Efficiency and Bank Merger in Singapore: A Joint Estimation of Non-Parametric, Parametric and Financial Ratios Analysis

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All findings, interpretations, and conclusions are solely of the authors' opinion and do not necessarily represents the views of the institutions.

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ABSTRACT

This paper provides event study window analysis of pre- and post-merger bank performance in Singapore by employing Financial Ratio Analysis and Data Envelopment Analysis (DEA) approach. The findings from financial ratio analysis suggests that the merger has not resulted in a higher profitability of Singaporean banking groups post-merger, which could be attributed to the higher costs incurred. However, the merger has resulted in higher Singaporean banking groups' mean overall efficiency. In most cases, the acquiring banks mean overall efficiency improved (deteriorates) post-merger resulting from merger with a more (less) efficient bank. Further, Tobit regression analysis is employed to explain changes in the efficiencies with the finding shows that, more efficient banks tend to maintain higher degree of capitalization, post higher profits and incur higher overhead costs.

JEL Classification: G21; D24
Keywords: Bank Mergers, Data Envelopment Analysis (DEA), Tobit Model, Financial Ratios, Singapore

1. INTRODUCTION

Financial sectors worldwide have been undergoing a remarkable restructuring and consolidation process. Globalization and competition have forced banks to focus on their effectiveness in providing financial services to meet the increasing demands for better products and services. This requires an appropriate assessment of performance in banks, which reflects their ability to survive the ongoing wave of mergers and acquisitions. Banks could supposedly generate efficiency gains by increasing the scale of operations, and as a consequence improve profitability. However, numerous studies have shown that a merger between banks hardly improves cost efficiency (Canoy *et al.,* 2001) and no significant predictable effect on efficiency (Berger and Humphrey, 1994).

There are several other possible motives or reasons that banks engage in mergers and acquisitions. According to the efficiency theory, the main motive of mergers and acquisition is to gain operating and financial synergy (Berger *et al.,* 1999). The operating synergy, including both economies of scale and economies of scope, has the most economically sound basis. One of the main sources of operating synergy is the cost reduction that occurs as a result of economies of scale. This implies a decrease in per-unit costs that derive from an increase in the size or scale of a firm's operations. On the other hand, the concept of economies of scope relates to the ability of a firm to utilize one set of inputs to provide a broader range of products and services. The financial institutions that undergone merger, can share inputs and offer a broader range of services which smaller banks may not be able to afford the costs.

The main objective of the paper is to answer three important questions. Firstly, by utilizing the non-parametric DEA methodology and financial ratios analysis, the study attempt to investigate the empirical evidence on the changes in performance and efficiency of the Singapore banking groups' which is involved in mergers and acquisitions over the past decade. Secondly, the study attempts to examine whether a less efficient bank becomes the target for acquisition or whether a less (more) efficient target result in the deterioration (acceleration) in the acquirer's mean overall efficiency level post-merger. Finally, the study will provide empirical evidence on whether the mergers and acquisitions among the domestically incorporated Singapore banks have resulted in improvement in the Singaporean banking groups' performance relative to other non-merged banks.

The paper is structured as follows: the next section gives a brief overview of the Singaporean banking system, Section 3 reviews related studies in the main literature with respect to studies on non-parametric assessment of banks efficiency, Section 4 outlines the approaches to the measurement and estimation of efficiency change, Section 5 discusses the results and finally, Section 6 provides some concluding remarks.

2. MERGERS AND ACQUISITIONS IN THE SINGAPORE BANKING SECTOR

The main premise behind the Singapore government's desire for the consolidation of the local banks is size matters. As Lee (2001) stated, "…if we want strong banks, then they have to be big banks, and if they are to be big banks, then we must have fewer banks." With the government's initiative, the first wave of mergers and acquisitions took place in 1998. Development Bank of Singapore (DBS) acquired the Post Office Savings Bank (POSB) and Keppel Bank merged with Tat Lee Bank. The government also intended to eventually merge the domestic financial institutions into two "super banks", for Singaporean banks to compete successfully in the new era of globalization. The outcome would leave Singapore with only two banks, DBS and UOB, each with assets of more than S$100 billion and a third bank, OCBC, with S$85 billion in assets. This would place the banks among the top 100 banks in Asia in terms of assets.

[Insert Table 1]

Table 1 below presents the operating efficiency of the five local Singapore banks from 1997 to 2000. DBS and Keppel, the two banks that consolidated in 1998 showed a marked decrease in efficiency in the year that the mergers took place. This was due to the costs involved in the entire process. The figures indicate that the mergers failed to lead to any improvements in efficiencies.

[Insert Table 2]

One of the reasons for this trend could be the increased overhead costs incurred to upgrade the IT infrastructure of banks needed to cope with the Y2K bug. The inevitable advent

of e-banking and the decreasing importance of bank branches as a way to conduct day-to-day transactions make these investments necessary. These costs were actually expensed off rather than capitalized and depreciated over time. Moreover, banks were badly affected by the Asian Crisis between 1997 and 1998, causing failing revenues and higher expense ratios. This could have distorted the efficiency ratios. Moreover, any restructuring process takes time and concerns regarding the welfare of consumers and workers could have delayed any required cost cutting measures[1]. Therefore, figures in Table 2 may not provide a reliable picture about the effects of local mergers on cost efficiencies.

Arguments have also been brought up questioning the validity of generalizing the effect of mergers. Some believe that the results should be viewed on a case-by-case basis. Therefore, the overall effects of these mergers have to be examined together with the touted advantages that size brings along. Table 3 shows that banks that merged and increased their assets showed the greatest improvement in their ROA. This provides some evidence that mergers may actually improve profitability. The fact that Keppel had the largest increase in ROA supports previous studies that smaller banks may benefit more from mergers.

[Insert Table 3]

Compared to DBS, which has the largest asset base, OCBC and UOB experienced a drop in their ROA. These two banks were also the ones that exhibited the smallest increase in total assets between 1997 and 2000. Two main factors stand out in this respect. First, OCBC and UOB had substantial operations in the ASEAN region (outside Singapore); while other banks like Keppel and DBS had a larger share of their operations in Singapore[2]. Most of the ASEAN countries were severely affected by the Asian Financial Crisis (relative to Singapore). Therefore, the crisis rather than asset size could have caused the resultant ROA trend. Second, the increase in DBS's ROA could have been caused by a recovery in their operations after being badly hit by the Asian Financial Crisis in 1997[3]. Therefore, the base year ROA was relatively low and the increase in ROA was not caused by the increase in assets.

