	933926.28	655193.81
Min.	139943	106571	107637	45900	14246
Max.	5598126	5305492	4447805	3938566	2546211
Loanable funds (VND millions)					

Mean	124773193	107812669	80119224	60164879	50626666
SD	132492344	119470730	103198882	87514110	71329219
Min.	8853410	5353988	1742320	1478991	841780
Max.	491133444	455943905	421230246	352496014	273803616
Loans (VND millions)					
Mean	89178812	77950304	59756654	43171862	36786976
SD	116972185	105558841	88210801	70664649	60195911
Min.	4333380	3626199	1785004	1292829	627455
Max.	440895421	420419729	361739747	288940827	247092135
Other earning assets (VND millions)					
Mean	56664965	46941677	33154077	26880902	22655079
SD	47034010	39108030	32283560	31787989	26669876
Min.	6584439	4010903	495988	1030998	545425
Max.	148514381	124667077	108909721	105766992	95465928
Other income (VND millions)					
Mean	722732.38	904157	665992.33	444639.95	522542.86
SD	821287.64	1218871.6	1190168.1	592053.54	990639.57
Min.	13851	2206	13175	3188	5560
Max.	2763808	4965988	5480975	2189570	3789832

Source: Estimates based on author's calculation

Given the sample of 21 banks, a 3x3 set has been used in this study which is consistent with DEA literature. Avkiran (1999) suggested that the product of inputs and outputs should be less than the sample size for the analysis in order to discriminate between the units. More strictly, Nunamaker (1988) argued that the sample size should be at least three times larger than the sum of the number of inputs and outputs.

5.4.5 Data of variables used in the regression model

As discussed above, Table 5.6 presents the descriptive information on the independent variables that will be used in regression model (equation 22).

Table 5.6 Variables used in regression model (equation 22)

Variables	Descriptions	Mean	SD	Min.	Max.
SIZE	The natural logarithm of total assets	17.7676	1.3090	14.0742	20.1368
OWNER	A dummy variable that takes the value of 1 for a SOCB, and 0 otherwise	0.1905	0.3946	0	1
MARKET POWER	The natural logarithm of total deposits	17.1118	1.4911	12.9412	19.8235
DIVERSIFICATION	The ratio of non-interest income to total assets	0.8714	0.5982	0.0333	3.4274
CAPITAL	The ratio of total equity to total assets	10.6667	7.0212	2.4480	41.3903
MANAGEMENT	The ratio of non-interest expenses to total assets	1.5399	0.5537	0.3602	3.2768
RISK	The ratio of loan loss provisions to total loans	1.2611	0.9792	0.1397	5.1355

Source: Estimates based on author's calculation.

It is important to note that total deposits of banks should include total deposits from customers (individual households and economic entities) and total deposits from credit institutions. However, data availability in most banks does not allow for distinguishing between deposits and borrowings from other credit institutions since the proportion of deposits from other credit institutions is relatively marginal. Therefore, a measure of total deposits used in the present study considers only funds collected from individual households and businesses in the economy.

5.5 Summary

Chapter 5 first defined the key terms. Then, DEA was justified as an appropriate approach to estimating the efficiency scores of banks. Due to the limitations of conventional DEA, the bootstrap DEA as introduced by Simar and Wilson (1998, 2000) was used to produce confidence limits on the efficiencies of banks to capture the true efficiency frontier within the specified interval. Thereafter, the two-step procedure of DEA was proposed to generate VBMs. Furthermore, the Mann-Whitney rank-sum and the Wilcoxon signed-rank tests were used to test the hypotheses concerning whether there is a difference in the technical efficiency of banks within two groups. In addition, a two-stage framework was proposed to examine the various impacts on the technical efficiency of banks. In the first stage, the bootstrap DEA will be used to calculate BCVRS efficiency scores of banks. In the second stage, these BCVRS

efficiency scores will be regressed with control variables in an OLS regression. It is important to notice that the modified OLS regression will be run to address the corresponding research question.

Last, the method for data collection was introduced. The specification of inputs and outputs used in DEA was discussed. As per the intermediation approach, the inputs included labour costs, capital and loanable funds, while the outputs involved loans, other earning assets and other income (a proxy for OBS activities). Thereafter, balanced panel data for 21 Vietnamese commercial banks were obtained, and financial information was collected from annual reports of individual banks and the Vietstock database. Finally, data of inputs and outputs used in DEA and data of variables used in the regression model were presented.

Chapter 6 Data analysis and results

6.1 Introduction

Chapter 5 introduced the data collection, methods used in the present study, and this chapter presents the data analysis and findings. Chapter 6 begins with the investigation of the impact of off-balance-sheet (OBS) activities on the technical efficiency of Vietnamese commercial banks. To understand the impact of OBS activities on bank mergers (given the limited number of banks in Vietnam), a series of virtual bank mergers (VBMs) have been made. Data envelopment analysis (DEA) has been used to compute technical efficiency scores to address RQ1 (What is the impact of the inclusion of off-balance-sheet activities on the technical efficiency of Vietnamese commercial banks?). Thereafter, the study examines the impact of GFC on the technical efficiency of VBMs in order to address SQ1 (What is the impact of GFC on the technical efficiency of banks created via VBMs?). Next, the impact of ownership on the technical efficiency of banks created via VBMs is examined to address SQ2 (What is the impact of ownership on the technical efficiency of banks created via VBMs?). In addition, the impact of interaction between ownership and GFC on the technical efficiency of VBMs is examined to address SQ3 (What is the impact of interaction between ownership and GFC on the technical efficiency of banks created via VBMs?). Further, the determinants of the technical efficiency of Vietnamese commercial banks are investigated to answer SQ4 (What are determinants of technical efficiency of Vietnamese commercial banks?). Last, the study assesses the technical efficiency of non-merging banks to answer RQ3 (What is the technical efficiency of non-merging banks after VBMs have taken place?).

6.2 Investigation of the impact of off-balance-sheet activities on the technical efficiency of Vietnamese commercial banks (RQ1)

The literature on banking efficiency suggests that the exclusion of OBS activities leads to underestimation of the technical efficiency of banks (Berger & Mester 1997; Casu &

Girardone 2005; Lieu, Yeh & Chiu 2005). Most studies examined the impact of OBS on cost and profit efficiency (Clark & Siems 2002; Rime & Stiroh 2003; Rogers 1998). Two recent simulation studies, by Halkos and Tzeremes (2013) using Greek data and by Halkos, Matousek and Tzeremes (2014) using Japanese data, did not include OBS activities in their estimations. Accordingly, the present study is the first attempt to assess what impact the inclusion of OBS activities has on the technical efficiency of Vietnamese commercial banks.

The research questions and hypotheses (as stated in Chapter 4) are presented here again, for ready reference.

> RQ1: What is the impact of the inclusion of off-balance-sheet activities on the technical efficiency of Vietnamese commercial banks?

The hypotheses relating to the above question are:

> $H1_0$: There is no difference in the technical efficiency of banks when OBS activities are included in the output specification.
>
> $H1_1$: The technical efficiency of banks is higher when OBS activities are included than without the inclusion of OBS activities.

In order to test the above hypotheses, the study estimates the technical efficiency scores of the existing Vietnamese commercial banks (there were 21) between 2007 and 2011 using DEA. Two models, A and B, are run. In Model A, the OBS activities as proxied by 'other income' are included. In Model B, OBS activities are excluded. The inputs and outputs used in the two models are indicated in Table 6.1.

Table 6.1 Inputs and outputs used in Models A and B

	Model A	Model B
Inputs	Labour costs	Labour costs

	Capital	Capital
	Loanable funds	Loanable funds
Outputs	Loans	Loans
	Other earning assets	Other earning assets
	Other income (proxy for OBS)	

Note: This follows the intermediation approach as used in most prior studies in the literature (Drake & Hall 2003; Montgomery, Harimaya & Takahashi 2014; Sathye 2001; Sealey & Lindley 1977; Sufian et al. 2012).

Technical efficiency reflects the ability of a bank to produce its existing level of outputs with minimum inputs. It is calculated using DEA, which involves comparing the relative efficiency scores of various decision-making units (DMUs; that is, banks) in the particular sample. By doing so, each of the banks is compared with the best-practice bank in the sample. The input-oriented model under the variable returns to scale (VRS) assumption is used in the study. Simar and Wilson (2007), however, found that DEA scores could give invalid results due to complicated and unknown serial correlations among estimated efficiencies, and recommended bootstrapping of these raw scores. Accordingly, we compute the bias-corrected VRS scores (BCVRS) as per the procedure suggested by these authors. The BCVRS of banks are obtained using the bootstrap procedure introduced by Simar and Wilson (1998, 2000, 2007) after running the input-oriented VRS in DEA for the sample of 21 banks.

Table 6.2 and Table 6.3 provide descriptive statistics of BCVRS of banks between 2007 and 2011 in two models, with and without OBS, respectively (the estimated bias [BIAS], the standard deviation [STD] of the bias and the 95% confidence intervals of the BCVRS [LB= lower bound, UB=upper bound] are indicated in appendices 1 to 10).

Table 6.2 BCVRS scores of 21 banks in Model A (with OBS)

	2007	2008	2009	2010	2011	2007-2011
Mean	0.9684	0.9423	0.9615	0.9526	0.9391	**0.9528**
Median	0.9790	0.9606	0.9722	0.9678	0.9589	0.9673
SD	0.0465	0.0630	0.0353	0.0386	0.0492	0.0276
Min.	0.7701	0.6897	0.8517	0.8414	0.7971	0.8722
Max.	0.9906	0.9796	0.9855	0.9769	0.9729	0.9742

Source: Estimates based on the author's calculation.

Table 6.3 BCVRS scores of 21 banks in Model B (without OBS)

Banks	2007	2008	2009	2010	2011	2007-2011
Mean	0.9572	0.9148	0.9520	0.9533	0.9372	**0.9429**
Median	0.9704	0.9411	0.9667	0.9678	0.9559	0.9601
SD	0.0480	0.0678	0.0393	0.0387	0.0500	0.0298
Min.	0.7659	0.6814	0.8507	0.8416	0.7938	0.8678
Max.	0.9854	0.9590	0.9837	0.9772	0.9702	0.9692

Source: Estimates based on the author's calculation.

As can be seen from the above tables, in each year the mean efficiency level of banks in Model A is higher than that in Model B, except in 2010. This suggests that the inclusion of OBS activities results in higher average technical efficiency of banks in the sample.

In order to test the statistical significance of such differences, a non-parametric test was used. The Mann-Whitney test is used to verify the null hypothesis that there is no difference in median technical efficiency of banks when OBS activities are included and when these are excluded. As the *p*-value obtained from these tests is 0.0228 and the Z-value is 2.2642, null hypothesis 1 can be rejected. The Wilcoxon test also found similar results.

Table 6.4 Mann-Whitney test (median values)

	2007	2008	2009	2010	2011	2007–2011
With	0.9790	0.9606	0.9722	0.9678	0.9589	0.9673
Without	0.9704	0.9411	0.9667	0.9678	0.9559	0.9601
H_0	Rejected	Rejected	Rejected	*	Rejected	Rejected
Z-value	2.8559	3.7356	2.7804	-0.9314	2.1388	2.2642
P-value	0.0036	0.0000	0.0047	0.3587	0.0319	0.0228

Note: * not rejected

Table 6.5 Wilcoxon signed-rank test (median values)

	2007	2008	2009	2010	2011	2007–2011
With	0.9790	0.9606	0.9722	0.9678	0.9589	0.9673
Without	0.9704	0.9411	0.9667	0.9678	0.9559	0.9601
H_0	Rejected	Rejected	Rejected	Rejected	Rejected	Rejected
P-value	0.0000	0.0000	0.0009	0.0284	0.0101	0.0000

We conclude that the inclusion of OBS in the model results in higher technical efficiency. This reinforces the early literature that the exclusion of OBS items from output specification results in the underestimation of efficiency levels of banks. Studies by Rogers (1998) and Clark and Siems (2002) found that US banks demonstrated higher estimated cost efficiency when OBS activities (non-interest income [NII] output as a proxy) were included in the model. In the same vein, Berger and Mester (1997) suggested that the estimated cost efficiency would be biased when OBS outputs were excluded from the model. As banks often use technical efficiency scores to make strategic decision about the allocation of resources, Berger and Mester (1997) emphasised their correct calculation. Consequently, the inclusion of OBS in the model is desirable. Bank management strategies will be biased by an improperly estimated efficiency level (Lieu, Yeh & Chiu 2005).

6.3. Investigation of the determinants of bank's technical efficiency (RQ2)

6.3.1 Investigation of the impact of global financial crisis on the technical efficiency of banks created via virtual bank mergers (SQ1)

In order to answer this research question, the first step is the generation of VBMs. The process used to generate VBMs, as well as to calculate DEA technical efficiency, was described in Chapter 5. Table 6.6 provides the results of DEA VRS efficiency. The BCVRS scores are not used as they do not produce the benchmark for classification of efficient banks. As per DEA VRS efficiency, a bank which obtains a score of 1 is considered efficient.

As can be seen from the Table 6.6, 17 banks out of the 21 in the sample were found to be efficient as per Model A. As per Model B, the number of efficient banks was 15. Using Model B (without OBS), two banks (NCB and SHB) were excluded from the possibility of undergoing virtual mergers with other efficient banks, thereby reducing the number of

possible combinations for mergers. Consequently, the 17 banks as per Model A would be used to generate VBMs.

Table 6.6 DEA VRS scores of 21 banks, 2007

	Model A (with OBS)	Model B (without OBS)
AGB	1.0000	1.0000
BIDV	1.0000	1.0000
VCB	1.0000	1.0000
CTG	1.0000	1.0000
ABB	1.0000	1.0000
ACB	1.0000	1.0000
EAB	1.0000	1.0000
EIB	1.0000	1.0000
MSB	1.0000	1.0000
MB	1.0000	1.0000
NCB	1.0000	0.9062
VietCapitalBank	1.0000	1.0000
OceanBank	1.0000	1.0000
SacomBank	0.9694	0.9694
PNB	0.7760	0.7760
TechcomBank	0.9523	0.9523
VPBank	0.9986	0.9986
HBB	1.0000	1.0000
HDB	1.0000	1.0000
SHB	1.0000	0.9634
WesternBank	1.0000	1.0000

Notes: DEA score of 1 indicates a technically efficient bank under VRS assumption.

The 17 efficient banks as per Model A include four state-owned commercial banks (SOCBs) and 13 privately owned commercial banks (POCBs), respectively, as listed below:

- SOCBs
    - Vietnam Bank for Agriculture and Rural Development (AGB)
    - Joint Stock Commercial Bank for Investment and Development of Vietnam (BIDV)
    - Joint Stock Commercial Bank for Foreign Trade of Vietnam (VCB)
    - Vietnam Joint Stock Commercial Bank for Industry and Trade (CTG)
- POCBs
    - An Binh Commercial Joint Stock Bank (ABB)

- Asia Commercial Joint Stock Bank (ACB)
- Dong A Joint Stock Commercial Bank (EAB)
- Vietnam Export Import Commercial Joint Stock Bank (EIB)
- The Maritime Commercial Joint Stock Bank (MSB)
- Military Commercial Joint Stock Bank (MB)
- National Citizen Commercial Joint Stock Bank (NCB)
- Viet Capital Commercial Joint Stock Bank (VietCapitalBank)
- Ocean Commercial Joint Stock Bank (OceanBank)
- Hanoi Building Commercial Joint Stock Bank (HBB)
- HoChiMinh Development Joint Stock Commercial Bank (HDB)
- Saigon-Hanoi Commercial Joint Stock Bank (SHB)
- Western Commercial Joint Stock Bank (WesternBank).

According to theorem 14.1 proposed by Cooper, Seiford and Tone (2007, p.386) and the suggestion of Halkos and Tzeremes (2013), VBMs were generated by combining the inputs and outputs of efficient banks. Accordingly, 136 VBMs of 17 efficient banks were generated from those listed above. Next, the efficiency of the Vietnamese banking system over the period 2007 to 2011 was computed for the 136 VBMs. The BCVRS of VBMs were obtained using the bootstrap procedure introduced by Simar and Wilson (1998, 2000) after running the input-oriented VRS in DEA for the sample of 136 VBMs, as presented in appendices 11 to 15.

After the VBMs were generated, the following regression model was run in order to test the hypothesis that followed. Following from prior studies, ownership and size have been used as control variables.

$$EFFICIENCY_i = \beta_0 + \beta_1 GFC + \beta_2 OWNERSHIP_i + \beta_3 SIZE_i + \varepsilon$$

$H2_o$: The post-GFC technical efficiency of banks created via VBMs is not different from their pre-GFC technical efficiency.

$H2_1$: The post-GFC technical efficiency of banks created via VBMs is lower than their pre-GFC technical efficiency.

The dependent variable EFFICIENCY is the BCVRS scores of banks created via VBMs. In terms of independent variables, GFC is a dummy variable which takes the value of 1 for post-GFC, and 0 otherwise. OWNERSHIP is a dummy variable which takes the value of 1 if one of the merging banks is a SOCB, and 0 otherwise. SIZE is measured by natural logarithm of total assets.

The results are shown in Table 6.7.

Table 6.7 The impact of GFC on the technical efficiency of banks created via VBMs

	EFFICIENCY
GFC	-0.0256***
	(0.0029)
OWNERSHIP	0.0174***
	(0.0042)
SIZE	-0.0034
	(0.0021)
Constant	1.0427***
	(0.0370)
F-statistic	55.55
Adjusted R-square	0.1942
Number of observations	680

Notes: EFFICIENCY is bias-corrected efficiency scores of 136 virtually merged banks; GFC is a dummy variable which takes the value of 1 for post-GFC, and 0 otherwise; OWNERSHIP is a dummy variable which takes the value of 1 if one of the merging banks is a SOCB, and 0 otherwise; SIZE is measured by natural logarithm of total assets; standard errors in parentheses.

*** 1% of significance.

As can be seen in Table 6.7, the GFC coefficient is statistically significant and negative at the 1% level, thus null hypothesis 2 can be rejected. Accordingly, the post-GFC efficiency of banks created via VBMs is generally significantly lower than their pre-GFC efficiency. This suggests that VBMs in Vietnam do not result in improved technical efficiency in banks. These

findings are in line with the finding of Halkos and Tzeremes (2013) that the majority of VBMs in the Greek banking system in the post-Greek fiscal crisis were unable to generate technical efficiency gains.

6.3.2 Investigation of the impact of ownership on the technical efficiency of banks created via virtual bank mergers (SQ2)

The following hypotheses relate to SQ2:

> $H3_0$: The technical efficiency of banks created via VBMs that include a SOCB is not different from that of banks created via VBMs that do not include a SOCB.
>
> $H3_1$: The technical efficiency of banks created via VBMs that include a SOCB is higher than that of VBMs that do not include a SOCB.

As can be seen from Table 6.7, the coefficient of OWNERSHIP is statistically significant and positive at the 1% level, thus null hypothesis 3 can be rejected. Therefore, banks created via VBMs that include a SOCB are more efficient than banks created via VBMs that do not include a SOCB. This supports the earlier finding of Hadad et al. (2013) – using the Indonesian data between 2004 and 2009 – that the cost reduction resulting from a hypothetical merger is mainly found when the merged entity includes a SOCB. The positive effect of state-ownership on the technical efficiency of banks created via VBMs could be explained by the fact that Vietnamese SOCBs have an advantage in terms of the support they receive from the government (there is an implicit subsidy in the government funding). Accordingly, a merged entity which includes a SOCB acquires a cost advantage.

6.3.3 Investigation of the impact of interaction between ownership and global financial crisis on the technical efficiency of banks created via virtual bank mergers (SQ3)

In order to assess whether the post-GFC technical efficiency of banks created via VBMs that include a SOCB is positively significant, we included an interaction term in the above equation (as indicated in section 5.3.7.3) and reran the modified equation, shown below, to test the following hypotheses:

$$EFFICIENCY_i = \beta_0 + \beta_1 GFC + \beta_2 OWNERSHIP_i + \beta_3 SIZE_i + \beta_4 OWNERSHIP_i * GFC + \varepsilon$$

$H4_0$: The post-GFC technical efficiency of banks created via VBMs that include a SOCB is not different from that of banks created via VBMs that do not include SOCB and the pre-GFC technical efficiency of banks created via VBMs that include SOCBs and POCBs.

$H4_1$: The post-GFC technical efficiency of banks created via VBMs that include a SOCB is higher than that of banks created via VBMs that do not include a SOCB and the pre-GFC technical efficiency of banks created via VBMs that include SOCBs and POCBs.

The results of OLS regression are presented in Table 6.8.

Table 6.8 the impact of interaction between ownership and GFC on the technical efficiency of banks created via VBMs

	EFFICIENCY
GFC	-0.0322***
	(0.0038)
OWNERSHIP	0.0075

	(0.0055)
SIZE	-0.0023
	(0.0021)
OWNERSHIP*GFC	0.0133***
	(0.0049)
Constant	1.0260***
	(0.0373)
F-statistic	43.9
Adjusted R-square	0.2017
Number of observations	680

Notes: EFFICIENCY is bias-corrected efficiency scores of 136 virtually merged banks; GFC is a dummy variable which takes the value of 1 for post-GFC, and 0 otherwise; OWNERSHIP is a dummy variable which takes value of 1 if one of the merging banks is a SOCB, and 0 otherwise; SIZE is measured by natural logarithm of total assets; OWNERSHIP*GFC is a interaction term between ownership and GFC; standard errors in parentheses

*** 1% of significance.

The data in Table 6.8 indicate that the coefficient of OWNERSHIP*GFC is statistically significant and positive at the 1% level. As such, null hypothesis 4 can be rejected. We conclude that the post-GFC technical efficiency of banks created via VBMs that include a SOCB is significantly higher than that of banks created via VBMs that do not include a SOCB and the pre-GFC technical efficiency of banks created via VBMs that include both SOCBs and POCBs. This suggests that mergers that include a SOCB should be encouraged.

6.3.4 Investigation of the determinants of technical efficiency of Vietnamese commercial banks (SQ4)

In order to examine the determinants of technical efficiency of Vietnamese commercial banks, the regression model shown below was run to test the hypotheses that follow. The variables used in the model are derived from the prior studies, as explained in Chapter 4.

$$EFFICIENCY_i = \beta_0 + \beta_1 SIZE_i + \beta_2 OWNER_i + \beta_3 MARKET\ POWER_i + \beta_4 DIVERSIFICATION_i + \beta_5 CAPITAL_i + \beta_6 MANAGEMENT_i + \beta_7 RISK_i + \varepsilon$$

$H5_0$: Income diversification has no impact on the technical efficiency of Vietnamese commercial banks.

$H5_1$: Income diversification has a positive impact on the technical efficiency of Vietnamese commercial banks.

$H6_0$: Bank capital has no impact on the technical efficiency of Vietnamese commercial banks.

$H6_0$: Bank capital has a positive impact on the technical efficiency of Vietnamese commercial banks.

$H7_0$: The technical efficiency of banks with better management quality is not different from that of banks with poor management quality.

$H7_1$: The technical efficiency of banks with better management quality is higher than that of banks with poor management quality.

