



Review of Accounting and Finance

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Article information:

To cite this document:

Hsing-Chin Hsiao Mei-Hwa Lin , (2013), "Taiwan second financial restructuring and commercial bank productivity growth", *Review of Accounting and Finance*, Vol. 12 Iss 4 pp. 327 - 350

Permanent link to this document:

<http://dx.doi.org/10.1108/RAF-05-2012-0043>

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Taiwan second financial restructuring and commercial bank productivity growth

Taiwan second financial restructuring

M&As impact

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Received 13 May 2012
Revised 9 November 2012
23 January 2013
Accepted 27 January 2013

Abstract

Purpose – The purpose of this paper is to examine the impact of merger and acquisition (M&As) of “second financial restructuring” (SFR) on the productivity growth of commercial banks in Taiwan.

Design/methodology/approach – The paper uses the Malmquist productivity change index to evaluate the changes from pre-SFR to SFR period and from pre-SFR to post-SFR period. In addition, the bootstrapping regression method is applied to examine the relationship of SFR policy and productivity change.

Findings – Merged banks have improved their productivity and scale efficiency after the M&As program of SFR. In addition, the greater productivity growth of merged banks than non-merged banks is attributed to small-sized and private-voluntary merged banks. Furthermore, the small-sized merged banks have greater productivity growth and scale efficiency improvement than the big-sized merged banks, and the government-mandatory merged banks have lower productivity growth than private-voluntary merged banks after the SFR.

Research limitations/implications – This study has an academic implication for providing additional empirical evidence related to the impact of government M&As policy on bank productivity growth in the developing countries.

Practical implications – The findings on this paper have implications for financial reform policy and banking management on M&As activity, in particular, as they clarify the differential effects of big-sized vs small-sized and government-mandatory vs private-voluntary merged banks.

Originality/value – Understanding the impacts of financial reform is particularly important as the banking industry has become increasingly competitive. This paper contributes to this area by assessing the impact of the M&As policy of SFR on productivity growth and evaluating differential effects of M&As.

Keywords Data envelopment analysis, Mergers and acquisitions, Financial reform, Malmquist productivity change index

Paper type Research paper



1. Introduction

With the globalization, liberalization and innovation of financial markets over the past two decades, the banking industry has become increasingly competitive. The rapid increase in merger and acquisition (M&As hereafter) transactions since 1990s may be one of the strategies adopted by business to cope with difficulties faced by firms in the competitive environment. The economic theory and industry practitioners indicated

that M&As may reduce costs, increase profits, improve productivity, gain market power, and achieve scale and scope economies. M&As activities are especially pronounced in the financial sectors. Bank managers increase scale of operations through M&As (Cavallo and Rossi, 2001; Focarelli and Pozzolo, 2001) for survive or promoting competitive advantages. The market forces and regulatory reforms also urge banks to engage in M&As (Berger, 2003) for improving productivity.

The impact of M&As on bank productivity has been widely studied with approximately 98 percent of this research which focuses on banks of industrialized and liberalized countries (Group of Ten, 2001; Berger and Mester, 2003; Berger, 2003; Amel *et al.*, 2004; Casu *et al.*, 2004; Cummins and Xie, 2008). In these countries, financial institutions process M&As activities for success and survival voluntarily. However, the studies of banking M&As in developing economies are somehow scant. Usually, the government plays an important role in M&As activities in these countries. Banks are often key instruments of government-orchestrated economic development policy (Hsiao *et al.*, 2010), and the impact of M&As induced by regulatory reforms is different from those of liberalized countries.

Many literatures have attempted to measure the performance improvement from M&As activities (Group of Ten, 2001; Amel *et al.*, 2004; DeYoung *et al.*, 2009), particularly on the banking sectors of the USA. However, the empirical evidences of the impact of M&As on the banking productivity are mixed (Amel *et al.*, 2004). Some studies report positive productivity effects from M&As (Havrylchyk, 2004; Mylonidis and Kelnikola, 2005; Sherman and Rupert, 2006; Al-Sharkas *et al.*, 2008; Cummins and Xie, 2008; Siriopoulos and Tziogkidis, 2010), while others report negative productivity effects or no effect after M&As (Group of Ten, 2001; Amel *et al.*, 2004; Rezitis, 2008; Abdul-Majid *et al.*, 2011; Halkos and Tzeremes, 2013).

In this study, we investigate empirically the effect of M&As activities on developing economies by examining whether the banking reform in Taiwan, the so-called “second financial restructuring” (SFR), has accomplished its mission to improve the productivity of the banking sector. Banking in Taiwan has been a highly regulated industry, commensurate with its importance in the financial system as well (Hsiao *et al.*, 2010). In efforts to promote Taiwan as a financial service center in Asia-Pacific and to strengthen the competitiveness for banking industry, the Taiwan regulatory authorities constructed restructuring programs, including the SFR. The core of SFR is to engage M&As activities among financial institutions for the economies of scale, enhancing firm’s value and promoting globalization and competitive advantages in the banking industry. Taiwan Government anticipates the M&As program of SFR to accomplish operation scale enlargement and productivity improvement in banking sectors.

Our research is to examine the M&As impacts of SFR on bank productivity growth. We use the Malmquist productivity change index and its components, namely technical change, pure efficiency change and scale efficiency change, to evaluate these changes from pre-SFR to SFR period as well as changes from pre-SFR to post-SFR period for a sample of 32 banks. We find that the merged banks have improved their productivity and scale efficiency after the M&As program of SFR. The M&As result in greater performance of merged banks than non-merged banks. We also find the greater productivity growth of merged banks than non-merged banks is attributed to small-sized and private-voluntary merged banks. Furthermore, the small-sized merged banks show a greater productivity growth and scale efficiency improvement than the

big-sized merged banks, and the government-mandatory merged banks have lower productivity growth than private-voluntary merged banks after processing the M&As activity.

Our study contributes to the literature in various ways. First, our contribution is assessing the impact of SFR policy of Taiwan Government on productivity growth. Since gaining operational synergies through M&As is crucial in producing a higher and sustainable rate of economic growth, evaluating how M&As of SFR affecting productivity growth would provide insights for bank management seeking for improvement in operating performance and for policymakers considering financial reforms.

Second, our study evaluates differential effects of M&As on government-mandatory merged banks and private-voluntary merged banks. In response to the challenge from the global financial market competition, the regulation authority in Taiwan mandates the government-controlled banks to engage in merger activities to accomplish the SFR objectives. Most of M&As studies (Hahn, 2007; Cummins and Xie, 2008; Koetter, 2008; Siriopoulos and Tziogkidis, 2010) are conducted for voluntary private banks in free financial markets. Our study is the first to provide evidence of the impact of the M&As on productivity changes of government-mandatory merged banks and private-voluntary merged banks.

Third, our study provides additional empirical evidence for the impact of M&As policy on bank productivity in developing countries. In the developing countries, bank sector is often regulated by government-orchestrated economic development policy. M&As activities may or may not bring optimal outcomes for developing countries where markets and institutional structures are different from those of developed countries. In the SFR, Taiwan regulatory authorities manipulate the merger activities for government-controlled banks rather than employee voluntary M&As. Therefore, it is important to examine the effects of government policy on bank productivity in developing countries (Isik and Hassan, 2003).

The remainder of this paper is organized as follows. Section 2 provides institutional background of Taiwan's SFR program and a brief review of related literatures on M&As and bank productivity to motivate research hypotheses. Section 3 presents the research design including a description of sample data and the construction of the Malmquist productivity change index. Section 4 discusses the empirical results. The conclusions and implications of the study are presented in Section 5.

