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# Assessing the Impact of Mergers and Acquisitions on Bank Cost Efficiency

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***Abstract*:** The paper examined the impact of forced mergers and acquisitions on the cost efficiency of the Malaysian banking sector. The analysis consisted of three stages. Firstly, by using the Data Envelopment Analysis (DEA) approach, we calculated the cost, allocative, and technical efficiency of individual banks during the period 1997-2003. Secondly, we examined changes in the efficiency of the Malaysian banking sector during the pre- and post-merger periods by using a series of parametric and non parametric univariate tests. Finally, we employed the multivariate Tobit regression analysis to examine factors that influenced the efficiency of the Malaysian banking sector during the pre- and post-merger periods. The empirical findings suggest that the merger has resulted in a higher mean cost efficiency of the Malaysian banking sector post-merger. We found acquirers to have been relatively more cost efficient in all of the seven merger cases analysed. The results from the multivariate regression analysis suggest that loans intensity, size, income diversification, and capitalisation exhibit a positive relationship with bank efficiency. On the other hand, market share and expense preference behaviour were found to be negatively related to bank efficiency levels. The empirical findings suggest that banks in the control group have been relatively more cost efficient than those involved in mergers. The results suggest that the variations in Malaysian bank cost efficiency are not significantly related to economic conditions and concentration.

**Keywords**: Data Envelopment Analysis, Malaysia, mergers and acquisitions, multivariate Tobit regression analysis

## 1. Introduction

The consolidation of the banking sector in Malaysia started relatively later than the merger and acquisition waves in other developed countries. Although incentives had been introduced by the Central Bank to promote mergers and acquisitions particularly among the small domestic banking institutions, it was not until after the economic crisis in 1997 which left many Malaysian banking institutions saddled with high levels of non performing loans that serious and effective step toward this direction were taken leading to the completion of a massive merger exercise at the end of 2000 (Bank Negara Malaysia 1999).

While there have been numerous studies that examined voluntary bank mergers and acquisitions, virtually nothing has been published to examine the effect of forced mergers

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and acquisitions on the efficiency of the acquiring and target banks. Therefore, the case of Malaysia's merger programme offers an opportunity to assess the extent of the impact of government interventions on the efficiency of the banking sector.

The purpose of the this study is to employ the Data Envelopment Analysis (DEA) method to examine the impact of forced mergers and acquisitions on the cost efficiency of the Malaysian banking sector. This paper is different from previous papers that focus on the Malaysian banking sector as it adds insights in several aspects discussed below.

Firstly, we examined for the first time the impact of forced mergers and acquisitions on the efficiency of the Malaysian banking sector. Although a recent study by Sufian (2007) examined the impact of mergers and acquisitions on the efficiency of the Malaysian banking sector, the study only examined the impact of mergers and acquisitions on Malaysian banks' technical, pure technical, and scale efficiency. In contrast, the present study examined the cost efficiency of Malaysian banks and its mutually exhaustive components of technical and allocative efficiencies. While technical (in) efficiency is related to managerial factors, allocative (in) efficiency is often associated with regulatory factors (Isik and Hassan 2002). Within the context of the Malaysian banking sector, it is important to examine this issue as Okuda and Hashimoto (2004) suggest that the management of Malaysian banks is inefficient due to the various forms of government influence and regulations. They suggest that the management of Malaysian banks is unable to pursue managerial efficiency, as they are required by the government to provide loans for specific policy purposes. Thus, it is interesting to examine whether allocative rather than technical efficiency has a greater influence in determining the cost efficiency of the Malaysian banking sector.

Secondly, we ran a series of parametric and non parametric univariate tests to examine the difference in the efficiency of the Malaysian banking sector during the pre- and post-merger periods. We also ran the multivariate Tobit regression analysis to explain the relationship between cost efficiency and bank specific traits such as size, risk, and capitalisation while controlling for other macroeconomic and market condition variables. To the best of our knowledge, no study has been undertaken on such an analysis in respect of the Malaysian banking sector.

In essence, the present paper raises three important fundamental questions: (1) Did the mergers and acquisitions result in higher bank efficiency levels post-merger? (2) Were the acquirers the more efficient banks? (3) What are the factors that significantly explain the variations in Malaysian banks' cost efficiency during the pre- and post-merger periods?

The paper is structured as follows: the next section gives a brief overview of the forced mergers and acquisitions in the Malaysian banking sector. Section 3 reviews the main literature on bank mergers and acquisitions. 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. Forced Bank Mergers and Acquisitions

Financial sector consolidation in Malaysia can be traced back to the early 1990s when the central bank of Malaysia, Bank Negara Malaysia (BNM), introduced a two-tier banking system as an incentive to promote mergers, especially among the small domestic banking institutions. However, the move was unsuccessful in getting the desired results as only a few financial institutions merged to take advantage of the tier-1 banking group status.