The dependent variable EFFICIENCY is the BCVRS scores of 21 banks (the existing commercial banks), as indicated in appendices 1 to 5. The independent variable SIZE is measured by the natural logarithm of total assets. OWNER is a dummy variable which takes the value of 1 for SOCBs, and 0 otherwise. MARKET POWER is measured by natural logarithm of total deposits. DIVERSIFICATION is measured by the ratio of NII to total assets. CAPITAL is measured by the ratio of total equity to total assets. MANAGEMENT (the quality of management) is measured by the ratio of non-interest expenses to total assets. RISK is measured by the ratio of loan loss provisions to total loans.

The results of OLS regression are presented in Table 6.9.

Table 6.9 Determinants of technical efficiency of Vietnamese commercial banks

	EFFICIENCY
SIZE	0.0219
	(0.0210)
OWNER	0.0313*
	(0.0184)
MARKET POWER	-0.0097
	(0.0190)
DIVERSIFICATION	0.0172**
	(0.0078)
CAPITAL	0.0019*
	(0.0010)
MANAGEMENT	-0.0248**
	(0.0101)
RISK	-0.0062
	(0.0069)
Constant	0.7346***
	(0.1256)
F-statistic	2.24
Adjusted-R^2	0.0770
Number of observations	105

Notes: EFFICIENCY is the BCVRS scores of 21 banks; SIZE is measured by the natural logarithm of total assets; OWNER is a dummy variable which takes the value of 1 for SOCBs, and 0 otherwise; MARKET POWER is measured by natural logarithm of total deposits; DIVERSIFICATION is measured by the ratio of non-interest income to total assets; CAPITAL is measured by the ratio of total equity to total assets; MANAGEMENT is measured by the ratio of non-interest expenses to total assets; RISK is measured by the ratio of loan loss provisions to total loans; standard errors in parentheses.

* 1% of significance.

** 5% of significance.

*** 10% of significance.

The results shown in Table 6.9 indicate that the coefficient of the variable SIZE is positive but not statistically significant. These findings support the earlier finding of Arora (2014) in the context of the Indian banking system.

The coefficient of the variable OWNER is statistically significant and positive at the 10% level. This suggests that Vietnamese SOCBs are more efficient than Vietnamese POCBs. These findings are in line with the earlier findings of Nguyen, Roca and Sharma (2014) in the

Vietnamese banking system; Gardener, Molyneux and Nguyen-Linh (2011) in the South-East Asian banking; See and He (2015) in the Chinese banking system; and Isik and Hassan (2003) in the Turkish banking system.

The higher efficiency of SOCBs as compared with POCBs can be explained as follows. First, SOCBs have benefited from government subsidies and the banking reforms mainly focused on SOCBs, as discussed in the previous chapter, resulting in better governance and better cost management. Second, since SOCBs have a much larger deposit base and loans volume, they have the advantage of economies of scale, which reduce the per unit cost (Nguyen, Roca & Sharma 2014). Third, SOCBs are protected by implicit government guarantees. Due to their government ownership, SOCBs are considered as safe banks in the Vietnamese banking system. As a result, depositors are willing to accept lower deposit interest rates, thus reducing input costs for SOCBs (Nguyen, Roca & Sharma 2014).

The coefficient of the variable MARKET POWER[2] is negative but not statistically significant. Sathye (2001) suggested that, where banks enjoy market power, inefficiency follows not because of non-competitive pricing but more because of a relaxed environment with no incentives to minimise cost. His finding supports the quiet life hypothesis.

The coefficient of the variable DIVERSIFICATION is statistically significant and positive at the 5% level. Thus, null hypothesis 5 can be rejected. This suggests that more-diversified banks are more efficient than less-diversified banks. These findings are in line with the earlier findings of Sufian (2009) in the Malaysian banking system, Jeon and Miller (2005) in the Korean banking system, Alhassan (2015) in the Ghanaian banking system and Sarkar (2016) in the Indian banking system. The positive impact of bank diversification on the technical

[2] The study also uses as measures of market power: the ratio of deposits of each bank to total deposits in the industry, the ratio of loans of each bank to total loans in the industry, and the ratio of assets of each bank to total assets in the industry. The results show the coefficient of MARKET POWER is statistically not significant.

efficiency of Vietnamese commercial banks could be explained as follows. First, diversified banks can leverage managerial skills and abilities across products and services (Iskandar-Datta & McLaughlin 2005). Second, they can gain economies of scope by spreading fixed costs over multiple products (Drucker & Puri 2009). Third, they can provide more services to customers who demand multiple products and are willing to pay for extra convenience, thus increasing their income (Berger, Hasan & Zhou 2010). Last, they may reduce the expected costs of financial distress or bankruptcy by lowering risks by spreading their operations across different products or economic environments (Boot & Schmeits 2000).

The coefficient of the variable CAPITAL is statistically significant and positive at the 10% level. Thus, null hypothesis 6 can be rejected. This suggests that banks with a higher level of capital are more efficient than those holding a lower level of capital. These findings are in line with the earlier findings of Alhassan (2015) in the Ghanaian banking system; Perera, Skully and Wickramanayake (2007) in the South Asian banking system; and Gardener, Molyneux and Nguyen-Linh (2011) in the South-East Asian banking system. They demonstrated that banks that hold more capital are perceived by depositors and investors to be less risky, which in turn allows them to access cheaper funding. In addition, because bank capital reflects the degree to which shareholders have their own capital at risk in the bank, they have incentive to monitor its management to ensure the bank operates efficiently (Casu & Girardone 2004).

The coefficient of the variable MANAGEMENT (as measured by NIE/TA) is statistically significant and negative at the 5% level. Thus, null hypothesis 7 can be rejected. This suggests that banks with better quality of management are more efficient than those with poor quality of management. These findings are in line with the earlier findings of Vu and Turnell (2011) in the Australian banking system, Garza-García (2012) in the Mexican banking system, Das and Ghosh (2006) in the Indian banking system, and Sufian (2009) in the Malaysian banking system. The low score of technical efficiency of banks is a signal of poor senior management

practices which apply to input-usage and day-to-day operations, where managers are unable to efficiently control and monitor administrative expenses. In addition, managers of these banks may practice inadequate loan monitoring and bad debt control, which can result in lower interest income (Sathye & Sathye 2016).

The coefficient of the variable RISK is negative but not statistically significant. These findings support the earlier findings of Stewart, Matousek and Nguyen (2016) in the context of the Vietnamese banking system.

6.4 Investigation of the technical efficiency of non-merging banks after virtual bank mergers have taken place (RQ3)

A study by DeYoung, Evanoff and Molyneux (2009) suggested that performance gains may extend well beyond the merging banks – that is, the efficiency of non-merging banks may undergo change as other banks merge. Evanoff and Ors (2008), using US bank data, investigated the impact of increased potential competition resulting from bank mergers on the performance of non-merging banks, and suggested that the non-merging banks respond by enhancing their cost efficiency. Accordingly, the following hypothesis is formulated.

> $H8_0$: The post-merger technical efficiency of non-merging banks is not different from their pre-merger technical efficiency.
>
> $H8_1$: The post-merger technical efficiency of non-merging banks is higher than their pre-merger technical efficiency.

In order to test the above hypothesis, the study first estimated the pre-merger and post-merger BCVRS of non-merging banks over the five-year period. The pre-merger BCVRS scores of 21 non-merging banks (that is, the existing commercial banks) are shown in appendices 1 to 5. However, of these, 17 banks underwent VBMs, leaving only four non-merging banks in the existing list.

To compare the technical efficiency of these four non-merging banks in the post-merger scenario, the following procedure was used. First, the efficiency scores of 136 VBMs were calculated. Thereafter, VBMs with scores of less than 1 were excluded from the list. In the remaining list of VBMs, the original four non-merging banks were added. Thereafter, efficiency was calculated for banks in the list. The resultant scores of the non-merging banks in the group were compared with the non-merging banks in the original group. The BCVRS scores of the four non-merging banks in the post-merger scenario are indicated in appendices 16 to 20.

Accordingly, the resultant average pre- and post-merger BCVRS scores of non-merging banks over the period 2007 to 2011 are indicated in Table 6.10.

Table 6.10 Pre-merger and post-merger average BCVRS scores of non-merging banks, 2007 to 2011

	Pre-merger	Post-merger
Mean	**0.9306**	**0.9517**
Median	0.9425	0.9641
SD	0.0417	0.0398
Min.	0.8722	0.8939
Max.	0.9650	0.9847

Source: Estimates based on author's calculations.

As can be seen in Table 6.10, the mean post-merger technical efficiency score of non-merging banks is higher than their average pre-merger technical efficiency. It appears that the presence of more efficient banks, resulting from VBMs, puts pressure on the non-merging banks to improve their operations.

In order to test the statistical significance of such difference, the Mann-Whitney test was used to verify the null hypothesis. The result in Table 6.11 show that the p-value obtained from the

Mann-Whitney test is 0.3429 and the Z-value is 1.1547. Therefore, null hypothesis 8 cannot be rejected. The Wilcoxon test also found similar result.

Table 6.11 Mann-Whitney test (median values)

	2007–2011
Post-merger	0.9641
Pre-merger	0.9425
H_0	*
Z-value	**1.1547**
***P*-value**	**0.3429**

* not rejected

Table 6.12 Wilcoxon signed-rank test (median values)

	2007–2011
Post-merger	0.9641
Pre-merger	0.9425
H_0	*
P-value	0.125

* not rejected

We conclude that the post-merger technical efficiency of non-merging banks is not significantly different from their pre-merger technical efficiency. Evanoff and Ors (2008) found that non-merging banks in the US banking system responded to increased competition from market consolidation by decreasing costs and increasing their level of cost efficiency. Similarly, this appears to be the case with Vietnamese commercial banks.

6.5 Summary

This chapter examined the efficiency effect of VBMs and investigated the determinants of technical efficiency of Vietnamese commercial banks. The efficiency scores were obtained using bootstrap DEA. The main findings are summarised as follows.

RQ1 investigated the impact of the inclusion of OBS activities on the technical efficiency of Vietnamese commercial banks. The findings show that the inclusion of OBS activities in the

model resulted in higher technical efficiency. This reinforces the view in the banking literature that omitting the OBS items results in underestimation of efficiency levels (Clark & Siems 2002; Lieu, Yeh & Chiu 2005; Rogers 1998).

SQ1 examined the impact of GFC on the technical efficiency of banks created via VBMs. The findings indicate that the post-GFC efficiency of banks created via VBMs was in general significantly lower than their pre-GFC efficiency. This suggests that VBMs in Vietnam did not result in improvements in banks' technical efficiency. These findings are in line with those of Halkos and Tzeremes (2013) that the majority of VBMs in the Greek banking system after the Greek fiscal crisis were unable to generate technical efficiency gains.

SQ2 investigated the impact of ownership on the technical efficiency of banks created via VBMs. VBMs that included a SOCB were found to be more efficient than those that did not include a SOCB. This supports the earlier finding of Hadad et al. (2013), in the Indonesian context, that cost reductions resulting from hypothetical mergers are mainly found when the merged entity includes a SOCB.

SQ3 assessed the impact of interaction between state-ownership and GFC on the technical efficiency of banks created via VBMs. The findings show that the post-GFC technical efficiency of banks created via VBMs that included a SOCB was significantly higher than that of banks created via VBMs that did not include a SOCB and the pre-GFC technical efficiency of banks created via VBMs that included both a SOCB and a POCB. This suggests that mergers that include a SOCB should be encouraged.

SQ4 examined the determinants of technical efficiency of Vietnamese commercial banks. The results show that bank size had no impact on the technical efficiency of Vietnamese commercial banks. It was also found that SOCBs were more efficient than POCBs. This suggests that differences in ownership structure significantly impacted the technical

efficiency of Vietnamese commercial banks. Further, the findings indicate that market power had no impact on the technical efficiency of Vietnamese commercial banks. Accordingly, there is no evidence to support the quiet life hypothesis. In addition, the results demonstrate that income diversification has a positive impact on the technical efficiency of Vietnamese commercial banks. This suggests that more-diversified banks were more efficient than less-diversified banks. Further, banks with more capital were more efficient than those with less capital. This supports the view that Vietnamese authorities should increase the minimum charter capital requirement in the future in order to strengthen the banking system. Additionally, the findings indicate that banks with better management quality were more efficient than those with poor management quality. Finally, risk had no impact on the technical efficiency of Vietnamese commercial banks.

RQ3 investigated the response of non-merging banks after VBMs have taken place. The findings show that the mean post-merger technical efficiency score of non-merging banks was higher than their average pre-merger technical efficiency. The presence of more efficient, newly-merged banks puts pressure on the non-merging banks to improve their operations. However, the post-merger technical efficiency of non-merging banks was not significantly different from their pre-merger technical efficiency. Evanoff and Ors (2008) found that non-merging banks in the US banking system responded to increased competition from market consolidation by decreasing their costs and increasing their levels of cost efficiency.

Chapter 7 Conclusions and implications

7.1 Introduction

Chapter 7 discusses the conclusions and implications of the study. Section 7.2 indicates the major findings. Section 7.3 presents the study's contributions to theory and original academic research, policy and practice. Section 7.4 discusses its limitations. Finally, section 7.5 proposes suggestions for future research.

This study attempted to address four major gaps in the literature as indicated in chapter 3. First, prior studies have not taken into account off-balance sheet (OBS) activities when investigating the efficiency effect of bank mergers. Thus, the study examined the impact of inclusion of OBS activities in Vietnamese bank mergers. Second, performance gains may extend well beyond the merging banks. However, the effect of bank mergers on the efficiency of non-merging banks has not received much attention in the literature. There was only one study, by Evanoff and Ors (2008) using US bank data, has examined the effect that increased competition resulting from M&As has had on the performance of non-merging banks. Therefore, the present study investigated the technical efficiency of non-merging banks after virtual bank mergers in Vietnam have taken place. Third, the literature is dominated by studies from the US and Europe, where the larger market and numbers of banks mergers have traditionally facilitated econometric modelling. The evidence of bank mergers in emerging countries, especially in the Asia-Pacific region is limited. By examining the efficiency effect of bank mergers in Vietnam, this will increase external validity in relation with bank M&As in the Asia-Pacific region. Finally, so far no study has examined the impact of mergers on bank efficiency in Vietnam. This study fills the current gaps in empirical research by providing an answer to the debate on whether bank mergers would have improved efficiency of the Vietnamese banking system. Consequently, the findings on these counts will be useful for future studies to compare their results.

7.2 Summary of main findings

The major conclusions are discussed in this section.

First, it can be concluded that the exclusion of off-balance-sheet (OBS) activities from the model understated the technical efficiency of banks and reduced the number of possible combinations of efficient banks that could generate VBMs. This reinforces the early literature that the exclusion of OBS items from output specifications will lead to banks' efficiency levels being underestimated. Berger and Mester (1997) suggested that the estimated cost efficiency would be biased when OBS outputs are excluded from the model. As banks often use technical efficiency scores to make strategic decisions about the allocation of resources, Berger and Mester (1997) emphasised their correct calculation. Consequently, it is desirable to include OBS activities in the model.

Second, the study attempted to investigate the impact of mergers on technical efficiency of banks in Vietnam. Following the two-step procedure of data envelopment analysis (DEA), a new sample of 136 virtual banks, created via VBMs, was created. The findings show that the post-GFC technical efficiency of banks created via VBMs was generally lower than their pre-GFC technical efficiency. This suggests that bank mergers in Vietnam did not result in improvements in technical efficiency when the impact of global financial crisis (2007-08) was taken into account. In addition, the study concludes that VBMs that included a SOCB were generally more efficient than those that did not include a SOCB. Furthermore, the findings demonstrate that the post-GFC technical efficiency of banks created via VBMs that include a SOCB was significantly higher than that of banks created via VBMs that did not include a SOCB and the pre-GFC technical efficiency of banks created via VBMs that included both a SOCB and a POCB. All in all, it is strongly recommended that mergers that include a SOCB be encouraged, given the impact of the GFC (2007–08).

Last, after examining the determinants of technical efficiency in Vietnamese commercial banks (of which there were 21 in 2011), the findings indicate that SOCBs were more efficient than POCBs. This reinforces the early findings that banks created via VBMs that included a SOCB were more efficient than banks created via VBMs that did not include a SOCB. In addition, our findings show that more-diversified banks were more efficient than less-diversified banks. This supports the conglomeration hypothesis, suggesting that diversification towards non-interest activities has a positive impact on bank efficiency. Furthermore, the findings confirm that banks with more capital were more efficient than those with less capital. Finally, banks with better management quality were more efficient than those with poor management quality.

7.3 Contributions of the present study

Our findings make significant contributions to existing knowledge on the efficiency effect of bank mergers. In addition, the study has important policy implications, particularly with respect to the principal aim of restructuring the banking sector. The study's outcomes could help Vietnamese authorities in determining the future course of action to strengthen the Vietnamese banking sector.

7.3.1 Contributions to theory and original academic research

First, the findings confirm that the exclusion of OBS activities from output specification underestimates efficiency levels of banks and reduces the number of possible combinations of bank mergers. If the OBS activities are neglected, banks will mistakenly allocate more of the inputs used in their traditional businesses. Accordingly, bank management strategies will be biased by improperly estimated efficiency levels. Consequently, OBS activities should be included in output specification.

Second, the literature on the efficiency effect of bank mergers is dominated by studies from the US and Europe, where larger markets and numbers of bank mergers have traditionally facilitated econometric modelling. Dymski (2002) and Elumilade (2010) argued about whether the empirical evidence from developed markets reflects the true efficiency effect of bank mergers in other markets. Because there are differences in the regulatory and economic environments faced by banks in different economies, as well as differences in the level and quality of service associated with deposits and loans across nations, mergers will have differing effects on bank efficiency depending on where they take place. Research on bank mergers in emerging countries is scant, especially in Vietnam, due to its small market and limited number of banks. This study is the first attempt to investigate the effect of mergers on the technical efficiency of Vietnamese commercial banks. Policy measures drawn from the study could also be implemented in the decision-making processes about bank consolidation through M&As in other developing countries with banking structures similar to Vietnam's.

Last, the study suggests that a bootstrap DEA approach can be widely used as a pre-merger planning tool to examine whether potential efficiency gains would be generated from possible bank mergers. In addition, a two-step procedure of bootstrap DEA is proposed to examine the response of non-merging banks after VBMs have taken place. The findings show that the mean post-merger technical efficiency score of non-merging banks was higher than their average pre-merger technical efficiency. As more efficient banks created via VBMs come into the market, this puts pressure on non-merging banks to improve their operations. This may support the view of Evanoff and Ors (2008) that bank mergers should serve as a wake-up call to non-merging banks.

7.3.2 Contributions to policy

This study is the first attempt to investigate whether bank mergers would have improved efficiency of the Vietnamese banking system. It bridges a gap in empirical research and

outlines policy measures that could be implemented in the decision-making process about bank consolidation in Vietnam.

The findings show that the post-GFC technical efficiency of banks created via VBMs was generally significantly lower than their pre-GFC technical efficiency. These findings demonstrated that bank mergers alone would not ensure technical efficiency gains. In order to improve the effectiveness of bank mergers, the Vietnamese authorities should also consider other policy measures. Since M&A activities have recently been undertaken in the banking system, policy-makers should create favourable conditions and provide guidance for banks that intend to make acquisitions in the future.

In addition, the findings indicate that the post-GFC technical efficiency of banks created via VBMs that included a SOCB was higher than that of banks created via VBMs that did not include a SOCB and the pre-GFC technical efficiency of banks created via VBMs that included both SOCBs and POCBs. Consequently, our findings strongly support the view of the central bank that mergers that include a SOCB should be encouraged in order to generate operating efficiency gains (Techcombank n.d). The focus of SOCBs is serving large businesses and state-owned enterprises (SOEs) in main cities and industrial zones, while POCBs concentrate on providing universal banking services to small businesses and individual households in particular regions. Consequently, the newly-combined banks that include a SOCB could gain advantage with their increased size, improved financial capacity and improved customer base. In addition, smaller POCBs in Vietnam are at a disadvantage in terms of their embrace technological advancement. Mergers would help these banks to embrace technological advances, which would help them to promote cost performance in the medium and long term.

The findings demonstrate that POCBs were less efficient than SOCBs. This suggests that private ownership alone may be insufficient to ensure that banks operate efficiently. Consequently, future banking reforms should focus on helping POCBs to improve their efficiency and performance, rather than concentrating on SOCBs, which is the current situation.

Last, the findings indicate that banks with more capital were more efficient than banks with less capital. This suggests that policy-makers could further increase the minimum charter capital requirement on banks in order to improve their ability to absorb losses and to enhance their efficiency. In fact, the current requirement for charter capital in Vietnam is much lower than what is suggested in Basel III.

7.3.3 Contribution to practice

The study has several important implications for practice.

In response to the GFC (2007–08), the Vietnamese Government (2012) officially released a program to restructure the credit institutions system . Specifically, the program indicated that 10 banks needed to be restructured, and proposed several possible solutions. Six of the ten target banks are included in the analysis presented in this thesis. These banks include National Citizen Commercial Joint Stock Bank; Hanoi Building Commercial Joint Stock Bank; Viet Capital Commercial Joint Stock Bank and HoChiMinh Development Joint Stock Commercial Bank; Ocean Commercial Joint Stock Bank and Western Commercial Joint Stock Bank. As discussed above, we strongly recommend that the central bank should encourage or force these banks to merge (if necessary) with a SOCB.

For bank management, the findings indicate that more-diversified banks were more efficient than less-diversified banks. It is suggested that Vietnamese banks should diversify towards non-interest activities in order to enhance their efficiency. As discussed in Chapter 2,

domestic commercial banks should focus on the retail banking segment, where there are substantial opportunities for them to improve their income. In addition, the findings show that banks with better management quality were more efficient than those with poor management quality. This suggests that banks should implement superior management practices which apply to day-to-day operations, and minimise their input usage, especially by reducing repetition of labour and redundant office resources.

7.4 Limitations of the present study

As in other studies, the major limitations are acknowledged in the interpretation of the results of the study. Two main limitations are identified, which are outlined below.

7.4.1 Sample size of data

The small number of commercial banks is the first limitation of the study. Due to limited access to data on personnel expenses, or missing data on a number of full-time employees, only 21 commercial banks (four SOCBs and 17 joint-stock commercial banks) were examined in the study. This limited the sample size of banks and reduced the number of potential banks which should be the targets of future acquisitions.

7.4.2 The assumption on virtual bank mergers

Following theorem 14.1 in Cooper, Seiford and Tone (2007) and the suggestion of Halkos and Tzeremes (2013), a VBM is performed by combining the inputs and outputs of two efficient banks. Accordingly, the inputs (labour costs and fixed assets) of the virtually merged bank are estimated by simply combining these inputs of two efficient banks. However, in practice, merging banks may reduce repetition of labour and redundant office resources in order to improve their efficiency (Berger & Humphrey 1992a; DeYoung 1997). As a result, the merged banks in practice may use much less inputs compared to those banks created via

VBMs in the present study. However, this effect is beyond the scope of this study and should be considered in the future research.

7.5 Suggestions for future research

The following aspects of the study could be usefully developed in future research.

7.5.1 Future research on bank mergers

- Possible bank mergers formed by more than two banks

A bootstrap DEA procedure is used in this analysis to examine the efficiency effect of VBMs from two efficient banks. Our findings showed that VBMs that involved a SOCB are more efficient than those that did not include a SOCB. A study by Hadad et al. (2013) using Indonesian data found that mergers between three banks that included a SOCB resulted in substantial cost savings. Consequently, this suggests that future research could use the same bootstrap DEA procedure to investigate whether VBMs from three efficient banks would lead to efficiency gains.

