6. THE STUDY ON THE RELATIONSHIP BETWEEN BANK M&A, SME LENDING, CREDIT GUARANTEE AND BANK EFFICIENCY

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Abstract

Small and medium enterprises (SMEs) make significant contributions to investments and employment and play a particularly important role in the country's economic growth and industrial development. Due to the small scale and poor financial information transparency and structure of SMEs, they rely greatly on bank loans and credit guarantee in fund sources. The effect to bank efficiency from loans to SMEs and credit guarantee, therefore, is an important topic. In addition, banks in Taiwan have been undergoing consolidation in more than one decade. Therefore, the aim of this study is to investigate the relationship between bank M&A, SME lending, credit guarantee and efficiency from Taiwan commercial bank point of view. Based on our empirical results, the SME lending has a positive effect on the cost and profit efficiency. When banks increase credit guarantee for SMEs, the profit efficiency of banks would increase, but cost efficiency decreases instead. The result shows that credit guarantee scheme can reduce the expected loss generated from bad debts and increase expected return derived from lending. In M&A, foreign M&A or foreign capital invested banks have relatively better profit efficiency underwent to merge.

Keywords: bank M&A, SME lending, credit guarantee, bank ownership structure, cost and profit efficiency
JEL Classification: G20, G21, G34

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1. Introduction

Small and medium enterprises (SMEs) make significant contribution to investments and employment that exert positive externalities on economy and society. They play an important role in economic growth and industry development in Taiwan. There are 1.248 million SMEs in Taiwan, accounting for 97.68% of the total enterprises. These enterprises hire 77.85% of total employees. Development and contribution of SMEs is a key factor in economic growth.

Due to small scale and poor transparency and structure of finance, SMEs mainly rely on indirect financing for funds. Financial institutions do not prioritize loads to SMEs, but to large enterprises, because SMEs to the relatively smaller loan amount, less strict accounting system, incomplete financial data, lack of full disclosure of information, poor quality of accounting personnel, strong family business ties, insufficient collateral, uncertainty of cash flow and poor response to economic situations. Hence, SMEs either fail to access loans or suffer from high cost for funds. The SMEs are also the first group to face tightened loans in declined economic situations, making operation of SMEs even more difficult.

According to the situation mentioned, helping banks to provide SMEs with more financing, increasing policy-oriented loans for SMEs or establishing SMEs credit guarantee funds are often deemed as major measures of reducing SME financing gap (OECD, 2006). Credit guarantee is also one way that governments encourage banks to increase loans to SMEs (Green, 2003) so that the problem of financing gap of SMEs can be solved. For the purpose of encouraging banks to increase loans to SMEs, Taiwanese government initiated “Project of Enhancing Loans by Local Banks to Small and Medium Enterprises” from 1st July 2005 while strengthening use of credit guarantee fund for credit guarantee. This has increased the SME lending to 46.8% of total loan. Credit guarantee outstanding accounted for 3.6% of GDP.

In a review of merger events in the Taiwan banking industry before 2000, the government directed the merger policy and asked healthy banks to undertake troubled financial institutions. After 2000, the government encouraged mergers and acquisitions among financial institutions. Voluntary mergers inspired by strategic consideration have been developed. After 1990, banking industry in Taiwan noticed three situations in ownership structure: privatization of government controlled banks, M&A by private banks, M&A by foreign banks or foreign capital investment.

However, as SMEs having more severe information opacity with their relatively low economic status, they are often subject to more stringent credit restrictions as compared to large enterprises (Stiglitz and Weiss, 1981), making it hard for them to obtain funding from the market. Therefore, the topic of loans to SMEs has long been a focused issue among major countries. The financing gap is expected to decrease by strengthening SMEs lending, credit guarantee system and other related policies. When banks come across some SMEs with lack of clear information, the banks will face ‘adverse selection’ and ‘moral hazard’ problems. The effect to bank efficiency from loans to SMEs and credit guarantee, therefore, is an important topic. In addition, banks in Taiwan have been undergoing consolidation in more than one decade. Banks are one of most important source of loans for SMEs. The relationship between efficiency and the following situations: whether a bank will undergo M&A, before and after M&A and changes in ownership structure, should be investigated with further details.

This study employs a New Cost and New Profit model of the data envelopment analysis (DEA) to investigate cost and profit efficiency from Taiwan commercial bank point of view. Our study covers a period of 9 years between 2004 and 2012. We then use Tobit regression

model to study the relationship between SME lending, credit guarantee, management ability, credit risk, the financial crisis, bank M&A, the changes in ownership structure and bank efficiency.

The remainder of this paper is as follows: Section 2 is literature review, Section 3 discusses the methodology, data used in the study, section 4 elaborates the empirical analysis, and section 5 summarizes our findings.

2. Literature Review

With positive externalities in economy, society and politics of SMEs, to correct market failure and maximize market efficiency for higher social welfare, the government has to get involved in markets. Many countries choose to apply measures approved by public financial institutions, such as policy-oriented loans or the government-supported credit guaranteed scheme, in order to make up for the inadequate market mechanism or market failure.

2.1 SME Financing

Studies on relation between asset size of banks and SME lending, Strahan and Weston (1998) mentioned that banks with assets less than USD 300 million had a positive relationship between asset size and SME financing; banks with assets over USD 300 million showed negative relation. Berger et al. (2001) found that size of bank assets and organizations structure of banks and banks with financial crisis in Argentina on loans to SMEs are in negative relation.

Petersen and Rajan (1994) pointed out that long-term relation between banks and enterprises reduce asymmetric information in loan market. Provided SMEs build a good relation with financial institutions, they obtain higher credit line but not necessarily low interest rate. With longer history of enterprises, enterprises enjoy lower interest rate, meaning lower default risks to financial institutions.

Bose and Cothren (1997) showed that higher interest rates affect investment decision of borrowers and tend to make borrowers choose high risk projects for higher return. In case the investment fails, borrowers may leave the lost to banks. Without supervisory mechanism after making loans, banks tend to encounter moral hazard. Compared with large enterprises, SMEs suffer stricter credit limitations, which affect their survival and development.

2.2 Credit Guarantee

There are close to 100 countries and regions implement over 2,250 types of credit guarantee programs (Green, 2003). Craig *et al*. (2008) found that credit guarantee aims to increase expected return of banks by lowering expected loan loss of borrowers to solve adverse selection problem. Banks can set loan interest rates based on average risk level of all borrowers. After lending through credit guarantee, bank loan loss reduces significantly, meaning higher expected return. Loan credit guarantee can also help reducing minimum acceptable lending rates of banks, meaning easing moral hazard.