1 A good example would be the public uproar over DBS's closure of branches and the implementation of bank charges.

2 OCBC and UOB have 13.37% and 9.43% of their assets in ASEAN in 1998, the largest among the five local banks. DBS and Keppel had 87.78% and 95.17% of their assets in Singapore compared to 74.81% and 73.89% for OCBC and UOB respectively.

3 DBS's net profit before tax was only 70% of 1996. It did recover in 1999 and 2000.

The Monetary Authority of Singapore (MAS) has always believed that size does matter based on the present scale of the local banks. MAS believed that the local banks are not large enough by international standards and there will definitely be cost efficiency as the banks become larger. The MAS believed that three important developments may give the local banks the upper hand. First, opening up of the financial sectors to foreign players, second, the internationalization of business and third, is the growing importance of technology in the banking industry. The opening up of regional financial sectors provides banks with a larger market. The MAS believed that small banks may not have the resources to take advantage of such opportunities, as even they may not be able to do it profitably due to the lack of infrastructure and expertise.

The two recent mergers and acquisition activities among the domestic incorporated Singapore banks occurred on June 12, 2001, when Singapore's third largest bank, Overseas-Chinese Banking Corporation (OCBC) announced a S$4.8 billion bid (voluntary general offer) for Keppel Capital Holdings (KCH), which owns Singapore's smallest bank, Keppel Tat Lee Bank and on June 29, 2001, when Singapore's second largest lender, United Overseas Bank (UOB) made a competing bid for Overseas Union Bank (OUB), Singapore's fourth largest bank, after DBS Holdings Group's unsolicited bid of S$9.4 billion for OUB. UOB's bid succeeded in August 2001 forming Singapore's largest bank in terms of assets.

3. LITERATURE REVIEW

The increasing pace of bank mergers and acquisitions has given rise to an extensive economic research and today there is quite an abundance of literature available on the subject. A comprehensive review of studies evaluating mergers and acquisitions is provided by Berger *et al*. (1999). Particularly, the authors conclude that the evidence suggests little or no cost efficiency improvements on average due to mergers.

There are basically two different research methods that are used in gauging the success of mergers and acquisitions. One is the operational performance approach, which comprises studies dealing with the link between mergers and the productive efficiency of the banks involved, either measured through accounting data or through the estimation of cost and profit functions. The

other approach includes studies dealing with the impact of merger announcements on the price of publicly listed banking companies.

The operating performance approach studies the merged companies before and after the merger and examines the development of the financial indicators, such as profitability, costs and efficiency measures, based on accounting data. The primary methods used have been statistical analyses of the performance of the involved companies and have reflected the point of view of managers or shareholders. The operating performance methodology has been utilized frequently in bank merger studies (Rhoades (1994) and Berger and Humphrey (1994) for comprehensive surveys of U.S. studies). The increased interest in cost cutting and efficiency in the banking industry, particularly through acquisitions, has rendered this approach attractive since this methodology permits the researcher to focus specifically on costs and efficiency.

Bank mergers and acquisitions may enable banking firms to benefit from new business opportunities that have been created by changes in the regulatory and technological environment. Berger *et al.* (1999) pointed that mergers and acquisitions may lead to changes in efficiency, market power, economies of scale and scope, availability of services to small customers and payments systems efficiency. Besides improvement in cost and profit efficiency, mergers and acquisitions could also lead banks to earn higher profits through the banking market in leveraging loans and deposit interest rates. Prager and Hannan (1998) found that banks mergers and acquisitions have resulted in higher banks concentration, which in turn leads to significantly lower rates on deposits. Some evidence also suggested that U.S. banks that involved in M & As improved the quality of their outputs in the 1990s in ways that increased costs, but still improved profit productivity by increasing revenues than costs (Berger and Mester).

Earlier evidence of cost efficiency associated with mergers and acquisitions in the U.S. banking industry in the 1980s proved to be insignificant and that the average cost curve had a relatively flat U-shape with medium sized banks being slightly more cost scale efficient than either large or small banks (Berger and Humphrey, 1992; Rhoades, 1993; DeYoung, 1997). Average costs were usually found to be minimised somewhere in the wide range between about $100 million and $10 billion in assets (Berger *et al*., 1987; Hunter *et al.*, 1990; Noulas *et al*., 1990). However, studies in the 1990s have shown mixed results. Berger (2003) noted that it is possible that technological progress would have increased scale economies in the production of financial services as most of the researchers used data on financial institutions in from the 1980s.

Studies performed to investigate U.S. banks mergers performance in the 1990s have arrived at different conclusions. Rhoades (1998) found that there were modest cost efficiency gains for most mergers and acquisitions involving large U.S. banks whereas Berger (1998) suggest very little improvement in cost efficiency for mergers and acquisitions for both large and small banks. Despite that, mergers and acquisitions in the 1980s and 1990s did result in the improvement in profit efficiency (Akhavein *et al*., 1997; Berger, 1998). In addititon, the results show that mergers and acquisitions help to improve profitability, not by improvement in efficiency, but rather by a change in the output mix in favour of more loans and fewer securities holdings.

Studies examining the efficiency effects on bank mergers and acquisitions in the U.S. banking sector involved a large number of M & As. However, a growing number of empirical studies have been undertaken to analyse a small number of M & As using a non-parametric method Data Envelopment Analysis (DEA). The DEA method has increasingly been the preferred method to investigate the impacts of mergers and acquisitions on banks efficiency, in particular if the sample size is small (see Table 2). Avkiran (1999) stated that it is advisable to work with a sample size substantially larger than the product of number of inputs and number of outputs if the analysis to discriminate effectively between efficient and inefficient decision making units (DMUs). Previous studies undertaken to analyse a small number of M & As include among others Avkiran (1999), and Liu and Tripe (2002).

[Insert Table 4]

Avkiran (1999) employed DEA and financial ratios to a small sample of 16 to 19 Australian banks during the period of 1986-1995, studied the effects of four mergers on efficiency and the benefits to public. He adopted the intermediation approach and two DEA models. He reported that acquiring banks were more efficient than target banks. He also found that acquiring banks do not always maintain their pre-merger efficiency, but that, during the deregulated period, overall efficiency, employees' productivity and return on assets (ROA) improved. There were mixed evidence from the four cases on the extent to which the benefits of efficiency gains from mergers were passed on to the public.

