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Article

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Cogent Business & Management

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Suggested Citation: Nguyen, Phuong Anh; Pham, Linh Dan; McMillan, David (2020) : Non-parametric analysis of bank merger gains: The case of Vietnam, Cogent Business & Management, ISSN 2331-1975, Taylor & Francis, Abingdon, Vol. 7, Iss. 1, pp. 1-17, https://doi.org/10.1080/23311975.2020.1823582

This Version is available at:
https://hdl.handle.net/10419/244954

Cogent Business & Management

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/oabm20

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To cite this article: Phuong Anh Nguyen & Linh Dan Pham | (2020) Non-parametric analysis of bank merger gains: The case of Vietnam, Cogent Business & Management, 7:1, 1823582, DOI: 10.1080/23311975.2020.1823582

To link to this article: https://doi.org/10.1080/23311975.2020.1823582

Published online: 05 Oct 2020.

Nguyen & Pham, *Cogent Business & Management* (2020), 7: 1823582
https://doi.org/10.1080/23311975.2020.1823582

cogent business & management

BANKING & FINANCE | RESEARCH ARTICLE

Non-parametric analysis of bank merger gains: The case of Vietnam

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Received: 31 January 2020
Accepted: 31 August 2020

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Reviewing editor:
David McMillan, University of Stirling, Stirling, UK

Additional information is available at the end of the article

Abstract: Over the last years, the banking sector in Vietnam has been going through the restructuring period, in order to cope with non-performing loans and build up mergers and acquisitions. This paper applies the non-parametric method proposed by Bogetoft and Wang in 2005 to evaluate the bank merger gains in Vietnam during the period 2010–2016. The potential gains from mergers are thus estimated and decomposed into technical efficiency, scale efficiency and harmony effect. The results indicate that under the production approach, all six mergers obtain potential gains with the main sources from technical efficiency and harmony effect. Under the intermediation approach, five mergers exhibit potential gains with the main source from harmony effect, while technical efficiency contributes to the potential gain of two mergers. Accordingly, banks could benefit from the new management or learn from the more efficient ones and reap benefits from harmony effect by reallocating the service portfolio of related parties in the merger to boost their activities. The post-merger efficiency scores are also calculated and are found to increase slightly compared to the efficiency scores before merger, which supports the statement that mergers help banks improve their efficiency. This paper contributes to the gap of lacking analysis on mergers and acquisitions in Vietnam banking sector.

Subjects: Econometrics; Banking; Risk Management; Strategic Management

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Dr. Phuong Anh Nguyen is a Researcher and Lecturer at the Department of Finance and Banking in the International University, Vietnam National University of Ho Chi Minh City. Her research interests include bank efficiency, bank risk management, control and optimization theory with a strong focus on using quantitative methods to provide insightful analyses for managers, investors and policy makers. She has been working with various research teams in Europe and Asia. Her research works have been published in international journals such as Applied Economics, Journal of Optimization Theory and Application, SIAM Journal of Control and Optimization.
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PUBLIC INTEREST STATEMENT

This paper is a part of the research project investigating the efficiency of the Vietnamese banking system during the restructuring period. This paper contributes to the bank merger analysis in Vietnam, which is useful for bank managers, investors and policy makers.

Keywords: Vietnam commercial banks; mergers; potential gains; technical efficiency; scale efficiency; harmony effect

Subjects: G21; G34; L11; L22; P41

1. Introduction

Nowadays a stable and effective financial system offers a concrete foundation to motivate economic boom since it plays a crucial role in distributing financial resources to all factors of the economy. The worldwide financial crisis during the period 2007–2008 led to negative consequences considered as the downturn in production forces and economy pullback. As a result, a series of financial institutions as well as banks and even those leading in the US financial market could not avoid the widespread uncontrollable phenomenon. The failure of some colossal banks and financial institutions such as Bear Sterns, Lehman Brothers, Merrill Lynch & Co and Mac Bancorp Inc raised concerns about banks' health issue. This also raised the need of looking for ways to achieve better performance of the whole banking system.

Merger strategy has become more popular since it was first conducted in America in the late 1990s. These transactions were quickly spread worldwide, especially it took place in the banking industry of many developed countries. Among these, some well-known banks in the US and Europe were also involved, particularly, JPMorgan Chase took over Bearn Sterns, Barclays merged with Lehman Brothers and Merrill Lynch was acquired by Bank of America.

Vietnam banking system started to be impacted in a negative way in the early 2010s because of the world financial crisis. Due to the unstable credit growth rate and the high non-performing loan ratio, the Decision No 254/QD-TTg in March 2012 was issued by the Government with the purpose of restructuring the whole banking industry, encouraging domestic commercial banks to carry on M&As.

According to BMI research, more M&A activities in this sector are expected to happen in the future to boost the competitiveness of domestic banks, prepare these players for greater international competition under the ASEAN Banking Integration Framework (ABIF). In the five-year period from 2012 to 2016, the Vietnam banking system was reorganized with a series of M&As transactions.