There were three mergers instituted during the earlier part of the 1990s: DCB Bank with Kwong Yik Bank[1], DCB Finance with Kwong Yik Finance, and United Overseas Bank with Chung Khiaw Bank, which resulted in both DCB Bank and Kwong Yik Bank being granted the tier-1 institutions status.[2] The smaller banks with tier-2 status had instead augmented their capital to graduate to tier-1 status. Furthermore, to secure sufficient return on capital, several tier-2 banks had also been lending aggressively and, subsequently, suffered great losses during the East Asian financial crisis.

Following the deepening Asian financial crisis in 1997/1998, BNM took stronger measures to force the domestic incorporated banking institutions to merge in a move to minimise the potential impacts of systemic risks on the banking sector as a whole. A new merger plan was announced that called for all domestic banking institutions to form their own merger groups and choose their own leader in each group by end-January 2000. In response to this approach, approval was granted for the formation of 10 banking groups. However, BNM warned that it would still intervene directly to select partners if banks failed to carry through the mergers. The 10 anchor banks were: Malayan Banking Berhad, RHB Bank Berhad, Public Bank Berhad, Bumiputra-Commerce Bank Berhad, Multi-Purpose Bank Berhad, Hong Leong Bank Berhad, Perwira Affin Bank Berhad, Arab-Malaysian Bank Berhad, Southern Bank Berhad, and EON Bank Berhad.

Each bank had a minimum shareholder fund of RM2 billion and an asset base of at least RM25 billion. With the formation of these 10 banking groups, the number of domestic banking institutions was substantially reduced to 29 consisting of 10 commercial banks, 10 finance companies, and 9 merchant banks. Table 1 summarises the post-merger banking institutions as at 30 June 2000.

The merger programme for domestic banking institutions initiated in 1999 was concluded by end 2000. Ten anchor banks emerged having complied with all the requirements of an anchor bank status, such as minimum capitalisation, total asset size, and other prudential requirements. The domestic banking groups then focused on entering the next stage to complete the business integration processes and rationalisation exercises such as branch networks and workforce.

## 3. Literature Review

As surveyed by Berger *et al.* (1999), substantial literature investigates the causes and consequences of bank mergers. Bank mergers and acquisitions may enable banking firms to benefit from new business opportunities created by changes in the regulatory and technological environment. Berger *et al.* (1999:136) pointed out the consequences of mergers and acquisitions such as changes in efficiency, market power, economies of scale and scope, availability of services to small customers and efficiency of payment system. Besides improvements in cost and profit efficiencies, mergers and acquisitions may entail diverging effects on cost and profit efficiency, as well as on loan and deposit pricing, which may lead

[1] Rashid Hussain Bank (RHB) was formed out of a merger between DCB Bank and Kwong Yik Bank as the second largest bank and later agreed to buy Sime Bank, which suffered large losses for the second half-year of 1997.

[2] As of end 1997, 10 commercial banks had been accorded tier-1 status.

**Table 1.** Malaysian banks mergers and acquisitions as at 30 June 2000

| Anchor banks | Banks acquired | Anchor banks total assets as at 30 June '00 RM billion | Post-merger assets RM billion | % of system assets |
|---|---|---|---|---|
| Maybank | The Pacific Bank | 127 | 150 | 24.0 |
| Bumiputra-Commerce Bank | N.A. | 63 | 67 | 10.7 |
| RHB Bank | N.A. | 51 | 56 | 9.0 |
| Public Bank | Hock Hua Bank | 43 | 50 | 8.0 |
| Arab-Malaysian Bank[1] | N.A. | 11 | 39 | 6.2 |
| Hong Leong Bank | Wah Tat Bank | 29 | 35 | 5.6 |
| Multi-Purpose Bank | Sabah Bank | 9 | 14 | 2.2 |
| Affin Bank[2] | BSN Commercial Bank | 15 | 30 | 4.8 |
| Southern Bank | Ban Hin Lee Bank | 24 | 25 | 4.0 |
| EON Bank | Oriental Bank | 14 | 25 | 4.0 |

[1] The merger between Utama Banking group comprising Bank Utama and Utama Merchant Bank with Arab-Malaysian banking group did not proceed due to a disagreement over the ultimate control of the merged entity initially

[2] Another merger that failed to materialise was that of Multi-Purpose Bank and MBf Finance due to Multi-Purpose Bank's minority shareholders balking at the price involved. The Arab-Malaysian Banking Group however acquired MBf Finance from Danaharta.

*Source*: Bank Negara Malaysia

banks to earn higher profits. Prager and Hannan (1998) found that bank mergers and acquisitions results in higher bank concentration, which in turn leads to significantly lower rates on deposits. Some evidence also suggests that U.S. banks involved in mergers and acquisitions improved the quality of their outputs in the 1990s in ways that increased costs, but still improved profit productivity by increasing revenue more than costs (Berger and Mester 2003: 88).