Liu and Tripe (2002) using a small sample of 7 to 14 banks, employed accounting ratios and two DEA models to explore the efficiency of 6 bank mergers in New Zealand between 1989

and 1998. They found that the acquiring banks to be generally larger than their targets, although they were not consistently more efficient. They found that five of the six merged banks had efficiency gains based on the financial ratios while another only achieved a slight improvement in operating expenses to average total income. Based on the DEA analysis, they found that only some banks were more efficient than the target banks pre-merger. The results suggest that four banks had obvious efficiency gains post-merger. However, they could not decisively conclude on possible benefits of the mergers on public benefits.

Despite substantial studies performed in regard to the efficiency and productivity of financial institutions in the U.S., Europe and other Asia-Pacific banking industries, the Singapore banking industry has not followed suite partly due to the lack of available data sources and the small sample of banks. Among the notable microeconomic research performed on Singapore banks' efficiency was by Chu and Lim (1998), Rezvanian and Mehdian (2002), and Randhawa and Lim (2005). Using DEA with three inputs and two outputs, Chu and Lim (1998) evaluate the relative cost and profit efficiency of a panel of six Singapore listed banks during the period 1992-1996. They found that during the period the six Singapore listed banks have exhibit higher overall efficiency of 95.3% compared to profit efficiency of 82.6%. They also found that large Singapore banks have reported higher efficiency of 99.0% compared to the 92.0% for the small banks. The also suggest that scale inefficiency dominates pure technical inefficiency during the period of study.

Rezvanian and Mehdian (2002) employed both the translog cost function and a non-parametric approach to examine the production performance and cost structure of a sample of 10 fully licensed Singaporean commercial banks during the period 1991 to 1997. They found that the average cost curve is U-shaped for the Singaporean banking industry and there are economies of scale for banks of small and medium size. However, economies of scope were found in all banks regardless of size, implying that joint production of outputs is less costly than producing each output separately. On the other hand, the results from the non-parametric analysis suggest that the Singapore banking groups could have produced the same amount of outputs by employing only 57% of the inputs it uses. Their findings suggest that the Singapore commercial banks' cost inefficiency was caused almost equally by allocative and technical inefficiencies.

More recently, Randhawa and Lim (2005) utilise DEA to investigate the locally incorporated banks in Hong Kong and Singapore X-efficiencies during the period 1995 to 1999.

They found that during the period the seven domestic incorporated Singapore banks have exhibit an average overall efficiency score of 80.4% under the intermediation approach and 97.2% under the production approach. They suggest that the large Singapore banks have reported higher overall efficiency compared to the small banks under the production approach while on the other hand the small banks exhibits higher overall efficiency under the intermediation approach. They also suggest that pure technical inefficiency dominates scale inefficiency under both approaches during the period of study.

4.0 METHODOLOGY AND THE CHOICE OF VARIABLES

The DEA approach has been widely applied to the research topic of bank operating performance and efficiency. Modern efficiency measurement begins with Farrell (1957) who defined a simple measure of firm efficiency which could account for multiple inputs. He proposed that the efficiency of a firm consists of two components: *technical efficiency*, which reflects the ability of a firm to obtain maximal output from a given set of inputs, and *allocative efficiency*, which reflects the ability of a firm to use the inputs in optimal proportions, given their respective prices. These two measures are then combined to provide a measure of total *economic efficiency*. Charnes, *et al.* (1978) proposed a model which had an input orientation and assumed constant returns to scale (CRS) and termed the model as *data envelopment analysis* (DEA).

The DEA approach involves the use of linear programming methods to construct a nonparametric piecewise frontier over the data, so as to be able to calculate efficiencies relative to this surface. In other words, the purpose of DEA is to construct a non-parametric envelopment frontier over the data points such that all observed points lie on or are below the production frontier. The value of efficiency score obtained for any DMU must be less than or equal to one, with a value of 1 indicating a point on the frontier and hence a technically efficient DMU, according to the Farrell (1957) definition. Using the duality in linear programming, we derive an *envelopment* form of the problem to estimate operating efficiency scores of sample banks

$$\min_{u,v} (u' y_i / v' x_i),$$

$$u' y_i / v' x_i \leq 1, \quad j = 1, 2, \ldots, N,$$

$$u, v \geq 0 \qquad (1)$$

The above formulation has a problem of infinite solutions and therefore we impose the constraint $v'x_i = 1$, which leads to:

$$\min_{\mu,\varphi} (\mu' y_i),$$

$$\varphi' x_i = 1$$

$$\mu' y_i - \varphi' x_j \leq 0 \quad j = 1, 2, \ldots, N,$$

$$\mu, \varphi \geq 0 \qquad (2)$$

where we change notation from u and v to μ and φ, respectively, in order to reflect transformations. Using the duality in linear programming, an equivalent envelopment form of this problem can be derived:

$$\min_{\theta, \lambda} \theta,$$

$$y_i + Y\lambda \geq 0$$

$$\theta x_i - X\lambda \geq 0$$

$$\lambda \geq 0 \qquad (3)$$

where θ is a scalar representing the value of the efficiency score for the ith decision-making unit which will range between 0 and 1. λ is a vector of N x 1 constants. The linear programming has to be solved N times, once for each decision-making unit in the sample. In order to calculate efficiency under the assumption of variable returns to scale, the convexity constraint ($N1'\lambda = 1$) will be added to ensure that an inefficient firm is only compared against firms of similar size, and therefore provides the basis for measuring economies of scale within the DEA concept. The convexity constraint determines how closely the production frontier envelops the observed input-output combinations and is not imposed in the constant returns to scale case. The variable returns to scale technique therefore forms a convex hull which envelops the data more tightly than the constant returns to scale, and thus provides efficiency scores that are greater than or equal to those obtained from the constant returns to scale model.

In the spirit of Rhoades (1998), a [-3, 3] event window is constructed to analyze the effect of mergers and acquisitions on the Singapore banking groups' efficiency. The choice of the event

window is motivated by Rhoades (1998), who pointed out that, there has been unanimous agreement among the experts that about half of any efficiency gains should be apparent after one year and all gains should be realized within three years after the merger. The whole period, (i.e. 1998-2004) is divided into three sub-periods: 1998-2000 refers to the pre-merger period, 2001 is considered as the merger year and 2002-2004 represents the post-merger period, when the merger and acquisitions is expected to have some impact on the efficiency of Singapore banking groups. The expectation that it is able to capture the effects of mergers and acquisitions on the efficiency of Singapore banks during this period. The mean overall efficiency of the targets and acquirers during all periods are compared, along with its decomposition of pure technical and scale efficiencies scores.