In 2011, there was a merger among three banks which were Tin Nghia Bank, Ficom Bank and Sai Gon Joint Stock Bank. After this transaction, the newly established entity was named Sai Gon Joint Stock Commercial Bank (SCB). The second merger occurred in 2012, which involved Saigon-Hanoi Commercial Bank and Hanoi Building Bank and then a year later, Ho Chi Minh Development Joint Stock Commercial Bank officially took over Dai A Joint Stock Bank. Moreover, 2015 is the year of M&As because lots of banks joined the reform program carried out by the State Bank of Vietnam (SBV). To give more details, Mekong Development Commercial Bank was merged with Maritime Bank, Housing Bank of Mekong Delta was merged with Bank for Investment and Development of Vietnam, and Southern Commercial Bank was merged with Sai Gon Thuong Tin Commercial Bank (Sacombank). Consequently, only healthy commercial banks would remain in operation, the number of banks in this industry would be reduced and the whole Vietnamese banking system is predicted to experience numerous changes in the future.

In general, M&A in the banking system is an effective solution to help the involved parties achieve some targets such as the effectiveness, profitability and synergy. In many cases, financially unhealthy banks are usually subject of M&As in the banking system and such kind of transactions would result in exclusive control in the market. Consequently, a larger number of firms consider this strategy to grow and expand in recent years.

Since the main business of commercial banks is credit lending, which leads to a variety of risks, these banks are extremely sensitive to fluctuations in the market. This problem raised the need of restructuring banking system so that only banks which are healthy could remain and work as

a concrete foundation for others. Although distressed banks could be bettered by M&A, the acquirers may illustrate the opposite trend as they are likely to face more risks, weaken their competitive advantages or even worsen their performance.

Nevertheless, deficient outcomes from previous study have raised concerns about the advantages and disadvantages that mergers bring out to both merged banks and acquiring banks. Although being suggested by previous researchers, not many further studies examining the effect of M&As have been conducted in an emerging economy like Vietnam. Accordingly, this paper intends to fill in this research gap.

This study aims to evaluate the effectiveness of the restructuring program towards the Vietnamese banking sector by estimating the gains from mergers among domestic Commercial Banks over the seven-year period from 2010 to 2016. Consequently, these following questions have been brought up to indicate the goals of this study: What are the potential merger gain levels of M&As in Vietnam banking sector? Which are the main sources of potential gains? How M&As influence the bank efficiency scores?

The non-parametric method developed by Bogetoft and Wang in 2005 is employed in this research to compute the potential gains from bank mergers in Vietnam. Then, this merger gain is divided into three main components, which are technical efficiency, scale (size) efficiency and mix (harmony) effect. The study extends the results further to calculate the efficiency scores captured after the merger under both production and intermediation approach.

2. Literature review

2.1. Current situation of M&As in Vietnam

After joining the WTO in 2006 and 2007, Vietnam economy achieved higher growth rates. As a result, M&A transactions in Vietnam became more attractive to investors from overseas because of the positive changes in legal system and policies. During this period, the M&A wave was more exciting since foreign investors chose M&A as a mean to operate in a new and potential market like Vietnam. As a result, the competitiveness was higher for domestic banks, especially weak banks.

In addition, due to business' characteristics, banks are always engaged with various risks, which explains why these banks are sensitive to market fluctuations. Although Vietnam economy has been thought to overcome the world financial crisis, the unstable banking sector still suffers from the crisis's aftereffect. Most domestic banks must deal with many issues such as higher bad debt, liquidity constraint and bad management system which is known as unethical behaviour in operating over recent years. Acknowledging these problems, State Bank of Vietnam issued a Decision to reform the whole banking system in order to eliminate weak banks and maintain the healthy ones.

Since 2011, there has been a series of M&A transactions as indicated in Table 1. There was a merger among three banks which were Tin Nghia Bank, Ficom Bank and Saigon Commercial Bank in 2011. One year later, Saigon-Hanoi Commercial Bank and Hanoi Building Bank were merged. In 2013, Ho Chi Minh Development Bank officially took over Dai A Bank and in 2015, Mekong Development Bank was merged with Maritime Bank, Housing Bank of Mekong Delta was officially acquired by Bank for Investment and Development of Vietnam and Southern Commercial Bank was merged with Sai Gon Thuong Tin Commercial Bank.

2.2. Previous studies

2.2.1. Previous studies worldwide

Over the last decade, the current wave of M&As has been gaining attention from economic researchers worldwide during the restructuring period. As a result, further evidence has been obtained in the field of bank mergers and acquisitions.

Table 1. Merged banks over period 2010–2016

	Target banks	Acquiring banks	M&A Year
1	Vietnam Tin Nghia Commercial Joint Stock Bank First Joint Stock Commercial Bank	Sai Gon Joint Stock Commercial Bank (SCB)	2011
2	Hanoi Building Commercial Joint Stock Bank	Saigon-Hanoi Commercial Joint Stock Bank (SHB)	2012
3	Dai A Joint Stock Commercial Bank	Ho Chi Minh Development Joint Stock Commercial Bank (HDB)	2013
4	Mekong Development Joint Stock Commercial Bank	Maritime Commercial Joint Stock Bank (MSB)	2015
5	Housing Bank of Mekong Delta	Bank for Investment and Development of Vietnam (BIDV)	2015
6	Southern Commercial Joint Stock Bank	Sai Gon Thuong Tin Joint Stock Commercial Bank (Sacombank)	2015