In terms of methodology, empirical literature analysing the effects of consolidation on banks' performance follows two main empirical methods. The majority of studies follow event study-type methodology, often based on changes in stock prices around the period of the announcement of the merger. These studies typically attempt to ascertain whether the announcement of a bank merger creates shareholder value, normally in the form of cumulated abnormal stock market returns for the shareholders of the target, the bidder or the combined entity (see Beitel and Schiereck (2001) for an excellent review).

A second strand of literature measures the impact of financial integration on bank performance via accounting ratios of performance (such as the return on assets, return on equity, etc.) or productive efficiency indicators (such as indicators of cost, profit, or technical efficiency). The potential for scale economies is often one of the main reasons given by practitioners to justify mergers and acquisitions. However, the majority of U.S. studies found that these potential efficiency gains resulting from size rarely materialise after the

merger (Berger *et al.* 1999). A possible reason could be that some efficiency gains may take longer to accrue such as the benefits derived from cost reductions or scope economies.

In regard to the frontier efficiency techniques, two main approaches are commonly used to assess the impact of mergers and acquisitions on bank efficiency, namely the parametric and non parametric approaches. The parametric approach on one hand comprises three major approaches, namely the Stochastic Frontier Approach (SFA), the Distribution Free Approach (DFA), and the Thick Frontier Approach (TFA), while Data Envelopment Analysis (DEA) and Free Disposal Hull (FDH) are non parametric approaches. While both techniques require the specification of a cost or production function or frontier, the former involves the specification and econometric estimation of a statistical or parametric function/ frontier while the non parametric approach provides a piecewise linear frontier by enveloping the observed data points.

The DEA method has been widely applied in the empirical estimation of financial institutions, health care, and education sectors' efficiency worldwide. Notwithstanding, the technique has increasingly been the preferred method to investigate the impact of mergers and acquisitions on bank efficiency, in particular if the sample size is small. Previous studies undertaken to analyse a small number of mergers and acquisitions include among others Avkiran (1999), Liu and Tripe (2002), Sufian and Majid (2007) and Sufian (2007).

By employing the DEA method to a small sample of 16 to 19 Australian banks during the period of 1986-1995, Avkiran (1999) investigated the effects of four bank mergers on efficiency and the benefits to the public. He adopted the intermediation approach and two DEA models. The results suggest that the acquiring banks are relatively more efficient than the target banks. He found that the acquiring banks did not always maintain their pre-merger efficiency, but that, during the deregulated period, technical efficiency, employees' productivity and return on assets (ROA) improved. The evidence is inconclusive to the extent to which the benefits of efficiency gains from mergers are passed on to the public.

Liu and Tripe (2002) examined the efficiency of 6 bank mergers in New Zealand. By using accounting ratios and two DEA models to a small sample of 7 to 14 banks between 1989 and 1998, they found the acquiring banks to be generally larger than their targets, although they had not been consistently more efficient. Their results found that five of the six merged banks exhibited efficiency gains based on the financial ratios, while another achieved a slight improvement in operating expenses to average total income. Based on the DEA analysis, they found that only some banks had been relatively more efficient than the target banks during the pre-merger period. The results suggest that four banks exhibited obvious efficiency gains post-merger. However, they could not decisively conclude on the possible benefits of the mergers to the public.

Sufian and Majid (2007) employed the Data Envelopment Analysis (DEA) approach to a small sample size of 6 banks and examined the effects of mergers and acquisitions on the Singapore domestic banking groups' efficiency. They followed a variant of the intermediation approach to two models to detect any efficiency gains (loss) resulting from the mergers and acquisitions. The results from both models found that the merger had resulted in a higher mean technical efficiency of the Singapore banking groups post merger. They did not find evidence of more efficient acquirers compared to the targets, as the findings from both models suggest that both the targets had been relatively more efficient than the acquirers. The empirical results further supported the hypothesis that the acquiring banks' mean

technical efficiency improved during the post-merger period resulting from the merger with a more efficient bank.

More recently, Sufian (2007) examined the effects of mergers and acquisitions on Malaysian banks' technical and scale efficiency. The results suggest that the merger had resulted in a higher mean technical efficiency of the Malaysian banking sector post merger. The empirical findings suggest that the acquirers had been relatively more technically efficient in five out of the seven merger cases analysed. The empirical findings also suggest that the acquiring banks' mean technical efficiency improved (deteriorated) from the merger with a more (less) efficient bank in five out of the seven merger cases analysed.