2. Institutional background, literature review and hypotheses development

2.1 Second financial restructuring

Through the 1970s and 1980s, the Taiwan economy grew rapidly due to government policies to open foreign investment on the one hand. The accompanying accumulation of assets led to a tremendous increase in financial activity. On the other hand, the increasing labor costs and the appreciation of New Taiwan dollar (NTD) in the 1980s sped up the globalization of Taiwanese capital by encouraging investment and other financial involvement in overseas markets. However, since banks in Taiwan were over-regulated, effectiveness of the financial market mechanism is restricted.

To overcome this problem, Taiwan opened its market for new banks in the early 1990s, resulting in the establishment of 16 new banks and creating an over-banking problem (Hsiao *et al.*, 2010). Over-banking stimulated severe market competition, encouraged aggressive banking practices, and resulted in the non-performing loan

ratio to an ever increasing high of 11.27 percent in 2001, which deteriorated asset quality and financial structure of banks. In July 2002, the regulatory authority inaugurated its “first financial restructuring” (FFR), requiring banks to have a minimum capital adequacy ratio of 8 percent and a maximum non-performing loan ratio of 5 percent by the end of 2003 to resolve the non-performing loan problems.

However, even after FFR, banking sectors still incurred many problems, including:

- over-banking phenomenon (there are still too many banks in the market.);
- small banking operation scale;
- too many homogenous banks;
- small profit margin; and
- lack of competitive advantages and globalization, as compared to other Asian banks.

According to the Executive Yuan Economic Planning and Development (2004), the market share of the top five banks in Taiwan accounted for 37 percent only, while in Korea, Singapore, Japan, and Hong Kong they were 87, 73, 55 and 76 percent in 2004, respectively. For Asian top 300 banks, the scales of banks of Hong Kong, Korea and Singapore were 2.12, 2.76 and 4.67 times of Taiwan’s banks. To enlarge scale size and to improve competitive advantages for banking industry, the SFR representing the second phase of financial reform was initiated in September 2004. The government anticipated to achieve the objectives by encouraging aggressive M&As of financial institutions, government-owned banks in particular within two years. To speed up M&As, the Financial Supervisory Commission (FSC) had been trying to create a beneficial environment and incentives[1] for consolidation.

2.2 The impact of M&As of banks on banking productivity

In recent decades, severe competition in the banking sector stimulates M&As to be one of the main strategies (Altunbas *et al.*, 2001; Cavallo and Rossi, 2001) for obtaining the anticipated operational synergies. M&As are motivated by value-enhancing factors and non-value-enhancing factors, resulting in the improvements or deteriorations in productivity (Cummins and Xie, 2008). Value-enhancing factors include economies of scale, economies of scope, X-efficiency, market power, earnings diversifications, corporate control, selective redeployment of assets, transfer of asset control to better quality managers, and renegotiation of implicit labor contracts (Berger *et al.*, 2001; Bessler and Murtagh, 2002; Lambrecht, 2004; Cummins and Xie, 2008). Non-value-enhancing factors are composed of agency problems, managerial hubris, manager-utility-maximization, empire-building, managerial compensation, and expense preference behavior (Bessler and Murtagh, 2002; Cummins and Xie, 2008).

Prior empirical studies report that M&As improve productivity. Havrylchuk (2004) analyzed M&As taken place in Poland between 1997 and 2001 and found merged banks have increased profitability as well as improved cost efficiency. Mylonidis and Kelnikola (2005) investigated whether profit, operating efficiency, and labor productivity ratios improved after mergers (1999-2000) for Greek banks. Their results indicated that operating efficiency of merged banks did not improve after mergers, but the merger had a positive impact on performance compared with the non-merged banks. Sherman and Rupert (2006) found the merger benefits were not

realized until four years later due to political pressures, personnel, system integration issues, and financial components. Hahn (2007) investigated the 800 Austrian banks participated in domestic mergers from 1996 to 2002 and found merged banks achieved a higher productivity than non-merged banks. The merger gains remained significant over a longer period of time (more than five years), but exhibited a slight tendency to level off. Al-Sharkas *et al.* (2008) found that mergers in the US banking industry improved the cost and profit efficiencies. Koetter (2008) found German bank mergers had persistent improvements in terms of profit efficiency. Siriopoulos and Tziogkidis (2010) evaluated the M&As efficiency of Greek commercial banks from 1995 to 2003 and found a relatively increase in management efficiency on average during the periods.

In contrast to these positive effects of M&A activities on productivities, other studies found that M&As had no effect or had a negative effect on productivity. Group of Ten (2001) indicated that while more efficient banks acquire relatively inefficient banks, there is little evidence of subsequent cost reduction and improvement. Amel *et al.* (2004) found that M&As did not significantly improve cost, profit efficiency or shareholder value. Many studies found that scale economies exist only for very small and medium-sized banks but not for large banks (Altunbas *et al.*, 2001; Group of Ten, 2001; Amel *et al.*, 2004). Rezitis (2008) examined the M&As impact on the technical efficiency and total factor productivity of the Greek banking sectors during the period of 1993-1994. The results indicated that M&As effects on technical efficiency and total factor productivity growth of Greek banks are rather negative. Abdul-Majid *et al.* (2011) also found that merged banks have higher input usage and lower productivity change and M&As have not contributed positively to bank performance. Halkos and Tzeremes (2013) applied the DEA to investigate the degree of operating efficiency gains of 45 possible M&As in the Greek banking industry over the period from 2007 to 2011. The results indicated the majority of the potential bank M&As under examination are unable to generate short-run operating efficiency gains.

In this study, we examine the productivity change index and its components of the banking sector from pre-merger to merger period and from pre-merger to post-merger period in Taiwan. We develop the research hypotheses in the following sections.

2.3 Research hypotheses

The objective of SFR is anticipated to enlarge operation scale and improve productivity for banking sectors by aggressively encouraging the M&As of financial institutions. To speed up the M&As activities, the regulatory authorities created a beneficial environment and offered many tax and non-tax incentives for financial institutions. We therefore expect the performance of merged banks would improve after merger to meet SFR objectives compared to non-merged banks, as suggested by previous studies (Berger, 2003; Havrylychuk, 2004; Hahn, 2007; Cummins and Xie, 2008). Thus, we construct our first hypothesis as follows:

- H1. Merged banks improve their productivity after the SFR, compared to non-merged banks.

However, some studies found M&As yield productivity growth or economies of scale for small and medium-sized banks, but not for large banks (Berger and Humphrey, 1997;

Altunbas *et al.*, 2001; Group of Ten, 2001; Amel *et al.*, 2004). They consider that due to small operation scale, the return to scale will increase following scale expansion through M&As for small and medium-sized banks. The big-sized merged banks do not result in scale economies due to decreased return to scale and operation complexity. Therefore, we anticipate productivity growth and scale efficiency improvement of small-sized merged banks are greater than big-sized merged banks after the M&As. Thus, the second hypothesis is stated as follows:

- H2.* For merged banks, productivity growth and scale efficiency improvement of small-sized merged banks are greater than big-sized merged banks after the M&As of SFR.

During SFR period (2005-2007), there are 15 M&A transactions occurred. Three out of these 15 are state-controlled banks and are initiated by the government. These M&As activities result in the top three largest banks in Taiwan. They are Bank of Taiwan, Mega International Commercial Bank and Taiwan Cooperative Bank. The remaining 12 are M&As initiated by the private-voluntary banks, which are publicly listed commercial banks and established in the early 1990 when Taiwan opened its financial market.