An overall summary of papers analyzing the effect of M&A is given by Berger et al. (1999). In particular, the researchers implied that mergers hardly lead to an improvement in cost efficiency. In general, one of the major techniques employed to evaluate the result of M&A is the operational performance approach. Many previous studies applied this approach to investigate the relationship between mergers and the bank's productive efficiency while other approaches were used to analyze the influence of merger declarations on the value of public banks that are listed. The operating performance approach evaluates the improvement of the financial factors, such as profitability, costs and efficiency measures, based on accounting data of the merged firms in the pre- and post- merger periods. This technique has been widely applied in bank merger studies, in particularly, managers and investors often use it as a statistical analysis to evaluate firm's performance. Owing to the fact that this method allows the researcher to focus specifically on costs and efficiency, the interest in cost cutting and efficiency improvement in the banking system has increased.

Firms in banking industry may reap the benefits from new business opportunities because mergers and acquisitions bring about changes in the regulatory and technological environment. This kind of transaction affects not only the banking system, but also the overview of the economy in general. Moreover, not only the economies of scale, but also the economies of scope are different from those before the transaction. Market power also changed in line with the above aspects. The more specific statement about the relationship between bank mergers, acquisitions, its concentration and deposit rates is indicated by Prager and Hannan (1998). Bank concentration is higher when there is the presence of merger and acquisition, in contrast deposit rates tend to be lower. Therefore, Prager and Hannan stated that merger and acquisition activities can help banks earn more profit because these banks can make use of either loans or interest rates from the banking market.

Other studies investigated the output quality of American banks involved in M&As, and the conclusions on the mergers' performance of U.S banks in the 1990s are different among various studies. Berger et al., (1999) found very little improvement in cost efficiency for mergers and acquisitions for both large and small banks, while Rhoades (1998) implied that there were modest cost efficiency gains for most mergers and acquisitions involving large U.S. banks. However, those past findings did contribute to the advance in profit efficiency (Akhavein et al., 1997; Berger et al., 1999). Furthermore, the findings imply that M&As lead to the increase in profitability, not by enhancement in efficiency, but rather by a difference in the product portfolios in favour of more loans and fewer securities holdings. Many papers analyzing the efficiency effects resulting from M&As had also been carried out in the U.S. banking sector.

Nevertheless, a rising figure for empirical research has attempted to examine the influence of M&As by employing Data Envelopment Analysis (DEA). The DEA method has become a favorite method to evaluating the influence of mergers and acquisitions on banks efficiency, especially for small-sized samples. Accordingly, several papers aimed to analyze a small number of M&As, among others were Avkiran (1999), and Liu and Tripe (2003). Applying DEA along with financial ratios to a sample about 16 to 19 banks in Australia from 1986 to 1995, Avkiran (1999) investigated the effect of four mergers on efficiency and the benefits to public. Choosing the intermediation approach and two DEA models, the author reported that acquiring banks were more efficient than target banks. However, acquiring banks do not always maintain their pre-merger efficiency, but overall efficiency, productivity of employees and return on assets (ROA) improved. Also applying three DEA models and accounting ratios to a smaller sample of 7 to 14 banks, Liu and Tripe (2003) explored the efficiency of 6 bank mergers in New Zealand over the period 1989–1998. Their findings indicated that five out of six banks had a gain in efficiency as a result of merger while the last one only displayed a moderate increase in operating expenses to average total income. The results stated that four banks had obvious efficiency gains after the merger.

2.2.2. Previous studies in Vietnam

Obviously, very few publications can be found in the literature that discuss the issue of bank mergers in Vietnam.

Among these works, Le (2015) used a 4-step procedure of bootstrapped DEA to investigate the efficiency effect of bank merger. The research evaluated the impact of virtual bank mergers on technical efficiency from 2007 to 2011. In this study, the author concluded that there are no technical efficiency gains when mergers happen among efficient banks. However, the author suggested that merger activities in the banking system should be encouraged in the future.

On the other hand, Le (2017) examined the efficiency of Vietnamese banks over the eight-year period from 2008 to 2015. Using traditional DEA approach, the author found that, during the analyzing period, the efficiency level is rather high and stable. Consequently, the author concluded that our banking industry is less influenced by the world financial crisis and most of the merger cases result in an increase in efficiency. He also suggested that small and medium banks should be promoted in future acquisitions to improve efficiency.

For these reasons, this paper will contribute to the gap of lacking analysis on mergers and acquisitions in the Vietnam banking sector.

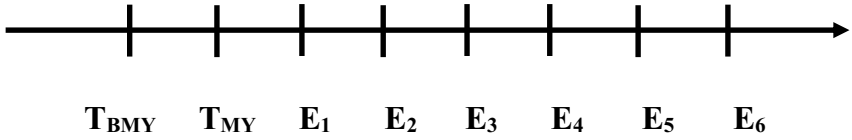
3. Methodology

3.1. DEA and nonparametric method applied to merger analysis

Data Envelopment Analysis (DEA) is a non-parametric method first introduced by Charnes et al. (1978). Based on linear programming, DEA method is used to address the problem of calculating relative efficiency for a group of Decision-Making Units (DMUs) by using a weighted measure of multiple inputs and outputs (Wanke et al., 2017).