## 4. Methodology and Choice of Variables

*4.1 Data Envelopment Analysis*

The non parametric Data Envelopment Analysis (DEA) method was employed with variable returns to scale (VRS) assumption, to measure input-oriented cost efficiency of Malaysian banks. DEA involved constructing a non parametric production frontier based on the actual input-output observations in the sample relative to which efficiency of each bank in the sample was measured (Coelli 1996). To discuss DEA in more technical terms, let us assume that there is data on $K$ inputs and $M$ outputs for each $N$ bank. For the $i$th bank, these are represented by the vectors $x_i$ and $y_i$ respectively. According to Charnes *et al.* (1978), the input-oriented measure of a particular bank is calculated as:

$$\begin{aligned} &\min \theta, \\ &\theta, \lambda \\ &y_i + Y\lambda \geq 0 \\ &\theta x_i - X\lambda \geq 0 \\ &\lambda \geq 0 \end{aligned} \qquad (1)$$

where $\theta$ is a scalar representing the value of the efficiency score for the $i$th bank which will range between 0 and 1, $\lambda$ is a vector of $N$ x 1 constants. The linear programming has to be solved $N$ times, once for each bank in the sample. In order to calculate efficiency under the assumption of VRS, the convexity constraint ($N1'\lambda$-1) will be added. 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 (CRS) case.

Next, in order to estimate cost efficiency, the objective function of the programme is altered to capture total bank costs (Fare *et al.* 1985). The linear programme is specified as:

$$\begin{aligned} &\min w_i' x_i \\ &x_i, \lambda_i \\ &\text{subject to } y_i \leq Y\lambda_i \\ &x_i \leq X\lambda_i \\ &\text{and } \lambda_i \geq 0 \end{aligned} \qquad (2)$$

Letting $x^*_i$ be the cost minimising vector of input for bank $i$, cost efficiency (CE) is given by $CE_i = w_i' x^*_i / w_i' x_i$. Given estimates of $CE$ and technical efficiency (TE), allocative efficiency (AE) is estimated by the ratio $AE_i = CE_i/TE_i$. The solution of the cost efficiency programme provides the cost minimising input vector conditional on the observed technology in the

sample. If the ratio $x_{ik}=x^*_{ik}<1$, the bank is under utilising input $k$; and if $x_{ik}=x^*_{ik}>1$, the bank is over utilising input $k$.

Allocative efficiency represents how optimally input factors are mixed to minimise total input costs given output quantity and input prices. Firms achieve cost efficiency by adopting the best practice technology (becoming technically efficient) and choosing the optimal mix of input (becoming allocatively efficient), conditional on output and input prices. Technical efficiency for a given bank is defined as the ratio of the input usage of a fully efficient bank producing the same output vector to the input usage of the bank under consideration (Fare *et al.* 1985).

*4.2 Multivariate Tobit Regression Analysis*

As defined in Equations 1 and 2, the DEA score falls between the intervals 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 (in) efficiency measures and thus yield results that can provide important policy guidelines to improve performance (Coelli *et al.* 1998). The standard Tobit model can be defined as follows for observation (bank) *i*:

$$y_i^* = \beta' x_i + \varepsilon_i$$

$$y_i = y_i^* \text{ if } y_i^* \geq 0$$

$$\text{and } y_i = 0 \text{ otherwise} \qquad (3)$$

where $x_i$ is a vector of explanatory variables and $\hat{a}$ is the set of parameters to be estimated, $\varepsilon_i \sim N(0, \sigma^2)$ denotes the error term, $y_i^*$ is a latent variable, and $y_i$ is the efficiency score obtained from the DEA model.[3]

By using the cost efficiency scores as the dependent variable, we estimated the following model:

$$\gamma_{jt}=\beta_0+\beta_1\Sigma Characteristics+\zeta_2\Sigma Econ+\varepsilon_{jt} \qquad (4)$$

where $\gamma_{jt}$ is the cost efficiency of the *j*th bank in period *t* obtained from the DEA model, *Characteristics* is a set of bank specific traits variables, and *Econ* is a vector of economic and market conditions.

*4.3 Data and Construction of Variables*

We used annual bank level data of all Malaysian commercial banks covering the period 1997-2003. The variables were collected from published balance sheet information in annual

[3] The likelihood function ($L$) is maximised to solve $\beta$ ? and $\sigma$ based on 193 observations (banks) of $y_i$ and $x_i$ is $L=\prod_{y_i=0}(1-F)\prod_{y_i>0}\frac{1}{(2\Pi\sigma^2)^{1/2}}\times e^{-\{1/(2\sigma^2)\}(y^i-\beta x_i)^2}$ where, $F_i=\int_{-\infty}^{\beta x_i/\sigma}\frac{1}{(2\Pi)^{1/2}}e^{-t^2/2}dt$

The first product is over the observations for which the banks are 100 per cent 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 $\beta' x_i/\sigma$.

reports of each individual bank, while the macroeconomic variables were sourced from various issues of Bank Negara Malaysia's annual reports. The total number of commercial banks operating in Malaysia varied from 33 banks in 1997 to 22 banks in 2003 due to entry and exit of banks during the past decade. This gave us a total of 193 bank year observations. The sample represented the whole gamut of the industry's total assets.