- Examination of co-insurance hypothesis

In the context of the Vietnamese banking system, domestic commercial banks are more exposed to risk because of their high level of non-performing loans (NPLs). In addition, the average capital adequacy ratio of Vietnamese banks was approximately 13.48%. This ratio just met the minimum requirement imposed by the central bank and was far below the requirement level in other countries, especially the Asia-Pacific region (approximately 19%) (Nguyen & Simioni 2015). Consequently, the Vietnamese banking system may face a high probability of bankruptcy. As per the co-insurance hypothesis, the rationale behind a bank merger may well be to minimise the likelihood of institutional bankruptcies in order to stabilise the banking industry, rather than efficiency gains obtained from scale and scope

effects (Higgins & Schall 1975; Lewellen 1971; Seth 1990). Consequently, future research should investigate whether bank mergers would reduce the risk of bankruptcy.

- Examination of too-big-to-fail effect

Berger and Hannan (1998) suggested that the managers of merging banks could experience a quiet life (especially relevant to the finding for SOCBs, the largest banks in this study), given that the resultant merged bank could exert greater market power over its competitors. This may result in cost increases rather than cost reductions, as managers may believe that the newly-combined bank is 'too-big-to-fail'. This suggests that bank mergers that include a SOCB should be approached with caution. Testing this possibility is beyond the scope of this study but should be considered in future research.

- Response of non-merging banks when consolidation occurs

The findings indicate that the mean post-merger technical efficiency scores of non-merging banks were higher than their average pre-merger technical efficiency scores. However, the post-merger technical efficiency of non-merging banks was not significantly different from their pre-merger technical efficiency, using non-parametric tests (although the Z-values were found to be positive). This could be mainly due to the limited number of observations (four non-merging banks) within each group. Future research needs to verify whether bank mergers serve as a wake-up call to non-merging banks, by making a larger number of observations within these groups.

- Future research on the effect of bank mergers on cost efficiency and profit efficiency

The DEA model used in the study could be modified to estimate the cost and profit efficiencies of Vietnamese banks when input and output prices are used. The findings from

this study could be used as the benchmark for future studies when comparing the predicted and actual costs of Vietnamese bank mergers.

7.5.2 The two-stage bootstrap data envelopment analysis

It is important to note that the focus of this study is on investigating the determinants of the technical efficiency of Vietnamese commercial banks (the existing commercial banks) using the two-stage framework. In the first stage, the bootstrap DEA was used to compute the bias-corrected efficiency scores of banks. In the second stage, these scores were regressed with control variables in order to examine the determinants of the technical efficiency in banks. For future research, a double-bootstrap DEA procedure suggested by Simar and Wilson (2007) could be used. Accordingly, DEA is used to compute efficiency scores of banks. Thereafter, the bootstrap DEA scores with a truncated bootstrap regression are used in which environment factors are incorporated in the model to estimate the bias-corrected efficiency scores of banks. Consequently, a confidence interval for the efficiency estimates and inferences for factors that explain bank efficiency are produced.

Appendices

Appendix 1 Efficiency estimates (with OBS) of the Vietnamese banks, 2007

Banks	VRS	BCVRS	BIAS	SD	UB	LB
AGB	1.0000	0.9781	-0.0224	0.0021	0.9996	0.8200
BIDV	1.0000	0.9776	-0.0229	0.0022	0.9996	0.8189
VCB	1.0000	0.9790	-0.0215	0.0019	0.9995	0.8200
CTG	1.0000	0.9835	-0.0168	0.0007	0.9995	0.8909
ABB	1.0000	0.9871	-0.0131	0.0001	0.9995	0.9610
ACB	1.0000	0.9796	-0.0208	0.0015	0.9995	0.8496
EAB	1.0000	0.9839	-0.0164	0.0005	0.9995	0.9196
EIB	1.0000	0.9865	-0.0137	0.0001	0.9995	0.9576
MSB	1.0000	0.9887	-0.0114	0.0001	0.9996	0.9707
MB	1.0000	0.9790	-0.0215	0.0020	0.9996	0.8194
NCB	1.0000	0.9776	-0.0229	0.0021	0.9994	0.8192
VietCapitalBank	1.0000	0.9770	-0.0235	0.0023	0.9995	0.8179
OceanBank	1.0000	0.9790	-0.0214	0.0019	0.9994	0.8215
STB	0.9694	0.9619	-0.0080	0.0000	0.9690	0.9495
PNB	0.7760	0.7701	-0.0100	0.0001	0.7757	0.7574
TechcomBank	0.9523	0.9449	-0.0082	0.0000	0.9519	0.9341
VPBank	0.9986	0.9906	-0.0081	0.0001	0.9981	0.9748
HBB	1.0000	0.9809	-0.0195	0.0011	0.9996	0.8809
HDB	1.0000	0.9765	-0.0240	0.0024	0.9995	0.8176
SHB	1.0000	0.9767	-0.0238	0.0023	0.9996	0.8188
WesternBank	1.0000	0.9785	-0.0220	0.0020	0.9995	0.8199
Mean	0.9855	0.9684	-0.0177	0.0012	0.9851	0.8685
SD	0.0495	0.0465	0.0058	0.0010	0.0495	0.0668
Min.	0.7760	0.7701	-0.0240	0.0000	0.7757	0.7574
Max.	1.0000	0.9906	-0.0080	0.0024	0.9996	0.9748

Notes: VRS (efficiency estimates under VRS assumption), BCVRS (bias-corrected efficiency estimates under VRS assumption), BIAS (bootstrap bias estimates), SD (the standard deviation of the bias), 95% confidence intervals of the bias-corrected efficiency scores (LB=lower bound, UB= upper bound)

Appendix 2 Efficiency estimates (with OBS) of the Vietnamese banks, 2008

BANKS	VRS	BCVRS	BIAS	SD	UB	LB
AGB	1.0000	0.9592	-0.0425	0.0039	0.9990	0.7764
BIDV	1.0000	0.9586	-0.0432	0.0040	0.9991	0.7746
VCB	1.0000	0.9604	-0.0413	0.0035	0.9990	0.7763
CTG	1.0000	0.9672	-0.0339	0.0013	0.9989	0.8734
ABB	1.0000	0.9719	-0.0290	0.0005	0.9990	0.9228
ACB	1.0000	0.9642	-0.0371	0.0017	0.9987	0.8623
EAB	1.0000	0.9609	-0.0407	0.0030	0.9989	0.8090
EIB	1.0000	0.9708	-0.0301	0.0006	0.9988	0.9225
MSB	1.0000	0.9568	-0.0451	0.0044	0.9991	0.7735
MB	1.0000	0.9610	-0.0406	0.0036	0.9990	0.7753
NCB	0.9424	0.9249	-0.0200	0.0002	0.9410	0.8962
VietCapitalBank	0.9850	0.9667	-0.0192	0.0004	0.9839	0.9295
OceanBank	1.0000	0.9605	-0.0411	0.0034	0.9987	0.7789
STB	0.9316	0.9144	-0.0202	0.0004	0.9306	0.8762
PNB	0.7015	0.6897	-0.0245	0.0003	0.7008	0.6719
TechcomBank	0.9990	0.9796	-0.0198	0.0002	0.9980	0.9481
VPBank	0.8840	0.8673	-0.0217	0.0003	0.8829	0.8377
HBB	1.0000	0.9706	-0.0303	0.0007	0.9989	0.9203
HDB	1.0000	0.9643	-0.0370	0.0017	0.9989	0.8682
SHB	1.0000	0.9588	-0.0430	0.0041	0.9990	0.7743
WesternBank	1.0000	0.9606	-0.0410	0.0037	0.9988	0.7762
Mean	0.9735	0.9423	-0.0334	0.0020	0.9724	0.8354
SD	0.0693	0.0630	0.0093	0.0016	0.0692	0.0737
Min.	0.7015	0.6897	-0.0451	0.0002	0.7008	0.6719
Max.	1.0000	0.9796	-0.0192	0.0044	0.9991	0.9481

Notes: VRS (efficiency estimates under variable returns to scale assumption), BCVRS (bias-corrected efficiency estimates under variable returns to scale assumption), BIAS (bootstrap bias estimates), SD (the standard deviation of the bias), 95% confidence intervals of the bias-corrected efficiency scores (LB=lower bound, UB= upper bound)

Appendix 3 Efficiency estimates (with OBS) of the Vietnamese banks, 2009

BANKS	VRS	BCVRS	BIAS	SD	UB	LB
AGB	1.0000	0.9719	-0.0289	0.0011	0.9992	0.8867
BIDV	1.0000	0.9723	-0.0285	0.0010	0.9992	0.8904
VCB	1.0000	0.9717	-0.0292	0.0011	0.9991	0.8836
CTG	1.0000	0.9742	-0.0265	0.0009	0.9992	0.8900
ABB	0.9646	0.9522	-0.0134	0.0001	0.9636	0.9335
ACB	1.0000	0.9711	-0.0297	0.0011	0.9990	0.8857
EAB	1.0000	0.9722	-0.0286	0.0011	0.9991	0.8851
EIB	1.0000	0.9855	-0.0147	0.0001	0.9990	0.9622
MSB	1.0000	0.9729	-0.0278	0.0010	0.9992	0.8879
MB	1.0000	0.9718	-0.0290	0.0011	0.9992	0.8857
NCB	1.0000	0.9720	-0.0288	0.0010	0.9989	0.8852
VietCapitalBank	1.0000	0.9721	-0.0287	0.0010	0.9991	0.8865
OceanBank	1.0000	0.9725	-0.0283	0.0010	0.9989	0.8866
STB	1.0000	0.9722	-0.0286	0.0010	0.9992	0.8874
PNB	1.0000	0.9756	-0.0250	0.0005	0.9992	0.9267
TechcomBank	1.0000	0.9739	-0.0268	0.0007	0.9992	0.9084
VPBank	0.8742	0.8618	-0.0165	0.0001	0.8736	0.8465
HBB	1.0000	0.9783	-0.0221	0.0003	0.9992	0.9438
HDB	1.0000	0.9731	-0.0276	0.0008	0.9990	0.9009
SHB	0.8632	0.8517	-0.0157	0.0001	0.8625	0.8344
WesternBank	1.0000	0.9722	-0.0286	0.0010	0.9990	0.8866
Mean	0.9858	0.9615	-0.0254	0.0008	0.9849	0.8945
SD	0.0397	0.0353	0.0054	0.0004	0.0397	0.0288
Min.	0.8632	0.8517	-0.0297	0.0001	0.8625	0.8344
Max.	1.0000	0.9855	-0.0134	0.0011	0.9992	0.9622

Notes: VRS (efficiency estimates under variable returns to scale assumption), BCVRS (bias-corrected efficiency estimates under variable returns to scale assumption), BIAS (bootstrap bias estimates), SD (the standard deviation of the bias), 95% confidence intervals of the bias-corrected efficiency scores (LB=lower bound, UB= upper bound)

Appendix 4 Efficiency estimates (with OBS) of the Vietnamese banks, 2010

BANKS	VRS	BCVRS	BIAS	SD	UB	LB
AGB	1.0000	0.9680	-0.0331	0.0013	0.9992	0.8778
BIDV	1.0000	0.9680	-0.0330	0.0013	0.9990	0.8797
VCB	1.0000	0.9680	-0.0331	0.0013	0.9990	0.8793
CTG	1.0000	0.9683	-0.0327	0.0012	0.9990	0.8816
ABB	0.8555	0.8414	-0.0196	0.0002	0.8546	0.8201
ACB	1.0000	0.9664	-0.0348	0.0014	0.9989	0.8773
EAB	1.0000	0.9678	-0.0332	0.0014	0.9992	0.8774
EIB	1.0000	0.9679	-0.0332	0.0013	0.9989	0.8801
MSB	1.0000	0.9688	-0.0322	0.0012	0.9990	0.8820
MB	0.9059	0.8908	-0.0187	0.0002	0.9051	0.8613
NCB	1.0000	0.9670	-0.0341	0.0013	0.9989	0.8799
VietCapitalBank	1.0000	0.9677	-0.0334	0.0013	0.9991	0.8796
OceanBank	1.0000	0.9681	-0.0330	0.0013	0.9988	0.8781
STB	1.0000	0.9685	-0.0325	0.0012	0.9992	0.8847
PNB	1.0000	0.9670	-0.0341	0.0014	0.9991	0.8772
TechcomBank	1.0000	0.9674	-0.0337	0.0014	0.9991	0.8786
VPBank	1.0000	0.9705	-0.0304	0.0008	0.9993	0.9066
HBB	1.0000	0.9665	-0.0347	0.0014	0.9991	0.8768
HDB	1.0000	0.9769	-0.0237	0.0003	0.9989	0.9358
SHB	0.8695	0.8567	-0.0172	0.0002	0.8687	0.8347
WesternBank	0.9682	0.9530	-0.0164	0.0003	0.9674	0.9200
Mean	0.9809	0.9526	-0.0298	0.0010	0.9800	0.8795
SD	0.0448	0.0386	0.0063	0.0005	0.0447	0.0239
Min.	0.8555	0.8414	-0.0348	0.0002	0.8546	0.8201
Max.	1.0000	0.9769	-0.0164	0.0014	0.9993	0.9358

Notes: VRS (efficiency estimates under variable returns to scale assumption), BCVRS (bias-corrected efficiency estimates under variable returns to scale assumption), BIAS (bootstrap bias estimates), SD (the standard deviation of the bias), 95% confidence intervals of the bias-corrected efficiency scores (LB=lower bound, UB= upper bound)

Appendix 5 Efficiency estimates (with OBS) of the Vietnamese banks, 2011

BANKS	VRS	BCVRS	BIAS	SD	UB	LB
AGB	1.0000	0.9591	-0.0426	0.0022	0.9989	0.8504
BIDV	1.0000	0.9594	-0.0423	0.0021	0.9987	0.8525
VCB	1.0000	0.9593	-0.0424	0.0021	0.9988	0.8524
CTG	1.0000	0.9588	-0.0430	0.0023	0.9986	0.8508
ABB	0.8142	0.7971	-0.0264	0.0004	0.8132	0.7657
ACB	1.0000	0.9563	-0.0457	0.0024	0.9985	0.8468
EAB	1.0000	0.9591	-0.0427	0.0020	0.9990	0.8618
EIB	1.0000	0.9603	-0.0414	0.0017	0.9986	0.8692
MSB	1.0000	0.9607	-0.0409	0.0018	0.9988	0.8662
MB	0.9523	0.9336	-0.0210	0.0003	0.9512	0.8909
NCB	1.0000	0.9581	-0.0437	0.0021	0.9985	0.8531
VietCapitalBank	1.0000	0.9589	-0.0429	0.0021	0.9987	0.8515
OceanBank	1.0000	0.9596	-0.0421	0.0022	0.9984	0.8497
STB	1.0000	0.9597	-0.0420	0.0021	0.9987	0.8531
PNB	1.0000	0.9588	-0.0430	0.0021	0.9988	0.8516
TechcomBank	1.0000	0.9593	-0.0424	0.0022	0.9988	0.8487
VPBank	1.0000	0.9578	-0.0440	0.0022	0.9990	0.8517
HBB	1.0000	0.9568	-0.0452	0.0025	0.9989	0.8471
HDB	0.8406	0.8230	-0.0256	0.0003	0.8395	0.7945
SHB	0.8712	0.8535	-0.0237	0.0004	0.8702	0.8144
WesternBank	1.0000	0.9729	-0.0279	0.0005	0.9986	0.9224
Mean	0.9752	0.9391	-0.0386	0.0017	0.9739	0.8497
SD	0.0574	0.0492	0.0080	0.0008	0.0573	0.0310
Min.	0.8142	0.7971	-0.0457	0.0003	0.8132	0.7657
Max.	1.0000	0.9729	-0.0210	0.0025	0.9990	0.9224

Notes: VRS (efficiency estimates under variable returns to scale assumption), BCVRS (bias-corrected efficiency estimates under variable returns to scale assumption), BIAS (bootstrap bias estimates), SD (the standard deviation of the bias), 95% confidence intervals of the bias-corrected efficiency scores (LB=lower bound, UB= upper bound)

Appendix 6 Efficiency estimates (without OBS) of the Vietnamese banks, 2007

BANKS	VRS	BCVRS	BIAS	SD	UB	LB
AGB	1.0000	0.9699	-0.0311	0.0022	0.9993	0.8231
BIDV	1.0000	0.9722	-0.0286	0.0012	0.9993	0.8850
VCB	1.0000	0.9702	-0.0307	0.0020	0.9991	0.8230
CTG	1.0000	0.9741	-0.0266	0.0010	0.9991	0.8857
ABB	1.0000	0.9804	-0.0199	0.0002	0.9993	0.9508
ACB	1.0000	0.9704	-0.0305	0.0017	0.9990	0.8444
EAB	1.0000	0.9752	-0.0254	0.0007	0.9992	0.9104
EIB	1.0000	0.9797	-0.0207	0.0002	0.9992	0.9501
MSB	1.0000	0.9843	-0.0160	0.0001	0.9992	0.9629
MB	1.0000	0.9773	-0.0232	0.0005	0.9994	0.9282
NCB	0.9062	0.8937	-0.0155	0.0001	0.9053	0.8728
VietCapitalBank	1.0000	0.9700	-0.0309	0.0019	0.9992	0.8416
OceanBank	1.0000	0.9701	-0.0308	0.0020	0.9991	0.8255
SacomBank	0.9694	0.9570	-0.0134	0.0001	0.9688	0.9368
PNB	0.7760	0.7659	-0.0170	0.0002	0.7755	0.7433
TechcomBank	0.9523	0.9402	-0.0135	0.0001	0.9517	0.9223
VPBank	0.9986	0.9854	-0.0135	0.0001	0.9978	0.9616
HBB	1.0000	0.9748	-0.0258	0.0007	0.9993	0.9150
HDB	1.0000	0.9680	-0.0330	0.0024	0.9991	0.8192
SHB	0.9634	0.9523	-0.0121	0.0001	0.9628	0.9328
WesternBank	1.0000	0.9704	-0.0305	0.0021	0.9992	0.8229
Mean	0.9793	0.9572	-0.0233	0.0009	0.9786	0.8837
SD	0.0522	0.0480	0.0073	0.0009	0.0522	0.0606
Min.	0.7760	0.7659	-0.0330	0.0001	0.7755	0.7433
Max.	1.0000	0.9854	-0.0121	0.0024	0.9994	0.9629

Notes: VRS (efficiency estimates under variable returns to scale assumption), BCVRS (bias-corrected efficiency estimates under variable returns to scale assumption), BIAS (bootstrap bias estimates), SD (the standard deviation of the bias), 95% confidence intervals of the bias-corrected efficiency scores (LB=lower bound, UB= upper bound)

Appendix 7 Efficiency estimates (without OBS) of the Vietnamese banks, 2008

BANKS	VRS	BCVRS	BIAS	SD	UB	LB
AGB	1.0000	0.9396	-0.0643	0.0044	0.9984	0.7817
BIDV	1.0000	0.9399	-0.0640	0.0041	0.9980	0.7948
VCB	1.0000	0.9402	-0.0636	0.0042	0.9983	0.7869
CTG	1.0000	0.9447	-0.0585	0.0024	0.9983	0.8541
ABB	1.0000	0.9549	-0.0472	0.0009	0.9980	0.9030
ACB	1.0000	0.9445	-0.0588	0.0027	0.9984	0.8435
EAB	1.0000	0.9416	-0.0621	0.0036	0.9984	0.8026
EIB	1.0000	0.9567	-0.0453	0.0008	0.9975	0.9134
MSB	1.0000	0.9392	-0.0648	0.0043	0.9982	0.7844
MB	1.0000	0.9539	-0.0484	0.0012	0.9982	0.8838
NCB	0.9424	0.9117	-0.0357	0.0006	0.9405	0.8623
VietCapitalBank	0.9850	0.9525	-0.0346	0.0009	0.9823	0.8854
OceanBank	1.0000	0.9411	-0.0626	0.0038	0.9981	0.7925
SacomBank	0.8384	0.8122	-0.0386	0.0006	0.8372	0.7770
PNB	0.7015	0.6814	-0.0420	0.0007	0.7003	0.6559
TechcomBank	0.9531	0.9264	-0.0303	0.0003	0.9514	0.8961
VPBank	0.8840	0.8544	-0.0391	0.0006	0.8820	0.8111
HBB	1.0000	0.9590	-0.0428	0.0007	0.9982	0.9133
HDB	1.0000	0.9460	-0.0571	0.0021	0.9983	0.8630
SHB	0.8499	0.8282	-0.0308	0.0003	0.8479	0.8022
WesternBank	1.0000	0.9422	-0.0614	0.0040	0.9984	0.7868
Mean	0.9597	0.9148	-0.0501	0.0021	0.9579	0.8283
SD	0.0784	0.0678	0.0123	0.0016	0.0782	0.0625
Min.	0.7015	0.6814	-0.0648	0.0003	0.7003	0.6559
Max.	1.0000	0.9590	-0.0303	0.0044	0.9984	0.9134

Notes: VRS (efficiency estimates under variable returns to scale assumption), BCVRS (bias-corrected efficiency estimates under variable returns to scale assumption), BIAS (bootstrap bias estimates), SD (the standard deviation of the bias), 95% confidence intervals of the bias-corrected efficiency scores (LB=lower bound, UB= upper bound)

Appendix 8 Efficiency estimates (without OBS) of the Vietnamese banks, 2009

Banks	VRS	BCVRS	BIAS	SD	UB	LB
AGB	1.0000	0.9676	-0.0335	0.0013	0.9992	0.8820
BIDV	1.0000	0.9692	-0.0318	0.0012	0.9990	0.8869
VCB	1.0000	0.9680	-0.0330	0.0013	0.9990	0.8818
CTG	1.0000	0.9674	-0.0337	0.0014	0.9991	0.8786
ABB	0.9646	0.9518	-0.0139	0.0001	0.9638	0.9341
ACB	1.0000	0.9653	-0.0359	0.0015	0.9992	0.8787
EAB	1.0000	0.9668	-0.0343	0.0014	0.9991	0.8789
EIB	1.0000	0.9837	-0.0166	0.0002	0.9990	0.9548
MSB	1.0000	0.9673	-0.0338	0.0013	0.9989	0.8794
MB	0.9795	0.9647	-0.0157	0.0001	0.9786	0.9372
NCB	1.0000	0.9658	-0.0354	0.0014	0.9990	0.8794
VietCapitalBank	1.0000	0.9667	-0.0344	0.0014	0.9991	0.8806
OceanBank	1.0000	0.9665	-0.0347	0.0014	0.9987	0.8807
SacomBank	1.0000	0.9810	-0.0194	0.0002	0.9991	0.9548
PNB	1.0000	0.9721	-0.0287	0.0007	0.9990	0.9123
TechcomBank	0.8906	0.8761	-0.0186	0.0002	0.8897	0.8442
VPBank	0.8677	0.8547	-0.0175	0.0001	0.8668	0.8363
HBB	1.0000	0.9756	-0.0250	0.0003	0.9990	0.9359
HDB	0.9602	0.9457	-0.0160	0.0001	0.9593	0.9262
SHB	0.8632	0.8507	-0.0171	0.0001	0.8625	0.8322
WesternBank	1.0000	0.9657	-0.0355	0.0014	0.9990	0.8796
Mean	0.9774	0.9520	-0.0269	0.0008	0.9765	0.8931
SD	0.0451	0.0393	0.0085	0.0006	0.0451	0.0358
Min.	0.8632	0.8507	-0.0359	0.0001	0.8625	0.8322
Max.	1.0000	0.9837	-0.0139	0.0015	0.9992	0.9548