In Asia, state ownership of banks is often used as a source of government revenue to assist national economic development policies (Williams and Nguyen, 2005) rather than seeking the profit maximization as that of private banks. Furthermore, Levine (1997) suggested that state-owned banks could induce increased risk and poor allocation of assets. The SFR mandated government-mandatory merged banks to process merger activity, while the private-voluntary merged banks owned by the public proceed the M&As voluntarily. Therefore, we anticipate the government-mandatory merged banks have a negative impact on productivity growth compared to private-voluntary merged banks after M&As. Accordingly, we propose the following research hypothesis:

- H3.* For merged banks, productivity growth of government-mandatory merged banks is smaller than private-voluntary merged banks after the M&As of SFR.

3. Methodology

3.1 Data and sample

The sample of banks included in this study is obtained from the *Taiwan Economic Journal (TEJ)* database, the Central Bank of the Republic of China, the FSC of Executive Yuan, and other related resources. The official statistical data consists of 49 banks in 2004, 45 banks in 2005, 41 banks in 2006, 39 banks in 2007, and 37 banks in each of 2008[2], 2009 and 2010. Although the government promoted the SFR – M&As policy and expected to accomplish the M&A activities within two years (2005-2006), some merger transactions were not finished until 2007. Thus, this study regards SFR period as 2005-2007. To reduce the FFR (2002-2003) confounding effect, our study period is from 2004 to 2010. The research period includes three sections: pre-SFR (2004), the SFR (2005-2007) and post-SFR (2008-2010). We begin with an original sample of 37 banks but eliminate three banks due to exceptional business types and two banks due to incomplete data.

The total sample consists of 32 banks over the period 2004-2010. 15 are merged banks and the remaining 17 are non-merged banks. Our research is to examine the

M&As impacts of SFR on bank productivity growth. We use the Malmquist productivity change index and its components to evaluate and compare these changes from pre-SFR to SFR period and from pre-SFR to post-SFR period. Meanwhile, we treat consolidated reporting entities from M&As transaction as a single entity and name it as merged banks.

3.2 Data envelopment analysis and Malmquist productivity index

We employ data envelopment analysis (DEA) to estimate the Malmquist productivity change index as well as its corresponding components. DEA introduced by Charnes *et al.* (1978) and extended by Banker *et al.* (1984) has been used to evaluate banking efficiency and productivity change in response to financial reforms (Casu *et al.*, 2004; Cook *et al.*, 2004; Park and Weber, 2006; Cummins and Xie, 2008; Banker *et al.*, 2010; Hsiao *et al.*, 2010; Sanyal and Shankar, 2011).

Let $Y_{jt} = (y_{1jt}, \dots, y_{rjt}, \dots, y_{Rjt}) \geq 0$ and $X_{jt} = (x_{1jt}, \dots, x_{ijt}, \dots, x_{Ijt}) \geq 0, j = 1, \dots, N, t = 0$ (i.e. pre-SFR period) or 1 (i.e. the SFR period or post-SFR period), be the observed output and input vectors generated from an underlying production set $S_t = \{(Y_t, X_t) | \text{outputs } Y_t \text{ can be produced from inputs } X_t \text{ at period } t\}$ for a sample of N commercial banks in Taiwan. The input-oriented efficiency of a bank observation $(Y_{j\tau}, X_{j\tau})$ at period τ , relative to benchmark technology S_t from period t , measured radially by the reciprocal of Shephard's (1970) distance function, is given by:

$$\theta_{j\tau}^t = \theta^t(Y_{j\tau}, X_{j\tau}) = \inf\{\theta^t | (Y_{j\tau}, \theta^t X_{j\tau}) \in S_t\}.$$

Assume that the production set S_t is monotonically increasing and convex. We can then follow Banker (1993) to obtain a consistent estimator of $\theta_{j\tau}^t, \theta_{jt}^t$ by solving the following DEA model:

$$\hat{\theta}_{j\tau}^t = \text{Min } \theta \tag{1.0}$$

$$s.t. \quad \sum_j \lambda_{jt} x_{ijt} \leq \theta x_{ij\tau} \quad \forall i = 1, \dots, I \tag{1.1}$$

$$\sum_j \lambda_{jt} y_{rjt} \geq y_{rj\tau} \quad \forall r = 1, \dots, R \tag{1.2}$$

$$\sum_j \lambda_{jt} = 1 \tag{1.3}$$

$$\theta, \lambda_{jt} \geq 0 \quad \forall j = 1, \dots, N \tag{1.4}$$

where θ is a scalar and λ_{jt} are the best possible weights placed on each $j = 1, \dots, N$ under which bank j at period τ is being evaluated using benchmark technology from period t .

DEA model in equations (1.0)-(1.4) allows variables returns to scale (VRS) to prevail and is referred to as the BCC model of DEA (Banker *et al.*, 1984), and the estimated $\hat{\theta}_{j\tau}^t$ is labeled as $\theta_{j,\tau}^{v,t}$ where superscript v refers to VRS technology. If a constant return to scale (CRS) technology assumption is maintained instead, the constraint in equation (1.3) is removed and the resulting model is referred to as the CCR model of DEA (Charnes *et al.*, 1978), and the estimated $\hat{\theta}_{j\tau}^t$ is labeled as $\theta_{j,\tau}^{c,t}$, where superscript c refers to CRS technology.

Following Färe *et al.* (1992), the Malmquist productivity index to measure the productivity change from pre-SFR ($t = 0$) to SFR period ($t = 1$) for a bank-year observation j based on CRS production technology from period zero or period one can be expressed as the geometric mean of two indices as follows:

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$$MI_j^{01} = \left[\frac{\theta_{j,1}^{c,0} \theta_{j,1}^{c,1}}{\theta_{j,0}^{c,0} \theta_{j,0}^{c,1}} \right]^{1/2} \quad (2)$$

Ray and Desli (1997) proposed further decomposition of Malmquist productivity change index (MI^{01}) in equation (2) into indices of technical change (TC), pure efficiency change (PEC) and scale efficiency change (SEC) under VRS production technology as follows:

$$MI^{01} = TC \times PEC \times SEC \quad (3)$$

where:

$$TC = \left[\frac{\theta_{j,1}^{v,0} \theta_{j,0}^{v,0}}{\theta_{j,1}^{v,1} \theta_{j,0}^{v,1}} \right]^{1/2}, \quad (3a)$$

$$PEC = \frac{\theta_{j,1}^{v,1}}{\theta_{j,0}^{v,0}}, \quad (3b)$$

$$SEC = \left[\frac{\theta_{j,0}^{v,1} \theta_{j,1}^{c,1} \theta_{j,0}^{v,0} \theta_{j,1}^{c,0}}{\theta_{j,0}^{c,1} \theta_{j,1}^{v,1} \theta_{j,0}^{c,0} \theta_{j,1}^{v,0}} \right]^{1/2}. \quad (3c)$$

MI^{01} measures the growth in productivity from pre-SFR to the SFR; TC is the technical progress capturing the shift in the production frontier; PEC represents the change in efficiency relative to their peers, reflecting movement toward or away from the production frontier, and is referred to as the catching up to the frontier; and SEC measures the average productivity progress towards the most productive scale size (Banker *et al.*, 1984). A value greater than unity in MI^{01} , TC , PEC and SEC indicates an improvement in that measure from pre-SFR to SFR period, and a value less than unity indicates a deterioration in performance over time.