As in most recent studies, (e.g. Isik and Hassan 2002; Pasiouras 2008), we adopted the intermediation approach. Accordingly, three inputs and three output variables were chosen. The input vectors used were (X1) Total Deposits, (X2) Capital, and (X3) Labour, while, (Y1) Total Loans, (Y2) Investments, and (Y3) Non Interest Income were the output vectors. To measure cost and allocative efficiencies, the input prices were (P1) Price of Deposits, (P2) Price of Labour, and (P3) Price of Capital. The summary of data used to construct the efficiency frontiers are presented in Table 2.

The bank specific variables included in the second stage multivariate regression models were LNDEPO (log of total deposits), LOANS/TA (total loans divided by total assets), LNTA (log of total assets), LLP/TL (loans loss provisions divided by total loans), NII/TA (non-interest income divided by total assets), NIE/TA (total overhead expenses divided by total assets), and EQASS (book value of stockholders' equity as a fraction of total assets). To examine the relationship between cost efficiency and the acquiring banks, a binary dummy variable DUMACQ was included in regression model 2. A binary variable CON_GRP was included in regression model 3 to examine the relationship between cost efficiency and banks not involved in any merger during the years under study. To measure the relationship between economic and market specific factors and bank efficiency, LNGDP, PRE_MER, POST_MER, and CR_3 were used. The independent variables and their hypothesised relationship with efficiency are detailed in Table 3

Our data covered the registered mergers and acquisitions that took place in the Malaysian banking sector during the year 2000. To be included in the sample, both the target and the acquiring banks must not have been involved in other mergers in the three years prior to the merger. In addition to the banks that were involved in mergers and acquisitions during the study period, we also included 19 other domestic and foreign banks that had not been involved in any mergers and acquisitions during the years as a control group in the analysis. In the study population, seven major mergers and acquisitions were analysed:

*Case 1* : Affin Bank Berhad acquisition of BSN Commercial Bank Berhad.
*Case 2* : Alliance Bank Berhad acquisition of Sabah Bank Berhad.
*Case 3* : EON Bank Berhad acquisition of Oriental Bank Berhad.
*Case 4* : Hong Leong Bank Berhad acquisition of Wah Tat Bank Berhad.
*Case 5* : Maybank Berhad acquisition of The Pacific Bank in Berhad.
*Case 6* : Public Bank Berhad acquisition of Hock Hua Bank Berhad.
*Case 7* : Southern Bank Berhad acquisition of Bank Hin Lee Bank Berhad.

## 5. Empirical Results

In the spirit of Rhoades (1998), we developed a [-3, 3] event window, to investigate the effect of mergers and acquisitions on Malaysian bank efficiency. The choice of the event window was motivated by Rhoades (1998:278) who pointed out that there has been

**Table 2.** Descriptive statistics for inputs, outputs, and input prices (million RM)

| | Y1 | Y2 | Y3 | X1 | X2 | X3 | P1 | P2 | P3 |
|---|---|---|---|---|---|---|---|---|---|
| Min | 53,411.00 | 205.00 | 14.00 | 131,352.00 | 1,248.00 | 1,898.00 | 0.005 | 0.002 | 0.009 |
| Mean | 12,335.73 | 3,767,524.55 | 180,873.30 | 888,037.68 | 184,255.20 | 152,612.30 | 0.056 | 0.008 | 0.252 |
| Max | 109,070.50 | 36,423.40 | 1,800,718.00 | 137,864.10 | 1,417,961.00 | 1,419,973.00 | 1.461 | 0.019 | 7.340 |
| S.D | 5,790.82 | 2,346,414.05 | 80,638.77 | 6,551.73 | 61,636.41 | 78,243.08 | 0.084 | 0.001 | 0.411 |

*Notes*: Y1: Loans (includes loans to customers and other banks), Y2: Investments (includes dealing and investment securities), Y3: Non Interest Income (defined as fee income and other non interest income, which among others consist of commission, service charges and fees, guarantee fees, and foreign exchange profits), X1: Total Deposits (includes deposits from customers and other banks), X2: Capital (measured by the book value of property, plant, and equipment), X3: Personnel Expenses (inclusive of total expenditure on employees such as salaries, employee benefits and reserve for retirement pay)[4], P1: Price of Deposits (interest expense divided by total deposits), P2: Price of Labour (personnel expenses divided by total assets), P3: Price of Capital (capital cost and depreciation divided by fixed assets).

*Source*: Banks annual reports and authors own calculations

[4] As data on the number of employees are not readily made available, personnel expenses have been used as a proxy measure.