It is also a considerable interest to explain the determinants of technical efficiency scores derived from the DEA models. As defined in equations (3) the DEA score falls between the interval 0 and 1 ($0 < h^* \leq 1$) making the dependent variable a limited dependent variable. A commonly held view in previous studies is that the use of the Tobit model can handle the characteristics of the distribution of efficiency measures and thus provide results that can guide policies to improve performance. DEA efficiency measures obtained in the first stage are the dependent variables in the second stage of the Tobit model. This model is also known as truncated or censored regression models where expected errors are not equal zero. Therefore, estimation with an Ordinary Least Squares (OLS) regression of h^* would lead to a biased parameter estimate since OLS assumes a normal and homoscedastic distribution of the disturbance and the dependent variable (Maddala, 1983).

In recent years, many DEA applications employ a two-stage procedure involving both DEA and Tobit. Among others, Jackson and Fethi (2000) apply DEA with Tobit to evaluate technical efficiency in Turkish banks. The standard Tobit model can be defined as follows for observation (bank) i:

$$\begin{aligned} & y_i^* = \beta' x_i + \varepsilon_i \\ & y_i = y_i^* \quad \text{if} \quad y_i^* \geq 0 \quad \text{and} \\ & y_i = 0, \text{otherwise} \end{aligned} \tag{4}$$

where $\varepsilon_i \sim N(0, \sigma^2)$, x_i and β are vectors of explanatory variables and unknown parameters, respectively. The y_i^* is a latent variable and y_i is the DEA score.

The likelihood function (L) is maximized to solve $\beta_.$ and σ based on 20 observations (banks) of y_i and x_i is

$$L = \prod_{y_i=0}(1-F)\prod_{y_i>0}\frac{1}{(2\Pi\sigma^2)^{1/2}} \times e^{-[1/(2\sigma^2)](y^i-\beta x_i)^2} \quad (5)$$

where

$$F_i = \int_{-\infty}^{\beta x_i/\sigma}\frac{1}{(2\Pi)^{1/2}}e^{-t^2/2}dt \quad (6)$$

The first product is over the observations for which the banks are 100 percent efficient (y = 0) and the second product is over the observations for which banks are inefficient (y >0). F_i is the distribution function of the standard normal evaluated at $\beta' x_i/\sigma$.

4.1 Inputs and Outputs Definition and the Choice of Variables

The definition and measurement of inputs and outputs in the banking function remains a contentious issue among researchers. To determine what constitutes inputs and outputs of banks, one should first decide on the nature of banking technology. In the banking theory literature, there are two main approaches competing with each other in this regard: the production and intermediation approaches (Sealey and Lindley, 1977). Previous studies adopting the production approach among others are by Sherman and Gold (1985), Ferrier and Lovell (1990) and Fried *et al.* (1993) while previous banking efficiency studies research that adopted intermediation approach are among others Charnes *et al.* (1990), Bhattacharyya *et al.* (1997) and Sathye (2001).

For the purpose of this study, a variation of the intermediation approach or asset approach originally developed by Sealey and Lindley (1977) will be adopted in the definition of input and output definition. According to Berger and Humphrey (1997), the production approach might be more suitable for branch efficiency studies, as at most times bank branches basically process customer documents and bank funding, while investment decisions are mostly not under the control of branches. Furthermore, Sathye (2001) also noted that this approach is more relevant to financial institutions, as it is inclusive of interest expenses, which often accounts for one-half to two-thirds of total costs depending on the phase of the interest rate cycles.

The aim in the choice of variables for this study is to provide a parsimonious model and to avoid the use of unnecessary variables that may reduce the degree of freedom[4]. All variables are measured in millions of Singapore Dollars. Descriptive statistics are provided for the variables used in the analysis. Given the sensitivity of efficiency estimates to the specification of outputs and inputs, two alternative models are estimated in this study. In Model 1, follow the approach by Avkiran (1999), to include *Total Deposits* (*x1*) as an input vector to produce *Total Loans* (*y1*) and *Non-Interest Income* (*y2*).

[Insert Table 5]

To recognize that banks in recent years have been increasingly generating income from 'off-balance sheet' business and fee income generally, following Sturm and Williams (2004), Drake and Hall (2003) and Isik and Hassan (2003) among others, *Non-Interest Income* (*y2*) will be incorporated as a proxy to non-traditional activities as output in Model 2. Non-interest income is defined as fee income, investment income and other income, which among others consist of commission, service charges and fees, guarantee fees, net profit from sale of investment securities and foreign exchange profit. Accordingly, in Model 2, it is assumed that *Interest Income* (*y1*) and *Non-Interest Income* (*y2*) and are produced from *Interest Expense* (*x1*) and *Non-Interest Expense* (*x2*).

As for the potential determinants in the Tobit regression, the following variables from the published annual report of individual banks from 1998 to 2004 are used. First, we determine the impact of banks' size on Singapore banking groups' efficiency and the impact of efficiency on the Singapore banking groups' profitability. Bank size is measured by the amount of total assets and bank profitability is measured by net operating income to total assets. Second, there are various bank specific characteristics have the impact on efficiency performance. Three variables are utilized to explain the Singapore banking groups' efficiency; 1) capitalization is measured by the amount of share and supplementary capital divided by total assets; 2) assets quality is measured by provision/loans and 3) overhead cost is measured by personnel expense over numbers of employees.

4 For a detailed discussion on the optimal number of inputs and outputs in DEA, see Avkiran (2002).

4.2 Analysis of the Financial Ratios

To measure the effect of the merger on the acquirers' performance, we compare the post-merger financial ratios relative to the pre-merger period as well as the control group, which was not involved in any domestic merger during the period of study. We define this as the change in relative operating ratio (CROR) and compute it using the following formula:

$$CROR = [\overline{\xi_{it+1}} - \overline{\delta_{it+1}^{Control}}] - [\overline{\xi_{it}} - \overline{\delta_{it}^{Control}}] \quad (7)$$

where ξ and δ is the average financial ratio analyzed, the subscript $t+1$ stands for post-merger period, subscript t for pre-merger period, i denotes an individual bank and *Control* stand for the control group.

The average financial ratios for each bank and the control group for 3 years before the merger and 3 years after the merger are computed and omit the year of the merger because it is a transitional period. Due to the nature of Singapore banking sector, the integration process is completed relatively quickly. In some cases, three years might seem too short however, interviews confirm that 50% of all cost savings occur within the first year of a merger (Rhoades, 1998). Singapore banking group is used as a control group, which has not participated in merger activity in the same year.