3.3 Selection of input and output variables

We extend the first financial reform issue of Hsiao *et al.* (2010) and use the Malmquist productivity change index and its components to investigate the M&As impacts of SFR on bank productivity growth. We employ DEA model to estimate the Malmquist productivity change index as well as its corresponding components. Thus, we follow Hsiao *et al.* (2010) to choose the same three outputs and three inputs for estimation of banking productivity change. The three inputs are interest expenses, non-interest expenses, and total deposits while the three outputs are interest revenue, non-interest revenue, and total loans.

4. Results and discussion

4.1 Descriptive statistics

Table I provides descriptive statistics for inputs, outputs, and the control variables in regression analysis for years 2004, 2007, and 2010. As shown in Panels A and B, due to the change in interest rate[3], the interest expense and revenue of 2007 are substantially higher than those of 2004 and 2010. The monetary values are in NTD, where 1 US\$ was approximately equal to 30 NT dollars. In 2007, the mean (median) of the non-interest expense and non-interest revenue increased dramatically which may be induced by M&As activities. Furthermore, total deposits, total loans and total assets of 2010 are higher than 2004. The result indicates bank scale enlargement after the merger of SFR.

In Panel C, the mean (median) of the non-performing loan ratio for years 2004, 2007, and 2010 are 2.48 percent (2.33 percent), 2.11 percent (1.86 percent), and 0.71 percent (0.58 percent), respectively, while mean (median) of the capital adequacy ratios are 10.72 percent (10.68 percent), 10.9 percent (10.54 percent), and 11.77 percent (11.35 percent). These results reveal that banks continuously maintain and improve the FFR requirement for enhancing banking and risk management practices.

Panel D presents the descriptive statistics for the merged banks and non-merged banks separately. In 2007, the mean differences of interest expense (16,479.6 vs 11,152.4), non-interest expense (39,021.8 vs 24,149.1), total deposits (656,229.2 vs 482,574.6), interest revenue (26,696.6 vs 19,825.2), non-interest revenue (31,584.3 vs 16,285.3), and total loans (538,139.1 vs 418,114.4) between merged banks and non-merged banks are higher than the mean differences (8,501.3 vs 6,657.6), (12,118.1 vs 12,847.2), (546,541.6 vs 472,747.2), (17,624.7 vs 17,306.1), (7,463.9 vs 5,498.6), (409,796.7 vs 399,346.5) in 2004. The result suggests merged banks might be affected by the M&As.

Panel D also shows that although the means of inputs, outputs and total assets of merged banks are higher than non-merged banks, but the merged banks have dissimilar scales due to lower medians and higher standard deviations. This result indicates that further analysis by bank size might be necessary.

Table II presents the correlations among the variables in Table I. The correlations among the input and output variables are significantly positive, consistent with isotonicity relations and these variables are justified to be included in the model (Golany and Roll, 1989). The control variables of non-performing loan ratio, capital adequacy ratio, and total assets are correlated with input and output variables.

4.2 Sample of merged banks

In Table III, we list all merger transactions, including six mergers in 2005, five mergers in 2006, and four mergers in 2007, total to 15 merger deals. Based on mean total assets of sample banks in 2004, we partition our sample into big-sized and small-sized banks, including seven big-sized and eight small-sized merged banks. The mean total asset of big-sized merged banks is around 5.78 times of small-sized merged banks in 2004. After M&As, the mean total asset of big-sized merged banks is around 5.95 times of small-sized merged banks in 2007. The average sizes of big-sized and small-sized merged banks grow up 19.09 and 15.68 percent, respectively, from pre-SFR to SFR period.

Table III shows that out of 15 mergers, 12 are private-merged banks and three government-merged banks. The former is considered as voluntary mergers and the

Table I.
Descriptive statistics
on inputs, outputs,
and the control variables
in regression analysis
of the SFR

Variable	Year	Mean	SD	Q1	Median	Q3
<i>Interest Expense (IE)</i>	2004	7,521.9	8,187.5	2,639.5	3,508.5	10,852.3
	2007	13,649.5	13,309.2	3,743.8	6,465.6	21,526.8
	2010	4,787.6	4,786.4	1,508.9	2,626.6	6,853.6
<i>Non-interest Expense (NIE)</i>	2004	12,505.4	9,471.1	5,829.0	8,793.0	20,735.0
	2007	31,120.7	33,035.6	11,673.3	20,810.4	35,721.8
	2010	20,560.8	21,969.1	5,655.1	13,793.7	27,104.2
<i>Total Deposits (TD)</i>	2004	507,338.3	490,229.3	185,647.8	268,971.0	752,909.8
	2007	563,975.2	520,712.4	181,176.0	312,543.7	885,539.9
	2010	700,789.5	635,924.6	220,233.6	496,891.4	1,098,866.4
<i>Interest Revenue (IR)</i>	2004	17,455.4	1,344.3	7,811.3	10,624.0	30,230.8
	2007	23,046.2	19,065.5	8,000.4	13,741.6	37,192.7
	2010	13,196.1	10,273.1	5,071.2	9,359.5	19,265.8
<i>Non-interest Revenue (NIR)</i>	2004	6,419.8	6,506.4	2,045.3	3,933.5	9,367.0
	2007	23,456.7	32,263.9	4,940.8	10,444.9	27,267.1
	2010	16,817.5	20,295.9	3,312.3	9,656.8	21,306.8
<i>Total Loans (TL)</i>	2004	404,245.0	369,318.6	149,656.5	202,139.5	626,642.0
	2007	474,376.0	443,602.3	149,336.8	244,135.3	709,836.5
	2010	531,286.6	491,885.6	149,790.6	294,101.0	812,493.7
NPL	2004	2.48	1.3	1.54	2.33	3.38
	2007	2.11	1.02	1.47	1.86	2.46
	2010	0.71	0.40	0.42	0.58	0.85
CA	2004	10.72	1.3	9.74	10.68	11.59
	2007	10.90	2.62	9.72	10.54	11.10
	2010	11.77	1.85	10.78	11.35	12.95
TA	2004	686,731.9	649,247.0	247,270.0	360,116.5	1,098,825.8
	2007	746,029.1	682,408.1	228,740.7	385,363.6	1,146,304.8
	2010	868,231.3	782,508.6	275,260.0	618,728.2	1,349,498.3
<i>Variable Interest Expense (IE)</i>	Year	Mean	SD	Median	Mean	Median
	2004	8,501.3	10,153.2	3,894.0	6,657.6	3,445.0
	2007	16,479.6	16,365.0	6,497.0	11,152.4	6,434.2
2010	5,706.5	6,047.1	2,643.2	3,976.9	2,610.0	
Merged banks						Non-merged banks
(n = 15) and non-merged (n = 17) banks						SD

(continued)