In this paper, we employ the nonparametric method developed by Bogetoft and Wang (2005). The potential gains resulting from mergers are estimated and broken down into technical efficiency, scale or size efficiency, and harmony or mix efficiency components. The efficiency scores of the acquirer before and after merger are computed using BCC-DEA method proposed by Banker et al. (1984).

Adopting the notations as used by Gourlay et al. (2006), below is the working timeline considered in this paper:



Where $\mathbf{T_{BMY}}$ is the year right before actual merger, $\mathbf{T_{MY}}$ is the year when merger really happened, and $\mathbf{E_t}$ is the efficiency score in year **t** after merger.

This method reaps the benefits from the idea of super-additivity output by combining the inputs and output of parent firms to establish the merged entity. An estimation of the potential overall efficiency gain is obtained by computing the ultimate amount of cumulative output when cumulative input is provided. A measure greater than 1 illustrates benefits from M&As because the newly established firm can create greater cumulative output given the aggregated input.

Let **N** be the total number of banks, **x** be the inputs consumed, $\mathbf{x} \in R_+^m$, **y** be the outputs produced, $\mathbf{y} \in R_+^l$. The production set is described as $\mathbf{T(x, y)} = \{\mathbf{(x, y):}\ \mathbf{x}$ can produce $\mathbf{y}\}$. Some properties of the production set are assumed as follows:

(1) Disposability: $(\mathbf{x, y}) \in T \Rightarrow (\mathbf{x', y'}) \in T$ for all $\mathbf{x'} \geq \mathbf{x}, \mathbf{y'} \leq \mathbf{y}$

(2) Convexity: $(\mathbf{x, y}) \in T$, $(x', y') \in T \Rightarrow \mu\ (\mathbf{x, y}) + (1- \mu)(\mathbf{x', y'}) \in T$ for all $\mu \in [0, 1]$

(3) Returns to scale:

Constant Returns to Scale (CRS): $(\mathbf{x, y}) \in T \Rightarrow k\ (\mathbf{x, y}) \in T$ for all $k \geq 0$

Increasing Returns to Scale (IRS): $(\mathbf{x, y}) \in T \Rightarrow k\ (\mathbf{x, y}) \in T$ for all $k \geq 1$

Decreasing Returns to Scale (DRS): $(\mathbf{x, y}) \in T \Rightarrow k\ (\mathbf{x, y}) \in T$ for all $0 \leq k \leq 1$

Now, given that **J** banks out of the total **N** banks merged, the inputs and outputs of the merged entity, at time $\mathbf{T_{BMY}}$ one year before merging, are:

$$\tilde{x}_i^J = \sum_{k=1}^{k=J} x_{ik,} \qquad i = 1 \ldots \ldots m$$

$$\tilde{y}_r^J = \sum_{k=1}^{k=J} y_{rk,} \qquad r = 1 \ldots \ldots l,$$

where $\mathbf{x_{ik}}$ is the input **i** of the bank **k** in the merger, $\mathbf{y_{rk}}$ is the output **r** of the bank **k** in the merger. Therefore, by using output-oriented program under CRS, the potential overall efficiency gain (OE) from the merger is estimated as:

$$F^J = max\left\{ F \mid \begin{array}{c} \sum_{j=1}^{j=N} \lambda_j x_{ij} \leq \tilde{x}_i^J, \sum_{j=1}^{j=N} \lambda_j y_{rj} \geq F\tilde{y}_r^J, \lambda_j \geq 0, \\ i = 1 \ldots m, \quad r = 1 \ldots l, \end{array} \right\}$$

where $\mathbf{x_{ij}}$ is the input **i** of the bank **j**, $\mathbf{y_{rj}}$ is the output **r** of the bank **j**. If $\mathbf{F^J} > 1$, the bank can offer a greater aggregated output quantity while consuming the same aggregated input amount. In contrast, when $\mathbf{F^J} < 1$, the merger would be disadvantageous due to the decrease in aggregated outputs after the merger while utilizing the same aggregated inputs.

Next the overall efficiency gain (OE) can be decomposed into technical efficiency (TE), scale effect (SE) and harmony effect (HE), thus:

$$\mathbf{OE} = \mathbf{TE} * \mathbf{HE} * \mathbf{SE}$$

At first, to evaluate the potential technical efficiency (TE), an examination among merger group is conducted by computing the technical efficiency of banks which were engaged in the merger. As a result, the overall gain is adjusted and computed again when the technical efficiency is set apart. Due to the fact that the range of adjustment possibilities for each merger may be more limited, the CRS assumption might not be favoured in this step. By confining the technical efficiency gains of merger group under VRS and thus, focusing on the increase in pure technical efficiency within this group, more gains would be distributed to other elements. Accordingly, the BCC-DEA method under Variable Returns to Scale (VRS) below is applied at this stage:

$$F^{o} = max\left\{ F \middle| \begin{array}{c} \sum_{j=1}^{j=N} \lambda_j x_{ij} \le x_{io}, \sum_{j=1}^{j=N} \lambda_j y_{rj} \ge F y_{ro}, \sum_{j=1}^{j=N} \lambda_j = 1, \\ \lambda_j \ge 0, \quad i = 1 \dots m, \quad r = 1 \dots l, o \in J \end{array} \right\}$$