Following Rhoades (1998) and Avkiran (1999), five financial ratios are chosen to analyze costs, profitability, and risk. Non-interest expenses are the most often cited by practitioners as those directly affected by mergers. Two expense ratios are employed, which are scaled according to total assets in order to show not just change in costs, but also in efficiency, namely, *non-interest expenses/total assets* (NIE/TA) and *personnel expenses/total assets* (PE/TA). To trace the development of the loan portfolio quality, the development of *non-performing loans/total loans* (NPL/TL) ratio is also used in the analysis with two others profitability ratios, namely, *return on assets* (ROA) and *return on equity* (ROE).

4.3 Data

For the empirical analysis, *all* domestically incorporated Singapore commercial banks will be incorporated in the study. In the spirit of maintaining homogeneity, only commercial

banks that make commercial loans and accept deposits from the public are included in the analysis, hence, investment banks are excluded from the sample. The annual balance sheet and income statement used to construct the variables for the empirical analysis were taken from published balance sheet information in annual reports of each individual bank. Three banks were omitted from our study, namely, Bank of Singapore, Far Eastern Bank and Industrial and Commercial Bank, which are all wholly owned subsidiaries of the OCBC and UOB groups.

5.0 EMPIRICAL RESULTS

5.1 The Analysis of the Financial Ratios

The summary of the empirical findings of the financial ratios is presented in Table 6. It should also be noted that the CRORs show the direction and strength of the change of the ratios, but cannot be used to compare one merged bank with another.

The profitability ratio most often followed by managers, shareholders and other stakeholders of banks is ROE and ROA. As can be seen from Table 6, both mergers have resulted in lower ROE and ROA post-merger relative to pre-merger. The lower profitability could be due to the deterioration in cost efficiency, since all Singapore banking group's average post-merger cost, measured by the non-interest expense/total assets have increased. Similarly, this is also suggesting that none of the banking groups were able to reduce their labor costs post-merger.

There are a few plausible explanations for this: First, managers could be limited in their ability to lay off staff due to the rigid labor market regulation in Singapore. Second, although theoretically, consolidation would reduce the amount of back office personnel, the reductions could however be offset by increases in the front office personnel, implying a better customer service. In contrast, the risk analysis measure (non-performing loans/total assets) indicates that all banking groups have experienced positive effect on the quality of their loan portfolios. Hence, the mergers could have resulted in a more prudent risk management by the banking groups.

[Insert Table 6]

5.2 Analysis of Pre- and Post-Merger Efficiency (Model 1)

The overall efficiency estimates are presented in Table 7 along with its decomposition into pure technical and scale efficiency estimates for Model 1. It is apparent that, during the pre-merger period, Singapore banks have exhibit average overall efficiency score of 93.82%, suggesting that the banking system has performed relatively well in its basic function – transforming deposits to loans, with relatively minimal mean input waste of 6.18%. The result implies that during the pre-merger period, the banking groups could have produced the same amount of outputs with only 93.82% of the amount of inputs used and could only have reduced its inputs by 6.18% to produce the same amount of outputs produced during the pre-merger period. The results congregate with Chu and Lim (1998) and Randhawa and Lim (2005) and also compare favorably with Fukuyama (1993) study on Japanese banks and Bhattacharyya *et al.* (1997) for Indian bank.

[Insert Table 7]

From Table 7 given the initial decline of the mean overall efficiency from 93.82% pre-merger to 88.67% during the merger, it is clear that the merger has resulted in the improvement of the banking groups mean overall efficiency for Model 1 post-merger. The deterioration in the mean overall efficiency during the merger year, which was solely attributed to scale inefficiency, could be due to the larger size resulting from the merger. During the post-merger period, it is apparent from Table 7 that the banking groups have exhibited a mean overall efficiency of 98.77%. Despite exhibiting improvement in its mean overall efficiency level relative to the merger year, the only bank to be inefficient during the post-merger period is UOB with the mean overall efficiency of 96.3% which is still lower compared to the 100.0% level during the pre-merger period, while DBS exhibits significant improvement in its efficiency levels and in the case of OUB, the inefficiency was attributed solely to scale during the post-merger period.

5.3 Analysis of Pre- and Post-Merger Efficiency (Model 2)

The overall efficiency estimates are presented, along with its decomposition into pure technical and scale efficiency for Model 2 are presented in Table 8. It is apparent that, during the pre-merger period, Singapore banking groups have exhibited mean overall efficiency score of

97.09%, slightly higher compared to 93.82% for Model 1. The decomposition of overall efficiency estimates suggest that, during the pre-merger period, Singapore banks inefficiency was largely attributed to scale (1.43%) rather than pure technical efficiency (0.65%). During the period, the result shows that, all Singapore banking groups were pure technically efficient, with the exception of OUB, which inefficiency were largely attributed to pure technical (3.27%) rather than scale (0.87%). It is also interesting to note that UOB was the only bank identified to be scale efficiency during the pre-merger period, while the other Singapore banking groups exhibit scale inefficiency in the range of 0.87% for OUB to 4.90% in the case of KEP.

[Insert Table 8]

Similar to Model 1, it is apparent from Table 8 that the merger has resulted in the improvement of Singapore banking groups mean overall efficiency for Model 2, increasing from 97.09% during the pre-merger period to 98.96% post-merger. During the post-merger period, OCBC is the only bank, which was inefficient due solely to scale inefficiency. It is clear from Table 5 that the largest bank in our sample, DBS, exhibits significant improvement in its mean overall efficiency as the bank has been operating at CRS post-merger while UOB has been able to maintain to operate at CRS post-merger. It is also interesting to note that despite earlier evidence, which suggests that the lack of competition may result in lower technical efficiency, (Sathye, 2001; Walker, 1998). According to Walker (1998) high degree of concentration may result in the "quiet life" hypothesis to come into play which predict that as firms enjoy greater market power and concentration, inefficiency follows not because of non-competitive pricing but more so because of a relaxed environment with no incentives to minimize costs.

5.4 Is the Acquirer a More Efficient Bank?

Theoretically, the more efficient banks should acquire the less efficient ones (Berger *et al.*, 1993, Rhoades, 1993). The more efficient banks are assumed to be well organized and have a more capable management. The idea is that, since there is room for improvement concerning the performance of the less efficient bank, a takeover by a more efficient bank will lead to a transfer of the better management quality to the inefficient bank. This will in turn lead to a more efficient and better performing merged unit. In order to see whether indeed it is the case for banks that are

more efficient acquire the inefficient ones, the difference in overall efficiency between an acquiring and an acquired bank is calculated. This efficiency difference is measured as the overall efficiency of the acquiring bank, minus the mean overall efficiency of the acquired banks for the last observation period before consolidation.