Green (2003) showed that independent banks engaging in SME lending and collaborations between credit guarantee scheme and banks have more advantages and could effectively overcome information asymmetry problems, such as high risk and lack of sufficient collaterals. This study refers to pros and cons of a SME credit guarantee scheme, which requires an in-depth observation on whether a loan provided to a SME by a financial institution is extended due to the credit guarantee scheme.

Beck *et al.* (2008) compares 76 credit guarantee schemes across 46 countries and finds significant differences in organizations features of credit guarantee, government roles, risk management and pricing mechanism. Overall, government focus on the funding of the funds and the operations management but rarely pay attention to evaluation of loan risk and loan recovery.

Honohan (2008) points out that credit guarantee, unlike other policy financial tools, fails to precisely evaluate risks and pay no fees before the contract defaults, resulting in excessive risks undertaken by decision makers. The default rate instantly increases in case of systematic events, which may cause great damages to credit guarantee institutions.

Credit guarantee may also cause moral hazard. Uesugi *et al.* (2010) mention that credit guarantee does increase willingness of banks with insufficient capital adequacy ratio to replace non-guarantee with credit guarantee to reduce the exposure to risky assets. This helps maintain employment but reduces willingness of banks to make long-term loans. Except for enterprises with high net worth, credit guarantee may accelerate moral hazards by encouraging enterprises to engage in high risk investments, which may result in financial distress and lower profitability.

2.3 Bank M&A and Ownership Structure Changes

Berger and Humphrey (1992) study bank M&A in the U.S. in 1980's and find little or no changes in cost efficiency after M&A. Study on bank M&A in 1990's show different results. Rhoades (1998) finds significant cost efficiency improvement but some banks show no cost efficiency at all.

Berger *et al.* (2005) analyze the static, selection, and dynamic effects of domestic, foreign, and state ownership on bank performance. Using data from Argentina in the 1990s, the study found that state-owned banks have poor long-term performance (static effect), those undergoing privatization had particularly poor performance beforehand (selection effect), and these banks dramatically improved following privatization (dynamic effect), although much of the measured improvement is likely due to placing nonperforming loans into residual entities, leaving good privatized banks. Some studies find that foreign ownership, foreign investments and less limitation of local government on banks has relationship between domestic bank competitions.

Berger *et al.* (2004) finds positive effect of foreign ownership on enterprises credit loan funds, especially to small and medium enterprises. Berger *et al.* (2009) analyze the relationship between ownership and efficiency of Chinese banks from 1994 to 2003. The findings show the four state-owned banks are least efficient and foreign banks are most efficient. Banks with foreign investments show significant improvement in efficiency. Cross-country studies such as those by Grigorian and Manole (2002) and Bonin *et al.* (2005a, b) show that banks with foreign capital or management teams and private banks have better performance than state-owned banks.

3. Methodology and Framework

The study first uses the New-Cost model and New-Profit model of DEA to investigate efficiency from Taiwan commercial bank point of view. Then, we use Tobit regression model to study the relationship between the SME lending, credit guarantee, bank M&A and bank ownership and the efficiency of bank.

3.1 Data Envelopment Analysis

The DEA method cannot separate statistical noise or measurement errors from random errors. Researchers need not assume the functional form relating inputs to outputs. Thus, the relative efficiency scores obtained from DEA may be subject to the effects from the uncontrollable factors. DEA uses the linear programming method to construct a piecewise linear surface or frontier over the investigated data. DEA searches for points with the lowest unit cost for any given output, and connects these points to form the efficiency frontier. Any company not on the frontier is considered inefficient. A numerical coefficient is assigned to each firm, defining its relative efficiency (between 0 and 1) compared with efficient peers.

3.1.1 The New-Cost-DEA Model

Because the common price and cost assumption[4] is not always valid in actual business environment and efficiency measures based on this assumption can be misleading. We therefore adopt Tone's the New Cost Model to measure the cost efficiency from the Taiwan bank point of view.

The undesirable property of Farrell raised by Tone is caused by the structure of the supposed production possibility set P:

$$P=\{(x,y)\,|\; x\geq X\lambda, y\leq Y\lambda, \lambda\geq 0\} \tag{1}$$

P is defined only by using technical factors $X=(x_1,...,x_n)\in R^{m\times n}$ and $Y=(y_1,...,y_n)\in R^{s\times n}$, but excludes the consideration of unit input costs $c=(c_1,...,c_n)$.

Let us define another cost-based production possibility set P_c as:

$$P_c=\{(\bar{x},y)\,|\; \bar{x}\geq \bar{X}\lambda, y\leq Y\lambda, \lambda\geq 0\} \tag{2}$$

where: $\bar{X}=(\bar{x}_1,...,\bar{x}_n)$ with $\bar{x}_j=(c_{1j}x_{1j},...,c_{mj}x_{mj})^T$.

Here we assume that the matrices X and C are non-negative. We also assume that the elements of $\bar{x}_{ij}=(c_{ij}x_{ij})$ $(\forall(i,j))$ are denominated in homogeneous units, dollars, so that adding up the elements of $\bar{x}_{ij}$ is well defined.

Based upon this new production possibility set P_c, a new "technical efficiency"〔NTec〕measure, $\bar{\theta}^*$, is obtained as the optimal solution of the following LP problem:

$$\text{[NTec]}\quad \bar{\theta}^*=\min_{\bar{\theta},\lambda}\bar{\theta} \tag{3}$$

$$\text{subject to}\quad \bar{\theta}\bar{x}_o\geq \bar{X}\lambda,\quad y_0\leq Y\lambda,\quad \lambda\geq o,$$

[4] *Tone had approved that using the Farrell cost efficiency model both DMUs A and B have the same cost (overall) and allocative efficiencies even when the cost of DMU B is half that of DMU A. This is not acceptable.*

The new cost efficiency〔NCost〕 $\overline{\gamma}^*$ is defined as

$$\overline{\gamma}^* = e\overline{x}_0^* / e\overline{x}_0, \tag{4}$$

where: $e \in R^m$ is a row vector with all elements being equal to 1, and $\overline{x}_0^*$ is the optimal solution of the LP given below:

$$\text{[NCost]} \quad e\overline{x}_0^* = \min_{\overline{x},\lambda} e\overline{x} \tag{5}$$

$$\text{subject to} \quad \overline{x} \geq \overline{X}\lambda$$
$$y_0 \leq Y\lambda$$
$$\lambda \geq o,$$

The new allocative efficiency $\overline{\alpha}^*$ is then defined as the ratio of $\overline{\gamma}^*$ to $\overline{\theta}^*$, i.e. $\overline{\alpha}^* = \overline{\gamma}^* / \overline{\theta}^*$.