where $\mathbf{x_{io}}$ is the input **i** of the bank **o** in the merger, $\mathbf{y_{ro}}$ is the output **r** of the bank **o** in the merger, $\mathbf{x_{ij}}$ is the input **i** of the bank **j**, $\mathbf{y_{rj}}$ is the output **r** of the bank **j**. As being adjusted to the optimal level, the output **r** of the merger entity is refined as follows:

$$\tilde{Ey}_r^J = \sum_{k=1}^{k=J} F^k y_{rk}$$

where $\mathbf{y_{rk}}$ is the output **r** of the bank **k** in the merger. The below program shows the way to re-calculate the overall efficiency with the adjusted output levels:

$$F^{*J} = max\left\{ F \middle| \begin{array}{c} \sum_{j=1}^{j=N} \lambda_j x_{ij} \le (\tilde{x}_i^J), \sum_{j=1}^{j=N} \lambda_j y_{rj} \ge F(\tilde{Ey}_r^J), \lambda_j \ge 0, \\ i = 1 \dots m, \quad r = 1 \dots l \end{array} \right\}$$

Now, the technical efficiency is captured as:

$$\mathbf{TE^J} = \mathbf{F^J}/\mathbf{F^{*J}}$$

Note that **TE** > 1 indicates at what level the output can be expanded by individual adjustments in different units in the merger, with eliminating or reducing inefficiency by imitating the better performer.

The other main effect of a merger is the mix of inputs and outputs. These mix effects imply the benefits by combining the output portfolio of the target bank. In other words, the merged bank might reap more benefits in efficiency by modifying its output portfolio to be more alike with their rivals' products. Harmony effect (HE) is captured by evaluating how much an output level could be increased on average with a provided average input level.

$$H^J = max\left\{ H \middle| \begin{array}{c} \sum_{j=1}^{j=N} \lambda_j x_{ij} \le \left[(\tilde{x}_i^J)/J\right], \sum_{j=1}^{j=N} \lambda_j y_{rj} \ge H\left[(\tilde{Ey}_r^J)/J\right], \\ \lambda_j \ge 0, \quad i = 1 \dots m, \quad r = 1 \dots l \end{array} \right\}$$

Note that $\mathbf{H^J} > 1$ indicates a savings potential because of improved harmony, while $\mathbf{H^J} < 1$ implies a cost of harmonizing the inputs and outputs, which means there is no potential harmony gain as a result of merger.

Next, any remaining efficiency derives from differences in size of the entity is considered as scale efficiency (SE), which is also the last component in the decomposition. The merged bank may reap the benefits of any returns to scale following the merger. This scale efficiency is computed using the below program:

$$S^J = max\left\{ S \middle| \begin{array}{c} \sum_{j=1}^{j=N} \lambda_j x_{ij} \le (\tilde{x}_i^J), \sum_{j=1}^{j=N} \lambda_j y_{rj} \ge S\left[H^J \tilde{Ey}_r^J\right], \\ \lambda_j \ge 0, \quad i = 1 \dots m, \quad r = 1 \dots l \end{array} \right\}$$

Note that if $\mathbf{S^J} > 1$ we have economies of scale and rescaling is advantageous. If $\mathbf{S^J} < 1$ the return to scale property does not favour larger units and rescaling is costly.

In this paper, the method is employed for the year right before the merger year. After evaluating the potential merger gains, the BCC–DEA method is employed to examine the extent to which such gains are captured. This method is applied to the sample after merger in every post-merger year $\mathbf{E_t}$.

Let **Q** be the number of banks in year $\mathbf{E_t}$ after merger, the merged bank efficiency score in post-merger period is the reciprocal of θ^{MB} which is computed with the BCC-DEA (VRS) program as follows:

$$\theta^{MB} = max\left\{\theta \left| \begin{array}{c} \sum_{p=1}^{p=Q} \lambda_p x_{ip} \le x_{is}, \sum_{p=1}^{p=Q} \lambda_p y_{rp} \ge \theta y_{rs}, \\ \sum_{p=1}^{p=Q} \lambda_p = 1, \lambda_p \ge 0, \\ i = 1 \ldots m, \quad r = 1 \ldots l, 1 \le S \le Q \end{array} \right.\right\}$$

The bank is efficient when the efficiency score $1/\theta^{MB}$ is equal to 1; and inefficient when the efficiency score is less than 1.

3.2. Input-output specification and data

It is known that the selection of variables in efficiency studies significantly influences the outcomes. The role of commercial banks is generally defined as collecting the savings of households and other agents to finance the investment needs of firms and consumption needs of individuals. Two approaches dominate the literature: the production approach and the intermediation approach. These two methods utilize the traditional microeconomic theory of the firm to banking industry and differ only in the specification of banking activities.

Under the production approach, labour and capital resources are used to generate products and services which are customer deposit and customer loan. In such case, outputs are computed by the amount of deposit and loan accounts, while fixed assets (capital) and operating expenses (representing for labour costs in this research) are considered as inputs.

From the viewpoint of the intermediation approach, banks are considered as financial intermediaries that combine deposits, labour and capital to generate income from loans and investments. Thus, the amount of loans, investments securities and operating income are considered as output measures, while operating expense (labour), deposits (material) and fixed asset (capital) are inputs. We also scale the inputs and outputs by total equity.