For Model 1, from Table 8 that during the pre-merger period KEP's (the target) overall efficiency level of 98.43% which is higher compared to OCBC's (the acquirer) overall efficiency of 95.03%. Conversely, from Table 8 it is clear that during the pre-merger period, for Model 1, UOB exhibit higher overall efficiency level of 100.0% compared to its target, OUB overall efficiency of 99.73%. Thus, our results from Model 1 reject the hypothesis that the targets were less efficient relative to the acquirers.

In contrast to Model 1, the results for Model 2 suggest that KEP's mean overall efficiency is lower at 95.1% compared to its acquirer's, OCBC, mean overall efficiency level of 98.6%. Similar to Model 1, the results from Model 2 suggest that during the pre-merger period, UOB's (the acquirer) mean overall efficiency of 100.0% is higher compared to its target, OUB's, mean overall efficiency of 95.9%. Hence, the results from Model 2 support the hypothesis that the acquirers are more efficient than the targets.

5.5 Implications of Mergers on Acquiring Banks' Efficiency

The ex-post performance of the merged banking groups is discussed and analyzed in order to establish whether there is a positive (negative) relationship between the difference in the efficiency before the merger and the performance of the institutions after the consolidation. The analysis will examine whether there has been any transfer of better management quality from the acquiring bank to the one acquired one or whether a less efficient target would consequently result in the deterioration of the mean efficiency levels of the acquirers. This is done by computing the difference between the acquirers' mean efficiency levels (overall, pure technical and scale) during the post-merger period compared to pre-merger period.

[Insert Table 9]

For Model 1, KEP (the target) mean overall efficiency level of 98.43% is higher compared to OCBC (the acquirer) mean overall efficiency of 95.03% during the pre-merger

period. It is apparent from Table 9 above that, the merger between OCBC and KEP has resulted in the improvement of OCBC's mean overall efficiency during the merger and post-merger, when OCBC has been operating at CRS. Conversely, during the pre-merger period, UOB exhibit higher overall efficiency level of 100.0% for Model 1 compared to its target, OUB with the overall efficiency of 99.73%. Our results suggest that, UOB's overall efficiency deteriorated to 88.8% during the merger year. Although UOB's mean overall efficiency improved to 96.3% during the post-merger period, it is still lower relative to pre-merger, when the bank was operating as a fully efficient bank. Based on the results for Model 1, the findings conclude that, a more efficient (inefficient) target resulted in the improvement (deterioration) of the acquirers' mean overall efficiency post-merger.

[Insert Table 10]

In contrast to our results from Model 1, the results for Model 2 from Table 10 suggest that KEP's mean overall efficiency of 95.1% is lower compared to its acquirer's, OCBC, mean overall efficiency of 98.6%. This suggests that, the merger has resulted in the deterioration of OCBC's mean overall efficiency level post-merger to 96.87%. For Model 2, during the pre-merger period, UOB's overall efficiency of 100.0% is higher compared to its target, OUB's overall efficiency of 95.9%. UOB's mean overall efficiency level remained stable and that the bank has been operating at CRS during the merger year and has been operating as a fully efficient bank post-merger. Hence, for Model 2, mixed evidence is found on the implications of mergers on acquirers' mean overall efficiency post-merger.

5.6 Results of Tobit Regression Analysis

To further investigate the determinants of the Singapore banking groups' efficiency over time, the efficiency scores for DEA Model 1 and DEA Model 2 are estimated by using the censored Tobit model. Unlike a conventional Ordinary Least Square (OLS) estimation, in case with limited dependent variables, the Tobit model is known to generate consistent estimates of regression coefficients. The results of the estimation are presented in Table 11. A positive coefficient implies an efficiency increase whereas a negative coefficient reflects the deterioration in efficiency.

[Insert Table 11]

It is apparent from Table 11 that bank size has a positive effect on efficiency indicating that large banks tend to post higher efficiency scores. Size could have a positive impact via two channels: First, if it relates positively to market power, large banks should pay less for their inputs. Second, there might be increasing returns to scale as a result of highly specialized workforce. However, the bank size is insignificant at conventional level, hence, indicates that the efficiency is independent of the size of the bank. The results also suggest that profitability has a significant positive relationship with banks' efficiency for both Model 1 and Model 2, indicating that the more profitable bank tend to exhibit higher efficiency score. This could be due to the fact that, banks reporting higher profitability attracts the biggest share of deposit as well as the best potential borrowers, as it is deem as preferential by clients, particularly in the Singaporean banking sector. The finding also corresponds with the study by Jackson and Fethi (2000) on the Turkish banks.

In the context of bank characteristics and its influence on Singapore banking groups' efficiency, Table 11 clearly shows that, capitalization yields a positive impact and highly significant at conventional level in explaining Singapore banking groups' efficiency. This indicate that strong capital structure is essential for banks to increase the ability to collect deposits and in line with the conventional wisdom of capital playing a role of implicit deposit insurance, which in turn encourages more deposits. In performing further investigation, we treated loans as homogenous with respect to risk. The significant negative coefficient of the provisions/loans supports the prediction that if a bank has poor quality loan portfolio, this should entail additional costs associated with monitoring and enforcement of loan repayment as well as the inability of the bank to select reliable borrowers hence not being able to use their resources efficiently (Berger and DeYoung, 1997).

At first glance, the effect of overhead costs on banks' efficiency seems counterintuitive, where higher overhead costs seem to pay off. Although theoretically consolidation should reduce the amount of back office personnel, the reductions could however be offset by increases in the front office personnel and more specialized workforce, implying a better customer service and better professional management. Furthermore, as suggested by Sathye (2001), a more professional management might require higher remuneration and thus highly significant positive

relationship with efficiency measure is natural. Claessens *et al*. (2001) has also found that overstaffing of domestic banks has only resulted in the deterioration of banks' efficiency in middle-income countries compared to the high-income countries.

6.0 CONCLUSIONS

The paper attempts to analyze the impact of the merger and acquisitions that have been taken place in the Singapore banking sector during the past decade, by analyzing changes in profitability, cost efficiency, risk and efficiency. In doing so, a relatively new method (CROR), is applied to analyze the Singapore banking groups' financial ratios. A non-parametric frontier approach, Data Envelopment Analysis (DEA) is also applied in the paper to investigate the effects of merger and acquisitions on the efficiency of domestic incorporated Singapore banking groups. The sample period is divided into three sub-periods i.e. pre-merger, during merger and post-merger periods, to compare the difference in Singapore banking group's mean efficiency levels during all periods.