**Table 3**. Description of variables used in regression models

| Variable | Description | Hypothesised relationship with efficiency |
|---|---|---|
| | Bank characteristics | |
| LOANS/TA | Total loans over total assets | +/- |
| LNTA | Natural logarithm of total assets | +/- |
| LLP/TL | Loan loss provisions over total loans | - |
| NII/TA | Non interest income over total assets | + |
| NIE/TA | Non interest expense over total assets | - |
| EQASS | Total book value of shareholders equity over total assets | +/- |
| DUMACQ | Binary variable that takes a value of 1, if a bank is an acquiring bank, 0 otherwise. | +/ |
| CON_GRP | Binary variable that takes a value of 1, if a bank is not involved in any merger during the years, 0 otherwise. | +/ |
| | Economic/ Market conditions | |
| LNGDP | Natural logarithm of gross domestic products | +/- |
| CR_3 | Proxy for concentration in terms of assets of three largest banks. | +/- |
| PRE-MER | Binary variable that takes a value of 1 for pre- merger years, 0 otherwise. | +/ |
| POST_MER | Binary variable that takes a value of 1 for post- merger years, 0 otherwise. | +/ |

unanimous agreement among the experts that about half of any efficiency gains should be apparent after one year and all gains should be realised within three years after the merger. The whole period (i.e. 1997-2003) was divided into three sub-periods: 1997-1999 refers to the pre-merger period, 2000 is considered the merger year, and 2001-2003 represents the post-merger period, when the mergers and acquisitions are expected to have some impact on Malaysian bank efficiency. We expected to capture the effects of mergers and acquisitions on the efficiency of Malaysian banks during this period. During all periods the targets and acquirers' mean cost efficiency along with its decomposition of allocative and technical efficiency scores were compared. This could help shed some light on the sources of inefficiency of the Malaysian banking system in general, as well as to differentiate between the targets' and acquirers' efficiency scores. To allow (in) efficiency to vary over time, the efficiency frontiers were constructed for each year by solving the linear programming (LP) problems rather than constructing a single multi-year frontier.

*5.1 Did the Mergers and Acquisitions Result in Higher Bank Efficiency Levels?*

Table 4 illustrates the CE estimates, along with its decomposition into AE and TE. It is apparent that during the pre-merger period Malaysian banks exhibited a mean CE of 83.5 per cent. Overall, the results suggest that the Malaysian banking system had performed relatively well in its basic function – transforming deposits to loans, with a relatively minimal input waste of 16.5 per cen. Thus, the results imply that during the pre merger period Malaysian banks could have produced the same amount of outputs with only 83.5 per cent of the amount of inputs used. In other words, Malaysian banks could have reduced their inputs by 16.5per cent and still produced the same amount of outputs. The decomposition of CE into its AE and TE estimates suggest that during the pre-merger period, the inefficiency of the Malaysian banking sector was largely due to TE (42.6%) rather than AE (4.9%). While technical (in) efficiency is related to managerial factors, allocative (in) efficiency is often associated with regulatory factors (Isik and Hassan 2002). Thus, the results imply that during the pre-merger period the cost of inefficiency in the Malaysian banking sector was largely due to managerial practices rather than regulatory forbearance.

During the post-merger period, the findings suggest that the merger had resulted in the improvement of Malaysian banking sector's CE. It is apparent from Table 4 that the Malaysian banks exhibited a mean CE of 86.9 per cent during the post-merger period, higher than the 83.5 per cent recorded during the pre-merger period. A closer look at the decomposition of CE into its AE and TE components reveals that the improvement in CE during the post merger period was mainly attributed to the improvement in TE. It is also interesting to note that despite earlier evidence implying that the lack of competition may resulted in lower TE (see Sathye 2001), it is apparent from Table 4 that all Malaysian banks reported a higher mean TE score during the post-merger period.

To examine the difference in the efficiency of the acquiring banks between the two periods, that is, before and after the mergers, we performed a series of parametric ($t$-test) and non parametric (Mann-Whitney [Wilcoxon]) and Kruskal-Wallis tests. The results are presented in Table 5. The results from the parametric $t$-test support the findings that the Malaysian banking sector exhibited a higher mean CE post- merger ($0.83328 < 0.86530$), but was not statistically significant at any conventional level. The decomposition of the CE into its AE and TE components suggest that the improvement in the Malaysian banking sector's