Notes: VRS (efficiency estimates under variable returns to scale assumption), BCVRS (bias-corrected efficiency estimates under variable returns to scale assumption), BIAS (bootstrap bias estimates), SD (the standard deviation of the bias), 95% confidence intervals of the bias-corrected efficiency scores (LB=lower bound, UB= upper bound)

Appendix 9 Efficiency estimates (without OBS) of the Vietnamese banks, 2010

BANKS	VRS	BCVRS	BIAS	SD	UB	LB
AGB	1.0000	0.9689	-0.0321	0.0012	0.9989	0.8818
BIDV	1.0000	0.9668	-0.0343	0.0013	0.9990	0.8790
VCB	1.0000	0.9671	-0.0340	0.0014	0.9991	0.8763
CTG	1.0000	0.9687	-0.0323	0.0012	0.9990	0.8819
ABB	0.8555	0.8416	-0.0193	0.0002	0.8548	0.8217
ACB	1.0000	0.9678	-0.0333	0.0013	0.9990	0.8799
EAB	1.0000	0.9688	-0.0322	0.0012	0.9990	0.8825
EIB	1.0000	0.9675	-0.0336	0.0013	0.9988	0.8781
MSB	1.0000	0.9679	-0.0331	0.0012	0.9991	0.8829
MB	0.9059	0.8912	-0.0181	0.0002	0.9051	0.8662
NCB	1.0000	0.9678	-0.0332	0.0013	0.9988	0.8775
VietCapitalBank	1.0000	0.9676	-0.0335	0.0014	0.9991	0.8768
OceanBank	1.0000	0.9678	-0.0333	0.0013	0.9992	0.8781
SacomBank	1.0000	0.9732	-0.0276	0.0006	0.9992	0.9221
PNB	1.0000	0.9687	-0.0323	0.0012	0.9990	0.8807
TechcomBank	1.0000	0.9693	-0.0317	0.0011	0.9991	0.8892
VPBank	1.0000	0.9724	-0.0284	0.0008	0.9992	0.9075
HBB	1.0000	0.9695	-0.0315	0.0010	0.9992	0.8919
HDB	1.0000	0.9772	-0.0234	0.0003	0.9990	0.9370
SHB	0.8695	0.8572	-0.0166	0.0001	0.8690	0.8367
WesternBank	0.9682	0.9531	-0.0164	0.0003	0.9676	0.9184
Mean	0.9809	0.9533	-0.0290	0.0009	0.9800	0.8831
SD	0.0448	0.0387	0.0062	0.0005	0.0447	0.0253
Min.	0.8555	0.8416	-0.0343	0.0001	0.8548	0.8217
Max.	1.0000	0.9772	-0.0164	0.0014	0.9992	0.9370

Notes: VRS (efficiency estimates under variable returns to scale assumption), BCVRS (bias-corrected efficiency estimates under variable returns to scale assumption), BIAS (bootstrap bias estimates), SD (the standard deviation of the bias), 95% confidence intervals of the bias-corrected efficiency scores (LB=lower bound, UB= upper bound)

Appendix 10 Efficiency estimates (without OBS) of the Vietnamese banks, 2011

BANKS	VRS	BCVRS	BIAS	SD	UB	LB
AGB	1.0000	0.9553	-0.0468	0.0020	0.9984	0.8536
BIDV	1.0000	0.9562	-0.0458	0.0019	0.9987	0.8569
VCB	1.0000	0.9551	-0.0471	0.0021	0.9983	0.8524
CTG	1.0000	0.9547	-0.0474	0.0021	0.9982	0.8493
ABB	0.8142	0.7938	-0.0316	0.0005	0.8134	0.7598
ACB	1.0000	0.9579	-0.0439	0.0018	0.9988	0.8576
EAB	1.0000	0.9572	-0.0447	0.0016	0.9982	0.8675
EIB	1.0000	0.9582	-0.0436	0.0015	0.9983	0.8747
MSB	1.0000	0.9583	-0.0435	0.0016	0.9987	0.8709
MB	0.9450	0.9221	-0.0262	0.0004	0.9435	0.8829
NCB	1.0000	0.9562	-0.0458	0.0019	0.9987	0.8559
VietCapitalBank	1.0000	0.9559	-0.0462	0.0019	0.9984	0.8555
OceanBank	1.0000	0.9563	-0.0457	0.0018	0.9988	0.8589
SacomBank	0.9918	0.9702	-0.0224	0.0003	0.9903	0.9292
PNB	1.0000	0.9558	-0.0462	0.0019	0.9986	0.8548
TechcomBank	1.0000	0.9674	-0.0337	0.0006	0.9987	0.9211
VPBank	1.0000	0.9551	-0.0470	0.0018	0.9986	0.8573
HBB	1.0000	0.9558	-0.0463	0.0020	0.9987	0.8520
HDB	0.8406	0.8203	-0.0295	0.0004	0.8392	0.7907
SHB	0.8712	0.8506	-0.0277	0.0004	0.8699	0.8145
WesternBank	1.0000	0.9684	-0.0327	0.0005	0.9988	0.9190
Mean	0.9744	0.9372	-0.0402	0.0014	0.9730	0.8588
SD	0.0574	0.0500	0.0084	0.0007	0.0573	0.0388
Min.	0.8142	0.7938	-0.0474	0.0003	0.8134	0.7598
Max.	1.0000	0.9702	-0.0224	0.0021	0.9988	0.9292

Notes: VRS (efficiency estimates under variable returns to scale assumption), BCVRS (bias-corrected efficiency estimates under variable returns to scale assumption), BIAS (bootstrap bias estimates), SD (the standard deviation of the bias), 95% confidence intervals of the bias-corrected efficiency scores (LB=lower bound, UB= upper bound)

Appendix 11 Efficiency estimates of the virtual bank mergers (VBMs), 2007

VBMs	VRS	BCVRS	Bias	SD	UB	LB
AGB&BIDV	1.0000	0.9936	-0.0065	0.0001	0.9999	0.9691
AGB&VCB	1.0000	0.9936	-0.0065	0.0001	0.9999	0.9688
AGB&CTG	1.0000	0.9936	-0.0064	0.0001	0.9999	0.9690
AGB&ABB	0.9950	0.9931	-0.0019	0.0000	0.9948	0.9899
AGB&ACB	0.9750	0.9731	-0.0020	0.0000	0.9749	0.9675
AGB&EAB	1.0000	0.9963	-0.0037	0.0000	0.9999	0.9905
AGB&EIB	0.9957	0.9936	-0.0021	0.0000	0.9955	0.9897
AGB&MSB	0.9909	0.9890	-0.0019	0.0000	0.9907	0.9862
AGB&MB	0.9883	0.9866	-0.0018	0.0000	0.9882	0.9841
AGB&NCB	1.0000	0.9953	-0.0047	0.0000	0.9999	0.9847
AGB&VietCapitalBank	1.0000	0.9958	-0.0042	0.0000	0.9999	0.9868
AGB&OceanBank	1.0000	0.9958	-0.0043	0.0000	0.9999	0.9866
AGB&HBB	0.9983	0.9960	-0.0023	0.0000	0.9982	0.9900
AGB&HDB	1.0000	0.9956	-0.0044	0.0000	0.9999	0.9863
AGB&SHB	0.9886	0.9868	-0.0018	0.0000	0.9885	0.9837
AGB&WesternBank	0.9998	0.9977	-0.0021	0.0000	0.9998	0.9898
BIDV&VCB	1.0000	0.9935	-0.0065	0.0001	0.9999	0.9675
BIDV&CTG	1.0000	0.9939	-0.0062	0.0001	0.9999	0.9697
BIDV&ABB	0.9998	0.9983	-0.0015	0.0000	0.9997	0.9961
BIDV&ACB	1.0000	0.9945	-0.0055	0.0000	0.9999	0.9784
BIDV&EAB	1.0000	0.9944	-0.0056	0.0000	0.9999	0.9756
BIDV&EIB	1.0000	0.9962	-0.0038	0.0000	0.9999	0.9889
BIDV&MSB	0.9956	0.9937	-0.0020	0.0000	0.9955	0.9901
BIDV&MB	1.0000	0.9940	-0.0061	0.0001	0.9999	0.9708
BIDV&NCB	1.0000	0.9946	-0.0055	0.0000	0.9999	0.9765
BIDV&VietCapitalBank	1.0000	0.9947	-0.0054	0.0000	0.9999	0.9780
BIDV&OceanBank	1.0000	0.9962	-0.0039	0.0000	0.9999	0.9884
BIDV&HBB	1.0000	0.9963	-0.0037	0.0000	0.9999	0.9896
BIDV&HDB	1.0000	0.9945	-0.0055	0.0000	0.9999	0.9782
BIDV&SHB	1.0000	0.9960	-0.0040	0.0000	0.9999	0.9880
BIDV&WesternBank	0.9985	0.9962	-0.0023	0.0000	0.9984	0.9872
VCB&CTG	1.0000	0.9940	-0.0060	0.0001	0.9999	0.9695
VCB&ABB	1.0000	0.9971	-0.0029	0.0000	0.9999	0.9918
VCB&ACB	1.0000	0.9935	-0.0065	0.0001	0.9999	0.9712
VCB&EAB	1.0000	0.9959	-0.0042	0.0000	0.9999	0.9849
VCB&EIB	1.0000	0.9967	-0.0033	0.0000	0.9999	0.9916
VCB&MSB	0.9972	0.9949	-0.0024	0.0000	0.9971	0.9896
VCB&MB	1.0000	0.9941	-0.0059	0.0001	0.9999	0.9690
VCB&NCB	1.0000	0.9952	-0.0048	0.0000	0.9999	0.9827
VCB&VietCapitalBank	1.0000	0.9976	-0.0024	0.0000	0.9999	0.9940
VCB&OceanBank	1.0000	0.9942	-0.0059	0.0001	0.9999	0.9707
VCB&HBB	1.0000	0.9942	-0.0059	0.0001	0.9999	0.9748
VCB&HDB	1.0000	0.9945	-0.0055	0.0000	0.9999	0.9765

VCB&SHB	1.0000	0.9949	-0.0051	0.0000	0.9999	0.9814
VCB&WesternBank	0.9979	0.9963	-0.0015	0.0000	0.9977	0.9940
CTG&ABB	1.0000	0.9981	-0.0019	0.0000	0.9999	0.9947
CTG&ACB	1.0000	0.9937	-0.0064	0.0001	0.9999	0.9710
CTG&EAB	1.0000	0.9960	-0.0040	0.0000	0.9999	0.9891
CTG&EIB	1.0000	0.9961	-0.0039	0.0000	0.9999	0.9884
CTG&MSB	0.9952	0.9931	-0.0021	0.0000	0.9951	0.9892
CTG&MB	1.0000	0.9940	-0.0060	0.0001	0.9999	0.9697
CTG&NCB	1.0000	0.9944	-0.0057	0.0000	0.9998	0.9793
CTG&VietCapitalBank	1.0000	0.9948	-0.0053	0.0000	0.9999	0.9802
CTG&OceanBank	1.0000	0.9961	-0.0039	0.0000	0.9999	0.9865
CTG&HBB	1.0000	0.9951	-0.0049	0.0000	0.9999	0.9822
CTG&HDB	1.0000	0.9954	-0.0046	0.0000	0.9999	0.9846
CTG&SHB	0.9912	0.9887	-0.0025	0.0000	0.9911	0.9814
CTG&WesternBank	0.9992	0.9968	-0.0024	0.0000	0.9991	0.9860
ABB&ACB	0.9957	0.9934	-0.0023	0.0000	0.9956	0.9881
ABB&EAB	0.9902	0.9882	-0.0020	0.0000	0.9901	0.9855
ABB&EIB	0.9982	0.9967	-0.0015	0.0000	0.9981	0.9944
ABB&MSB	1.0000	0.9967	-0.0033	0.0000	0.9999	0.9917
ABB&MB	1.0000	0.9950	-0.0050	0.0000	0.9999	0.9811
ABB&NCB	0.9743	0.9729	-0.0015	0.0000	0.9742	0.9706
ABB&VietCapitalBank	1.0000	0.9947	-0.0053	0.0000	0.9999	0.9776
ABB&OceanBank	1.0000	0.9936	-0.0064	0.0001	0.9999	0.9701
ABB&HBB	1.0000	0.9949	-0.0052	0.0000	0.9999	0.9800
ABB&HDB	1.0000	0.9952	-0.0049	0.0000	0.9999	0.9824
ABB&SHB	0.9841	0.9822	-0.0020	0.0000	0.9840	0.9791
ABB&WesternBank	0.9943	0.9921	-0.0022	0.0000	0.9941	0.9863
ACB&EAB	0.9820	0.9799	-0.0022	0.0000	0.9819	0.9766
ACB&EIB	1.0000	0.9978	-0.0022	0.0000	0.9999	0.9937
ACB&MSB	0.9935	0.9910	-0.0025	0.0000	0.9934	0.9850
ACB&MB	1.0000	0.9941	-0.0060	0.0001	0.9999	0.9716
ACB&NCB	0.9777	0.9756	-0.0022	0.0000	0.9776	0.9720
ACB&VietCapitalBank	0.9931	0.9913	-0.0018	0.0000	0.9929	0.9882
ACB&OceanBank	0.9971	0.9948	-0.0023	0.0000	0.9970	0.9865
ACB&HBB	1.0000	0.9940	-0.0060	0.0001	0.9999	0.9725
ACB&HDB	0.9843	0.9824	-0.0020	0.0000	0.9842	0.9798
ACB&SHB	0.9740	0.9717	-0.0024	0.0000	0.9739	0.9643
ACB&WesternBank	0.9890	0.9872	-0.0019	0.0000	0.9889	0.9837
EAB&EIB	1.0000	0.9948	-0.0052	0.0000	0.9999	0.9797
EAB&MSB	0.9693	0.9676	-0.0019	0.0000	0.9692	0.9653
EAB&MB	1.0000	0.9959	-0.0041	0.0000	0.9999	0.9888
EAB&NCB	0.9850	0.9832	-0.0018	0.0000	0.9848	0.9800
EAB&VietCapitalBank	1.0000	0.9940	-0.0060	0.0001	0.9999	0.9696
EAB&OceanBank	0.9756	0.9735	-0.0022	0.0000	0.9755	0.9683
EAB&HBB	0.9827	0.9809	-0.0019	0.0000	0.9826	0.9784
EAB&HDB	1.0000	0.9936	-0.0065	0.0001	0.9999	0.9684

EAB&SHB	1.0000	0.9983	-0.0017	0.0000	0.9999	0.9947
EAB&WesternBank	0.9966	0.9944	-0.0022	0.0000	0.9965	0.9860
EIB&MSB	0.9789	0.9772	-0.0018	0.0000	0.9788	0.9736
EIB&MB	1.0000	0.9944	-0.0056	0.0000	0.9999	0.9775
EIB&NCB	0.9696	0.9678	-0.0019	0.0000	0.9695	0.9649
EIB&VietCapitalBank	1.0000	0.9958	-0.0042	0.0000	0.9999	0.9854
EIB&OceanBank	0.9833	0.9816	-0.0017	0.0000	0.9832	0.9799
EIB&HBB	0.9882	0.9862	-0.0021	0.0000	0.9881	0.9813
EIB&HDB	1.0000	0.9965	-0.0036	0.0000	0.9999	0.9902
EIB&SHB	0.9784	0.9769	-0.0016	0.0000	0.9783	0.9747
EIB&WesternBank	0.9928	0.9905	-0.0023	0.0000	0.9927	0.9812
MSB&MB	1.0000	0.9948	-0.0052	0.0000	0.9999	0.9808
MSB&NCB	0.9644	0.9629	-0.0016	0.0000	0.9642	0.9603
MSB&VietCapitalBank	1.0000	0.9955	-0.0045	0.0000	0.9999	0.9864
MSB&OceanBank	1.0000	0.9939	-0.0062	0.0001	0.9999	0.9692
MSB&HBB	1.0000	0.9960	-0.0040	0.0000	0.9999	0.9871
MSB&HDB	0.9745	0.9725	-0.0020	0.0000	0.9743	0.9682
MSB&SHB	0.9899	0.9878	-0.0021	0.0000	0.9898	0.9846
MSB&WesternBank	0.9973	0.9953	-0.0020	0.0000	0.9972	0.9903
MB&NCB	1.0000	0.9939	-0.0061	0.0001	0.9999	0.9696
MB&VietCapitalBank	1.0000	0.9935	-0.0065	0.0001	0.9999	0.9701
MB&OceanBank	1.0000	0.9939	-0.0061	0.0001	0.9999	0.9707
MB&HBB	1.0000	0.9939	-0.0061	0.0001	0.9999	0.9707
MB&HDB	1.0000	0.9958	-0.0043	0.0000	0.9999	0.9855
MB&SHB	1.0000	0.9939	-0.0062	0.0001	0.9999	0.9700
MB&WesternBank	0.9985	0.9962	-0.0023	0.0000	0.9985	0.9866
NCB&VietCapitalBank	1.0000	0.9938	-0.0062	0.0001	0.9999	0.9701
NCB&OceanBank	1.0000	0.9937	-0.0063	0.0001	0.9999	0.9698
NCB&HBB	1.0000	0.9937	-0.0063	0.0001	0.9999	0.9689
NCB&HDB	1.0000	0.9938	-0.0062	0.0001	0.9999	0.9709
NCB&SHB	1.0000	0.9941	-0.0059	0.0001	0.9999	0.9700
NCB&WesternBank	0.9313	0.9286	-0.0031	0.0000	0.9312	0.9215
VietCapitalBank&OceanBank	1.0000	0.9933	-0.0067	0.0001	0.9999	0.9663
VietCapitalBank&HBB	1.0000	0.9939	-0.0062	0.0001	0.9999	0.9689
VietCapitalBank&HDB	1.0000	0.9936	-0.0064	0.0001	0.9999	0.9676
VietCapitalBank&SHB	1.0000	0.9938	-0.0063	0.0001	0.9999	0.9705
VietCapitalBank&WesternBank	1.0000	0.9934	-0.0066	0.0001	0.9999	0.9693
OceanBank&HBB	1.0000	0.9935	-0.0065	0.0001	0.9999	0.9697
OceanBank&HDB	1.0000	0.9939	-0.0061	0.0001	0.9999	0.9689
OceanBank&SHB	1.0000	0.9939	-0.0061	0.0001	0.9999	0.9705
OceanBank&WesternBank	1.0000	0.9941	-0.0059	0.0001	0.9999	0.9700
HBB&HDB	1.0000	0.9949	-0.0051	0.0000	0.9999	0.9813
HBB&SHB	0.9624	0.9608	-0.0017	0.0000	0.9623	0.9586
HBB&WesternBank	0.9929	0.9906	-0.0023	0.0000	0.9927	0.9830
HDB&SHB	1.0000	0.9938	-0.0063	0.0001	0.9999	0.9700
HDB&WesternBank	0.9930	0.9906	-0.0024	0.0000	0.9929	0.9812

SHB&WesternBank	0.9779	0.9753	-0.0028	0.0000	0.9778	0.9689
Mean	0.9950	0.9910	-0.0040	0.0000	0.9949	0.9787
SD	0.0101	0.0093	0.0018	0.0000	0.0101	0.0102
Min.	0.9313	0.9286	-0.0067	0.0000	0.9312	0.9215
Max.	1.0000	0.9983	-0.0015	0.0001	0.9999	0.9961

Notes: VRS (efficiency estimates under variable returns to scale assumption), BCVRS (bias-corrected efficiency estimates under variable returns to scale assumption), BIAS (bootstrap bias estimates), SD (the standard deviation of the bias), 95% confidence intervals of the bias-corrected efficiency scores (LB=lower bound, UB= upper bound)

Appendix 12 Efficiency estimates of the virtual bank mergers (VBMs), 2008

VBMs	VRS	BCVRS	Bias	SD	UB	LB
AGB&BIDV	1.0000	0.9893	-0.0108	0.0003	0.9998	0.9382
AGB&VCB	1.0000	0.9896	-0.0105	0.0003	0.9999	0.9367
AGB&CTG	1.0000	0.9922	-0.0079	0.0001	0.9998	0.9740
AGB&ABB	0.9584	0.9559	-0.0027	0.0000	0.9582	0.9513
AGB&ACB	0.9206	0.9166	-0.0047	0.0000	0.9204	0.9033
AGB&EAB	0.9794	0.9771	-0.0024	0.0000	0.9792	0.9731
AGB&EIB	0.9473	0.9445	-0.0032	0.0000	0.9471	0.9394
AGB&MSB	0.9561	0.9534	-0.0030	0.0000	0.9559	0.9478
AGB&MB	0.9305	0.9282	-0.0026	0.0000	0.9303	0.9243
AGB&NCB	0.9799	0.9784	-0.0015	0.0000	0.9797	0.9762
AGB&VietCapitalBank	0.9794	0.9783	-0.0012	0.0000	0.9793	0.9765
AGB&OceanBank	0.9810	0.9788	-0.0023	0.0000	0.9808	0.9742
AGB&HBB	0.9719	0.9700	-0.0020	0.0000	0.9717	0.9670
AGB&HDB	0.9847	0.9835	-0.0012	0.0000	0.9845	0.9817
AGB&SHB	0.9465	0.9434	-0.0035	0.0000	0.9463	0.9377
AGB&WesternBank	0.9810	0.9798	-0.0012	0.0000	0.9809	0.9781
BIDV&VCB	1.0000	0.9887	-0.0115	0.0003	0.9998	0.9350
BIDV&CTG	1.0000	0.9894	-0.0107	0.0003	0.9999	0.9376
BIDV&ABB	1.0000	0.9970	-0.0030	0.0000	0.9998	0.9927
BIDV&ACB	1.0000	0.9901	-0.0100	0.0002	0.9998	0.9553
BIDV&EAB	1.0000	0.9896	-0.0105	0.0002	0.9998	0.9460
BIDV&EIB	1.0000	0.9938	-0.0063	0.0000	0.9998	0.9840
BIDV&MSB	0.9986	0.9955	-0.0031	0.0000	0.9984	0.9904
BIDV&MB	1.0000	0.9895	-0.0106	0.0003	0.9998	0.9367
BIDV&NCB	0.9961	0.9925	-0.0036	0.0000	0.9958	0.9825
BIDV&VietCapitalBank	0.9960	0.9935	-0.0026	0.0000	0.9959	0.9882
BIDV&OceanBank	1.0000	0.9912	-0.0089	0.0001	0.9998	0.9659
BIDV&HBB	1.0000	0.9940	-0.0060	0.0000	0.9998	0.9789
BIDV&HDB	1.0000	0.9930	-0.0071	0.0000	0.9998	0.9800
BIDV&SHB	1.0000	0.9900	-0.0101	0.0002	0.9998	0.9545
BIDV&WesternBank	0.9984	0.9956	-0.0028	0.0000	0.9983	0.9898
VCB&CTG	1.0000	0.9897	-0.0104	0.0002	0.9998	0.9496
VCB&ABB	0.9959	0.9937	-0.0022	0.0000	0.9957	0.9908
VCB&ACB	1.0000	0.9890	-0.0112	0.0003	0.9998	0.9345
VCB&EAB	1.0000	0.9908	-0.0093	0.0001	0.9998	0.9578
VCB&EIB	1.0000	0.9949	-0.0051	0.0000	0.9998	0.9875
VCB&MSB	1.0000	0.9891	-0.0110	0.0002	0.9998	0.9411
VCB&MB	1.0000	0.9900	-0.0101	0.0002	0.9998	0.9398
VCB&NCB	0.9929	0.9897	-0.0032	0.0000	0.9927	0.9807
VCB&VietCapitalBank	0.9906	0.9884	-0.0023	0.0000	0.9905	0.9854
VCB&OceanBank	1.0000	0.9901	-0.0100	0.0002	0.9998	0.9523
VCB&HBB	1.0000	0.9946	-0.0055	0.0000	0.9998	0.9815
VCB&HDB	0.9967	0.9945	-0.0022	0.0000	0.9965	0.9910