From the analysis of the financial ratios, the findings show that the merger has not resulted in a higher profitability of the Singapore banking groups post-merger. The lower profitability could be the result of the deterioration in cost efficiency, since all banking group's average post-merger cost, measured by the non-interest expense/total assets have increased. Similarly, the findings also suggest that none of the banking groups were able to reduce their labor costs post-merger, which could be due to the limited ability to lay off employees due to the rigid labor market regulation in Singapore. Although theoretically consolidation should reduce the amount of back office personnel, the reductions could however be offset by increases in the front office personnel, implying a better customer service. However, the risk analysis measure, the non-performing loans/total assets ratio indicates that, all Singapore banking groups have experienced positive effect on the quality of their loan portfolios. Hence, the results suggest that, the merger has resulted in a more prudent risk management by the Singapore banking groups.

The results from both of the DEA models suggest that the merger has resulted in higher mean overall efficiency of Singapore banks. The results from Model 1 suggest that, Singapore banking groups have exhibit a commendable overall efficiency level of 93.82% suggesting minimal input waste of 6.18%. During the merger year, Singapore banking groups overall

efficiency level deteriorates slightly to 88.67%, which was solely due to scale inefficiency. Despite that, during the post merger period, Singapore banking groups have exhibit higher mean overall efficiency levels compared to the pre-merger period. Although mergers has resulted in a more efficient banking system, as it may appear from our results for Model 1 and Model 2, size has become the biggest source influencing the inefficiency of the Singapore banking system. Mixed evidence is found on the characteristics of the acquirers and targets efficiencies. While the results from the merger between KEP and OCBC revealed mixed findings, hence do not fully support for the hypothesis of a less efficient bank becoming a merger target.

The explanation of the efficiency scores using the Tobit regression analysis offers useful economic insights. The significance of profitability can be interpreted as an indication of the ability to attract the biggest share of deposit as well as the best potential borrowers. The significance of the level of loan quality portfolio proxy by provision of bad loans should entail additional costs associated with monitoring and enforcement of loan repayment, hence negatively related to efficiency. Not surprising, capitalization yields a positive impact and highly significant at conventional level in line with the conventional wisdom of capital playing a role of implicit deposit insurance, which in turn encourages more deposits. Furthermore, the overhead cost tend to contribute positively to bank performance which might be due to the cost of attracting highly skilled personnel with high remuneration packages which indirectly indicate that banks with better risk management and advance operational techniques usually operate more efficiently.

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Table 1: **Characteristics of Singapore's Commercial Banking Groups after the M & As in 2001**

	DBS	UOB + OUB	OCBC + KEP
Total Assets (S$ billion)	111.0	113.7	83.0
Total Loans (S$ billion)	54.2	61.5	50.4
Total Deposits (S$ billion)	92.8	96.6	71.1
Total Shareholders Fund (S$ billion)	8.4	13.1	8.3
Number of Branches	107	93	74
Number of ATMs	900	426	381

Note: DBS is Development Bank of Singapore; UOB is United Overseas Bank; OUB is Overseas Union Bank; OCBC is Overseas-Chinese Banking Corporation; and KEP is Keppel Capital Holdings (which owns Keppel Tat Lee Bank).

Source: *Banks Annual Reports*

Table 2: **Singapore Banking Groups' Efficiency Ratios**

Bank	**1997** (%)	**1998** (%)	**1999** (%)	**2000** (%)	**Increase Over the Years (%)**
DBS	33	40	35	42	1.30
OCBC	26	25	29	38	1.46
UOB	NA	33	32	39	1.19
Keppel	34	46	33	35	1.03
OUB	36	35	36	38	1.05

Source: *Authors own calculations*

Table 3: **Singapore Banking Groups' Profitability Ratios**

Bank	**1997** (%)	**1998** (%)	**1999** (%)	**2000** (%)	**ROA for 2000/ROA for 1997 (1998 for OUB) (%)**
DBS	2.3	1.9	2.8	2.6	1.14
OCBC	3.3	3.5	3.3	2.9	0.89
UOB	NA	3.0	3.5	2.9	0.95
Keppel	1.7	1.7	2.6	2.6	1.54
OUB	2.7	2.5	3.1	2.7	1.01

Source: *Authors own calculations*

Table 4: **Examples of Small Sample Size in DEA Literature**

Researchers (Date)	Sample Size	Inputs x Outputs
Liu and Tripe (2002)	7-14	2x2=4 and 2x3=6
Avkiran (1999)	16-19	2x2=4
Oral and Yolalan (1990)	20	5x4=20
Vassiloglou and Giokas (1990)	20	4x4=16
Giokas (1991)	17	3x3=9
Hang and Jaska (1995)	14	3x4=12
Yeh (1996)	7	3x3=9

Table 5: **Descriptive Statistics**

Variable	Mean	Std. Dev.	Minimum	Maximum
Total Loans (*y1*)	45,348.21	18,845.16	12,713.56	71,021.0
Non-Interest Income (*y2*)	727.26	477.50	73.31	2,153.0
Interest Income (*y3*)	3,201.95	1,153.90	944.39	5,298.0
Total Deposits (*x1*)	56,598.01	30,090.08	12,089.23	113,206.0
Interest Expense (*x2*)	1,674.51	736.21	568.64	3,501.26
Non-Interest Expense (*x3*)	991.64	627.17	169.09	2,446.0

Note:
Model 1 – Outputs = *y1 (Total Loan, y2 (Non-Interest Income*), Inputs = *x1 (Total Deposit*)
Model 2 – Outputs = *y3 (Interest Income), y2 (Non-Interest Income*), Inputs = *x2 (Total Deposit)*, *x3 (Non-Interest Income*)

Table 6: **Changes in the Relative Operation Ratios (CRORs) of the Banks Participating in the M & As Activity**

			Pre-Merger					Post-Merger				
Acquirer	**Acquirer More Efficient Than Target[1]**	**Acquirer More Efficient Than Target[2]**	**Mean ROE (%)**	**Mean ROA (%)**	**Mean NIE/TA (%)**	**Mean PE/TA (%)**	**Mean NPL/TL (%)**	**Mean ROE (%)**	**Mean ROA (%)**	**Mean NIE/TA (%)**	**Mean PE/TA (%)**	**Mean NPL/TL (%)**
OCBC	NO	YES	9.14	1.21	0.98	0.51	12.15	9.66	1.00	1.13	0.51	7.08
								(-0.49)	(-0.27)	(-0.26)	(-0.11)	(1.24)
UOB	YES	YES	10.95	1.20	1.12	0.55	8.56	9.36	1.06	1.13	0.47	8.51
								(-2.60)	(-0.20)	(-0.40)	(-0.19)	(6.26)
Mean			10.05	1.21	1.05	0.53	10.36	9.51	1.03	1.13	0.49	7.8
								(-1.55)	(-0.24)	(-0.33)	(-0.15)	(-3.75)
Control												
DBS	Not Applicable	Not Applicable	8.17	0.79	1.00	0.46	11.35	9.18	0.85	1.41	0.57	5.04

Calculations are based on the 3 years averages before and after the transaction, the year of the merger or acquisition is considered a transaction year and therefore is skipped.
The font in bold indicates changes that are beneficial for the banking group.
Number in parentheses indicates CRORs.