**Table 4.** Summary of mean efficiency levels of Malaysian banks

| Bank | ABB | Pre-merger* | | | During merger** | | | Post-merger*** | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | CE | AE | TE | CE | AE | TE | CE | AE | TE |
| Affin Bank | AFF | 0.883 | 0.972 | 0.533 | 0.764 | 0.920 | 0.836 | 0.792 | 0.927 | 0.853 |
| Alliance Bank | ALB | 0.914 | 0.988 | 0.539 | | | | 0.869 | 0.978 | 0.888 |
| Arab Malaysian Bank | AMB | 0.916 | 0.916 | 0.855 | 0.971 | 0.971 | 1.000 | 0.846 | 0.971 | 0.871 |
| Ban Hin Lee Bank | BHL | 0.759 | 0.959 | 0.413 | | | | | | |
| Bumiputra-Commerce Bank | BCB | 0.975 | 0.975 | 0.741 | 0.801 | 0.965 | 0.831 | 0.850 | 0.973 | 0.873 |
| Bank Utama | BUB | 0.884 | 0.961 | 0.411 | 0.912 | 0.988 | 0.923 | 0.966 | 0.966 | 1.000 |
| BSN Commercial Bank | BSN | 0.683 | 0.780 | 0.591 | | | | | | |
| EON Bank | EON | 0.903 | 0.966 | 0.517 | 0.850 | 0.973 | 0.874 | 0.925 | 0.895 | 0.842 |
| Hock Hua Bank (Sabah) | HHS | 0.398 | 0.916 | 0.281 | | | | | | |
| Hock Hua Bank | HHB | 0.733 | 0.987 | 0.355 | | | | | | |
| Hong Leong Bank | HLB | 0.895 | 0.981 | 0.462 | 0.915 | 0.915 | 0.754 | 0.721 | 0.920 | 0.786 |
| Maybank | MBB | 0.998 | 0.998 | 0.519 | 0.823 | 0.948 | 0.870 | 0.879 | 0.969 | 0.907 |
| Oriental Bank | OBB | 0.840 | 0.988 | 0.450 | | | | | | |
| Phileo Allied Bank | PAB | 0.796 | 0.950 | 0.609 | | | | | | |
| Public Bank | PBB | 0.959 | 0.990 | 0.428 | 0.700 | 0.932 | 0.755 | 0.785 | 0.955 | 0.822 |
| RHB Bank | RHB | 0.995 | 0.995 | 0.617 | 0.890 | 0.947 | 0.944 | 0.895 | 0.961 | 0.930 |
| Sabah Bank | SBH | 0.599 | 0.986 | 0.378 | | | | | | |
| Southern Bank | SBB | 0.916 | 0.964 | 0.492 | 0.835 | 0.950 | 0.880 | 0.871 | 0.926 | 0.942 |
| Pacific Bank | PAC | 0.758 | 0.984 | 0.423 | | | | | | |
| Wah Tat Bank | WTB | 0.523 | 0.969 | 0.309 | | | | | | |
| ABN-Amro Bank | ABN | 0.587 | 0.843 | 0.580 | 0.693 | 0.945 | 0.791 | 0.843 | 0.896 | 0.942 |
| Bangkok Bank | BBB | 0.738 | 0.849 | 0.453 | 0.568 | 0.972 | 0.586 | 0.958 | 0.988 | 0.969 |
| Bank of America | BOA | 0.544 | 0.794 | 0.536 | 0.352 | 0.522 | 0.957 | 0.788 | 0.954 | 0.826 |

Continued on next page

Table 4. Continued

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Bank of Nova Scotia | BNS | 1.000 | 1.000 | 1.000 | 0.875 | 0.875 | 1.000 | 0.751 | 0.911 | 0.831 |
| Bank of Tokyo | BOT | 0.944 | 0.944 | 0.903 | 0.951 | 0.951 | 1.000 | 0.947 | 0.947 | 1.000 |
| Citibank | CIT | 0.891 | 0.988 | 0.628 | 0.922 | 0.971 | 0.949 | 0.985 | 0.985 | 1.000 |
| Deutsche Bank | DEU | 0.784 | 0.784 | 0.877 | 0.816 | 0.816 | 1.000 | 0.963 | 0.992 | 0.971 |
| Hongkong Bank | HBB | 0.952 | 0.994 | 0.475 | 0.627 | 0.948 | 0.665 | 1.000 | 1.000 | 1.000 |
| JP Morgan Chase | JPM | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 0.816 | 0.968 | 0.843 |
| OCBC Bank | OCB | 0.989 | 0.995 | 0.593 | 0.861 | 0.945 | 0.914 | 0.759 | 0.941 | 0.805 |
| OUB Bank | OUB | 0.959 | 0.998 | 0.825 | 1.000 | 1.000 | 1.000 | 0.892 | 0.972 | 0.916 |
| Standard Chartered Bank | SCB | 0.996 | 0.996 | 0.549 | 0.909 | 0.952 | 0.955 | 0.887 | 0.975 | 0.909 |
| UOB Bank | UOB | 0.860 | 0.962 | 0.609 | 0.799 | 0.923 | 0.870 | 0.858 | 0.940 | 0.916 |
| **Mean** | | **0.835** | **0.951** | **0.574** | **0.819** | **0.927** | **0.885** | **0.869** | **0.955** | **0.870** |