In this paper, as indicated in Table 2, both production and intermediation approaches are used to better capture bank efficiency performance from both aspects, under output-oriented approach to compute banks efficiency scores. This output-oriented approach implies that banks should maximize the amount of operating income, customer loans and investment income while keeping the same amount of current customer deposits, fixed assets and operating expenses. The data set is obtained from the consolidated Financial Statements of Vietnamese commercial banks over the period 2010–2016 and then analyzed with R software. The data availability, input and output definitions are explained in Appendix A and Appendix B.

4. Results and discussion

Using R software, the overall merger efficiency gain (OE) and its decomposition along with post-merger efficiency scores under two approaches are summarized in Table 3. An example of the computations is given in Appendix A.

Table 2. Input-output specification

Model	Inputs	Outputs
Production Approach (1)	Fixed asset Operating expenses	Deposits Loans
Intermediation Approach (2)	Deposits Fixed asset Operating expenses	Loans Investments Securities Operating income

Table 3. Merger efficiency gains and actual post-merger efficiency scores

MODEL 1: PRODUCTION APPROACH

MERGER	CRS				POST MERGER EFFICIENCY SCORES UNDER BCC-DEA					AVERAGE POST-MERGER EFFICIENCY
	OE	TE	HE	SE	E1	E2	E3	E4	E5	
1	2.018	1.850	1.088	1.000	1.000	1.000	1.000	1.000	1.000	1.000
2	1.848	1.336	1.383	1.000	0.840	0.929	1.000	0.787		0.889
3	1.410	1.199	1.176	1.000	0.923	0.766	0.675			0.788
4	1.809	1.215	1.489	1.000	1.000					1.000
5	1.441	1.222	1.179	1.000	1.000					1.000
6	1.732	1.225	1.414	1.000	1.000					1.000

MODEL 2: INTERMEDIATION APPROACH

MERGER	CRS				POST MERGER EFFICIENCY SCORES UNDER BCC-DEA					AVERAGE POST-MERGER EFFICIENCY
	OE	TE	HE	SE	E1	E2	E3	E4	E5	
1	1.094	1.064	1.028	1.000	0.973	1.000	1.000	1.000	1.000	0.995
2	1.149	1.000	1.149	1.000	1.000	1.000	1.000	1.000		1.000
3	1.108	1.002	1.106	1.000	1.000	0.901	0.957			0.953
4	1.000	1.000	1.000	1.000	1.000					1.000
5	1.028	1.000	1.028	1.000	1.000					1.000
6	1.410	1.137	2.480	0.500	1.000					1.000

Under the production approach, all six merger gains (OE) vary from 1.410 to 2.018, which means all banks could benefit from mergers by expanding the aggregated output from 29% to 50.5% while maintaining the same level of aggregated input. The main sources of all six merger gains are from technical efficiency and harmony effect since all values of technical efficiency gain (TE) and harmony effect (HE) are greater than 1, ranging from 1.199 to 1.850 and from 1.088 to 1.489, respectively.

Under the intermediation approach, 5 mergers could benefit from potential gains, which are SCB, SHB, HDB, BIDV and Sacombank with overall efficiency (OE) values ranging from 1.028 to 1.41. Consequently, the merger aggregated output could increase from 2.7% to 29% while keeping the same level of aggregated input. The harmony effect is one main source of potential gains for all these 5 mergers, ranging harmony effect (HE) values from 1.028 to 2.48. The technical efficiency is another main source of potential gains for the case of SCB and Sacombank, ranging TE from 1.064 to 1.137.

With potential technical efficiency gain (TE>1), the merger may benefit from new management, or the inefficient banks could learn from the practices and procedures of the more efficient ones to improve skills, provide incentives to encourage motivation, and transfer management know-how.

With potential harmony effect gain (HE>1), the mix of products and services is vital for potential efficiency gains from bank mergers. The bank mergers could take advantage of the harmony effect by reallocating the service portfolio of involved parties in the merger to boost efficiency after merging. This is consistent with Dermine (1999) that the state of offering and cross selling a variety of products to different groups of customers may help entities increase in revenue and reduce in credit risk. The potential gains derived from harmony effect may be the primary motivation for healthier banks to merge with financial distress banks, even voluntarily or obligatorily, in order to keep up with foreign competitors who entered Vietnam market in recent years.

Note that only for the case of Sacombank under the intermediation approach, the scale efficiency SE is equal to 0.5. This reveals that partly size of M&A deal would be more advantageous instead of full-scale merger.

Tables 4 and 5 report the efficiency scores of the acquiring bank one year before and after merger time. The efficiency score is the reciprocal of θ^{MB} obtained from (Section 3.1). In general, the efficiency scores increase or maintain the efficiency level after merger. More specifically, from Table 4, BIDV is efficient before merging and maintains its efficiency level after merger. The other three acquiring banks SCB, MSB and Sacombank become efficient after merging. The remaining two cases of SHB and HDB improve their efficiency scores after merging. Also, looking at Table 5 under the intermediation approach, all merger cases reveal the stable efficiency level except for the acquiring bank SCB which becomes efficient after merger.