[1]Based on DEA Scores for Model 1
[2]Based on DEA Scores for Model 2

ROE – Return on Shareholders Equity
ROA – Return on Assets
NIE/TA – Non-Interest Expense/Total Assets
PE/TA – Personnel Expenses/ Total Employees
NPL/TL – Non-Performing Loans/Total Loans

Table 7: **Summary of Mean Efficiency Levels of Singapore Banks (Model 1)**

Bank	Pre-Merger*			During Merger**			Post-Merger***		
	OE	**PTE**	**SE**	**OE**	**PTE**	**SE**	**OE**	**PTE**	**SE**
KEP	98.43	100.0	98.43						
OCBC	95.03	100.0	95.03	100.0	100.0	100.0	100.0	100.0	100.0
OUB	99.73	100.0	99.73						
UOB	100.0	100.0	100.0	88.8	100.0	88.8	96.3	100.0	96.3
DBS	75.93	100.0	75.93	77.2	100.0	77.2	100.0	100.0	100.0
Mean	**93.82**	**100.0**	**93.82**	**88.67**	**100.0**	**88.67**	**98.77**	**100.0**	**98.77**

* 1998-2000; ** 2001; *** 2002-2004
OE – Overall Efficiency
PTE – Pure Technical Efficiency
SE – Scale Efficiency

Table 8: **Summary of Mean Efficiency Levels of Singapore Banks (Model 2)**

Bank	Pre-Merger*			During Merger**			Post-Merger***		
	OE	**PTE**	**SE**	**OE**	**PTE**	**SE**	**OE**	**PTE**	**SE**
KEP	95.1	100.0	95.1						
OCBC	98.6	100.0	98.6	100.0	100.0	100.0	96.87	100.0	96.87
OUB	95.9	96.73	99.13						
UOB	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
DBS	95.87	100.0	100.0	94.2	100.0	94.2	100.0	100.0	100.0
Mean	**97.09**	**99.35**	**98.57**	**98.077**	**100.0**	**98.07**	**98.96**	**100.0**	**98.96**

* 1998-2000; ** 2001; *** 2002-2004
OE – Overall Efficiency
PTE – Pure Technical Efficiency
SE – Scale Efficiency

Table 9: **Summary of Mean Efficiency Levels of the Acquirers – Model 1**

Bank	Pre-Merger*			During Merger**			Post-Merger***		
	OE	**PTE**	**SE**	**OE**	**PTE**	**SE**	**OE**	**PTE**	**SE**
OCBC	95.03	100.0	95.03	100.0	100.0	100.0	100.0	100.0	100.0
UOB	100.0	100.0	100.0	88.8	100.0	88.8	96.3	100.0	96.3

* 1998-2000; ** 2001; *** 2002-2004
OE – Overall Efficiency
PTE – Pure Technical Efficiency
SE – Scale Efficiency

Table 10: **Summary of Mean Efficiency Levels of the Acquirers – Model 2**

Bank	Pre-Merger*			During Merger**			Post-Merger***		
	OE	**PTE**	**SE**	**OE**	**PTE**	**SE**	**OE**	**PTE**	**SE**
OCBC	98.6	100.0	98.6	100.0	100.0	100.0	96.87	100.0	96.87
UOB	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

* 1998-2000; ** 2001; *** 2002-2004
OE – Overall Efficiency
PTE – Pure Technical Efficiency
SE – Scale Efficiency

Table 11: **Censored TOBIT Regression Analysis of Technical Efficiency and Bank Characteristics**

$$\varphi_{it} = \alpha + \beta_1 SIZE_{it} + \beta_2 PROFITABILITY_{it} + \beta_3 CAPITALISATION_{it} + \beta_4 PROVISION/LOANS_{it} + \beta_5 OVERHEADS_{it} + \varepsilon_{it}$$

The dependent variable is bank's efficiency scores derived from DEA Model 1 and DEA Model 2; *SIZE* is a measure of bank's market share calculated as a natural logarithm of total bank assets; *PROFITABILITY* is a measure of bank's profit calculated as the ratio of net operating income to bank total assets; *CAPITALIZATION* is the bank's specific characteristics measured as the ratio of the amount of share and supplementary capital divided by total assets; *PROVISIONS/LOANS* is a measure of bank's assets quality calculated as the ratio of total loan loss provisions divided by total loans; *OVERHEADS* is a measure of overhead costs calculated as personnel expense over numbers of employees; OE and SE refer to Overall Efficiency and Scale Efficiency respectively. DEA A refers to DEA scores generated from Model 1 and DEA B refers to DEA scores generated from Model 2.

***, **, and * indicate significance at 1, 5 and 10% levels.

Explanatory Variables	**OE**		**SE**	
	DEA A	**DEA B**	**DEA A**	**DEA B**
CONSTANT	0.899***	0.815***	0.899***	0.956***
	(3.282)	(3.880)	(3.282)	(6.257)
Bank Characteristics				
SIZE	0.016	0.043	0.016	0.024
	(0.486)	(1.538)	(0.486)	(1.107)
PROFITABILITY	0.139***	0.024***	0.139***	0.022***
	(9.721)	(3.149)	(9.721)	(3.290)
CAPITALIZATION	0.034***	0.012**	0.034***	0.014***
	(4.879)	(2.436)	(4.879)	(3.482)
PROVISIONS/LOANS	-0.109**	-0.001	-0.109**	-0.008
	(-2.847)	(-0.049)	(-2.847)	(-0.478)
OVERHEADS	1.137	0.706*	1.137	0.660*
	(1.329)	(1.727)	(1.329)	(1.776)
No. of Observations	20	20	20	20
Log likelihood	29.07	34.20	29.07	36.83
R^2	0.90	0.48	0.90	0.64
Adj. R^2	0.84	0.41	0.84	0.33

Note: z-statistics are in parenthesis.