We note that the new efficiency measures $\overline{\theta}^*$, $\overline{\gamma}^*$ and $\overline{\alpha}^*$ are all units invariant so long as $\overline{X}$ has a common unit of cost, e.g., dollars, cents or pounds. According to the above model, the efficiency measure produces values between 0 to 1. A smaller (lower) value of efficiency implies a less efficient bank. On the other hand, the higher (larger) the efficiency, the closer the CE is to 1 and a more efficient the bank becomes.

3.1.2 The New-Profit DEA Model

Consider an industry producing *m* outputs from *n* inputs. An input–output bundle (*x,y*) is considered feasible when the output bundle y can be produced from the input bundle x. The technology faced by the firms in the industry can be described by the production possibility set

$$T = \{(x,y) : y \text{ can be produced from } x\} \tag{6}$$

In the single output case, one can conceptualize the production function

$$f(x) = \max y : (x,y) \in T. \tag{7}$$

In the multiple output case, frontier of the production possibility set is the production correspondence *F(x,y)* = 1.

The method of Data Envelopment Analysis introduced by Charnes *et al.* (1978) and further extended to non-constant returns technologies by Banker *et al.* (1984) provides a way to construct the production possibility set from an observed data set of input–output bundles without assuming a functional form of the production technology**.**

Suppose that (x^j,y^j) is the input–output bundle observed for firm *j* (*j* = 1,2,. . . ,*N*). Clearly, these input–output bundles are all feasible. Then the smallest production possibility set satisfying the assumptions of convexity and free disposability that includes these observed bundles is

$$S = \langle (x, y) : x \geq \sum_{j=1}^{N} \lambda_j x^j ; y \leq \sum_{j=1}^{N} \lambda_j y^j ; \times \sum_{j=1}^{N} \lambda_j = 1; \lambda_j \geq 0 (j = 1,2,..., N) \ldots \quad (8)$$

The set *S* is also known as the free disposal convex hull of the observed input–output bundles. One can obtain various measures of efficiency of a firm using the set *S* as the reference technology. In the following paragraphs we describe how the efficiency of a firm can be measured under alternative assumptions on the choice variables.

For a commercial firm, both inputs and outputs are choice variables and the only constraint would be the feasibility of the input–output bundle chosen. For such a firm, the criterion of efficiency is profit maximization. At input and output prices *w* and *p*, respectively, the actual profit of the firm producing the output bundle y^0 from the input bundle x^0 is

$$\Pi^0 = p' y - w' x^0 .$$

The maximum profit feasible for the firm is

$$\Pi(w, p) = \max p' y - w' x : (x, y) \in T$$

In any empirical application, the maximum profit may be obtained as

$$\Pi^* = \max p' y - w' x$$

$$\text{s.t. } \sum_{j=1}^{N} \lambda_j y^j \geq y; \sum_{j=1}^{N} \lambda_j x^j \leq x; \sum_{j=1}^{N} \lambda_j = 1; \lambda_j \geq 0 (j = 1,2,..., N). \quad (9)$$

The profit efficiency of the firm is measured as $\delta = \frac{\Pi^0}{\Pi^{**}}$

This measure is also bounded between 0 and 1 except in the case where the actual profit is negative while the maximum profit is positive. In that case δ is less than 0. If the maximum profit is negative as well, δ exceeds unity.

3.2 Tobit Regression Model

This study first applied DEA to estimate bank efficiency and then used the Tobit regression model to determine the relationship between bank SME lending, credit guarantee, management ability, credit risk and financial crisis and efficiency. The explained variables in the Tobit regression model were obtained from the cost and profit efficiency in the cost and profit model. The efficiency scores (as the explained variable) from DEA are limited to value between 0 and 1. The explained variable in the regression equation cannot be expected to have a normal distribution. Thus, we cannot expect the regression error also meet the assumption of normal distribution. The OLS method as a result often leads to biased and inconsistent parameter estimates (Greene, 1981). We therefore use Tobit estimation (Coelli, Prasada Rao and Battese, 1998; Fried, Schmidt and Yaisawarng, 1999) to keep the parameter estimation unbiased and consistent in this study.

We selected five dummy variables to discuss the relationship between whether banks undergo M&A, before and after M&A or bank ownership structure changes[5], and bank cost and profit efficiency.

Our estimated model is as follows.

$$\begin{cases} y_i^* = \beta x_i + \varepsilon_i \\ y_i = \begin{cases} 1 & if \quad y_i^* \geq 1 \\ y_i^* & if \quad 0 < y_i^* < 1 \end{cases} \end{cases} \tag{10}$$

【Model 1】

$$Y_{it} = \beta_0 + \beta_1 \times SME_{it} + \beta_2 \times GUR_{it} + \beta_3 \times CI_{it} + \beta_4 \times NPL_{it} + \beta_5 \times Crisis + \varepsilon_{it} \tag{11}$$

In Eq.(11), Y_{it} represents the cost efficiency/profit efficiency of bank i at time t; SME_{it} is the ratio of SME lending of bank i at time t; GUR_{it} is credit guarantee ratio of bank i at time t; CI_{it} is management ability (cost to income ratio) of bank i at time t; NPL_{it} represents the credit risk (non-performing loan ratio) of bank i at time t; $Crisis$ represents the dummy variable of financial crisis; ε_{it} is random error of normal distribution $N(\mu, \sigma^2)$.

The aim of this study is to discuss the impact of SME lending and credit guarantee on bank efficiency. Previous studies have shown that bank management ability and credit risk affect bank efficiency (Cihák and Hesse, 2007; Zheng Zhengbin *et al.*, 2010). The control variable is credit risk (non-performing loans ratio), which expresses the quality of bank loan portfolio and affects banks lending to SMEs in the next period. The study chooses the cost to income ratio as a proxy for management ability (Fotios and Kyriaki, 2007; Fotios, 2008). The US subprime mortgage crisis resulted in a global financial crisis in August 2007. Therefore, we select the financial crisis as the dummy variable.