VCB&SHB	1.0000	0.9955	-0.0045	0.0000	0.9998	0.9827
VCB&WesternBank	0.9937	0.9915	-0.0022	0.0000	0.9935	0.9883
CTG&ABB	1.0000	0.9957	-0.0043	0.0000	0.9998	0.9895
CTG&ACB	1.0000	0.9906	-0.0095	0.0001	0.9998	0.9588
CTG&EAB	1.0000	0.9919	-0.0081	0.0001	0.9998	0.9734
CTG&EIB	1.0000	0.9936	-0.0064	0.0000	0.9997	0.9816
CTG&MSB	1.0000	0.9966	-0.0034	0.0000	0.9999	0.9903
CTG&MB	1.0000	0.9921	-0.0079	0.0001	0.9998	0.9729
CTG&NCB	0.9963	0.9934	-0.0030	0.0000	0.9961	0.9886
CTG&VietCapitalBank	0.9979	0.9948	-0.0031	0.0000	0.9977	0.9881
CTG&OceanBank	1.0000	0.9950	-0.0050	0.0000	0.9998	0.9876
CTG&HBB	1.0000	0.9952	-0.0048	0.0000	0.9998	0.9889
CTG&HDB	1.0000	0.9948	-0.0053	0.0000	0.9998	0.9856
CTG&SHB	1.0000	0.9925	-0.0075	0.0001	0.9998	0.9774
CTG&WesternBank	1.0000	0.9959	-0.0041	0.0000	0.9998	0.9893
ABB&ACB	0.9966	0.9938	-0.0028	0.0000	0.9964	0.9884
ABB&EAB	0.9959	0.9927	-0.0032	0.0000	0.9957	0.9854
ABB&EIB	1.0000	0.9921	-0.0079	0.0001	0.9998	0.9758
ABB&MSB	1.0000	0.9978	-0.0022	0.0000	0.9998	0.9946
ABB&MB	1.0000	0.9941	-0.0059	0.0000	0.9998	0.9816
ABB&NCB	0.9256	0.9220	-0.0042	0.0000	0.9254	0.9155
ABB&VietCapitalBank	0.9739	0.9699	-0.0042	0.0000	0.9738	0.9539
ABB&OceanBank	0.9964	0.9937	-0.0027	0.0000	0.9962	0.9893
ABB&HBB	1.0000	0.9947	-0.0053	0.0000	0.9998	0.9858
ABB&HDB	1.0000	0.9918	-0.0083	0.0001	0.9998	0.9717
ABB&SHB	0.9995	0.9968	-0.0028	0.0000	0.9993	0.9918
ABB&WesternBank	1.0000	0.9910	-0.0091	0.0001	0.9998	0.9659
ACB&EAB	0.9467	0.9446	-0.0024	0.0000	0.9465	0.9422
ACB&EIB	1.0000	0.9938	-0.0062	0.0000	0.9998	0.9799
ACB&MSB	1.0000	0.9893	-0.0108	0.0002	0.9998	0.9468
ACB&MB	1.0000	0.9894	-0.0107	0.0003	0.9998	0.9348
ACB&NCB	0.9875	0.9845	-0.0031	0.0000	0.9873	0.9789
ACB&VietCapitalBank	0.9979	0.9952	-0.0027	0.0000	0.9977	0.9910
ACB&OceanBank	1.0000	0.9926	-0.0075	0.0001	0.9998	0.9750
ACB&HBB	1.0000	0.9928	-0.0072	0.0001	0.9998	0.9740
ACB&HDB	1.0000	0.9970	-0.0030	0.0000	0.9998	0.9914
ACB&SHB	0.9750	0.9709	-0.0043	0.0000	0.9748	0.9586
ACB&WesternBank	1.0000	0.9963	-0.0037	0.0000	0.9998	0.9917
EAB&EIB	1.0000	0.9963	-0.0037	0.0000	0.9998	0.9926
EAB&MSB	0.9870	0.9837	-0.0034	0.0000	0.9868	0.9765
EAB&MB	1.0000	0.9909	-0.0092	0.0001	0.9998	0.9660
EAB&NCB	0.9569	0.9530	-0.0042	0.0000	0.9567	0.9409
EAB&VietCapitalBank	0.9706	0.9667	-0.0042	0.0000	0.9704	0.9563
EAB&OceanBank	1.0000	0.9893	-0.0108	0.0003	0.9999	0.9383
EAB&HBB	1.0000	0.9934	-0.0066	0.0000	0.9998	0.9777
EAB&HDB	1.0000	0.9911	-0.0090	0.0001	0.9998	0.9658

EAB&SHB	1.0000	0.9897	-0.0104	0.0003	0.9998	0.9383
EAB&WesternBank	1.0000	0.9930	-0.0070	0.0000	0.9998	0.9764
EIB&MSB	1.0000	0.9955	-0.0046	0.0000	0.9999	0.9889
EIB&MB	1.0000	0.9917	-0.0084	0.0001	0.9998	0.9699
EIB&NCB	0.9757	0.9726	-0.0032	0.0000	0.9755	0.9674
EIB&VietCapitalBank	0.9910	0.9878	-0.0032	0.0000	0.9908	0.9797
EIB&OceanBank	0.9959	0.9922	-0.0037	0.0000	0.9957	0.9829
EIB&HBB	1.0000	0.9932	-0.0069	0.0000	0.9998	0.9804
EIB&HDB	1.0000	0.9941	-0.0059	0.0000	0.9998	0.9843
EIB&SHB	0.9874	0.9850	-0.0025	0.0000	0.9872	0.9819
EIB&WesternBank	1.0000	0.9950	-0.0050	0.0000	0.9998	0.9871
MSB&MB	1.0000	0.9887	-0.0114	0.0003	0.9998	0.9364
MSB&NCB	0.9782	0.9748	-0.0035	0.0000	0.9779	0.9687
MSB&VietCapitalBank	0.9985	0.9946	-0.0039	0.0000	0.9983	0.9794
MSB&OceanBank	1.0000	0.9888	-0.0113	0.0003	0.9998	0.9360
MSB&HBB	1.0000	0.9917	-0.0084	0.0001	0.9998	0.9726
MSB&HDB	0.9845	0.9806	-0.0040	0.0000	0.9843	0.9715
MSB&SHB	0.9895	0.9857	-0.0038	0.0000	0.9892	0.9781
MSB&WesternBank	1.0000	0.9918	-0.0083	0.0001	0.9998	0.9686
MB&NCB	0.9735	0.9703	-0.0034	0.0000	0.9733	0.9648
MB&VietCapitalBank	0.9976	0.9938	-0.0039	0.0000	0.9974	0.9768
MB&OceanBank	1.0000	0.9892	-0.0109	0.0002	0.9998	0.9463
MB&HBB	1.0000	0.9895	-0.0106	0.0002	0.9998	0.9440
MB&HDB	1.0000	0.9914	-0.0087	0.0001	0.9998	0.9665
MB&SHB	1.0000	0.9896	-0.0105	0.0003	0.9998	0.9399
MB&WesternBank	1.0000	0.9917	-0.0084	0.0001	0.9998	0.9674
NCB&VietCapitalBank	0.9388	0.9357	-0.0035	0.0000	0.9386	0.9293
NCB&OceanBank	1.0000	0.9895	-0.0106	0.0002	0.9998	0.9440
NCB&HBB	0.9807	0.9772	-0.0036	0.0000	0.9805	0.9675
NCB&HDB	0.9772	0.9732	-0.0042	0.0000	0.9770	0.9613
NCB&SHB	0.9022	0.8993	-0.0036	0.0000	0.9020	0.8940
NCB&WesternBank	0.9599	0.9568	-0.0034	0.0000	0.9597	0.9505
VietCapitalBank&OceanBank	1.0000	0.9931	-0.0070	0.0001	0.9998	0.9769
VietCapitalBank&HBB	0.9961	0.9925	-0.0037	0.0000	0.9959	0.9800
VietCapitalBank&HDB	0.9882	0.9842	-0.0041	0.0000	0.9880	0.9683
VietCapitalBank&SHB	0.9775	0.9735	-0.0041	0.0000	0.9773	0.9573
VietCapitalBank&WesternBank	1.0000	0.9885	-0.0116	0.0003	0.9998	0.9350
OceanBank&HBB	1.0000	0.9887	-0.0114	0.0003	0.9998	0.9358
OceanBank&HDB	1.0000	0.9893	-0.0108	0.0003	0.9998	0.9383
OceanBank&SHB	1.0000	0.9892	-0.0109	0.0003	0.9998	0.9390
OceanBank&WesternBank	1.0000	0.9895	-0.0106	0.0003	0.9998	0.9415
HBB&HDB	1.0000	0.9911	-0.0090	0.0001	0.9998	0.9687
HBB&SHB	1.0000	0.9932	-0.0069	0.0000	0.9998	0.9786
HBB&WesternBank	1.0000	0.9918	-0.0083	0.0001	0.9998	0.9729
HDB&SHB	1.0000	0.9900	-0.0101	0.0002	0.9998	0.9522
HDB&WesternBank	1.0000	0.9895	-0.0106	0.0003	0.9998	0.9365

SHB&WesternBank	1.0000	0.9887	-0.0115	0.0003	0.9998	0.9329
Mean	0.9910	0.9850	-0.0061	0.0001	0.9908	0.9656
SD	0.0181	0.0168	0.0032	0.0001	0.0181	0.0214
Min.	0.9022	0.8993	-0.0116	0.0000	0.9020	0.8940
Max.	1.0000	0.9978	-0.0012	0.0003	0.9999	0.9946

Notes: VRS (efficiency estimates under variable returns to scale assumption), BCVRS (bias-corrected efficiency estimates under variable returns to scale assumption), BIAS (bootstrap bias estimates), SD (the standard deviation of the bias), 95% confidence intervals of the bias-corrected efficiency scores (LB=lower bound, UB= upper bound)

Appendix 13 Efficiency estimates of the virtual bank mergers (VBMs), 2009

VBMs	VRS	BCVRS	Bias	SD	UB	LB
AGB&BIDV	1.0000	0.9859	-0.0143	0.0006	0.9998	0.9092
AGB&VCB	1.0000	0.9855	-0.0147	0.0006	0.9999	0.9123
AGB&CTG	1.0000	0.9883	-0.0119	0.0003	0.9998	0.9510
AGB&ABB	0.9942	0.9917	-0.0026	0.0000	0.9940	0.9889
AGB&ACB	1.0000	0.9848	-0.0154	0.0006	0.9998	0.9122
AGB&EAB	1.0000	0.9920	-0.0081	0.0001	0.9998	0.9773
AGB&EIB	1.0000	0.9968	-0.0032	0.0000	0.9998	0.9922
AGB&MSB	1.0000	0.9930	-0.0071	0.0000	0.9998	0.9763
AGB&MB	1.0000	0.9914	-0.0087	0.0001	0.9998	0.9663
AGB&NCB	1.0000	0.9927	-0.0074	0.0000	0.9998	0.9786
AGB&VietCapitalBank	1.0000	0.9934	-0.0066	0.0000	0.9999	0.9829
AGB&OceanBank	0.9985	0.9955	-0.0031	0.0000	0.9983	0.9909
AGB&HBB	0.9987	0.9953	-0.0035	0.0000	0.9985	0.9880
AGB&HDB	1.0000	0.9958	-0.0042	0.0000	0.9998	0.9885
AGB&SHB	0.9876	0.9848	-0.0029	0.0000	0.9875	0.9797
AGB&WesternBank	1.0000	0.9954	-0.0046	0.0000	0.9998	0.9877
BIDV&VCB	1.0000	0.9857	-0.0145	0.0005	0.9998	0.9181
BIDV&CTG	1.0000	0.9860	-0.0142	0.0004	0.9999	0.9348
BIDV&ABB	0.9895	0.9871	-0.0025	0.0000	0.9893	0.9840
BIDV&ACB	1.0000	0.9871	-0.0131	0.0003	0.9998	0.9427
BIDV&EAB	1.0000	0.9913	-0.0087	0.0001	0.9998	0.9725
BIDV&EIB	1.0000	0.9959	-0.0041	0.0000	0.9998	0.9850
BIDV&MSB	1.0000	0.9913	-0.0088	0.0001	0.9998	0.9746
BIDV&MB	0.9928	0.9891	-0.0038	0.0000	0.9926	0.9754
BIDV&NCB	1.0000	0.9910	-0.0091	0.0001	0.9998	0.9695
BIDV&VietCapitalBank	1.0000	0.9929	-0.0072	0.0000	0.9998	0.9764
BIDV&OceanBank	0.9912	0.9872	-0.0042	0.0000	0.9911	0.9777
BIDV&HBB	0.9999	0.9965	-0.0034	0.0000	0.9997	0.9889
BIDV&HDB	0.9968	0.9940	-0.0029	0.0000	0.9966	0.9902
BIDV&SHB	0.9730	0.9710	-0.0022	0.0000	0.9728	0.9682
BIDV&WesternBank	0.9957	0.9927	-0.0030	0.0000	0.9955	0.9877
VCB&CTG	1.0000	0.9856	-0.0146	0.0004	0.9998	0.9319
VCB&ABB	0.9222	0.9189	-0.0039	0.0000	0.9220	0.9137
VCB&ACB	1.0000	0.9852	-0.0150	0.0006	0.9998	0.9154
VCB&EAB	0.9626	0.9591	-0.0038	0.0000	0.9625	0.9525
VCB&EIB	0.9317	0.9293	-0.0028	0.0000	0.9315	0.9258
VCB&MSB	1.0000	0.9877	-0.0125	0.0003	0.9998	0.9392
VCB&MB	0.9691	0.9653	-0.0040	0.0000	0.9689	0.9529
VCB&NCB	1.0000	0.9944	-0.0057	0.0000	0.9998	0.9840
VCB&VietCapitalBank	0.9494	0.9465	-0.0032	0.0000	0.9492	0.9417
VCB&OceanBank	0.9691	0.9652	-0.0041	0.0000	0.9689	0.9530
VCB&HBB	0.9728	0.9694	-0.0036	0.0000	0.9725	0.9612
VCB&HDB	0.9374	0.9336	-0.0044	0.0000	0.9372	0.9267

VCB&SHB	0.8926	0.8896	-0.0037	0.0000	0.8924	0.8831
VCB&WesternBank	0.9549	0.9523	-0.0029	0.0000	0.9547	0.9479
CTG&ABB	0.9966	0.9939	-0.0028	0.0000	0.9965	0.9906
CTG&ACB	1.0000	0.9868	-0.0134	0.0004	0.9998	0.9398
CTG&EAB	1.0000	0.9870	-0.0132	0.0003	0.9998	0.9437
CTG&EIB	1.0000	0.9929	-0.0072	0.0000	0.9998	0.9788
CTG&MSB	1.0000	0.9909	-0.0092	0.0001	0.9998	0.9678
CTG&MB	1.0000	0.9936	-0.0064	0.0000	0.9998	0.9791
CTG&NCB	1.0000	0.9950	-0.0050	0.0000	0.9997	0.9870
CTG&VietCapitalBank	1.0000	0.9944	-0.0057	0.0000	0.9998	0.9826
CTG&OceanBank	0.9914	0.9867	-0.0048	0.0000	0.9913	0.9715
CTG&HBB	1.0000	0.9956	-0.0045	0.0000	0.9998	0.9900
CTG&HDB	0.9993	0.9969	-0.0024	0.0000	0.9991	0.9935
CTG&SHB	0.9856	0.9826	-0.0031	0.0000	0.9854	0.9778
CTG&WesternBank	0.9981	0.9957	-0.0024	0.0000	0.9979	0.9924
ABB&ACB	0.9943	0.9913	-0.0030	0.0000	0.9941	0.9865
ABB&EAB	0.9860	0.9824	-0.0037	0.0000	0.9858	0.9751
ABB&EIB	0.9867	0.9847	-0.0020	0.0000	0.9865	0.9820
ABB&MSB	0.9864	0.9833	-0.0033	0.0000	0.9863	0.9748
ABB&MB	0.9854	0.9827	-0.0028	0.0000	0.9852	0.9777
ABB&NCB	0.9755	0.9722	-0.0035	0.0000	0.9753	0.9663
ABB&VietCapitalBank	0.9790	0.9749	-0.0044	0.0000	0.9788	0.9658
ABB&OceanBank	0.9664	0.9632	-0.0034	0.0000	0.9662	0.9570
ABB&HBB	0.9961	0.9938	-0.0024	0.0000	0.9959	0.9913
ABB&HDB	0.9693	0.9665	-0.0030	0.0000	0.9691	0.9622
ABB&SHB	0.9169	0.9148	-0.0025	0.0000	0.9168	0.9120
ABB&WesternBank	0.9717	0.9678	-0.0042	0.0000	0.9714	0.9582
ACB&EAB	1.0000	0.9930	-0.0071	0.0000	0.9998	0.9797
ACB&EIB	1.0000	0.9947	-0.0053	0.0000	0.9998	0.9854
ACB&MSB	1.0000	0.9849	-0.0154	0.0006	0.9998	0.9134
ACB&MB	1.0000	0.9848	-0.0154	0.0006	0.9998	0.9113
ACB&NCB	1.0000	0.9872	-0.0130	0.0003	0.9997	0.9460
ACB&VietCapitalBank	1.0000	0.9929	-0.0071	0.0000	0.9998	0.9787
ACB&OceanBank	0.9884	0.9841	-0.0044	0.0000	0.9882	0.9674
ACB&HBB	1.0000	0.9940	-0.0061	0.0000	0.9998	0.9818
ACB&HDB	1.0000	0.9957	-0.0043	0.0000	0.9998	0.9846
ACB&SHB	0.9731	0.9702	-0.0030	0.0000	0.9729	0.9651
ACB&WesternBank	1.0000	0.9891	-0.0110	0.0002	0.9998	0.9617
EAB&EIB	1.0000	0.9964	-0.0036	0.0000	0.9998	0.9874
EAB&MSB	1.0000	0.9874	-0.0128	0.0003	0.9998	0.9471
EAB&MB	1.0000	0.9861	-0.0141	0.0005	0.9998	0.9259
EAB&NCB	1.0000	0.9880	-0.0121	0.0003	0.9998	0.9442
EAB&VietCapitalBank	1.0000	0.9854	-0.0148	0.0006	0.9998	0.9112
EAB&OceanBank	1.0000	0.9866	-0.0136	0.0004	0.9998	0.9244
EAB&HBB	1.0000	0.9926	-0.0075	0.0001	0.9998	0.9721
EAB&HDB	1.0000	0.9907	-0.0094	0.0001	0.9998	0.9656

EAB&SHB	0.9562	0.9519	-0.0047	0.0000	0.9560	0.9401
EAB&WesternBank	0.9948	0.9911	-0.0037	0.0000	0.9946	0.9805
EIB&MSB	0.9883	0.9860	-0.0024	0.0000	0.9881	0.9834
EIB&MB	0.9926	0.9909	-0.0017	0.0000	0.9924	0.9893
EIB&NCB	0.9939	0.9913	-0.0026	0.0000	0.9937	0.9874
EIB&VietCapitalBank	1.0000	0.9886	-0.0115	0.0002	0.9998	0.9544
EIB&OceanBank	0.9467	0.9443	-0.0027	0.0000	0.9465	0.9414
EIB&HBB	0.9975	0.9951	-0.0023	0.0000	0.9973	0.9916
EIB&HDB	0.9940	0.9914	-0.0026	0.0000	0.9938	0.9866
EIB&SHB	0.9453	0.9430	-0.0026	0.0000	0.9451	0.9396
EIB&WesternBank	0.9915	0.9884	-0.0032	0.0000	0.9913	0.9814
MSB&MB	1.0000	0.9871	-0.0131	0.0004	0.9998	0.9401
MSB&NCB	1.0000	0.9854	-0.0148	0.0005	0.9997	0.9183
MSB&VietCapitalBank	0.9936	0.9907	-0.0030	0.0000	0.9934	0.9849
MSB&OceanBank	1.0000	0.9856	-0.0146	0.0005	0.9998	0.9125
MSB&HBB	1.0000	0.9911	-0.0090	0.0001	0.9998	0.9666
MSB&HDB	0.9931	0.9899	-0.0033	0.0000	0.9929	0.9829
MSB&SHB	0.9538	0.9505	-0.0037	0.0000	0.9537	0.9408
MSB&WesternBank	1.0000	0.9864	-0.0138	0.0004	0.9998	0.9298
MB&NCB	1.0000	0.9875	-0.0126	0.0003	0.9998	0.9508
MB&VietCapitalBank	1.0000	0.9939	-0.0061	0.0000	0.9998	0.9823
MB&OceanBank	1.0000	0.9864	-0.0138	0.0004	0.9998	0.9375
MB&HBB	1.0000	0.9936	-0.0065	0.0000	0.9998	0.9810
MB&HDB	1.0000	0.9879	-0.0123	0.0003	0.9998	0.9510
MB&SHB	0.9530	0.9499	-0.0034	0.0000	0.9528	0.9438
MB&WesternBank	1.0000	0.9872	-0.0130	0.0004	0.9998	0.9424
NCB&VietCapitalBank	1.0000	0.9847	-0.0156	0.0006	0.9998	0.9094
NCB&OceanBank	1.0000	0.9855	-0.0147	0.0005	0.9998	0.9145
NCB&HBB	1.0000	0.9867	-0.0135	0.0004	0.9998	0.9393
NCB&HDB	1.0000	0.9884	-0.0117	0.0003	0.9998	0.9501
NCB&SHB	0.9243	0.9218	-0.0030	0.0000	0.9242	0.9169
NCB&WesternBank	1.0000	0.9852	-0.0150	0.0006	0.9998	0.9109
VietCapitalBank&OceanBank	1.0000	0.9875	-0.0126	0.0003	0.9998	0.9516
VietCapitalBank&HBB	1.0000	0.9912	-0.0089	0.0001	0.9998	0.9728
VietCapitalBank&HDB	1.0000	0.9851	-0.0151	0.0005	0.9998	0.9214
VietCapitalBank&SHB	0.8841	0.8807	-0.0044	0.0000	0.8839	0.8723
VietCapitalBank&WesternBank	1.0000	0.9849	-0.0153	0.0006	0.9998	0.9123
OceanBank&HBB	1.0000	0.9924	-0.0076	0.0001	0.9998	0.9700
OceanBank&HDB	1.0000	0.9885	-0.0116	0.0002	0.9998	0.9570
OceanBank&SHB	0.9313	0.9280	-0.0038	0.0000	0.9312	0.9208
OceanBank&WesternBank	1.0000	0.9853	-0.0149	0.0006	0.9998	0.9125
HBB&HDB	1.0000	0.9950	-0.0050	0.0000	0.9998	0.9862
HBB&SHB	0.9409	0.9380	-0.0032	0.0000	0.9407	0.9329
HBB&WesternBank	1.0000	0.9904	-0.0097	0.0001	0.9998	0.9666
HDB&SHB	0.9027	0.8996	-0.0039	0.0000	0.9025	0.8917
HDB&WesternBank	1.0000	0.9855	-0.0147	0.0006	0.9998	0.9121