<i>Non-interest Expense (NIE)</i>	2004	12,118.1	9,853.5	10,360.0	12,847.2	9,411.4	8,394.0
	2007	39,021.8	42,700.5	22,964.8	24,149.1	20,221.5	20,186.5
	2010	27,117.6	27,533.5	16,332.5	14,775.4	13,996.9	9,903.9
<i>Total Deposits (TD)</i>	2004	546,541.6	568,699.6	320,654.0	472,747.2	424,175.9	223,366.0
	2007	656,229.2	616,057.1	336,989.2	482,574.6	422,175.3	230,115.8
	2010	837,411.5	749,931.9	531,530.7	580,240.7	508,417.0	286,228.6
<i>Interest Revenue (IR)</i>	2004	17,624.7	14,404.7	10,713.0	17,306.1	12,982.4	10,187.0
	2007	26,696.6	21,914.7	14,511.3	19,825.2	16,003.3	10,662.8
	2010	15,575.7	11,719.6	14,478.7	11,096.4	8,619.9	6,375.3
<i>Non-interest Revenue (NIR)</i>	2004	7,463.9	7,947.3	3,603.0	5,498.6	4,983.1	4,264.0
	2007	31,584.3	42,760.9	10,446.3	16,285.3	17,330.6	10,443.6
	2010	23,074.6	25,616.6	14,111.1	11,296.6	12,443.1	6,460.9
<i>Total Loans (TL)</i>	2004	409,796.7	392,463.8	249,742.0	399,346.5	359,776.2	194,079.0
	2007	538,139.1	516,705.8	245,951.8	418,114.4	374,807.4	195,618.6
	2010	598,043.3	551,005.8	302,697.3	472,383.6	441,882.6	228,460.5
<i>NPL</i>	2004	2.30	1.23	2.52	2.63	1.35	2.31
	2007	2.09	0.95	1.85	2.13	1.10	1.87
	2010	0.68	0.38	0.60	0.73	0.42	0.55
<i>CA</i>	2004	10.81	1.61	10.70	10.64	0.97	10.66
	2007	11.00	2.66	10.63	10.82	2.67	10.47
	2010	11.74	2.07	11.26	11.79	1.69	11.43
<i>TA</i>	2004	735,158.6	737,959.5	403,890.0	644,002.5	579,696.9	316,343.0
	2007	871,354.0	808,956.7	429,879.8	635,448.3	549,481.6	318,992.6
	2010	1,046,751.4	927,322.4	695,628.0	710,713.6	614,567.7	366,541.2

Notes: *Interest Expense (IE)* – interest expense of bank per year, *Non-interest Expense (NIE)* – includes the expenditures of transaction and commission, personnel, and other operating related expense, *Total Deposits (TD)* – total deposits at year end, *Interest Revenue (IR)* – interest revenue of the bank, *Non-interest Revenue (NIR)* – comprises transaction fee, commission revenue, bond transaction revenue, and other operating revenue, *Total Loans (TL)* – total loans at year end; all dollar amounts expressed in million NTDs and deflated to 2004, *NPL* – non-performing loan ratio, total non-performing loans/total loans, *CA* – capital adequacy ratio, expressed as a percentage of risk weighted credit exposures, *TA* – total assets measured in NTDs and deflated to 2004; *n* = 32 each year

Variable	IE	NIE	TD	IR	NIR	TL	NPL	CA	TA
IE	1.0000 (0.00)	0.6039 (0.00)	0.7760 (0.02)	0.9246 (0.00)	0.5871 (0.03)	0.7923 (0.00)	-0.0971 (0.34)	-0.0069 (0.94)	0.7982 (0.00)
NIE	0.8227 (0.00)	1.0000 (0.00)	0.5995 (0.00)	0.6439 (0.00)	0.9754 (0.00)	0.5640 (0.00)	-0.1707 (0.09)	0.0714 (0.49)	0.6005 (0.00)
TD	0.8488 (0.00)	0.7786 (0.00)	1.0000 (0.00)	0.8317 (0.00)	0.5788 (0.00)	0.9803 (0.00)	-0.2959 (0.00)	0.0679 (0.51)	0.9945 (0.00)
IR	0.9529 (0.00)	0.8487 (0.00)	0.8970 (0.00)	1.0000 (0.00)	0.5921 (0.00)	0.8598 (0.00)	-0.1504 (0.14)	-0.0033 (0.97)	0.8639 (0.00)
NIR	0.7781 (0.00)	0.9149 (0.00)	0.8155 (0.00)	0.8046 (0.00)	1.0000 (0.00)	0.5268 (0.00)	-0.2763 (0.00)	0.0695 (0.50)	0.5761 (0.00)
TL	0.8721 (0.00)	0.7721 (0.00)	0.9822 (0.07)	0.8973 (0.00)	0.7973 (0.00)	1.0000 (0.00)	-0.2658 (0.00)	0.0123 (0.90)	0.9826 (0.00)
NPL	-0.0416 (0.69)	-0.1774 (0.08)	-0.3944 (0.00)	-0.1395 (0.17)	-0.4237 (0.00)	-0.3525 (0.00)	1.0000 (0.00)	-0.1850 (0.07)	-0.2911 (0.00)
CA	0.0341 (0.74)	0.1738 (0.09)	0.1799 (0.08)	0.1116 (0.28)	0.2350 (0.02)	0.1374 (0.18)	-0.5030 (0.00)	1.0000 (0.00)	0.0684 (0.51)
TA	0.8724 (0.00)	0.7926 (0.00)	0.9923 (0.00)	0.9149 (0.00)	0.8240 (0.00)	0.9834 (0.00)	-0.3801 (0.00)	0.1950 (0.05)	1.0000 (0.00)

Table II.

Correlation matrix among these variables

Notes: Pearson correlations appear above the diagonal and Spearman correlations appear below the diagonal; all variable definitions appear in Table I

later is considered as mandatory mergers. The sizes of government-mandatory merged banks are much larger than private-voluntary merged banks and all these government-mandatory merged banks belong to big-sized merged banks.

4.3 Merger impact of SFR on productivity change

4.3.1 Univariate analysis. Table IV presents the statistical results of productivity change, technical change, pure efficiency change, and scale efficiency change between groups. We use non-parametric statistics, including Mann-Whitney test and median score test to examine mean differences between the groups. Panel A presents the differences of productivity change, technical change, pure efficiency change, and scale efficiency change from pre-SFR to SFR period and from pre-SFR to post-SFR period between merged and non-merged banks. The mean productivity change and technical change of merged banks is smaller than non-merged banks from pre-SFR to SFR period (1.0514 vs 1.0897 and 0.9722 vs 1.0855), but the improvements in productivity change, technical change, pure efficiency change, and scale efficiency change of merged banks are greater than non-merged banks from pre-SFR to post-SFR period (1.2831 vs 1.1605, 1.1697 vs 1.1128, 1.0110 vs 1.0000 and 1.1183 vs 1.0889). In addition, there is no significant difference of productivity change index and its components between 2004-2007 and 2004-2010 for non-merged banks, while for merged banks, the differences of productivity growth (0.2318) and scale efficiency improvement (0.0505) between 2004-2007 and 2004-2010 are statistically significant. Meanwhile, merged banks have higher scale efficiency progress (0.027) than non-merged banks between 2004-2007 and 2004-2010. The evidences demonstrate merged banks have higher productivity growth and scale efficiency progress after the M&As of SFR, compared to the non-merged banks. The result supports *H1*.

Name of the new institution	Names of target banks	Year of M&As	Total assets ^a in 2004	Total assets ^a in 2007
<i>Big size scale</i>				
1. Mega International Commercial Bank Co., Ltd ^b	The International Commercial Bank of China and Chiao-Tung Bank Co., Ltd ^b	2006	1,181,724	1,724,465
2. Chinatrust Commercial Bank	Chinatrust Commercial Bank and Enterprise Bank of Hualien	2007	1,262,683	1,321,356
3. Cathay United Bank	Cathay United Bank and Lucky bank	2006	1,028,724	1,137,652
4. Taipei Fubon Commercial Bank	Taipei Bank and Fubon Commercial Bank	2005	704,463	1,011,086
5. Bank SinoPac Company Limited	Bank SinoPac Company Limited and International Bank of Taipei	2006	472,046	883,651
6. Taiwan Cooperative Bank ^b	Taiwan Cooperative Bank and The Farmers Bank of China ^b	2006	2,052,280	2,156,863
7. Bank of Taiwan ^b	Bank of Taiwan and Central Trust of China ^b	2007	2,504,054	2,728,234
Average			1,315,139.1	1,566,186.6
<i>Small size scale</i>				
1. Standard Chartered Bank (Taiwan) Limited	Standard Chartered Bank and Hsinchu International Bank	2007	403,890	429,880
2. Union Bank of Taiwan	Union Bank of Taiwan and Chung-Shing Bank	2005	247,709	321,348
3. Yuanta Commercial Bank	Yuanta Commercial Bank and The Seventh and The Sixth Credit Cooperative of Tainan	2005	280,140	305,613
4. Taiwan Shin-Kong Commercial Bank	Makoto Bank and Shin-Kong Commercial Bank	2005	227,531	340,848
5. Sunny Bank	Sunny Bank and Kao-Shin Commercial Bank	2005	173,969	216,328
6. Citibank Taiwan	Citibank and Bank of Overseas Chinese	2007	258,822	249,519
7. Cota Bank	Cota Bank and Fengyuan Credit Cooperative	2006	79,920	91,530
8. Bank of Pan-Shin	Bank of Pan-Shin and Chiayi The First Credit Cooperative	2005	149,424	151,939
Average			227,675.6	263,375.5