【Model 2&3】

$$Y_{it} = \beta_0 + \beta_1 \times SME_{it} + \beta_2 \times GUR_{it} + \beta_3 \times CI_{it} + \beta_4 \times NPL_{it} + \beta_5 \times Crisis + \beta_6 \times Merge\_YN + \varepsilon_{it} \tag{12a}$$

$$Y_{it} = \beta_0 + \beta_1 \times SME_{it} + \beta_2 \times GUR_{it} + \beta_3 \times CI_{it} + \beta_4 \times NPL_{it} + \beta_5 \times Crisis + \beta_6 \times Merge\_BA + \varepsilon_{it} \tag{12b}$$

To study the impact of bank's merger on cost/profit efficiency, we assign dummy variables to each bank, depending on whether it undergo M&A or not. Therefore, we set *Merge_YN* =1 for underwent M&A and others =0. To examine the effectiveness of a merger event, we add a merger effect dummy variable, which is set *Merge_BA* = 0 for pre-merger (3 years before M&A) and *Merge_BA* = 1 for post-merger (3 years after M&A)

[5] *In the empirical period, a bank that selects to change or become a certain type of ownership means that such bank has the results of the ownership structure.*

【Model 4&5】

$$Y_{it} = \beta_0 + \beta_1 \times SME_{it} + \beta_2 \times GUR_{it} + \beta_3 \times CI_{it} + \beta_4 \times NPL_{it} + \beta_5 \times Crisis + \beta_6 \times Merge\_YN + B_7 \times S\_\mathrm{Priva} + \beta_8 \times S\_PBMerge + \beta_9 \times S\_Forei + \varepsilon_{it} \quad (13a)$$

$$Y_{it} = \beta_0 + \beta_1 \times SME_{it} + \beta_2 \times GUR_{it} + \beta_3 \times CI_{it} + \beta_4 \times NPL_{it} + \beta_5 \times Crisis + \beta_6 \times Merge\_BA + B_7 \times S\_\mathrm{Priva} + \beta_8 \times S\_PBMerge + \beta_9 \times S\_Forei + \varepsilon_{it} \quad (13b)$$

To discuss the relationship between bank ownership structure changes and bank efficiency, Berger *et al*. (2005) hold that all factors or effects related to bank efficiency shall be taken into consideration to avoid incorrect conclusions due to an incorrect model setup. In the case that a bank undergoes three ownership structure change events: private bank M&A, foreign M&A and privatization, all three events significantly improve bank efficiency, so if the study only considers privatization, the privatization effect might be measured incorrectly and obtain non-useful empirical results. The privatization effect is not as good as domestic M&A or foreign capital investments, the influence of bank privatization can be misinterpreted as no effect or negative effect on efficiency.

In the studies by Berger et al. (2005), the banks under ownership structure changes during the sample period were divided into three situations: bank privatization (Priva) such as First Commercial Bank and Hua Nan Bank; private bank M&A (PB_Merge) such as Chinatrust Commercial Bank and Cathay Bank; and foreign M&A or foreign capital investment ($Forei$), foreign M&A such as Citibank Taiwan and Standard Chartered Bank; foreign capital investment such as Ta Chong Bank and Cosmos bank. Some banks underwent more than one kind of ownership structure change. We adopt the definition developed by Berger *et al.* (2005), with the last change determining the ownership type. Banks corresponding to the dummy variable are set as 1 to explore the relationship between banks that underwent ownership structure changes and bank efficiency.

【Model 6&7】

$$Y_{it} = \beta_0 + \beta_1 \times SME_{it} + \beta_2 \times GUR_{it} + \beta_3 \times CI_{it} + \beta_4 \times NPL_{it} + \beta_5 \times Crisis + \beta_6 \times Merge\_YN + B_7 \times D\_\mathrm{Priva} + \beta_8 \times D\_PBMerge + \beta_9 \times D\_Forei + \varepsilon_{it} \quad (14a)$$

$$Y_{it} = \beta_0 + \beta_1 \times SME_{it} + \beta_2 \times GUR_{it} + \beta_3 \times CI_{it} + \beta_4 \times NPL_{it} + \beta_5 \times Crisis + \beta_6 \times Merge\_BA + B_7 \times D\_\mathrm{Priva} + \beta_8 \times D\_PBMerge + \beta_9 \times D\_Forei + \varepsilon_{it} \quad (14b)$$

Three dynamic dummy variables are set according to the selection dummy variables: banks after privatization (dynamic_bank privatization), private banks underwent M&A (dynamic_private bank M&A) and banks merged by foreign banks or with foreign capital investment (dynamic_ foreign M&A or foreign capital investment). Similarly, some banks underwent more than one kind of ownership structure change. The study classifies the ownership type based on the last ownership changes. Banks corresponding to dummy variables after ownership structure changes are set as 1; before ownership structure changes is set as 0; bank dynamic dummy variables are not in this category which is set as 0.

The definition of explanatory variables is as follows.

1. Main variable

(1) SME lending ratio (SME)

SME lending ratio is the ratio of SME lending to total lending. Asymmetric information of bank–lending to SME means potential risk factors. This means higher risky lending to SME and those banks face greater credit risks, which affects management efficiency (Dai and Ding, 2006). Some studies have shown that a higher SME lending ratio brings higher profits to banks. Therefore, the coefficient of SME lending ratio and bank cost and profit efficiency is uncertainty.

(2) Credit guarantee ratio (GUR)

The credit guarantee ratio (GUR) is used as the empirical indicator, which refers to the proportion of credit guaranteed amount to the total lending amount. The credit guarantee scheme helps SMEs obtain access to loans from banks, and reduces bankruptcy probability, lower NPL ratio of banks and moral hazard (Craig *et al*., 2008), as well as eases the high risk and lack of collateral of SMEs (Green, 2003). However, cases under credit guarantee are often at high risk of insufficient collateral, meaning higher risks. In case of systematic events, the default rate increase instantly (Honohan, 2008). The relationship between credit guarantee and bank efficiency is uncertain.

2. Bank characteristics variable

(1) Management ability (CI)

The study chooses cost to income ratio as a proxy for management ability. The cost to income ratio is bank operating cost divided by operating income to measure the operation effect of banks. High or low cost to income ratio means waste or tight control of operation expenditure. A higher cost to income ratio implies that banks spend too much on operation expenditures, making income unable to cover the expenses and increasing risk. This also implies that a bank with higher cost to income ratio will have poor efficiency (Cihák and Hesse, 2007; Fotios and Kyriaki, 2007). Banks can increase operation expenditures to by increasing the income to offset loss for higher cost efficiency. The coefficient of cost income ratio and bank efficiency is uncertainty.

(2) Credit risk (NPL)

The study chooses non-performing loan (NPL) ratio as a proxy for credit risk. The non-performing ratio is non-performing loans to total loan. Responding to a higher NPL ratio, a bank in general will allocate undistributed earnings to make provisions for loan losses. This also implies that a bank with lower asset quality will have a higher credit risk, as well as lower overall banking efficiency. Several studies indeed found that banks with higher NPL ratio would have lower efficiency (Berger and DeYoung, 1997; Berger and Mester, 1997; Drake and Hall, 2003).

3. Macroeconomic variable: Financial crisis (Crisis)

The US subprime mortgage crisis resulted in a liquidity run in August 2007. A number of large financial institutions went bankrupt or were taken over by the government. The worldwide stock crisis affected European countries and resulted in global recession in 2008. Financial crisis dummy variable, which is set Crisis=0 for pre financial crisis (before 2007), and Crisis=1 for pro financial crisis (after 2007). Financial crisis is expected to reduce bank efficiency.