SHB&WesternBank	0.8987	0.8952	-0.0043	0.0000	0.8986	0.8861
Mean	0.9868	0.9796	-0.0073	0.0001	0.9866	0.9563
SD	0.0250	0.0233	0.0046	0.0002	0.0250	0.0292
Min.	0.8841	0.8807	-0.0156	0.0000	0.8839	0.8723
Max.	1.0000	0.9969	-0.0017	0.0006	0.9999	0.9935

Notes: VRS (efficiency estimates under variable returns to scale assumption), BCVRS (bias-corrected efficiency estimates under variable returns to scale assumption), BIAS (bootstrap bias estimates), SD (the standard deviation of the bias), 95% confidence intervals of the bias-corrected efficiency scores (LB=lower bound, UB= upper bound)

Appendix 14 Efficiency estimates of the virtual bank mergers (VBMs), 2010

VBMs	VRS	BCVRS	Bias	SD	UB	LB
AGB&BIDV	1.0000	0.9765	-0.0241	0.0010	0.9996	0.8993
AGB&VCB	1.0000	0.9752	-0.0255	0.0011	0.9997	0.8990
AGB&CTG	1.0000	0.9764	-0.0241	0.0011	0.9996	0.8982
AGB&ABB	0.9861	0.9809	-0.0053	0.0000	0.9857	0.9732
AGB&ACB	1.0000	0.9914	-0.0086	0.0000	0.9996	0.9739
AGB&EAB	1.0000	0.9845	-0.0157	0.0002	0.9997	0.9567
AGB&EIB	1.0000	0.9873	-0.0129	0.0001	0.9996	0.9628
AGB&MSB	0.9619	0.9565	-0.0058	0.0000	0.9615	0.9483
AGB&MB	0.9920	0.9843	-0.0079	0.0001	0.9916	0.9605
AGB&NCB	1.0000	0.9918	-0.0083	0.0000	0.9996	0.9821
AGB&VietCapitalBank	1.0000	0.9937	-0.0063	0.0000	0.9996	0.9837
AGB&OceanBank	0.9934	0.9877	-0.0058	0.0000	0.9930	0.9773
AGB&HBB	1.0000	0.9853	-0.0149	0.0002	0.9996	0.9583
AGB&HDB	0.9944	0.9884	-0.0061	0.0000	0.9940	0.9756
AGB&SHB	0.9764	0.9706	-0.0061	0.0000	0.9761	0.9612
AGB&WesternBank	0.9979	0.9923	-0.0056	0.0000	0.9975	0.9823
BIDV&VCB	1.0000	0.9757	-0.0249	0.0011	0.9996	0.8984
BIDV&CTG	1.0000	0.9809	-0.0194	0.0005	0.9996	0.9335
BIDV&ABB	0.9857	0.9805	-0.0054	0.0000	0.9854	0.9726
BIDV&ACB	1.0000	0.9801	-0.0203	0.0005	0.9997	0.9311
BIDV&EAB	1.0000	0.9837	-0.0166	0.0002	0.9996	0.9563
BIDV&EIB	1.0000	0.9839	-0.0164	0.0002	0.9995	0.9506
BIDV&MSB	0.9486	0.9420	-0.0073	0.0000	0.9482	0.9265
BIDV&MB	0.9705	0.9625	-0.0085	0.0001	0.9701	0.9372
BIDV&NCB	1.0000	0.9923	-0.0077	0.0000	0.9996	0.9805
BIDV&VietCapitalBank	1.0000	0.9945	-0.0055	0.0000	0.9996	0.9866
BIDV&OceanBank	0.9975	0.9919	-0.0056	0.0000	0.9972	0.9831
BIDV&HBB	1.0000	0.9890	-0.0111	0.0001	0.9997	0.9752
BIDV&HDB	0.9954	0.9914	-0.0041	0.0000	0.9949	0.9859
BIDV&SHB	0.9827	0.9777	-0.0052	0.0000	0.9823	0.9706
BIDV&WesternBank	0.9964	0.9911	-0.0053	0.0000	0.9960	0.9830
VCB&CTG	1.0000	0.9754	-0.0252	0.0011	0.9996	0.8980
VCB&ABB	0.9530	0.9495	-0.0039	0.0000	0.9526	0.9450
VCB&ACB	1.0000	0.9754	-0.0253	0.0011	0.9997	0.8997
VCB&EAB	0.9751	0.9695	-0.0059	0.0000	0.9748	0.9597
VCB&EIB	1.0000	0.9823	-0.0180	0.0003	0.9997	0.9425
VCB&MSB	0.9968	0.9878	-0.0092	0.0001	0.9965	0.9499
VCB&MB	0.9808	0.9725	-0.0087	0.0001	0.9805	0.9452
VCB&NCB	1.0000	0.9867	-0.0135	0.0001	0.9997	0.9622
VCB&VietCapitalBank	0.9930	0.9885	-0.0046	0.0000	0.9927	0.9774
VCB&OceanBank	1.0000	0.9755	-0.0251	0.0010	0.9997	0.9093
VCB&HBB	1.0000	0.9766	-0.0240	0.0009	0.9995	0.9085
VCB&HDB	0.9858	0.9776	-0.0085	0.0001	0.9853	0.9522

VCB&SHB	0.8854	0.8802	-0.0066	0.0000	0.8850	0.8679
VCB&WesternBank	0.9877	0.9835	-0.0044	0.0000	0.9874	0.9733
CTG&ABB	0.9879	0.9833	-0.0047	0.0000	0.9875	0.9778
CTG&ACB	1.0000	0.9821	-0.0183	0.0004	0.9996	0.9364
CTG&EAB	1.0000	0.9878	-0.0124	0.0001	0.9996	0.9716
CTG&EIB	1.0000	0.9866	-0.0136	0.0001	0.9996	0.9622
CTG&MSB	0.9535	0.9461	-0.0081	0.0001	0.9531	0.9271
CTG&MB	0.9905	0.9828	-0.0079	0.0001	0.9902	0.9574
CTG&NCB	1.0000	0.9947	-0.0053	0.0000	0.9995	0.9884
CTG&VietCapitalBank	1.0000	0.9943	-0.0058	0.0000	0.9996	0.9869
CTG&OceanBank	0.9819	0.9777	-0.0044	0.0000	0.9815	0.9728
CTG&HBB	1.0000	0.9861	-0.0141	0.0001	0.9996	0.9649
CTG&HDB	0.9974	0.9915	-0.0060	0.0000	0.9970	0.9814
CTG&SHB	0.9862	0.9819	-0.0044	0.0000	0.9858	0.9761
CTG&WesternBank	0.9956	0.9904	-0.0053	0.0000	0.9952	0.9829
ABB&ACB	0.9707	0.9646	-0.0066	0.0000	0.9704	0.9531
ABB&EAB	0.9520	0.9445	-0.0084	0.0000	0.9516	0.9303
ABB&EIB	0.9745	0.9686	-0.0062	0.0000	0.9741	0.9608
ABB&MSB	0.9274	0.9217	-0.0067	0.0000	0.9271	0.9126
ABB&MB	0.8935	0.8883	-0.0065	0.0000	0.8932	0.8778
ABB&NCB	0.8846	0.8793	-0.0069	0.0000	0.8843	0.8719
ABB&VietCapitalBank	0.9260	0.9217	-0.0050	0.0000	0.9256	0.9144
ABB&OceanBank	0.8937	0.8888	-0.0062	0.0000	0.8933	0.8821
ABB&HBB	0.9143	0.9079	-0.0077	0.0000	0.9139	0.8996
ABB&HDB	0.9239	0.9187	-0.0062	0.0000	0.9236	0.9118
ABB&SHB	0.8953	0.8914	-0.0049	0.0000	0.8950	0.8872
ABB&WesternBank	0.8878	0.8831	-0.0061	0.0000	0.8875	0.8754
ACB&EAB	0.9903	0.9840	-0.0065	0.0000	0.9900	0.9740
ACB&EIB	1.0000	0.9764	-0.0242	0.0010	0.9996	0.9001
ACB&MSB	1.0000	0.9744	-0.0263	0.0012	0.9996	0.8967
ACB&MB	0.9898	0.9810	-0.0091	0.0002	0.9894	0.9422
ACB&NCB	1.0000	0.9901	-0.0100	0.0001	0.9995	0.9724
ACB&VietCapitalBank	1.0000	0.9929	-0.0071	0.0000	0.9997	0.9783
ACB&OceanBank	1.0000	0.9765	-0.0240	0.0009	0.9997	0.9074
ACB&HBB	1.0000	0.9808	-0.0196	0.0005	0.9997	0.9372
ACB&HDB	1.0000	0.9865	-0.0137	0.0001	0.9997	0.9649
ACB&SHB	0.9739	0.9678	-0.0064	0.0000	0.9735	0.9539
ACB&WesternBank	0.9909	0.9849	-0.0062	0.0000	0.9906	0.9715
EAB&EIB	1.0000	0.9771	-0.0235	0.0008	0.9996	0.9127
EAB&MSB	0.8547	0.8494	-0.0073	0.0000	0.8544	0.8399
EAB&MB	0.9673	0.9598	-0.0080	0.0000	0.9669	0.9435
EAB&NCB	1.0000	0.9870	-0.0132	0.0001	0.9995	0.9634
EAB&VietCapitalBank	1.0000	0.9819	-0.0184	0.0004	0.9997	0.9333
EAB&OceanBank	0.9758	0.9682	-0.0081	0.0000	0.9755	0.9544
EAB&HBB	1.0000	0.9757	-0.0249	0.0010	0.9996	0.9001
EAB&HDB	0.9949	0.9875	-0.0076	0.0000	0.9945	0.9689

EAB&SHB	0.9460	0.9389	-0.0080	0.0000	0.9457	0.9241
EAB&WesternBank	0.9917	0.9826	-0.0093	0.0002	0.9913	0.9412
EIB&MSB	1.0000	0.9778	-0.0227	0.0007	0.9997	0.9195
EIB&MB	1.0000	0.9763	-0.0243	0.0010	0.9996	0.8985
EIB&NCB	0.9947	0.9876	-0.0072	0.0001	0.9943	0.9655
EIB&VietCapitalBank	1.0000	0.9908	-0.0093	0.0000	0.9997	0.9765
EIB&OceanBank	1.0000	0.9775	-0.0231	0.0008	0.9996	0.9132
EIB&HBB	1.0000	0.9766	-0.0239	0.0010	0.9996	0.8987
EIB&HDB	1.0000	0.9879	-0.0123	0.0001	0.9997	0.9673
EIB&SHB	0.9774	0.9706	-0.0072	0.0000	0.9770	0.9589
EIB&WesternBank	0.9900	0.9829	-0.0074	0.0000	0.9897	0.9685
MSB&MB	0.9840	0.9755	-0.0088	0.0001	0.9837	0.9425
MSB&NCB	0.9500	0.9431	-0.0078	0.0000	0.9496	0.9313
MSB&VietCapitalBank	0.9954	0.9902	-0.0052	0.0000	0.9951	0.9784
MSB&OceanBank	1.0000	0.9768	-0.0237	0.0010	0.9996	0.9000
MSB&HBB	1.0000	0.9840	-0.0163	0.0003	0.9996	0.9503
MSB&HDB	1.0000	0.9855	-0.0147	0.0002	0.9996	0.9621
MSB&SHB	0.9472	0.9416	-0.0063	0.0000	0.9469	0.9329
MSB&WesternBank	0.9781	0.9731	-0.0053	0.0000	0.9776	0.9620
MB&NCB	0.8922	0.8865	-0.0072	0.0000	0.8918	0.8760
MB&VietCapitalBank	0.9451	0.9415	-0.0041	0.0000	0.9448	0.9346
MB&OceanBank	0.9468	0.9414	-0.0060	0.0000	0.9464	0.9324
MB&HBB	0.9765	0.9679	-0.0091	0.0001	0.9761	0.9327
MB&HDB	0.9805	0.9751	-0.0056	0.0000	0.9801	0.9663
MB&SHB	0.9051	0.8995	-0.0068	0.0000	0.9048	0.8921
MB&WesternBank	0.9253	0.9213	-0.0048	0.0000	0.9250	0.9142
NCB&VietCapitalBank	1.0000	0.9795	-0.0209	0.0006	0.9997	0.9259
NCB&OceanBank	1.0000	0.9761	-0.0245	0.0011	0.9996	0.8995
NCB&HBB	1.0000	0.9766	-0.0240	0.0010	0.9996	0.8980
NCB&HDB	0.9907	0.9844	-0.0064	0.0000	0.9903	0.9750
NCB&SHB	0.8867	0.8828	-0.0049	0.0000	0.8864	0.8781
NCB&WesternBank	0.9797	0.9704	-0.0098	0.0002	0.9793	0.9263
VietCapitalBank&OceanBank	1.0000	0.9803	-0.0201	0.0005	0.9995	0.9283
VietCapitalBank&HBB	1.0000	0.9794	-0.0210	0.0006	0.9996	0.9259
VietCapitalBank&HDB	1.0000	0.9824	-0.0179	0.0004	0.9996	0.9318
VietCapitalBank&SHB	0.9282	0.9248	-0.0039	0.0000	0.9279	0.9202
VietCapitalBank&WesternBank	1.0000	0.9757	-0.0249	0.0011	0.9995	0.8982
OceanBank&HBB	1.0000	0.9759	-0.0247	0.0011	0.9995	0.8985
OceanBank&HDB	1.0000	0.9831	-0.0171	0.0003	0.9996	0.9475
OceanBank&SHB	0.9255	0.9203	-0.0061	0.0000	0.9253	0.9127
OceanBank&WesternBank	0.9927	0.9827	-0.0102	0.0002	0.9924	0.9341
HBB&HDB	1.0000	0.9774	-0.0231	0.0008	0.9996	0.9112
HBB&SHB	0.9191	0.9136	-0.0066	0.0000	0.9188	0.9057
HBB&WesternBank	0.9926	0.9829	-0.0099	0.0002	0.9922	0.9354
HDB&SHB	0.9303	0.9250	-0.0062	0.0000	0.9299	0.9167
HDB&WesternBank	0.9626	0.9534	-0.0100	0.0002	0.9621	0.9158

SHB&WesternBank	0.8982	0.8945	-0.0046	0.0000	0.8979	0.8898
Mean	0.9775	0.9665	-0.0115	0.0002	0.9772	0.9386
SD	0.0342	0.0312	0.0071	0.0004	0.0342	0.0332
Min.	0.8547	0.8494	-0.0263	0.0000	0.8544	0.8399
Max.	1.0000	0.9947	-0.0039	0.0012	0.9997	0.9884

Notes: VRS (efficiency estimates under variable returns to scale assumption), BCVRS (bias-corrected efficiency estimates under variable returns to scale assumption), BIAS (bootstrap bias estimates), SD (the standard deviation of the bias), 95% confidence intervals of the bias-corrected efficiency scores (LB=lower bound, UB= upper bound)

Appendix 15 Efficiency estimates of the virtual bank mergers (VBMs), 2011

VBMs	VRS	BCVRS	Bias	SD	UB	LB
AGB&BIDV	1.0000	0.9544	-0.0477	0.0019	0.9989	0.8712
AGB&VCB	1.0000	0.9797	-0.0207	0.0003	0.9988	0.9367
AGB&CTG	1.0000	0.9546	-0.0476	0.0020	0.9988	0.8688
AGB&ABB	0.9487	0.9345	-0.0160	0.0001	0.9475	0.9183
AGB&ACB	1.0000	0.9866	-0.0136	0.0001	0.9989	0.9687
AGB&EAB	0.9705	0.9551	-0.0167	0.0001	0.9697	0.9366
AGB&EIB	0.9218	0.9050	-0.0202	0.0002	0.9206	0.8817
AGB&MSB	0.9518	0.9423	-0.0106	0.0000	0.9504	0.9301
AGB&MB	0.8972	0.8816	-0.0197	0.0001	0.8956	0.8615
AGB&NCB	0.9958	0.9870	-0.0089	0.0000	0.9949	0.9734
AGB&VietCapitalBank	0.9722	0.9584	-0.0149	0.0001	0.9709	0.9433
AGB&OceanBank	0.9914	0.9840	-0.0076	0.0000	0.9905	0.9742
AGB&HBB	0.9979	0.9895	-0.0084	0.0000	0.9968	0.9772
AGB&HDB	0.9665	0.9568	-0.0106	0.0000	0.9652	0.9432
AGB&SHB	0.9221	0.9076	-0.0174	0.0001	0.9210	0.8916
AGB&WesternBank	0.9431	0.9309	-0.0139	0.0001	0.9422	0.9147
BIDV&VCB	1.0000	0.9599	-0.0417	0.0011	0.9986	0.8965
BIDV&CTG	1.0000	0.9545	-0.0476	0.0019	0.9989	0.8713
BIDV&ABB	0.9857	0.9705	-0.0159	0.0001	0.9845	0.9523
BIDV&ACB	1.0000	0.9574	-0.0445	0.0013	0.9988	0.8933
BIDV&EAB	1.0000	0.9660	-0.0352	0.0006	0.9986	0.9258
BIDV&EIB	1.0000	0.9551	-0.0470	0.0016	0.9985	0.8841
BIDV&MSB	1.0000	0.9520	-0.0504	0.0019	0.9986	0.8757
BIDV&MB	0.9923	0.9714	-0.0217	0.0003	0.9911	0.9310
BIDV&NCB	1.0000	0.9772	-0.0234	0.0002	0.9984	0.9451
BIDV&VietCapitalBank	1.0000	0.9609	-0.0407	0.0009	0.9985	0.9149
BIDV&OceanBank	1.0000	0.9776	-0.0229	0.0002	0.9989	0.9506
BIDV&HBB	1.0000	0.9725	-0.0283	0.0003	0.9989	0.9428
BIDV&HDB	0.9851	0.9692	-0.0167	0.0001	0.9835	0.9449
BIDV&SHB	0.9821	0.9656	-0.0173	0.0001	0.9807	0.9465
BIDV&WesternBank	0.9925	0.9769	-0.0161	0.0001	0.9915	0.9588
VCB&CTG	1.0000	0.9537	-0.0485	0.0019	0.9985	0.8717
VCB&ABB	0.9040	0.8936	-0.0128	0.0000	0.9031	0.8832
VCB&ACB	1.0000	0.9524	-0.0500	0.0021	0.9988	0.8678
VCB&EAB	0.8986	0.8895	-0.0115	0.0000	0.8977	0.8791
VCB&EIB	0.9958	0.9721	-0.0245	0.0004	0.9947	0.9234
VCB&MSB	0.9525	0.9320	-0.0231	0.0003	0.9512	0.8943
VCB&MB	0.9383	0.9197	-0.0215	0.0002	0.9369	0.8967
VCB&NCB	0.9719	0.9624	-0.0101	0.0000	0.9708	0.9521
VCB&VietCapitalBank	0.9301	0.9173	-0.0150	0.0001	0.9292	0.9025
VCB&OceanBank	0.9717	0.9550	-0.0179	0.0001	0.9706	0.9318
VCB&HBB	0.9778	0.9663	-0.0122	0.0000	0.9764	0.9543
VCB&HDB	0.9218	0.9077	-0.0168	0.0001	0.9205	0.8929

VCB&SHB	0.8839	0.8672	-0.0218	0.0002	0.8829	0.8461
VCB&WesternBank	0.8732	0.8615	-0.0156	0.0001	0.8722	0.8494
CTG&ABB	0.9539	0.9455	-0.0093	0.0000	0.9529	0.9364
CTG&ACB	1.0000	0.9530	-0.0493	0.0020	0.9987	0.8671
CTG&EAB	0.9476	0.9344	-0.0149	0.0001	0.9462	0.9214
CTG&EIB	1.0000	0.9675	-0.0336	0.0006	0.9984	0.9169
CTG&MSB	0.9594	0.9405	-0.0210	0.0002	0.9581	0.9122
CTG&MB	0.9463	0.9327	-0.0155	0.0001	0.9450	0.9170
CTG&NCB	0.9732	0.9626	-0.0113	0.0000	0.9719	0.9497
CTG&VietCapitalBank	0.9759	0.9665	-0.0100	0.0000	0.9747	0.9569
CTG&OceanBank	0.9678	0.9551	-0.0138	0.0001	0.9666	0.9394
CTG&HBB	0.9768	0.9651	-0.0124	0.0000	0.9756	0.9517
CTG&HDB	0.9629	0.9534	-0.0103	0.0000	0.9618	0.9433
CTG&SHB	0.9386	0.9237	-0.0172	0.0001	0.9377	0.9072
CTG&WesternBank	0.9302	0.9189	-0.0132	0.0001	0.9290	0.9056
ABB&ACB	0.9559	0.9432	-0.0141	0.0001	0.9547	0.9293
ABB&EAB	0.9196	0.9005	-0.0231	0.0004	0.9184	0.8615
ABB&EIB	0.9646	0.9487	-0.0173	0.0001	0.9632	0.9257
ABB&MSB	0.8807	0.8651	-0.0205	0.0001	0.8796	0.8457
ABB&MB	0.8524	0.8401	-0.0171	0.0001	0.8514	0.8274
ABB&NCB	0.8636	0.8474	-0.0221	0.0002	0.8624	0.8209
ABB&VietCapitalBank	0.9864	0.9696	-0.0176	0.0001	0.9851	0.9436
ABB&OceanBank	0.8511	0.8354	-0.0221	0.0002	0.8500	0.8145
ABB&HBB	0.9016	0.8842	-0.0219	0.0003	0.9003	0.8539
ABB&HDB	0.8585	0.8452	-0.0182	0.0001	0.8574	0.8290
ABB&SHB	0.8868	0.8768	-0.0128	0.0000	0.8857	0.8661
ABB&WesternBank	0.8294	0.8133	-0.0240	0.0002	0.8281	0.7925
ACB&EAB	0.9437	0.9340	-0.0110	0.0000	0.9425	0.9251
ACB&EIB	1.0000	0.9542	-0.0480	0.0020	0.9987	0.8687
ACB&MSB	1.0000	0.9526	-0.0498	0.0020	0.9986	0.8690
ACB&MB	0.9754	0.9558	-0.0211	0.0003	0.9742	0.9220
ACB&NCB	0.9930	0.9724	-0.0214	0.0003	0.9918	0.9322
ACB&VietCapitalBank	1.0000	0.9728	-0.0279	0.0003	0.9986	0.9454
ACB&OceanBank	1.0000	0.9551	-0.0470	0.0016	0.9984	0.8846
ACB&HBB	1.0000	0.9711	-0.0298	0.0004	0.9987	0.9283
ACB&HDB	0.9823	0.9638	-0.0195	0.0001	0.9813	0.9394
ACB&SHB	0.9269	0.9104	-0.0195	0.0002	0.9256	0.8862
ACB&WesternBank	0.9078	0.8951	-0.0156	0.0001	0.9067	0.8823
EAB&EIB	0.9791	0.9627	-0.0174	0.0001	0.9777	0.9393
EAB&MSB	0.9336	0.9141	-0.0228	0.0003	0.9326	0.8795
EAB&MB	0.8923	0.8795	-0.0164	0.0001	0.8912	0.8680
EAB&NCB	1.0000	0.9759	-0.0247	0.0003	0.9986	0.9342
EAB&VietCapitalBank	1.0000	0.9551	-0.0470	0.0019	0.9989	0.8728
EAB&OceanBank	0.8879	0.8713	-0.0214	0.0001	0.8866	0.8532
EAB&HBB	1.0000	0.9739	-0.0268	0.0002	0.9984	0.9525
EAB&HDB	0.8994	0.8858	-0.0170	0.0001	0.8983	0.8680