Notes: ^aTotal assets measured in NTDs and deflated to 2004; ^brepresents government-mandatory merged bank

Table III.
List of M&As taken
place in 2005-2007
(in million NTD)

Table IV.
Statistical results of productivity change, technical change, pure efficiency change, and scale efficiency change between groups

Variables	Period from-to	Merged banks		Non-merged banks		Mean difference ^b
		Mean ^a	Median ^a	Mean ^a	Median ^a	
Productivity change	2004-2007	1.0514***	0.9571	1.0897***	0.9707	-0.0383
	2004-2010	1.2831***	1.1342**	1.1605***	1.2056**	0.1226
Mean difference		0.2318**		0.0707		0.1610
						-0.1133
Technical change	2004-2007	0.9722	0.9355	1.0855	0.9559	0.0569
	2004-2010	1.1697*	1.0667	1.1128*	1.0850	0.138
Mean difference		0.1813		0.0437		0.01
						0.023
Pure efficiency change	2004-2007	1.0037	1.0000	0.9837	1.0000	0.013
	2004-2010	1.0110	1.0000	0.9880	1.0000	0.0634
Mean difference		0.0073		-0.006		0.0294
						0.027
Scale efficiency change	2004-2007	1.0807	0.9986	1.0173	1.0139	0.0294
	2004-2010	1.1183***	1.1116***	1.0889*	1.0600**	0.027
Mean difference		0.0505		0.0237		

Variables	Period from-to	Big-sized merged banks		Small-sized merged banks		Mean difference ^b
		Mean ^a	Median ^a	Mean ^a	Median ^a	
Productivity change	2004-2007	1.2596**	1.0820	0.8691***	0.8952***	0.3905***
	2004-2010	1.2351**	1.1099*	1.3252**	1.1674**	-0.0901
Mean difference		-0.0245		0.4561***		-0.4807**
						0.1621*
Technical change	2004-2007	1.0648	0.9703	0.9027**	0.9132	-0.0758**
	2004-2010	1.1231	1.1358	1.1989**	1.059	-0.2379**
Mean difference		0.0583		0.2962**		-0.0428
						-0.0301
Pure efficiency change	2004-2007	0.9969	1.0000	1.0097	0.9994	0.2771**
	2004-2010	0.9882	1.0000	1.0310	1.0000	0.1136**
Mean difference		-0.0088		0.0213		0.1635
Scale efficiency change	2004-2007	1.2391**	1.0940	0.9620*	0.9713*	0.1136**
	2004-2010	1.1882**	1.1130*	1.0746***	1.0686**	-0.1635
Mean difference		-0.0509		0.1126		

(continued)

Panel C: private-voluntary merged banks ($n = 12$) and Government-mandatory merged banks ($n = 3$)

<i>Variables</i>	<i>Private-voluntary merged banks</i>			<i>Government-mandatory merged banks</i>			<i>Mean difference^b</i>
	<i>Period from-to</i>	<i>Mean^a</i>	<i>Median^a</i>	<i>Mean^a</i>	<i>Median^a</i>	<i>Mean difference^b</i>	
Productivity change	2004-2007	1.0573 ***	0.9316	1.0279	1.0544	0.0294 **	
	2004-2010	1.3411 ***	1.1674 **	1.0513	1.0798	0.2898 **	
Mean difference		0.2838 ***		0.0234		0.2604 **	
		0.9725	0.9189	0.9703	0.9703	0.0022	
Technical change	2004-2007	1.1962 *	1.0667	1.0240	1.0240	0.1722 *	
	2004-2010	0.2212 **		0.0537		0.1675 *	
Mean difference		1.0046	1.0000	1.0000	1.0000	0.0046	
		1.0138	1.0000	1.0000	1.0000	0.0138	
Pure efficiency change	2004-2007	0.0092		0.0000		0.0092	
	2004-2010	1.0863	0.9986	1.0475	1.0475	0.0388	
Mean difference		1.1110 ***	1.1116	1.1579	1.1579	-0.0469 **	
		0.0247 *		0.1104		-0.0857	

Notes: Significant at: *10, **5 and ***1 percent levels for one-sided hypothesis tests; ^atest null hypothesis whether productivity change, technical change, pure efficiency change, or scale efficiency change is significantly less than one; the values greater than one indicate improvement, those less than one indicate deterioration and those equal to 1 indicate no change; ^bmean differences were tested using non-parametric statistics, including Mann-Whitney test, and median score test

Panel B reports the differences of productivity index and its components of big-sized and small-sized merged banks from pre-SFR to SFR period and from pre-SFR to post-SFR period. The average productivity change, technical change, and scale efficiency change of small-sized merged banks are 0.8691, 0.9027, 0.9620, respectively, from pre-SFR to SFR period, which are significantly less than big-sized merged banks (1.2596, 1.0648, 1.2391). This result shows that the small-sized merged banks do not yet result in M&As benefit in the period (2004-2007), compared to big-sized merged banks. However, small-sized merged banks experience a statistically greater growth than big-sized merged banks in productivity growth (0.4561 vs -0.0245), technical progress (0.2962 vs 0.0583), and scale efficiency improvement (0.1126 vs -0.0509) for the period 2004-2010 compared to the period 2004-2007, suggesting that small-sized merged banks gain greater M&As benefits than big-sized merged banks after the SFR. The result supports *H2*.

Panel C reports the statistical results of the difference between private-voluntary and government-mandatory merged banks from 2004 to 2007 period and from 2004 to 2010 period. The average productivity change, technical change, pure efficiency change and scale efficiency change of private-voluntary merged banks are 1.3411, 1.1962, 1.0138, 1.1110, respectively, from 2004 to 2010 period, which are greater than government-mandatory merged banks (1.0513, 1.0240, 1.0000, 1.1579) except for scale efficiency change. The private-voluntary merged banks reveal statistically greater growth than government-mandatory merged banks after the M&As in productivity growth (0.2838 vs 0.0234) and technical progress (0.2212 vs 0.0537), with an exception in scale efficiency (0.0247 vs 0.1104)[4] for the period 2004-2010 compared to the period 2004-2007. Therefore, our study indicates private-voluntary merged banks improve the productivity after the M&As of SFR, compared to government-mandatory merged banks. The result supports *H3*.

As shown in Panel A, B, C of Table IV, we observe that M&As activities did not have a completely positive impact on bank productivity growth. The government-mandatory merged banks have less productivity change (1.0513) and technical change (1.0240) than non-merged banks (1.1605, 1.1128) from pre-SFR to post-SFR period. These results also reveal that merged banks have greater productivity growth than non-merged banks due to small-sized and private-voluntary merged banks contributions.