4. Merge effect

(1) M&A or not (Merge_YN)

Merger dummy variable, which is set Merge_YN =1 for underwent M&A (3 years before M&A, the M&A year and 3 years after M&A), and others =0

(2) Before and after M&A (Merge_BA)

Merger effect dummy variable, which is set Merge_BA = 0 for pre-merger (3 years before M&A) and Merge_BA = 1 for post-merger (the M&A year and 3 years after M&A).

5. Selection effect

(1) Selection for privatization (S_Priva)

Privatization dummy variable, which is set S_Priva=1 for banks underwent privatization and others =0.

(2) Selection for private bank merge (S_PBMerge)

Private bank's M&A dummy variable, which is set S_PBMerge=1 for M&A among private banks and others =0.

(3) Selection for foreign M&A or foreign capital investment (S_Forei)

Foreign M&A dummy variable, which is set S_Fore=1 for foreign M&A or foreign capital investment and others =0.

6. Dynamic effect

(1) Dynamic for privatization (D_Priva)

Dynamic privatization dummy variable, which is set D_Priva=1 for during the sample period banks underwent privatization and the second year following the change; D_Priva=0 for all periods for banks that did not undergo privatization.

(2) Dynamic for private bank merge (D_PBMerge)

Dynamic private bank's M&A dummy variable, which is set D_PBMerge =1 for M&A among private banks during the sample period and the second year following the change, D_PBMerge=0 for all periods for banks that did not undergo M&A.

(3) Dynamic for foreign M&A or foreign capital investment (D_Forei)

Dynamic foreign M&A dummy variable, which is set D_Forei=1 for foreign M&A or foreign capital investment during the sample period and the second year following the change. D_Forei=0 for all periods for banks that were not joined or acquired by the foreign capital.

Table 1 lists the definitions for these variables.

Table 1

Definition of Explanatory Variables

Variable name / Variable types	Variable Code	Variable Name	Description
Main variable	SME	SME lending ratio	SME lending to total lending
	GUR	Credit guarantee ratio	Credit guaranteed amount to total lending
Bank characteristics variable	CI	Cost to income ratio	Bank operating cost divided by operating income
	NPL	Non-performing loan ratio	Non-performing loans to total loan

Variable name / Variable types	Variable Code	Variable Name	Description
Macroeconomic variable	Crisis	Financial crisis	Financial crisis dummy variable, which is set Crisis=0 for pre financial crisis (before 2007), and Crisis=1 for post financial crisis (after 2007).
Merge effect	Merge_YN	M&A or not	Merger dummy variable, which is set Merge_YN =1 for underwent M&A (3 years before M&A, the M&A year and 3 years after M&A), and others =0
	Merge_BA	Before and after M&A	Merger effect dummy variable, which is set Merge_BA = 0 for pre-merger (3 years before M&A) and Merge_BA = 1 for post-merger (the M&A year and 3 years after M&A)
Selection effect	S_Priva	Selection_-privatization	Privatization dummy variable, which is set S_Priva=1 for banks underwent privatization and others =0.
	S_PBMerge	Selection_Private bank merge	Private bank's M&A dummy variable, which is set S_PBMerge=1 for M&A among private banks and others =0.
	S_Forei	Selection_Foreign M&A or foreign capital investment	Foreign M&A dummy variable, which is set S_Forei=1 for foreign M&A or foreign capital investment and others =0.
Dynamic effect	D_Priva	Dynamic_-privatization	Dynamic privatization dummy variable, which is set D_Priva=1 for during the sample period banks underwent privatization and the second year following the change; D_Priva=0 for all periods for banks that did not undergo a privatization.
	D_PBMerge	Dynamic_Private bank merge	Dynamic private bank's M&A dummy variable, which is set D_PBMerge =1 for M&A among private banks during the sample period and the second year following the change, D_PBMerge=0 for all periods for banks that did not undergo M&A.
	D_Forei	Dynamic_Foreign M&A or foreign capital investment	Dynamic foreign M&A dummy variable, which is set D_Forei=1 for foreign M&A or foreign capital investment during the sample period and the second year following the change. D_Fore=0 for all periods for banks that were not joined or acquired by the foreign capital.

4. Empirical Analysis

Based on new cost model and new profit model, bank cost and profit efficiency is estimated with DEA-Solver 6.0 and Tobit regression analysis is conducted with Eviews 6.0 to discuss the variables that affect bank cost/profit efficiency in Taiwan.

4.1 Data and Definition

Our research data are based on the Taiwan Economic Journal (TEJ), the Central Bank of Taiwan, and the Financial Supervisory Commission (FSC). Data regarding SME lending and credit guarantee come from the Small and Medium Enterprises Credit Guarantee Fund (SMEG) of Taiwan. Bank M&A and ownership structure change is from disclosed information from the Taiwan Financial Supervising Commission's database. They are unbalanced[6] with 33 banks covering the period from 2004 to 2012.

The DEA based method requires bank inputs and outputs whose choice is always an arbitrary issue (Berger and Humphrey, 1997). There are many ways to define and categorize input and output variables in banking literatures, and in this study we adopt the intermediation approach (Subhass and Abhiman, 2010; Dasa and Ghosh, 2009; Taufiq, 2008) to define the input and output of financial institutions. The intermediation approach may be superior for evaluating the importance of frontier efficiency for the profitability of financial institutions, since the minimization of total costs, and not just production costs, is needed to maximize profits (Iqbal and Molyneux, 2005).

Table 2

Definitions of Input and Output Variables

Variable	Variable name	Description
Input	Labor	Number of employees
	Capital	Net fixed assets
	Funding	Deposits plus borrowings
Input price	Price of labor	Employees salary divided by number of employees
	Price of capital	Operating expenses divided by net fixed assets
	Price of funding	Interest expenses on deposits plus other interest expenses divided by deposits plus borrowing
Output	Loans	Total of short-term and long-term loans
	Investment	Including short and long term investment
	Non-interest income	Including transaction fee and other commercial income,
Output price	Price of loans	Interest income on loans divided by loans
	Price of investment	Other operating income divided by investments
	Price of non-interest income	Price of non-interest income is unity

Three inputs are considered, employees, deposits and fixed assets. The prices of the first three inputs are: average staff cost per employee; cost of deposits, measured by average interest paid per rupee of deposits; and cost per unit fixed assets as measured by non-labor operational cost per rupee amount of fixed asset. On the output side, we use three variables, investments, loans and other non-interest fee based incomes. It is fairly standard in the

[6] Because of merger occurrence, the bank samples differ each year.

literature. The associated price indicator for the first two output measures are average interest earned per rupee of investment and average interest earned per rupee of loan, respectively. For non-interest income, the total amount itself is taken as an output in value term. Non-interest income emanates from fee, commission, brokerage, etc., and has fairly standardized pricing mechanism. Therefore, it is assumed that price of non-interest income is unity for all sample banks in each annual cross section data.