EAB&SHB	0.9182	0.9058	-0.0150	0.0001	0.9171	0.8922
EAB&WesternBank	0.9847	0.9668	-0.0187	0.0001	0.9833	0.9402
EIB&MSB	1.0000	0.9531	-0.0492	0.0019	0.9987	0.8679
EIB&MB	1.0000	0.9755	-0.0252	0.0003	0.9985	0.9358
EIB&NCB	0.9747	0.9595	-0.0163	0.0001	0.9734	0.9373
EIB&VietCapitalBank	1.0000	0.9600	-0.0417	0.0011	0.9988	0.9063
EIB&OceanBank	1.0000	0.9681	-0.0329	0.0005	0.9985	0.9320
EIB&HBB	1.0000	0.9720	-0.0288	0.0003	0.9988	0.9461
EIB&HDB	0.9696	0.9487	-0.0227	0.0003	0.9685	0.9141
EIB&SHB	0.9825	0.9635	-0.0200	0.0002	0.9813	0.9375
EIB&WesternBank	0.9681	0.9532	-0.0162	0.0001	0.9668	0.9354
MSB&MB	0.9727	0.9492	-0.0254	0.0006	0.9715	0.8868
MSB&NCB	0.9960	0.9751	-0.0215	0.0002	0.9945	0.9397
MSB&VietCapitalBank	1.0000	0.9547	-0.0474	0.0019	0.9988	0.8713
MSB&OceanBank	1.0000	0.9549	-0.0472	0.0019	0.9990	0.8680
MSB&HBB	1.0000	0.9632	-0.0383	0.0009	0.9988	0.9098
MSB&HDB	0.9577	0.9375	-0.0225	0.0003	0.9566	0.8998
MSB&SHB	0.9090	0.8909	-0.0224	0.0002	0.9077	0.8629
MSB&WesternBank	0.9317	0.9125	-0.0225	0.0003	0.9303	0.8784
MB&NCB	0.8663	0.8493	-0.0230	0.0002	0.8650	0.8316
MB&VietCapitalBank	0.9228	0.9084	-0.0171	0.0001	0.9217	0.8902
MB&OceanBank	0.9638	0.9428	-0.0231	0.0003	0.9626	0.9107
MB&HBB	0.9690	0.9530	-0.0173	0.0001	0.9679	0.9356
MB&HDB	0.8675	0.8538	-0.0185	0.0001	0.8662	0.8379
MB&SHB	0.8650	0.8506	-0.0197	0.0001	0.8640	0.8331
MB&WesternBank	0.8785	0.8636	-0.0197	0.0001	0.8775	0.8476
NCB&VietCapitalBank	1.0000	0.9541	-0.0481	0.0020	0.9988	0.8681
NCB&OceanBank	1.0000	0.9541	-0.0481	0.0018	0.9984	0.8764
NCB&HBB	1.0000	0.9551	-0.0470	0.0019	0.9987	0.8712
NCB&HDB	0.8673	0.8497	-0.0239	0.0003	0.8662	0.8185
NCB&SHB	0.8748	0.8645	-0.0136	0.0000	0.8738	0.8549
NCB&WesternBank	0.9593	0.9410	-0.0203	0.0002	0.9578	0.9088
VietCapitalBank&OceanBank	1.0000	0.9520	-0.0504	0.0020	0.9984	0.8688
VietCapitalBank&HBB	1.0000	0.9533	-0.0490	0.0019	0.9987	0.8689
VietCapitalBank&HDB	1.0000	0.9542	-0.0480	0.0017	0.9987	0.8802
VietCapitalBank&SHB	0.9719	0.9492	-0.0246	0.0003	0.9708	0.9165
VietCapitalBank&WesternBank	1.0000	0.9533	-0.0490	0.0020	0.9986	0.8680
OceanBank&HBB	1.0000	0.9537	-0.0486	0.0020	0.9986	0.8671
OceanBank&HDB	0.9343	0.9116	-0.0266	0.0005	0.9330	0.8608
OceanBank&SHB	0.8919	0.8775	-0.0184	0.0001	0.8910	0.8600
OceanBank&WesternBank	0.9865	0.9614	-0.0264	0.0004	0.9852	0.9129
HBB&HDB	0.9169	0.8963	-0.0250	0.0004	0.9158	0.8552
HBB&SHB	0.9082	0.8951	-0.0161	0.0001	0.9074	0.8787
HBB&WesternBank	1.0000	0.9591	-0.0426	0.0011	0.9986	0.8981
HDB&SHB	0.8749	0.8604	-0.0192	0.0001	0.8736	0.8409
HDB&WesternBank	0.8171	0.7995	-0.0270	0.0003	0.8159	0.7716

SHB&WesternBank	0.8536	0.8423	-0.0158	0.0001	0.8528	0.8314
Mean	0.9558	0.9332	-0.0249	0.0005	0.9546	0.8984
SD	0.0483	0.0424	0.0126	0.0007	0.0482	0.0414
Min.	0.8171	0.7995	-0.0504	0.0000	0.8159	0.7716
Max.	1.0000	0.9895	-0.0076	0.0021	0.9990	0.9772

Notes: VRS (efficiency estimates under variable returns to scale assumption), BCVRS (bias-corrected efficiency estimates under variable returns to scale assumption), BIAS (bootstrap bias estimates), SD (the standard deviation of the bias), 95% confidence intervals of the bias-corrected efficiency scores (LB=lower bound, UB= upper bound)

Appendix 16 Efficiency estimates of VBMs and non-merging banks, 2007

Banks	VRS	BCVRS	BIAS	SD	UB	LB
AGB&BIDV	1.0000	0.9928	-0.0072	0.0004	0.9998	0.9520
AGB&VCB	1.0000	0.9922	-0.0079	0.0005	0.9998	0.9511
AGB&CTG	1.0000	0.9942	-0.0058	0.0001	0.9998	0.9624
AGB&EAB	1.0000	0.9955	-0.0045	0.0000	0.9998	0.9895
AGB&NCB	1.0000	0.9951	-0.0050	0.0000	0.9998	0.9859
AGB&VietCapitalBank	1.0000	0.9951	-0.0049	0.0000	0.9998	0.9852
AGB&OceanBank	1.0000	0.9951	-0.0049	0.0000	0.9998	0.9864
AGB&HDB	1.0000	0.9953	-0.0048	0.0000	0.9998	0.9860
BIDV&VCB	1.0000	0.9919	-0.0082	0.0006	0.9998	0.9499
BIDV&CTG	1.0000	0.9929	-0.0072	0.0002	0.9998	0.9491
BIDV&ACB	1.0000	0.9951	-0.0049	0.0000	0.9998	0.9813
BIDV&EAB	1.0000	0.9948	-0.0052	0.0000	0.9998	0.9759
BIDV&EIB	1.0000	0.9955	-0.0045	0.0000	0.9998	0.9893
BIDV&MB	1.0000	0.9942	-0.0058	0.0001	0.9998	0.9574
BIDV&NCB	1.0000	0.9950	-0.0050	0.0000	0.9998	0.9782
BIDV&VietCapitalBank	1.0000	0.9947	-0.0053	0.0000	0.9998	0.9774
BIDV&OceanBank	1.0000	0.9954	-0.0046	0.0000	0.9998	0.9891
BIDV&HBB	1.0000	0.9958	-0.0042	0.0000	0.9998	0.9902
BIDV&HDB	1.0000	0.9949	-0.0052	0.0000	0.9998	0.9795
BIDV&SHB	1.0000	0.9955	-0.0045	0.0000	0.9998	0.9890
VCB&CTG	1.0000	0.9933	-0.0067	0.0002	0.9998	0.9505
VCB&ABB	1.0000	0.9963	-0.0037	0.0000	0.9998	0.9917
VCB&ACB	1.0000	0.9919	-0.0081	0.0006	0.9998	0.9500
VCB&EAB	1.0000	0.9953	-0.0047	0.0000	0.9998	0.9877
VCB&EIB	1.0000	0.9959	-0.0041	0.0000	0.9999	0.9911
VCB&MB	1.0000	0.9939	-0.0062	0.0001	0.9998	0.9491
VCB&NCB	1.0000	0.9952	-0.0049	0.0000	0.9999	0.9860
VCB&VietCapitalBank	1.0000	0.9969	-0.0031	0.0000	0.9998	0.9932
VCB&OceanBank	1.0000	0.9946	-0.0054	0.0000	0.9998	0.9673
VCB&HBB	1.0000	0.9946	-0.0054	0.0000	0.9998	0.9749
VCB&HDB	1.0000	0.9946	-0.0054	0.0000	0.9998	0.9760
VCB&SHB	1.0000	0.9950	-0.0051	0.0000	0.9998	0.9840
CTG&ABB	1.0000	0.9970	-0.0030	0.0000	0.9998	0.9929
CTG&ACB	1.0000	0.9941	-0.0059	0.0001	0.9998	0.9542
CTG&EAB	1.0000	0.9955	-0.0046	0.0000	0.9998	0.9885
CTG&EIB	1.0000	0.9955	-0.0045	0.0000	0.9998	0.9887
CTG&MB	1.0000	0.9943	-0.0057	0.0001	0.9998	0.9619
CTG&NCB	1.0000	0.9950	-0.0051	0.0000	0.9998	0.9801
CTG&VietCapitalBank	1.0000	0.9947	-0.0053	0.0000	0.9998	0.9754
CTG&OceanBank	1.0000	0.9955	-0.0046	0.0000	0.9998	0.9880
CTG&HBB	1.0000	0.9951	-0.0049	0.0000	0.9998	0.9847
CTG&HDB	1.0000	0.9953	-0.0047	0.0000	0.9999	0.9850
ABB&MSB	1.0000	0.9959	-0.0041	0.0000	0.9998	0.9916

ABB&MB	1.0000	0.9950	-0.0050	0.0000	0.9998	0.9827
ABB&VietCapitalBank	1.0000	0.9948	-0.0052	0.0000	0.9998	0.9750
ABB&OceanBank	1.0000	0.9933	-0.0068	0.0002	0.9998	0.9515
ABB&HBB	1.0000	0.9949	-0.0052	0.0000	0.9998	0.9821
ABB&HDB	1.0000	0.9951	-0.0049	0.0000	0.9998	0.9832
ACB&EIB	1.0000	0.9970	-0.0030	0.0000	0.9998	0.9924
ACB&MB	1.0000	0.9938	-0.0063	0.0001	0.9998	0.9492
ACB&HBB	1.0000	0.9938	-0.0062	0.0001	0.9998	0.9565
EAB&EIB	1.0000	0.9951	-0.0049	0.0000	0.9998	0.9814
EAB&MB	1.0000	0.9954	-0.0046	0.0000	0.9998	0.9887
EAB&VietCapitalBank	1.0000	0.9939	-0.0062	0.0001	0.9998	0.9506
EAB&HDB	1.0000	0.9935	-0.0065	0.0001	0.9998	0.9517
EAB&SHB	1.0000	0.9978	-0.0022	0.0000	0.9998	0.9947
EIB&MB	1.0000	0.9947	-0.0053	0.0000	0.9998	0.9746
EIB&VietCapitalBank	1.0000	0.9949	-0.0051	0.0000	0.9998	0.9768
EIB&HDB	1.0000	0.9957	-0.0043	0.0000	0.9998	0.9903
MSB&MB	1.0000	0.9951	-0.0050	0.0000	0.9998	0.9838
MSB&VietCapitalBank	1.0000	0.9953	-0.0048	0.0000	0.9998	0.9869
MSB&OceanBank	1.0000	0.9940	-0.0060	0.0001	0.9998	0.9623
MSB&HBB	1.0000	0.9956	-0.0044	0.0000	0.9998	0.9887
MB&NCB	1.0000	0.9931	-0.0070	0.0002	0.9998	0.9481
MB&VietCapitalBank	1.0000	0.9936	-0.0064	0.0001	0.9998	0.9505
MB&OceanBank	1.0000	0.9935	-0.0066	0.0001	0.9998	0.9494
MB&HBB	1.0000	0.9941	-0.0059	0.0001	0.9998	0.9597
MB&HDB	1.0000	0.9953	-0.0047	0.0000	0.9998	0.9881
MB&SHB	1.0000	0.9934	-0.0066	0.0002	0.9998	0.9530
NCB&VietCapitalBank	1.0000	0.9931	-0.0070	0.0003	0.9998	0.9539
NCB&OceanBank	1.0000	0.9917	-0.0084	0.0006	0.9998	0.9501
NCB&HBB	1.0000	0.9938	-0.0062	0.0001	0.9998	0.9525
NCB&HDB	1.0000	0.9942	-0.0059	0.0001	0.9997	0.9546
NCB&SHB	1.0000	0.9934	-0.0066	0.0001	0.9998	0.9472
VietCapitalBank&OceanBank	1.0000	0.9924	-0.0076	0.0005	0.9998	0.9500
VietCapitalBank&HBB	1.0000	0.9943	-0.0057	0.0000	0.9998	0.9641
VietCapitalBank&HDB	1.0000	0.9932	-0.0069	0.0002	0.9998	0.9518
VietCapitalBank&SHB	1.0000	0.9926	-0.0074	0.0004	0.9998	0.9518
VietCapitalBank&WesternBank	1.0000	0.9916	-0.0084	0.0006	0.9998	0.9487
OceanBank&HBB	1.0000	0.9917	-0.0084	0.0006	0.9998	0.9486
OceanBank&HDB	1.0000	0.9932	-0.0069	0.0003	0.9998	0.9600
OceanBank&SHB	1.0000	0.9924	-0.0077	0.0005	0.9998	0.9561
OceanBank&WesternBank	1.0000	0.9941	-0.0060	0.0001	0.9998	0.9541
HBB&HDB	1.0000	0.9951	-0.0049	0.0000	0.9998	0.9836
HDB&SHB	1.0000	0.9943	-0.0057	0.0001	0.9999	0.9544
SacomBank	0.9500	0.9472	-0.0031	0.0000	0.9498	0.9430
PNB	0.7934	0.7912	-0.0035	0.0000	0.7933	0.7883
TechcomBank	0.9404	0.9382	-0.0025	0.0000	0.9402	0.9356
VPBank	1.0000	0.9954	-0.0046	0.0000	0.9998	0.9883

Mean	0.9964	0.9910	-0.0055	0.0001	0.9963	0.9684
SD	0.0233	0.0228	0.0013	0.0002	0.0233	0.0257
Min.	0.7934	0.7912	-0.0084	0.0000	0.7933	0.7883
Max.	1.0000	0.9978	-0.0022	0.0006	0.9999	0.9947

Notes: VRS (efficiency estimates under variable returns to scale assumption), BCVRS (bias-corrected efficiency estimates under variable returns to scale assumption), BIAS (bootstrap bias estimates), SD (the standard deviation of the bias), 95% confidence intervals of the bias-corrected efficiency scores (LB=lower bound, UB= upper bound)

Appendix 17 Efficiency estimates of VBMs and non-merging banks, 2008

Banks	VRS	BCVRS	BIAS	SD	UB	LB
AGB&BIDV	1.0000	0.9873	-0.0128	0.0009	0.9997	0.9384
AGB&VCB	1.0000	0.9859	-0.0143	0.0015	0.9997	0.9168
AGB&CTG	1.0000	0.9910	-0.0091	0.0000	0.9995	0.9750
BIDV&VCB	1.0000	0.9867	-0.0134	0.0013	0.9997	0.9378
BIDV&CTG	1.0000	0.9883	-0.0118	0.0005	0.9996	0.9372
BIDV&ABB	1.0000	0.9944	-0.0056	0.0000	0.9997	0.9873
BIDV&ACB	1.0000	0.9907	-0.0094	0.0001	0.9997	0.9606
BIDV&EAB	1.0000	0.9900	-0.0101	0.0001	0.9997	0.9460
BIDV&EIB	1.0000	0.9921	-0.0080	0.0000	0.9997	0.9830
BIDV&MB	1.0000	0.9897	-0.0104	0.0002	0.9997	0.9333
BIDV&OceanBank	1.0000	0.9904	-0.0097	0.0001	0.9996	0.9646
BIDV&HBB	1.0000	0.9922	-0.0079	0.0000	0.9996	0.9819
BIDV&HDB	1.0000	0.9905	-0.0096	0.0001	0.9997	0.9677
BIDV&SHB	1.0000	0.9903	-0.0098	0.0001	0.9996	0.9560
VCB&CTG	1.0000	0.9900	-0.0101	0.0001	0.9996	0.9493
VCB&ACB	1.0000	0.9888	-0.0113	0.0004	0.9996	0.9404
VCB&EAB	1.0000	0.9900	-0.0101	0.0001	0.9997	0.9579
VCB&EIB	1.0000	0.9930	-0.0070	0.0000	0.9997	0.9853
VCB&MSB	1.0000	0.9900	-0.0101	0.0001	0.9997	0.9412
VCB&MB	1.0000	0.9893	-0.0109	0.0002	0.9996	0.9250
VCB&OceanBank	1.0000	0.9900	-0.0101	0.0001	0.9996	0.9457
VCB&HBB	1.0000	0.9928	-0.0072	0.0000	0.9997	0.9829
VCB&SHB	1.0000	0.9941	-0.0059	0.0000	0.9996	0.9849
CTG&ABB	1.0000	0.9935	-0.0066	0.0000	0.9997	0.9859
CTG&ACB	1.0000	0.9908	-0.0092	0.0001	0.9998	0.9611
CTG&EAB	1.0000	0.9911	-0.0090	0.0000	0.9997	0.9748
CTG&EIB	1.0000	0.9918	-0.0083	0.0000	0.9996	0.9815
CTG&MSB	1.0000	0.9951	-0.0050	0.0000	0.9995	0.9883
CTG&MB	1.0000	0.9914	-0.0086	0.0000	0.9997	0.9761
CTG&OceanBank	1.0000	0.9925	-0.0076	0.0000	0.9996	0.9837
CTG&HBB	1.0000	0.9932	-0.0069	0.0000	0.9996	0.9862
CTG&HDB	1.0000	0.9926	-0.0074	0.0000	0.9996	0.9821
CTG&SHB	1.0000	0.9911	-0.0089	0.0000	0.9997	0.9773
CTG&WesternBank	1.0000	0.9934	-0.0067	0.0000	0.9997	0.9831
ABB&EIB	1.0000	0.9912	-0.0089	0.0000	0.9997	0.9750
ABB&MSB	1.0000	0.9963	-0.0037	0.0000	0.9996	0.9920
ABB&MB	1.0000	0.9922	-0.0079	0.0000	0.9996	0.9811
ABB&HBB	1.0000	0.9928	-0.0073	0.0000	0.9996	0.9845
ABB&HDB	1.0000	0.9910	-0.0091	0.0001	0.9997	0.9724
ABB&WesternBank	1.0000	0.9901	-0.0100	0.0001	0.9996	0.9453
ACB&EIB	1.0000	0.9921	-0.0079	0.0000	0.9997	0.9814
ACB&MSB	1.0000	0.9898	-0.0103	0.0001	0.9995	0.9460
ACB&MB	1.0000	0.9884	-0.0118	0.0004	0.9997	0.9311

ACB&OceanBank	1.0000	0.9911	-0.0090	0.0000	0.9998	0.9760
ACB&HBB	1.0000	0.9917	-0.0084	0.0000	0.9997	0.9787
ACB&HDB	1.0000	0.9955	-0.0045	0.0000	0.9997	0.9893
ACB&WesternBank	1.0000	0.9937	-0.0064	0.0000	0.9997	0.9868
EAB&EIB	1.0000	0.9947	-0.0054	0.0000	0.9997	0.9901
EAB&MB	1.0000	0.9907	-0.0094	0.0001	0.9996	0.9661
EAB&OceanBank	1.0000	0.9881	-0.0121	0.0004	0.9997	0.9125
EAB&HBB	1.0000	0.9916	-0.0084	0.0000	0.9997	0.9806
EAB&HDB	1.0000	0.9906	-0.0095	0.0001	0.9997	0.9662
EAB&SHB	1.0000	0.9880	-0.0121	0.0004	0.9996	0.9155
EAB&WesternBank	1.0000	0.9908	-0.0093	0.0001	0.9997	0.9724
EIB&MSB	1.0000	0.9936	-0.0064	0.0000	0.9996	0.9870
EIB&MB	1.0000	0.9910	-0.0091	0.0001	0.9997	0.9703
EIB&HBB	1.0000	0.9914	-0.0087	0.0000	0.9996	0.9787
EIB&HDB	1.0000	0.9920	-0.0080	0.0000	0.9997	0.9823
EIB&WesternBank	1.0000	0.9921	-0.0080	0.0000	0.9997	0.9830
MSB&MB	1.0000	0.9895	-0.0106	0.0003	0.9997	0.9460
MSB&OceanBank	1.0000	0.9882	-0.0120	0.0005	0.9997	0.9322
MSB&HBB	1.0000	0.9908	-0.0092	0.0001	0.9997	0.9729
MSB&WesternBank	1.0000	0.9905	-0.0096	0.0001	0.9996	0.9622
MB&OceanBank	1.0000	0.9903	-0.0098	0.0001	0.9997	0.9474
MB&HBB	1.0000	0.9901	-0.0100	0.0001	0.9997	0.9437
MB&HDB	1.0000	0.9908	-0.0093	0.0001	0.9997	0.9686
MB&SHB	1.0000	0.9871	-0.0131	0.0011	0.9997	0.9356
MB&WesternBank	1.0000	0.9895	-0.0106	0.0001	0.9996	0.9466
NCB&OceanBank	1.0000	0.9874	-0.0127	0.0007	0.9996	0.9116
VietCapitalBank&OceanBank	1.0000	0.9918	-0.0083	0.0000	0.9996	0.9787
VietCapitalBank&WesternBank	1.0000	0.9868	-0.0134	0.0011	0.9997	0.9274
OceanBank&HBB	1.0000	0.9880	-0.0121	0.0005	0.9997	0.9312
OceanBank&HDB	1.0000	0.9889	-0.0113	0.0002	0.9996	0.9260
OceanBank&SHB	1.0000	0.9886	-0.0116	0.0004	0.9997	0.9386
OceanBank&WesternBank	1.0000	0.9883	-0.0119	0.0005	0.9996	0.9379
HBB&HDB	1.0000	0.9909	-0.0092	0.0001	0.9997	0.9696
HBB&SHB	1.0000	0.9918	-0.0083	0.0000	0.9997	0.9809
HBB&WesternBank	1.0000	0.9907	-0.0094	0.0001	0.9996	0.9716
HDB&SHB	1.0000	0.9902	-0.0099	0.0001	0.9997	0.9523
HDB&WesternBank	1.0000	0.9885	-0.0116	0.0004	0.9997	0.9307
SHB&WesternBank	1.0000	0.9866	-0.0136	0.0009	0.9996	0.9097
SacomBank	0.8940	0.8890	-0.0064	0.0000	0.8937	0.8810
PNB	0.6865	0.6828	-0.0078	0.0000	0.6863	0.6769
TechcomBank	1.0000	0.9894	-0.0107	0.0002	0.9997	0.9346
VPBank	0.9332	0.9280	-0.0060	0.0000	0.9329	0.9197
Mean	0.9943	0.9852	-0.0093	0.0002	0.9939	0.9560
SD	0.0364	0.0357	0.0022	0.0003	0.0364	0.0394
Min.	0.6865	0.6828	-0.0143	0.0000	0.6863	0.6769
Max.	1.0000	0.9963	-0.0037	0.0015	0.9998	0.9920