Table 4. Efficiency scores one-year before and after merger under production approach

	EFFICIENCY SCORES	
	Before Merger	**After Merger**
1	0.410	1.000
2	0.631	0.840
3	0.665	0.923
4	0.935	1.000
5	1.000	1.000
6	0.626	1.000

Table 5. Efficiency scores one-year before and after merger under intermediation approach

MERGER	EFFICIENCY SCORES	
	Before Merger	After Merger
1	0.886	0.973
2	1.000	1.000
3	1.000	1.000
4	1.000	1.000
5	1.000	1.000
6	1.000	1.000

Overall, all mergers have potential efficiency gains with main drivers from technical efficiency and harmony effect. Hence, the government could encourage inter-bank mergers, with a remark on the size effect and carefully examine which merger scale would be the most appropriate to guide the banks better during and after the M&A transaction.

5. Conclusion

Adopting a non-parametric approach developed by Bogetoft and Wang (2005), this study aims to evaluate the potential gains resulting from mergers and the post-merger efficiency of domestic commercial banks in Vietnam context during the period 2010–2016. The potential gains in this research are analyzed and separated into elements which are technical efficiency, scale efficiency and harmony effect. Accordingly, this is one of the first studies to consider the role of technical efficiency and harmony effect for M&As in Vietnam banking system. Furthermore, a closer look at the pre- and post-merger efficiency scores reflects the effect of M&A activities on the efficiency level in the banking sector.

From the research that has been carried out, under the production approach, all mergers earn potential merger gains, with the main sources from technical efficiency and harmony effect. Thus, banks could benefit from the new management or learn from the more efficient ones and take advantage of the harmony effect by reallocating the service portfolio of involved parties in the merger. Under the intermediation approach, 5 mergers benefit from potential gains with harmony effect as the main driver, among them technical efficiency is also the other main driver for 2 mergers.

Additionally, the post-merger efficiency scores are found to increase slightly compared to the efficiency scores before merger. However, mergers do not always benefit from full-scale efficiency, and consequently may favour the partly size of M&A deals. To conclude, this research supports the ongoing restructuring measures of the State Bank of Vietnam in terms of M&As during the restructuring period and provides some aspect that the State Bank of Vietnam may consider while guiding the banks implement M&A transactions in the future.

Funding
This research is funded by Vietnam National University of Ho Chi Minh City (VNUHCM) under grant number [C2017-28-01].

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Citation information
Cite this article as: Non-parametric analysis of bank merger gains: The case of Vietnam, Phuong Anh Nguyen & Linh Dan Pham, *Cogent Business & Management* (2020), 7: 1823582.

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APPENDIX A. Data availability of study sample (asterisk shows presence of banks)

Commercial Banks in Vietnam	2010	2011	2012	2013	2014	2015	2016
Saigon Commercial Joint Stock Bank	*	*	*	*	*	*	*
Vietnam Tin Nghia Commercial Joint Stock Bank	*						
First Joint Stock Commercial Bank	*						
Saigon-Hanoi Commercial Joint Stock Bank	*	*	*	*	*	*	*
Hanoi Building Joint Stock Commercial Bank	*	*					
Ho Chi Minh Development Joint Stock Commercial Bank	*	*	*	*	*	*	*
Dai A Joint Stock Commercial Bank	*	*	*				
Maritime Commercial Joint Stock Bank	*	*	*	*	*	*	*
Mekong Development Joint Stock Commercial Bank	*	*	*	*	*		
Bank for Investment and Development of Vietnam	*	*	*	*	*	*	*
Housing Bank of Mekong Delta	*	*	*	*	*		
Sai Gon Thuong Tin Joint Stock Commercial Bank (Sacom)	*	*	*	*	*	*	*
Southern Commercial Joint Stock Bank	*	*	*	*	*		
LienViet Post Commercial Joint Stock Bank	*	*	*	*	*	*	*
Export Import Commercial Joint Stock Bank	*	*	*	*	*	*	*
Military Commercial Joint Stock Bank	*	*	*	*	*	*	*
Nam A Commercial Joint Stock Bank	*	*	*	*	*	*	*
Nam Viet Commercial Joint Stock Bank	*	*	*	*	*	*	*
An Binh Commercial Joint Stock Bank	*	*	*	*	*	*	*
Orient Commercial Joint Stock Bank	*	*	*	*	*	*	*
Saigon Bank for Industry and Trade	*	*	*	*	*	*	*
Joint Stock Commercial Bank for Foreign Trade of Vietnam	*	*	*	*	*	*	*
Vietnam Technological and Commercial Joint Stock Bank	*	*	*	*	*	*	*
Tien Phong Commercial Joint Stock Bank	*	*	*	*	*	*	*
Vietnam International Commercial Joint Stock Bank	*	*	*	*	*	*	*
Asia Commercial Bank	*	*	*	*	*	*	*

APPENDIX B. Input and Output definitions

Deposit is the amount of money placed into a banking institution for safekeeping. Bank deposits are made to deposit accounts at a banking institution, such as savings accounts, checking accounts and money market accounts. The account holder has the right to withdraw any deposited funds, as set forth in the terms and conditions of the account. Customer Deposit is the main source of any bank, including saving accounts, checking accounts, etc.