Table 2 lists the definitions and Table 3 summary statistics for these variables.

Table 3

Descriptive Statistics of Input and Output Variables

	Min	Max	Average	Standard Deviation
Labor	382	9,881	3,916	2,411
Price of labor	49.5300	1,785.9000	900.2147	251.5122
Capital	954,086	97,864,904	13,634,524	15879983.529
Price of capital	0.0391	2.8613	0.4726	0.3615
Funding	35,532,817	3,306,902,117	708,243,059	6,589,304,589
Price of funding	0.0013	0.0450	0.0140	0.0067
Total loans	25,614,588	2,177,156,281	544,797,577	513,726,151
Price of loans	0.0052	0.1145	0.0386	0.0176
Investment	2,231,786	1,092,562,637	155,116,350	176,775,309
Price of investment	0.0000	0.0374	0.0031	0.0055
Non-interest income	8,151	25,331,149	3,824,428	4,297,636
Price of non-interest income*	1	1	1	0

Note: Unit Thousand (TWD)

**For non-interest income, the total amount itself is taken as an output in value term. Non-interest income emanates from fee, commission, brokerage, etc. and has a fairly standardized pricing mechanism. Thus, we have assumed that price of non-interest income is unity for all banks in each annual cross section data.*

Because cost and profit efficiencies are measured against a contemporaneous (rather than an inter-temporal) frontier, adjusting nominal values for inflation would not be necessary.

We apply the correlation analysis on explanatory variables to examine multicollinearity. The correlation coefficient of the Merge_YN was highly related with Merge_BA (0.806), the correlation coefficient of the S_Priva was highly related with D_Priva (1.000), S_PBMerge was highly related with D_PBMerge (0.739) and D_Forei was highly related with D_Forei (0.825). Based on the result of correlation, the study put the highly related explanatory variables in different model. For example, to investigate the merger effect, the study establishes the equation 12a and 12b in model 2&3 according to the Merge_YN and Merge_BA were high coefficient of correlation. We establish model 4&5 and model 6&7 respectively to avoid the multicollinearity problem. After the establishment of empirical models, all explanatory variables are found to show no high correlation and hence no multicollinearity in each empirical model. Table 4 lists the descriptive statistics and Table 5 lists the coefficient of correlation.

Table 4

Descriptive Statistics

	Min	Max	Average	Standard Deviation
CE	0.2632	1.0000	0.8385	0.1704
PE	0.0000	1.0000	0.5562	0.3628
SME	0.76	66.32	18.32	11.19
GUR	0.00	70.90	14.73	12.14
CI	15.37	82.15	37.01	10.37
NPL	0.05	7.38	1.33	1.07
Crisis	0	1	0.68	0.47
Merge_YN	0	1	0.39	0.49
Merge_BA	0	1	0.29	0.46
S_Priva	0	1	0.15	0.36
S_PBMerge	0	1	0.34	0.48
S_Forei	0	1	0.14	0.35
D_Priva	0	1	0.15	0.36
D_PBMerge	0	1	.22	.42
D_Forei	0	1	.10	.31

Table 5

The Correlation Coefficient

	SME	GUR	CI	NPL	Crisis	Merge_YN	Merge_BA	S_Priva	S_PBMerge	S_Forei	D_Priva	D_PBMerge	D_Forei
SME	1	-.050	-.215(**)	.026	.075	-.435(**)	-.338(**)	.414(**)	-.223(**)	-.128(*)	.414(**)	-.118(*)	-.129(*)
GUR	-.050	1	.200(**)	.128(*)	.003	-.044	.039	-.096	.034	.298(**)	-.096	-.076	.241(**)
CI	-.215(**)	.200(**)	1	-.044	.308(**)	-.192(**)	-.106	-.122(*)	-.077	.218(**)	-.122(*)	.040	.312(**)
NPL	.026	.128(*)	-.044	1	-.436(**)	.241(**)	.159(**)	.026	-.179(**)	.154(**)	.026	-.181(**)	.030
Crisis	.075	.003	.308(**)	-.436(**)	1	-.346(**)	-.143(*)	-.013	-.021	.030	-.013	.204(**)	.232(**)
Merge_YN	-.435(**)	-.044	-.192(**)	.241(**)	-.346(**)	1	.806(**)	-.282(**)	.276(**)	.094	-.282(**)	.071	.055
Merge_BA	-.338(**)	.039	-.106	.159(**)	-.143(*)	.806(**)	1	-.212(**)	.241(**)	.059	-.212(**)	.188(**)	.080
S_Priva	.414(**)	-.096	-.122(*)	.026	-.013	-.282(**)	-.212(**)	1	-.307(**)	-.176(**)	1.000(**)	-.227(**)	-.145(*)
S_PBMerge	-.223(**)	.034	-.077	-.179(**)	-.021	.276(**)	.241(**)	-.307(**)	1	-.295(**)	-.307(**)	.739(**)	-.243(**)
S_Forei	-.128(*)	.298(**)	.218(**)	.154(**)	.030	.094	.059	-.176(**)	-.295(**)	1	-.176(**)	-.218(**)	.825(**)
D_Priva	.414(**)	-.096	-.122(*)	.026	-.013	-.282(**)	-.212(**)	1.000(**)	-.307(**)	-.176(**)	1	-.227(**)	-.145(*)
D_PBMerge	-.118(*)	-.076	.040	-.181(**)	.204(**)	.071	.188(**)	-.227(**)	.739(**)	-.218(**)	-.227(**)	1	-.180(**)
D_Forei	-.129(*)	.241(**)	.312(**)	.030	.232(**)	.055	.080	-.145(*)	-.243(**)	.825(**)	-.145(*)	-.180(**)	1

4.2 The Analysis of Cost and Profit Efficiency

The DEA model requires that input and output variables satisfy monotonicity.[7] Both two types of variables were positively related as verified by correlation analysis. We used the New Cost and New Profit model under the assumption of return to scale (GRS) to analyze the cost and efficiency for all banks in Taiwan. We then separate the estimated results of banks into banks underwent M&A and those not underwent M&A and analyze their cost and profit efficiency. As shown in Figure 1, except for 2007, banks underwent M&A had poor cost efficiency than those not underwent M&A. As exhibited in and Figure 2, except for 2006, 2008 and 2012, banks underwent M&A had better profit efficiency than those not underwent M&A. The U.S. subprime crisis caused banks underwent and not underwent M&A had poor cost efficiency from 2006 to 2007. However, cost efficiency increased from 2007 to 2008. The banks didn't undergo M&A had poor profit efficiency from 2006 to 2007. But the banks underwent M&A had poor profit efficiency from 2007 to 2009.