4.3.2 Multivariate analysis. We use the second-stage procedure in equation (4) to evaluate the effect of bank contextual variables on productivity change index and its components based on prior research (Banker and Natarajan, 2008; Hsiao *et al.*, 2010). We investigate M&As effect of SFR program on productivity change index and its components from pre-SFR to post-SFR period. We also examine the coefficient difference between merged and non-merged banks, and between private-voluntary and government-mandatory merged banks in equation (4a). To avoid the interaction confounding effect of private-voluntary/government-mandatory and big-sized/small-sized merged banks, we separate the equation (4b) to test whether *H2* is confirmed.

We anticipate that the M&As transaction would have a differential effect on the productivity change of merged and non-merged banks. We include *MERGE* variable to examine the differences in productivity index and its components between merged and non-merged banks. We also include *GOV* to control ownership effect (Das and Ghosh, 2006; Iannotta *et al.*, 2007; Hsiao *et al.*, 2010; Zhao *et al.*, 2010). Furthermore, to investigate the differential impact of M&As between the private-voluntary merged

banks and the government-mandatory merged banks, we apply the interaction variable $MERGE*GOV$ in equation (4a). Finally, we include change rate in capital adequacy ratio (ΔCA_R) and non-performing loan ratio (ΔNPL_R) and size ($LnTA$) to control the impact on productivity based on prior studies (Berger and Mester, 2003; Das and Ghosh, 2006; Hsiao *et al.*, 2010). Specifically, we created the following regression model (4a):

$$\begin{aligned} & \text{Change measure (Productivity change, technical change,} \\ & \text{pure efficiency change and scale efficiency change)} \\ & = \beta_0 + \beta_1 MERGE + \beta_2 GOV + \beta_3 MERGE*GOV \\ & \quad + \beta_4 \Delta CA_R + \beta_5 \Delta NPL_R + \beta_6 LnTA + \varepsilon \end{aligned} \quad (4a)$$

To test the differential impact of M&As between big-sized and small-sized merged banks, we include $MERGE$, $SIZE$ dummy variable, others control variables and the interaction variable $MERGE*SIZE$ in equation (4b):

$$\begin{aligned} & \text{Change measure (Productivity change, technical change,} \\ & \text{pure efficiency change and scale efficiency change)} \\ & = \beta_0 + \beta_1 MERGE + \beta_2 SIZE + \beta_3 MERGE*SIZE \\ & \quad + \beta_4 \Delta CA_R + \beta_5 \Delta NPL_R + \beta_6 LnTA + \varepsilon \end{aligned} \quad (4b)$$

where *Change measures* are estimated from equation (3). $MERGE$ takes a value of 1 for merged banks, and 0 for non-merged banks. GOV is an indicator for banks controlled by government, and 0 for private ownership bank. $MERGE*GOV$ is the interaction of $MERGE$ and GOV representing the effect of government-mandatory merged banks. $CA_R[5]$ and $\Delta NPL_R[6]$ are change rates of capital adequacy ratio and non-performing loan ratio from 2004 to 2010. $LnTA$ is the natural logarithm of total assets and ε is the disturbance term. $SIZE$ takes a value of 1 for small-sized banks, and 0 for big-sized banks. $MERGE*SIZE$ is the interaction of $MERGE$ and $SIZE$ representing the effect of small-sized merged banks.

Due to small sample size, our study uses an ordinary least squares (OLS) regression with bootstrapping (Efron and Tishbirani, 1993) to estimate equation (4a) and (4b). We process 1,000 replicates (32,000 observations) of OLS regression analysis for robustness estimation. The results of regression with bootstrapping are presented in Table V[7]. Panel A shows the coefficients of $MERGE$ variable are 0.2332, 0.1455, 0.0368, and 0.0216 on productivity change, technical change, pure efficiency change and scale efficiency change, respectively, and are all significantly positive at 1 percent level, suggesting that merged banks improve their productivity from pre-SFR to post-SFR period, compared to the non-merged banks. The coefficients of $MERGE*GOV$ are -0.4248 , -0.3605 , -0.0103 , and 0.0099 on productivity change, technical change, pure efficiency change and scale efficiency change, respectively, which are significantly negative at 1 percent level except for scale efficiency change. The result demonstrates government-mandatory merged banks have less productivity growth from pre-SFR to post-SFR period. Panel B also shows the coefficients of $MERGE$ are significantly positive except for technical change and the coefficient of interaction variable $MERGE*SIZE$ are 0.1839, 0.1721, 0.0077, and 0.0214 on

Table V.
Results of OLS regression
with bootstrapping for
the M&As impact of SFR
on banking productivity
(2004-2010)

Variables	Productivity change	Technical change	Pure efficiency change	Scale efficiency change
<i>Panel A</i>				
<i>Productivity change, technical change, pure efficiency change and scale efficiency change = $\beta_0 + \beta_1 MERGE + \beta_2 GOV + \beta_3 MERGE * GOV + \beta_4 \Delta CA_R + \beta_5 \Delta NPL_R + \beta_6 \ln TA + \varepsilon$</i>				
Intercept	0.3722*** (0.00)	1.4546*** (0.00)	1.2008*** (0.00)	-0.6506 (0.00)
MERGE	0.2332*** (0.00)	0.1455*** (0.00)	0.0368*** (0.00)	0.0216*** (0.00)
GOV	0.1415*** (0.00)	0.3067*** (0.00)	0.0556*** (0.00)	-0.1750*** (0.00)
MERGE*GOV	-0.4248*** (0.00)	-0.3605*** (0.00)	-0.0103*** (0.00)	0.0099 (0.13)
ΔCA_R	0.2422*** (0.00)	0.2419*** (0.00)	0.0667*** (0.00)	-0.0921*** (0.00)
ΔNPL_R	-0.4812*** (0.00)	0.0370** (0.05)	-0.1390*** (0.00)	-0.2246*** (0.00)
$\ln TA$	0.0306*** (0.00)	-0.0327*** (0.00)	-0.0255*** (0.00)	0.1271*** (0.00)
R^2	0.4153	0.3211	0.4115	0.4469
Adj R^2	0.2762	0.1410	0.2715	0.3004
<i>Panel B</i>				
<i>Productivity change, technical change, pure efficiency change and scale efficiency change = $\beta_0 + \beta_1 MERGE + \beta_2 SIZE + \beta_3 MERGE * SIZE + \beta_4 \Delta CA_R + \beta_5 \Delta NPL_R + \varepsilon$</i>				
Intercept	0.8821*** (0.00)	1.2199*** (0.00)	0.8817*** (0.00)	0.9921*** (0.00)
MERGE	0.0149*** (0.00)	-0.0526*** (0.00)	0.0239*** (0.00)	0.0182*** (0.00)
SIZE	-0.1556*** (0.00)	-0.1131*** (0.00)	0.0213*** (0.00)	-0.1541*** (0.00)

(continued)

Variables	Productivity change	Technical change	Pure efficiency change	Scale efficiency change
<i>MERGE*SIZE</i>	0.1839 *** (0.00)	0.1721 *** (0.00)	0.0077 *** (0.00)	0.0214 *** (0.00)
ΔCA_R	0.2222 *** (0.00)	0.1897 *** (0.00)	0.0313 *** (0.00)	0.0275 *** (0.00)
ΔNPL_R	-0.5195 *** (0.00)	0.0822 *** (0.00)	-0.1335 *** (0.00)	-0.2823 *** (0.00)
R^2	0.3494	0.2493	0.3925	0.3820
Adj R^2	0.2243	0.0856	0.2757	0.2472