Operating Expenses are the expenses that keep banks operating every day, including payroll, sale commissions, employee benefits, pension contributions, transportation and travel, amortization, depreciation, rent, repairs, and taxes. Specifically, it is the sum of:

- Tax, duties and fees
- Salaries and related expenses
- Expenses on assets
- Administrative expenses
- Insurance expenses on deposit of customers
- Allowance for diminution in the value of other long-term investments made during the year
- Others

Fixed Asset is the book value of fixed assets on balance sheets such as land, buildings, equipment, machinery, vehicles, etc. that enable banks to carry on their operations. Fixed Asset is the combination of Tangible Fixed Assets, Intangible Fixed Assets, and Leased Fixed Assets.

Customer Loan is the amount of money lent to individuals or corporations for either personal or financial purposes. Together with Loans to local corporations and individuals at a significant portion, Customer Loan also consists of Discounted bills and valuable papers, Financial leases, Loans given to make payment on behalf of customers, Loans to foreign individuals and enterprises, and Frozen loans. This variable is subjected to Net Customer Loans, which equals Customer Loans minus Provision Customer Loans.

Investment Securities are the securities purchased in order to be held for investment. This contrasts with securities that are purchased by a broker-dealer or other intermediary for resale. Banks often purchase marketable securities to hold in their portfolios. Investment Securities are the total of available-for-sale securities and held-to-maturity securities.

Operating Income. In the Consolidated financial statements of Vietnamese commercial banks retrieved from annual report, the Operating Income is the total of:

- Net Interest Income
- Net Fee and Commission Income
- Net Gain from Trading Foreign Currencies
- Net Gain/(Loss) from Trading securities
- Net Gain from Investment securities
- Net Other Income/(Expenses)
- Net Income from Investments in Associates and Joint-Ventures

APPENDIX C. An example of R software results under production approach to calculate merger 1 overall efficiency, technical efficiency, harmony effect, scale effect

install.packages("lpSolve")

library(lpSolve)

f.obj <- c(0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,-1)

f.con <- matrix(c(

0.193583414,0.049615327,0.050550078,0.364828096,0.065943446,0.108601536,0.042421431-
,0.09725363,0.013343143,0.144376837,0.197742706,0.223672999,0.305196424,0.086712345,0.-
079017063,0.137748212,0.241226231,0.052696928,0.134875282,0.100223674,0.158593923,0.2-
67100033,0.106921907,0.035240702,0.033828538,0.092706735,0,

0.124915829,0.073908898,0.028074073,0.162454993,0.109508775,0.143324439,0.056264165-
,0.146059897,0.019359854,0.228970967,0.243746838,0.155349105,0.113895014,0.124518717,0-
.076001018,0.141165665,0.078561602,0.136065781,0.126584597,0.089594141,0.077914378,0.1-
53305664,0.16910446,0.061492735,0.180615944,0.189862542,0,

-7.455799387,-6.546876746,-1.251157689,-6.127739102,-4.580803135,-5.932301283,-
1.42107079,-7.684871442,-1.715366434,-10.10335933,-6.660272277,-5.588075658,-
7.999282748,-3.000041173,-4.30403257,-7.401293848,-2.658427637,-5.301439225,-
5.04218813,-2.766780887,-2.569766249,-31.32000413,-8.5791215,-2.363491965,-6.823787255,-
9.399568875,15.25383382,

-6.879972895,-6.661494303,-1.264664527,-5.761845318,-5.179108136,-4.938570272,-
1.795292782,-4.981602787,-0.698656633,-10.27668281,-6.9570091,-5.825535262,-
8.671042192,-2.376672858,-4.568041203,-5.410536903,-2.412875214,-5.260711118,-
4.227137259,-3.656213682,-2.921829425,-24.76644745,-5.572048663,-1.612456104,-
6.257641668,-7.601323295,14.80613173

), nrow = 4, byrow = TRUE)

f.rhs <- c(0.293748819, 0.226898801, 0, 0)

f.dir <- c("<=","<=","<=","<=")

lp("min", f.obj, f.con, f.dir, f.rhs)$solution

[1] 0.0000000 1.2831998 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000

[8] 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000

[15] 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000

[22] 0.8614093 0.0000000 0.0000000 0.0000000 0.0000000 2.0182230

lp("min", f.obj, f.con, f.dir, f.rhs)$solution

[1] 0.0000000 1.2831998 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000

0.0000000

[9] 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000

0.0000000

[17] 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.8614093 0.0000000

0.0000000

[25] 0.0000000 0.0000000 1.0881804

#So TE = F/F* = 2.0182/1.08818 = 1.85

lp("min", f.obj, f.con, f.dir, f.rhs)$solution

[1] 0.0000000 0.4277382 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000

0.0000000 0.0000000

[10] 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000

0.0000000 0.0000000

[19] 0.0000000 0.0000000 0.0000000 0.2871345 0.0000000 0.0000000 0.0000000

0.0000000 1.0881788

lp("min", f.obj, f.con, f.dir, f.rhs)$solution

[1] 0.0000000 1.2831998 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000

0.0000000 0.0000000

[10] 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000 0.0000000

0.0000000 0.0000000

[19] 0.0000000 0.0000000 0.0000000 0.8614093 0.0000000 0.0000000 0.0000000

0.0000000 1.0000022

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