Figure 1

The Cost Efficiency of Banks (Not) Underwent M&A

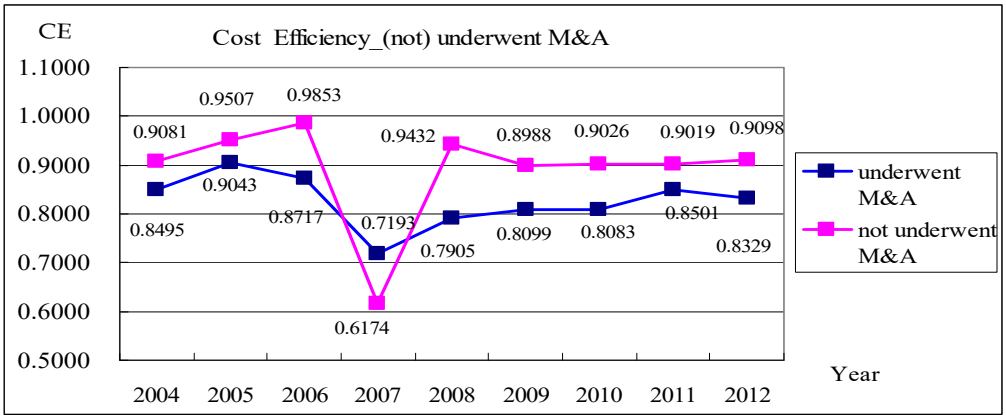
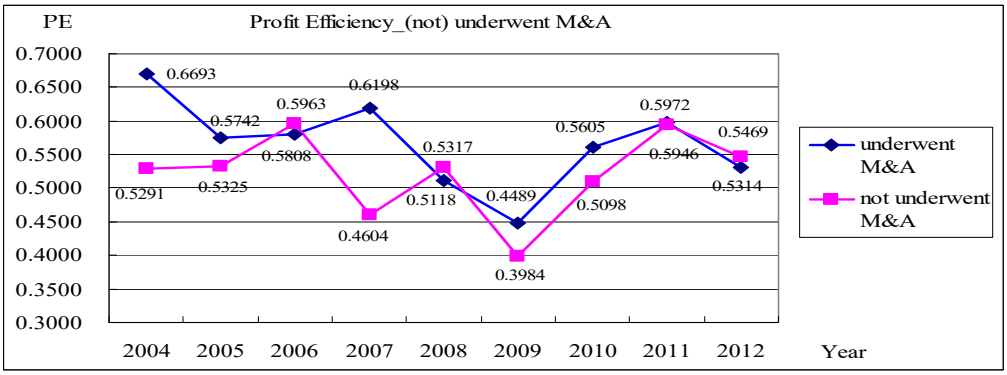


Figure 2

The Profit Efficiency of Banks (Not) Underwent M&A



[7] *The DEA model typically imposes monotonic (i.e. when the input increases, output cannot be reduced) assumption.*

4.3 The Tobit Regression Results

In the second stage of the analysis the aim is to uncover, by means of Tobin regression method, the underlying relationship between the calculated cost/profit efficiency levels and SME lending, credit guarantee, bank M&A, ownership structure changes. The parameter estimates and their results are presented in Table 6 and Table 7.

Each of Tables 6-7 reports regression results derived from the estimation of seven models. The first column presents the basic regression model that includes SME lending (SME), credit guarantee (GUR), bank-specific variables (CI & NPL) and financial crisis (Crisis) (model 1). The next two columns include M&A variables (including M&A or not (Merge_YN), Before and after M&A (Merge_BA)) to control the effect on bank efficiency (models 2-3). Model 4-5 accounts for the effect of M&A variables and selection variables (including selection for privatization (S_Priva), selection for private bank M&A (S_PBMerge), selection for foreign M&A (S_Forei). Model 6-7 corresponds to M&A variables and dynamic variables (including underwent for privatization (D_Priva), underwent for private bank M&A (D_PBMerge), underwent for foreign M&A (D_Forei).

Table 6

Empirical Result - Cost Efficiency

Model / Variable	1	2	3	4	5	6	7
SME	0.0022***	0.0013	0.0019**	0.0003	0.0006	0.0003	0.0006
	(0.0008)	(0.0009)	(0.0008)	(0.0009)	(0.0009)	(0.0009)	(0.0009)
GUR	-0.0028***	-0.0029***	-0.0028***	-0.0025***	-0.0024***	-0.0025***	-0.0024***
	(0.0007)	(0.0007)	(0.0007)	(0.0007)	(0.0007)	(0.0007)	(0.0007)
CI	-0.0030***	-0.0035***	-0.0032***	-0.0032***	-0.0030***	-0.0032***	-0.0030***
	(0.0009)	(0.0009)	(0.0009)	(0.0009)	(0.0009)	(0.0009)	(0.0009)
NPL	-0.0635***	-0.0599***	-0.0620***	-0.0593***	-0.0611***	-0.0604***	-0.0617***
	(0.0087)	(0.0088)	(0.0088)	(0.0088)	(0.0088)	(0.0086)	(0.0086)
Crisis	-0.1209***	-0.1284***	-0.1206***	-0.1220***	-0.1164***	-0.1120***	-0.1141***
	(0.0210)	(0.0212)	(0.0210)	(0.0207)	(0.0204)	(0.0218)	(0.0214)
Merge_YN		-0.0442**		-0.0316		-0.0288	
		(0.0208)		(0.0213)		(0.0209)	
Merge_BA			-0.0211		-0.0142		-0.0128
			(0.0199)		(0.0198)		(0.0199)
S_Priva				0.0960***	0.0984***		
				(0.0257)	(0.0257)		
S_PBMerge				0.0090	0.0041		
				(0.0204)	(0.0201)		
S_Forei				-0.0190	-0.0243		
				(0.0268)	(0.0266)		
D_Priva						0.0953***	0.0993***
						(0.0252)	(0.0250)
D_PBMerge						0.0051	0.0047
						(0.0213)	(0.0217)
D_Forei						-0.0252	-0.0292
						(0.0303)	(0.0303)

*Note : ***, **, * represent significance at the 1%, 5%, and 10% levels, respectively.*