Notes: VRS (efficiency estimates under variable returns to scale assumption), BCVRS (bias-corrected efficiency estimates under variable returns to scale assumption), BIAS (bootstrap bias estimates), SD (the standard deviation of the bias), 95% confidence intervals of the bias-corrected efficiency scores (LB=lower bound, UB= upper bound)

Appendix 18 Efficiency estimates of VBMs and non-merging banks, 2009

Banks	VRS	BCVRS	BIAS	SD	UB	LB
AGB&BIDV	1.0000	0.9978	-0.0022	0.0002	1.0000	0.9923
AGB&VCB	1.0000	0.9981	-0.0019	0.0001	1.0000	0.9924
AGB&CTG	1.0000	0.9988	-0.0012	0.0000	1.0000	0.9977
AGB&ACB	1.0000	0.9980	-0.0020	0.0001	1.0000	0.9974
AGB&EAB	1.0000	0.9991	-0.0009	0.0000	1.0000	0.9928
AGB&EIB	1.0000	0.9995	-0.0005	0.0000	1.0000	0.9989
AGB&MSB	1.0000	0.9992	-0.0008	0.0000	1.0000	0.9923
AGB&MB	1.0000	0.9991	-0.0009	0.0000	1.0000	0.9976
AGB&NCB	1.0000	0.9992	-0.0008	0.0000	1.0000	0.9980
AGB&VietCapitalBank	1.0000	0.9992	-0.0008	0.0000	1.0000	0.9980
AGB&HDB	1.0000	0.9994	-0.0006	0.0000	1.0000	0.9980
AGB&WesternBank	1.0000	0.9994	-0.0006	0.0000	1.0000	0.9976
BIDV&VCB	1.0000	0.9985	-0.0015	0.0001	1.0000	0.9977
BIDV&CTG	1.0000	0.9985	-0.0015	0.0001	1.0000	0.9945
BIDV&ACB	1.0000	0.9985	-0.0015	0.0000	1.0000	0.9923
BIDV&EAB	1.0000	0.9992	-0.0008	0.0000	1.0000	0.9981
BIDV&EIB	0.9994	0.9990	-0.0004	0.0000	0.9993	0.9983
BIDV&MSB	1.0000	0.9992	-0.0008	0.0000	1.0000	0.9981
BIDV&NCB	1.0000	0.9989	-0.0011	0.0000	1.0000	0.9922
BIDV&VietCapitalBank	1.0000	0.9991	-0.0009	0.0000	1.0000	0.9922
VCB&CTG	1.0000	0.9980	-0.0020	0.0001	1.0000	0.9917
VCB&ACB	1.0000	0.9974	-0.0027	0.0002	1.0000	0.9916
VCB&MSB	1.0000	0.9985	-0.0015	0.0001	1.0000	0.9977
VCB&NCB	1.0000	0.9992	-0.0008	0.0000	1.0000	0.9931
CTG&ACB	1.0000	0.9985	-0.0015	0.0000	1.0000	0.9975
CTG&EAB	1.0000	0.9987	-0.0013	0.0000	1.0000	0.9928
CTG&EIB	1.0000	0.9992	-0.0008	0.0000	1.0000	0.9944
CTG&MSB	1.0000	0.9991	-0.0009	0.0000	1.0000	0.9980
CTG&MB	1.0000	0.9992	-0.0008	0.0000	1.0000	0.9931
CTG&NCB	1.0000	0.9993	-0.0007	0.0000	1.0000	0.9964
CTG&VietCapitalBank	1.0000	0.9992	-0.0008	0.0000	1.0000	0.9935
CTG&HBB	1.0000	0.9993	-0.0007	0.0000	1.0000	0.9960
ACB&EAB	1.0000	0.9992	-0.0008	0.0000	1.0000	0.9978
ACB&EIB	1.0000	0.9993	-0.0007	0.0000	1.0000	0.9972
ACB&MSB	1.0000	0.9978	-0.0022	0.0002	1.0000	0.9976
ACB&MB	1.0000	0.9979	-0.0021	0.0002	1.0000	0.9977
ACB&NCB	1.0000	0.9988	-0.0012	0.0000	1.0000	0.9972
ACB&VietCapitalBank	1.0000	0.9991	-0.0009	0.0000	1.0000	0.9923
ACB&HBB	1.0000	0.9992	-0.0008	0.0000	1.0000	0.9949
ACB&HDB	1.0000	0.9996	-0.0004	0.0000	1.0000	0.9990
ACB&WesternBank	1.0000	0.9989	-0.0011	0.0000	1.0000	0.9920
EAB&EIB	0.9918	0.9914	-0.0004	0.0000	0.9918	0.9908
EAB&MSB	1.0000	0.9987	-0.0013	0.0000	1.0000	0.9947

EAB&MB	1.0000	0.9984	-0.0017	0.0001	1.0000	0.9979
EAB&NCB	1.0000	0.9988	-0.0012	0.0000	1.0000	0.9980
EAB&VietCapitalBank	1.0000	0.9979	-0.0021	0.0001	1.0000	0.9924
EAB&OceanBank	1.0000	0.9983	-0.0017	0.0001	1.0000	0.9924
EAB&HBB	1.0000	0.9992	-0.0008	0.0000	1.0000	0.9975
EAB&HDB	1.0000	0.9991	-0.0009	0.0000	1.0000	0.9974
EIB&VietCapitalBank	1.0000	0.9988	-0.0012	0.0000	1.0000	0.9925
MSB&MB	1.0000	0.9988	-0.0012	0.0000	1.0000	0.9980
MSB&NCB	1.0000	0.9985	-0.0015	0.0001	1.0000	0.9980
MSB&OceanBank	1.0000	0.9976	-0.0025	0.0002	1.0000	0.9917
MSB&HBB	1.0000	0.9991	-0.0009	0.0000	1.0000	0.9975
MSB&WesternBank	1.0000	0.9983	-0.0017	0.0001	1.0000	0.9927
MB&NCB	1.0000	0.9988	-0.0012	0.0000	1.0000	0.9977
MB&VietCapitalBank	1.0000	0.9994	-0.0006	0.0000	1.0000	0.9974
MB&OceanBank	1.0000	0.9985	-0.0015	0.0000	1.0000	0.9929
MB&HBB	1.0000	0.9992	-0.0008	0.0000	1.0000	0.9927
MB&HDB	1.0000	0.9987	-0.0013	0.0000	1.0000	0.9923
MB&WesternBank	1.0000	0.9987	-0.0013	0.0000	1.0000	0.9977
NCB&VietCapitalBank	1.0000	0.9981	-0.0019	0.0001	1.0000	0.9975
NCB&OceanBank	1.0000	0.9978	-0.0022	0.0002	1.0000	0.9925
NCB&HBB	1.0000	0.9987	-0.0013	0.0000	1.0000	0.9976
NCB&HDB	1.0000	0.9988	-0.0012	0.0000	1.0000	0.9927
NCB&WesternBank	1.0000	0.9980	-0.0020	0.0001	1.0000	0.9972
VietCapitalBank&OceanBank	1.0000	0.9990	-0.0010	0.0000	1.0000	0.9975
VietCapitalBank&HBB	1.0000	0.9991	-0.0009	0.0000	1.0000	0.9937
VietCapitalBank&HDB	1.0000	0.9986	-0.0014	0.0000	1.0000	0.9921
VietCapitalBank&WesternBank	1.0000	0.9976	-0.0024	0.0002	1.0000	0.9923
OceanBank&HBB	1.0000	0.9992	-0.0008	0.0000	1.0000	0.9926
OceanBank&HDB	1.0000	0.9989	-0.0011	0.0000	1.0000	0.9931
OceanBank&WesternBank	1.0000	0.9982	-0.0018	0.0001	1.0000	0.9980
HBB&HDB	1.0000	0.9993	-0.0007	0.0000	1.0000	0.9957
HBB&WesternBank	1.0000	0.9991	-0.0009	0.0000	1.0000	0.9980
HDB&WesternBank	1.0000	0.9982	-0.0018	0.0001	1.0000	0.9978
SacomBank	1.0000	0.9979	-0.0021	0.0002	1.0000	0.9974
PNB	1.0000	0.9979	-0.0021	0.0002	1.0000	0.9973
TechcomBank	1.0000	0.9982	-0.0018	0.0001	1.0000	0.9980
VPBank	0.8883	0.8879	-0.0005	0.0000	0.8882	0.8873
Mean	0.9985	0.9972	-0.0013	0.0000	0.9985	0.9941
SD	0.0125	0.0124	0.0006	0.0001	0.0125	0.0124
Min.	0.8883	0.8879	-0.0027	0.0000	0.8882	0.8873
Max.	1.0000	0.9996	-0.0004	0.0002	1.0000	0.9990

Notes: VRS (efficiency estimates under variable returns to scale assumption), BCVRS (bias-corrected efficiency estimates under variable returns to scale assumption), BIAS (bootstrap bias estimates), SD (the standard deviation of the bias), 95% confidence intervals of the bias-corrected efficiency scores (LB=lower bound, UB= upper bound)

Appendix 19 Efficiency estimates of VBMs and non-merging banks, 2010

Banks	VRS	BCVRS	BIAS	SD	UB	LB
AGB&BIDV	1.0000	0.9983	-0.0017	0.0000	0.9999	0.9841
AGB&VCB	1.0000	0.9984	-0.0016	0.0000	1.0000	0.9845
AGB&CTG	1.0000	0.9984	-0.0016	0.0000	0.9999	0.9846
AGB&ACB	1.0000	0.9988	-0.0012	0.0000	1.0000	0.9954
AGB&EAB	1.0000	0.9984	-0.0016	0.0000	1.0000	0.9854
AGB&EIB	1.0000	0.9984	-0.0016	0.0000	1.0000	0.9851
AGB&NCB	1.0000	0.9987	-0.0013	0.0000	1.0000	0.9928
AGB&VietCapitalBank	1.0000	0.9988	-0.0012	0.0000	1.0000	0.9960
AGB&HBB	1.0000	0.9983	-0.0017	0.0000	1.0000	0.9845
BIDV&VCB	1.0000	0.9983	-0.0017	0.0000	1.0000	0.9841
BIDV&CTG	1.0000	0.9984	-0.0016	0.0000	1.0000	0.9851
BIDV&ACB	1.0000	0.9984	-0.0016	0.0000	1.0000	0.9846
BIDV&EAB	1.0000	0.9983	-0.0017	0.0000	1.0000	0.9847
BIDV&EIB	1.0000	0.9983	-0.0017	0.0000	1.0000	0.9840
BIDV&NCB	1.0000	0.9988	-0.0012	0.0000	0.9999	0.9955
BIDV&VietCapitalBank	1.0000	0.9989	-0.0011	0.0000	1.0000	0.9965
BIDV&HBB	1.0000	0.9985	-0.0016	0.0000	1.0000	0.9868
VCB&CTG	1.0000	0.9983	-0.0017	0.0000	1.0000	0.9844
VCB&ACB	1.0000	0.9982	-0.0018	0.0000	1.0000	0.9826
VCB&EIB	1.0000	0.9983	-0.0017	0.0000	1.0000	0.9840
VCB&NCB	1.0000	0.9984	-0.0016	0.0000	0.9999	0.9843
VCB&OceanBank	1.0000	0.9984	-0.0016	0.0000	1.0000	0.9851
VCB&HBB	1.0000	0.9984	-0.0016	0.0000	1.0000	0.9856
CTG&ACB	1.0000	0.9983	-0.0017	0.0000	1.0000	0.9833
CTG&EAB	1.0000	0.9984	-0.0016	0.0000	1.0000	0.9845
CTG&EIB	1.0000	0.9984	-0.0016	0.0000	1.0000	0.9856
CTG&NCB	1.0000	0.9991	-0.0009	0.0000	1.0000	0.9979
CTG&VietCapitalBank	1.0000	0.9988	-0.0012	0.0000	1.0000	0.9954
CTG&HBB	1.0000	0.9985	-0.0015	0.0000	1.0000	0.9874
ACB&EIB	1.0000	0.9984	-0.0016	0.0000	1.0000	0.9855
ACB&MSB	1.0000	0.9984	-0.0016	0.0000	1.0000	0.9852
ACB&NCB	1.0000	0.9988	-0.0013	0.0000	1.0000	0.9945
ACB&VietCapitalBank	1.0000	0.9988	-0.0012	0.0000	1.0000	0.9958
ACB&OceanBank	1.0000	0.9984	-0.0016	0.0000	1.0000	0.9845
ACB&HBB	1.0000	0.9984	-0.0016	0.0000	1.0000	0.9855
ACB&HDB	1.0000	0.9985	-0.0015	0.0000	1.0000	0.9869
EAB&EIB	1.0000	0.9984	-0.0016	0.0000	1.0000	0.9850
EAB&NCB	1.0000	0.9984	-0.0016	0.0000	1.0000	0.9843
EAB&VietCapitalBank	1.0000	0.9983	-0.0017	0.0000	1.0000	0.9839
EAB&HBB	1.0000	0.9983	-0.0017	0.0000	1.0000	0.9845
EIB&MSB	1.0000	0.9983	-0.0017	0.0000	0.9999	0.9842
EIB&MB	1.0000	0.9983	-0.0017	0.0000	1.0000	0.9842
EIB&VietCapitalBank	1.0000	0.9986	-0.0014	0.0000	1.0000	0.9888

EIB&OceanBank	1.0000	0.9984	-0.0016	0.0000	0.9999	0.9850
EIB&HBB	1.0000	0.9984	-0.0016	0.0000	1.0000	0.9853
EIB&HDB	1.0000	0.9986	-0.0014	0.0000	1.0000	0.9893
MSB&OceanBank	1.0000	0.9983	-0.0017	0.0000	1.0000	0.9846
MSB&HBB	0.9761	0.9754	-0.0008	0.0000	0.9761	0.9743
MSB&HDB	1.0000	0.9987	-0.0013	0.0000	1.0000	0.9949
NCB&VietCapitalBank	1.0000	0.9982	-0.0018	0.0000	1.0000	0.9833
NCB&OceanBank	1.0000	0.9983	-0.0017	0.0000	1.0000	0.9845
NCB&HBB	1.0000	0.9984	-0.0016	0.0000	0.9999	0.9849
VietCapitalBank&OceanBank	1.0000	0.9982	-0.0018	0.0000	1.0000	0.9838
VietCapitalBank&HBB	1.0000	0.9983	-0.0017	0.0000	1.0000	0.9837
VietCapitalBank&HDB	1.0000	0.9984	-0.0016	0.0000	1.0000	0.9849
VietCapitalBank&WesternBank	1.0000	0.9984	-0.0016	0.0000	1.0000	0.9857
OceanBank&HBB	1.0000	0.9984	-0.0016	0.0000	0.9999	0.9846
OceanBank&HDB	1.0000	0.9983	-0.0017	0.0000	1.0000	0.9836
HBB&HDB	0.9831	0.9823	-0.0008	0.0000	0.9830	0.9811
SacomBank	1.0000	0.9984	-0.0016	0.0000	1.0000	0.9851
PNB	1.0000	0.9985	-0.0015	0.0000	1.0000	0.9860
TechcomBank	1.0000	0.9983	-0.0017	0.0000	1.0000	0.9838
VPBank	1.0000	0.9984	-0.0016	0.0000	0.9999	0.9848
Mean	0.9994	0.9978	-0.0015	0.0000	0.9993	0.9863
SD	0.0037	0.0035	0.0002	0.0000	0.0037	0.0044
Min.	0.9761	0.9754	-0.0018	0.0000	0.9761	0.9743
Max.	1.0000	0.9991	-0.0008	0.0000	1.0000	0.9979

Notes: VRS (efficiency estimates under variable returns to scale assumption), BCVRS (bias-corrected efficiency estimates under variable returns to scale assumption), BIAS (bootstrap bias estimates), SD (the standard deviation of the bias), 95% confidence intervals of the bias-corrected efficiency scores (LB=lower bound, UB= upper bound)

Appendix 20 Efficiency estimates of VBMs and non-merging banks, 2011

Banks	VRS	BCVRS	BIAS	SD	UB	LB
AGB&BIDV	1.0000	0.9992	-0.0008	0.0000	1.0000	0.9984
AGB&VCB	1.0000	0.9995	-0.0005	0.0000	1.0000	0.9979
AGB&CTG	1.0000	0.9992	-0.0008	0.0000	1.0000	0.9985
AGB&ACB	1.0000	0.9995	-0.0005	0.0000	1.0000	0.9983
BIDV&VCB	1.0000	0.9993	-0.0007	0.0000	1.0000	0.9986
BIDV&CTG	1.0000	0.9992	-0.0008	0.0000	1.0000	0.9985
BIDV&ACB	1.0000	0.9992	-0.0008	0.0000	1.0000	0.9985
BIDV&EAB	1.0000	0.9992	-0.0008	0.0000	1.0000	0.9984
BIDV&EIB	1.0000	0.9991	-0.0009	0.0000	1.0000	0.9978
BIDV&MSB	1.0000	0.9993	-0.0007	0.0000	1.0000	0.9985
BIDV&NCB	1.0000	0.9993	-0.0007	0.0000	1.0000	0.9983
BIDV&VietCapitalBank	1.0000	0.9993	-0.0007	0.0000	1.0000	0.9986
BIDV&OceanBank	1.0000	0.9994	-0.0006	0.0000	1.0000	0.9982
BIDV&HBB	1.0000	0.9993	-0.0007	0.0000	1.0000	0.9985
VCB&CTG	1.0000	0.9991	-0.0009	0.0000	1.0000	0.9983
VCB&ACB	1.0000	0.9991	-0.0009	0.0000	1.0000	0.9984
CTG&ACB	1.0000	0.9991	-0.0009	0.0000	1.0000	0.9983
CTG&EIB	1.0000	0.9992	-0.0008	0.0000	1.0000	0.9984
ACB&EIB	1.0000	0.9992	-0.0008	0.0000	1.0000	0.9985
ACB&MSB	1.0000	0.9992	-0.0008	0.0000	1.0000	0.9984
ACB&VietCapitalBank	1.0000	0.9992	-0.0008	0.0000	1.0000	0.9984
ACB&OceanBank	1.0000	0.9992	-0.0008	0.0000	1.0000	0.9984
ACB&HBB	1.0000	0.9991	-0.0009	0.0000	1.0000	0.9984
EAB&NCB	1.0000	0.9994	-0.0006	0.0000	1.0000	0.9985
EAB&VietCapitalBank	1.0000	0.9992	-0.0008	0.0000	1.0000	0.9984
EAB&HBB	1.0000	0.9992	-0.0008	0.0000	1.0000	0.9857
EIB&MSB	1.0000	0.9993	-0.0008	0.0000	1.0000	0.9985
EIB&MB	1.0000	0.9994	-0.0006	0.0000	1.0000	0.9984
EIB&VietCapitalBank	1.0000	0.9992	-0.0008	0.0000	1.0000	0.9985
EIB&OceanBank	1.0000	0.9991	-0.0009	0.0000	1.0000	0.9982
EIB&HBB	1.0000	0.9992	-0.0008	0.0000	1.0000	0.9985
MSB&VietCapitalBank	1.0000	0.9992	-0.0008	0.0000	1.0000	0.9985
MSB&OceanBank	1.0000	0.9992	-0.0008	0.0000	1.0000	0.9985
MSB&HBB	1.0000	0.9992	-0.0008	0.0000	1.0000	0.9984
NCB&VietCapitalBank	1.0000	0.9992	-0.0008	0.0000	1.0000	0.9984
NCB&OceanBank	1.0000	0.9991	-0.0009	0.0000	1.0000	0.9823
NCB&HBB	1.0000	0.9991	-0.0009	0.0000	1.0000	0.9982
VietCapitalBank&OceanBank	1.0000	0.9990	-0.0010	0.0000	1.0000	0.9824
VietCapitalBank&HBB	1.0000	0.9992	-0.0008	0.0000	1.0000	0.9986
VietCapitalBank&HDB	1.0000	0.9991	-0.0009	0.0000	1.0000	0.9829
VietCapitalBank&WesternBank	1.0000	0.9992	-0.0008	0.0000	1.0000	0.9985
OceanBank&HBB	1.0000	0.9991	-0.0009	0.0000	1.0000	0.9984
HBB&WesternBank	0.9810	0.9807	-0.0003	0.0000	0.9810	0.9802

SacomBank	1.0000	0.9992	-0.0008	0.0000	1.0000	0.9985
PNB	1.0000	0.9992	-0.0008	0.0000	1.0000	0.9985
TechcomBank	1.0000	0.9993	-0.0007	0.0000	1.0000	0.9987
VPBank	1.0000	0.9992	-0.0008	0.0000	1.0000	0.9985
Mean	0.9996	0.9988	-0.0008	0.0000	0.9996	0.9967
SD	0.0028	0.0027	0.0001	0.0000	0.0028	0.0049
Min.	0.9810	0.9807	-0.0010	0.0000	0.9810	0.9802
Max.	1.0000	0.9995	-0.0003	0.0000	1.0000	0.9987

Notes: VRS (efficiency estimates under variable returns to scale assumption), BCVRS (bias-corrected efficiency estimates under variable returns to scale assumption), BIAS (bootstrap bias estimates), SD (the standard deviation of the bias), 95% confidence intervals of the bias-corrected efficiency scores (LB=lower bound, UB= upper bound)

List of publications

(Peer-reviewed) Journal Articles

Le, TD, The interrelationship between net interest margin and non-interest income: Evidence from Vietnam, *International journal of Managerial Finance* (forthcoming).

Conference papers and working papers

Le, TD 2015, *Do bank mergers and acquisitions improve technical efficiency of Vietnamese commercial banks?*, paper presented at 28th Australasian Finance and Banking Conference (peer-reviewed), PHD Forum, Sydney, Australia.

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---- 2016, *The effect of income diversification on bank risk: Evidence from Vietnam*, Working paper, University of Canberra, Australia.

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