Notes: Significant at: *, **, *5 and ***1 percent levels; we process 1,000 replicates to confirm the fitness of OLS regression analysis; dependent variables are the bank-specific value of the productivity change, technical change, pure efficiency change and scale efficiency change from 2004 to 2010; independent variables: *MERGE* - 1 represents the merged bank, and 0 for non-merged bank, *GOV* - 1 state ownership bank if the bank was owned by government, 0 private ownership bank if the bank was owned by the public, *MERGE*GOV* - the interaction of *MERGE* and *GOV*, *MERGE*GOV* represents the impact of the government-mandatory merged bank, *SIZE* - 1 represents the small-sized bank, and 0 for big-sized bank; based on mean total assets of sample banks in 2004, we partition sample into big-sized banks and small-sized banks, *MERGE*SIZE* - the interaction of *MERGE* and *SIZE*, *MERGE*SIZE* represents the impact of the small-sized merged bank, ΔCA_R - (capital adequacy ratio in 2010 - capital adequacy ratio in 2004)/capital adequacy ratio in 2004, i.e. a measure of amount of a bank's capital expressed as a percentage of its risk weighted credit exposures, ΔNPL_R - (non-performing loan ratio in 2010 - non-performing loan ratio in 2004)/non-performing loan ratio in 2004, i.e. total non-performing loans/total loans, $lnTA$ - the natural logarithm of total assets in 2004; *p*-values in parentheses

productivity change, technical change, pure efficiency change and scale efficiency change, respectively, and are significantly positive at 1 percent level. The result supports that small-sized merged banks have greater productivity growth and scale efficiency progress than the big-sized merged banks after the M&As of SFR. Therefore, our *H1-H3* are reconfirmed.

4.4 Sensitivity analyses

In this section we report a series of robust tests. First, we examine the four change indexes from the SFR to post-SFR period to reconfirm the impacts after the M&As. We find that the average changes in productivity, technical, pure efficiency and scale efficiency of merged banks are 1.3209, 1.1820, 1.0093, and 1.1128, respectively, which are greater than non-merged banks (1.2316, 1.1662, 0.9943, 1.0655). The scale efficiency improvement of merged banks (1.1128) is significantly greater than non-merged banks (1.0655). The small-sized merged banks also have significantly greater improvements in productivity ($0.2601 = 1.4423 - 1.1822$), technical efficiency ($0.257 = 1.302 - 1.045$) and scale efficiency ($0.061 = 1.1453 - 1.0843$) from the SFR to post-SFR period, compared to big-sized merged banks. The private-voluntary merged banks reveal statistically greater growth than government-mandatory merged banks in productivity growth (1.3517 vs 1.1978) and technical progress (1.1950 vs 1.1301). These results are consistent with Table IV and demonstrate that merged banks have greater productivity growth than non-merged banks from the SFR to post-SFR period, which results primarily from scale efficiency progress. Small-sized merged banks have better productivity and scale efficiency improvement, and private-voluntary merged banks have better productivity growth after the SFR.

Second, we process bootstrapping regression with 2,000 replicates (64,000 observations). The coefficients of *MERGE*, *MERGE*GOV*, *MERGE*SIZE* are similar to Table V. For example, the coefficients of *MERGE*GOV* and *MERGE*SIZE* in equation (4a) and (4b) are, respectively, -0.4266 , -0.3699 , -0.0111 , 0.0139 and 0.1880 , 0.1688 , 0.0094 , 0.0249 . Third, we add a dummy variable *GROUP* into the regression model (4a) and (4b) to control for holding-banks effect. The coefficients of *MERGE*, *MERGE*GOV* are 0.2237 , 0.1203 , 0.0346 , 0.0369 and -0.3907 , -0.3213 , -0.0075 , -0.0035 in regression model (4a), respectively. The coefficients of *MERGE*, *MERGE*SIZE* are, respectively, 0.0165 , -0.0719 , 0.0217 , 0.0352 and 0.1715 , 0.1478 , 0.0083 , 0.0251 in regression model (4b). These numbers are robust and significant at 1 percent level, consistent with Table V.

5. Conclusion

The SFR representing the second phase of financial reform was inaugurated by Taiwanese regulatory authority in 2004. The primary objective of SFR is to enlarge operation scale and improve productivity for banking sectors by aggressively encouraging M&As of financial institutions. Our research examines the M&As impacts of SFR on bank productivity growth using the Malmquist productivity change index and its components to evaluate and compare these changes from pre-SFR to SFR period and from pre-SFR to post-SFR period. We find that the merged banks have improved their productivity and scale efficiency after the M&As of SFR. The merged banks have greater productivity growth than non-merged banks due to small-sized and private-voluntary merged banks contributions. Furthermore, the small-sized merged

banks have greater productivity growth and scale efficiency improvement than the big-sized merged banks, and government-mandatory merged banks have lower productivity growth than private-voluntary merged banks after the SFR.

The results of this study have implications for government policy decision and banking management. First, the mission of the SFR – M&As policy is to accomplish operation scale enlargement and productivity improvement in banking sectors. Our study provides evidence that the SFR – M&As policy resulted in greater productivity improvement for merged banks. Given an increasingly competitive environment where inefficient institutions are difficult to survive, it is imperative for regulators and bank managers to be knowledgeable about M&As effect on the banking industry and factors that might improve or exacerbate M&As benefits. Second, this study finds that small-sized merged banks have greater productivity and scale efficiency improvement than big-sized merged banks, and the private-voluntary merged banks also have better performance in productivity growth than government-mandatory merged banks after the SFR. These findings suggest that the regulatory authority should provide incentives for small-sized and private-voluntary commercial banks to proceed M&As activity to enhance the competitiveness for banking industry. Third, this study has an academic implication for providing additional empirical evidence related to the impact of government M&As policy on bank productivity growth in developing countries.

However, a limitation of this study is that data size is small. Only 32 banks are used in this study and are further partitioned into several groups to analyze the differential M&As impact between groups. The bootstrapping method is adopted to reduce the possible bias from the small sample and to increase the reliability of results for drawing generalized conclusions. Several sensitivity analyses are tested. The results are robust. Since the number of banks of M&A activities in China, Japan, Korea, Singapore, and other countries is also small, our study could provide a basis for future research.

Notes

1. The merged financial institutions were exempt from land value increment taxes, stamp taxes, and other taxes. Losses resulting from the sale of bad debts because of a merger could be amortized over a 15-year period. The law provided a legal basis for establishing asset management corporations (AMC) to help dispose of non-performing assets in the banking sector.
2. Two banks (The Chinese Bank and Bowa Bank) were merged by foreign banks in 2008 and were excluded from our sample. So, the numbers of commercial bank are reduced to 37 in 2008.
3. One-year-deposit rate was about 2.5 percent in 2007, compare to 2004 (1.6 percent) and 2010 (1.1 percent).
4. Some of the private-voluntary merged banks are part of big-sized merged banks. So, average scale efficiency improvement of private-voluntary merged banks is not necessarily greater than government-controlled merged banks.
5. It is measured by $(CA_{2010} - CA_{2004})/CA_{2004}$. Capital adequacy ratio is a measure of amount of a bank's capital expressed as a percentage of its risk weighted credit exposures.
6. It is measured by $(NPL_{2010} - NPL_{2004})/NPL_{2004}$. Non-performing loan ratio is defined as total non-performing loans divided by total loans.
7. We use Belsley *et al.* (1980) diagnostic for collinearity and White's (1980) test for heteroscedasticity. We do not find evidence of collinearity and heteroscedasticity problem in regression models.

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