Table 7

Empirical Result - Profit Efficiency

Model / Variable	1	2	3	4	5	6	7
SME	0.0023	0.0027	0.0029	0.0047**	0.0056***	0.0046**	0.0054***
	(0.0018)	(0.0021)	(0.0020)	(0.0021)	(0.0020)	(0.0021)	(0.0020
GUR	0.0106***	0.0106***	0.0106***	0.0077***	0.0090***	0.0086***	0.0088***
	(0.0017)	(0.0017)	(0.0017)	(0.0017)	(0.0017)	(0.0016)	(0.0016)
CI	-0.0185***	-0.0184***	-0.0182***	-0.0201***	-0.0196***	-0.0212***	-0.0207***
	(0.0022)	(0.0023)	(0.0023)	(0.0022)	(0.0022)	(0.0022)	(0.0022)
NPL	-0.0449**	-0.0462**	-0.0472**	-0.0502**	-0.0553***	-0.0510**	-0.0543***
	(0.0210)	(0.0214)	(0.0212)	(0.0208)	(0.0207)	(0.0202)	(0.0202)
Crisis	0.0005	0.0034	7.53E-05	-0.0204	-0.0135	-0.0762	-0.0663
	(0.0506)	(0.0513)	(0.0505)	(0.0484)	(0.0478)	(0.0508)	(0.0497)
Merge_YN		0.0170		-0.0436		-0.0454	
		(0.0507)		(0.0499)		(0.0487)	
Merge_BA			0.0353		0.0119		-0.0039
			(0.0479)		(0.0461)		(0.0463)
S_Priva				-0.1232**	-0.1187**		
				(0.0602)	(0.0602)		
S_PBMerge				0.0726	0.0600		
				(0.0477)	(0.0471)		
S_Forei				0.3205***	0.3107***		
				(0.0627)	(0.0622)		
D_Priva						-0.1491**	-0.1423**
						(0.0587)	(0.0584)
D_PBMerge						0.0498	0.0456
						(0.0497)	(0.0507)
D_Forei						0.3795***	0.3705***
						(0.0708)	(0.0708)

*Note : ***, **, * represent significance at the 1%, 5%, and 10% levels, respectively.*

The results show that SME lending and cost/profit efficiency are in positive relationship. As for cost efficiency, model 1 & 3 show statistically significant changes; as for profit efficiency, model 4-7 also show significant positive relationship. This implies that banks can improve efficiency by increasing SMEs lending, and the cost efficiency is affected more significantly especially when M&A variables are taken into consideration. As the ratios of SME reach 99.7%，load to SME is very important section of business for banks. In order to increase banks efficiency, the banks are suggested to consider privatization or M&A, as expansion of business can increase efficiency. The increase of lending to SME can also increase the profit of banks.

Our results indicate that, credit guarantee decreases bank cost efficiency but increases profit efficiency, and displays a statistically significant coefficient in all models. Credit guarantee schemes have the potential to reduce the costs of small-scale lending and to improve the information available on borrowers (Green, 2003). Credit guarantee scheme can reduce the expected loss generated from bad debts and increase expected return derived from lending, thus very likely removing adverse select ion. If there is a bad debt, a bank's actual loss will indeed be reduced enormously due to the effect of risk sharing of credit guarantee.

Therefore, credit guarantee could increase bank profit efficiency. However, the increase in guaranteed loan leads to the increase in man power and related operation, and therefore reduces cost efficiency.

A significant negative relationship is found between cost to income ratio (CI) and cost/profit efficiency in all models. As the bank's cost to income ratio becomes too high, the risk becomes higher because the bank's income is unable to cover its expenses and there is an excess waste in terms of control of operational expense (Cihak and Hesse, 2007).

Our study also indicates that the NPL ratio and cost/profit efficiency have a negative relationship in all models. The empirical results are consistent with Hughes and Mester (1993), Berger and De Young (1997), Drake and Hall (2003), the higher amount of non-performing loans face reductions in bank efficiency.

A significant negative relationship is found between the financial crisis (Crisis) and the bank's cost, in all models but insignificant on profit efficiency. It is thought that after the financial crisis, enterprises bankrupt, bad debt increase that would lower the bank efficiency. But financial crisis does not greatly affect profit efficiency.

According to the results, others than model 2, Bank M&A can lower the cost efficiency of banks. The results of other models cannot clearly show the benefits of M& A. This result of this study is similar to some studies' conclusion that bank merger does not necessarily improve operational efficiency (Houston and Rynagaert, 1994; Berger *et al*., 1999; Sanjeev, 2006).

In selection variables (model 4-5), the results showed that privatization could improve bank cost efficiency, but not profit efficiency, which indicate that privatization can decrease the operation cost of banks. Banks had significant adjustment in management model and were more flexible in their decisions, personnel and system; but not much benefit to profitability. In M&A, the results find a positive relation between private M&A (PB_Merge) and cost /profit efficiency, but insignificant. However, foreign M&A or foreign capital investment is significantly positive with a significance level of 1% to profit efficiency and implies that the profit of the foreign M&A bank increase with merger.

In the dynamic variables (model 6-7), the result is consistent with selection variables: privatization can increase cost efficiency but reduce profit efficiency; private bank M&A do not affect efficiency; and foreign M&A can increase profit efficiency.

5. Conclusion

SMEs make significant contributions to investments and employment and play a particularly important role in Taiwan's economic growth and industrial development. Due to the small scale and poor financial information transparency and structure of SMEs, they rely greatly on bank loans and credit guarantee in fund sources. Therefore, we study the cost efficiency and profit efficiency issues of SME lending, credit guarantee, bank M&A in Taiwan, our findings are as follows:

The results show that SME lending has a positive effect on the cost and profit efficiency. When banks improve efficiency by increasing SME lending, especially the bank underwent M&A. In order to increase banks efficiency, the banks are suggested to consider privatization or M&A, as expansion of business can increase efficiency.

We find that, when banks increase credit guarantee for SMEs, the profit efficiency of banks would increase, but cost efficiency decreases instead. It is showed that credit guarantee scheme can reduce the expected loss generated from bad debts and increase expected return derived from lending; avoid adverse selection and moral hazard problems, so that

profit efficiency can be improved. However, the increase in guaranteed loan leads to the increase in man power and related operation, and therefore reduces cost efficiency.

In bank-specific, cost to income (CI) ratio and NPL ratio have a negative effect on the cost and profit efficiency. This result implies that strengthening bank management and control on credit risk can affect bank efficiency significantly. Additionally, financial crisis clearly affects operation of banks that cost efficiency deteriorates.

The results showed that privatization could improve bank cost efficiency, but not the profit efficiency, which indicate that privatization can decrease the operation cost of banks. In terms of M&A, it can lower cost efficiency of banks, but the effect of M&A to private banks is not obvious. However, foreign M&A or foreign capital investment is positive to profit efficiency which implies that the profit of the foreign M&A bank increase with merger. In dynamic effect, it also showed that foreign M&A or foreign capital invested banks have relatively better profit efficiency underwent to merge in the long term.

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