* 1997-1999; ** 2000; *** 2001-2003

CE – Cost Efficiency; AE –Allocative Efficiency; TE – Technical Efficiency

CE post merger is mainly attributed to a higher TE (0.57555 < 0.89896) and is statistically significant at the 1 per cent level. The results from the parametric *t*-test were further confirmed by the non parametric Mann-Whitney [Wilcoxon] and Kruskal-Wallis tests. On the other hand, it is clear that the Malaysian banking sector also exhibited a higher AE during the post-merger period (0.95000 < 0.95376), but was not statistically significant at any conventional level. However, both the non parametric Mann-Whitney [Wilcoxon] and Kruskal-Wallis tests suggest that the difference is statistically significant at the 5 per cent level ($z$ statistics and $\chi^2 = 0.038$). Thus, we conclude that the Malaysian banking sector exhibited a higher CE during the post-merger period mainly attributed to improvements in TE.

*5.2 Are the Acquirers the More Efficient Banks?*

We now turn to the assessment of how the mergers and consolidation process affected the CE of the involved banks. First, the pre-merger performance of the banks concerned was analysed. Theoretically, the more efficient banks should acquire the less efficient ones. A more efficient bank is assumed to be well organised, and has a more capable management.

**Table 5**. Summary of parametric and non-parametric tests

| | Test groups | | | | | |
|---|---|---|---|---|---|---|
| | Parametric test | | Non parametric tests | | | |
| Individual tests | *t*-test | | Mann-Whitney [Wilcoxon Rank-Sum] test | | Kruskall-Wallis Equality of Populations test | |
| Hypotheses | $Median_{Pre\ Merger} = Median_{Post\ Merger}$ | | | | | |
| Test statistics | $t$ (Prb > $t$) | | $z$ (Prb > $z$) | | $\chi^2$ (Prb > $\chi^2$) | |
| | Mean | $t$ | Mean rank | $z$ | Mean rank | $\chi^2$ |
| Cost efficiency (CE) | | | | | | |
| Pre-merger | 0.83328 | | 83.80 | | 83.80 | |
| Post-merger | 0.86530 | -1.237 | 84.28 | -0.064 | 84.28 | 0.004 |
| Allocative efficiency (AE) | | | | | | |
| Pre-merger | 0.95000 | | 90.55 | | 90.55 | |
| Post-merger | 0.95376 | -0.284 | 74.93 | -2.075** | 74.93 | 4.306** |
| Technical efficiency (TE) | | | | | | |
| Pre-merger | 0.57555 | | 58.64 | | 58.64 | |
| Post-merger | 0.89896 | -11.261*** | 119.14 | -8.013*** | 119.14 | 64.203*** |

*Note:* Test methodology follows among others, Aly *et al.* (1990), Elyasiani and Mehdian (1992), and Isik and Hassan (2002).

***, **, * indicates significance at the 0.01%, 0.05%, and 0.10% levels respectively

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 that banks that are more efficient acquire the inefficient ones, we calculated the difference in the cost efficiency between the acquiring and the acquired banks. This efficiency difference was measured as the mean CE of the acquiring banks, minus the mean CE of the acquired banks for the last observation period before consolidation.

It is clear from Table 6 that during the pre-merger period, in all of the seven merger cases analysed, the acquirers were relatively more cost efficient compared to the targets. In the next step, we again performed a series of parametric (*t*-test) and non parametric (Mann-Whitney [Wilcoxon] and Kruskal-Wallis tests to verify the difference between the acquirers' and targets' efficiencies. The results are presented in Table 7. The results seem to suggest that the acquirers were relatively more cost efficient (0.92395 > 0.69910) and this is statistically

**Table 6.** Summary of mean efficiency levels of targets and acquirers banks

| Bank | Target/ Acquirer | Acquirer more efficient than target | Pre-merger | | |
|---|---|---|---|---|---|
| | | | CE | AE | TE |
| | | | **AFF + BSN** | | |
| Affin Bank | Acquirer | **YES** | 0.883 | 0.972 | 0.533 |
| BSN Commercial Bank | Target | | 0.683 | 0.780 | 0.591 |
| | | | **ALB + SBH** | | |
| Alliance Bank | Acquirer | **YES** | 0.914 | 0.988 | 0.539 |
| Sabah Bank | Target | | 0.599 | 0.986 | 0.378 |
| | | | **EON + OBB** | | |
| EON Bank | Acquirer | **YES** | 0.903 | 0.966 | 0.517 |
| Oriental Bank | Target | | 0.840 | 0.988 | 0.450 |
| | | | **HLB + WTB** | | |
| Hong Leong Bank | Acquirer | **YES** | 0.895 | 0.981 | 0.462 |
| Wah Tat Bank | Target | | 0.523 | 0.969 | 0.309 |
| | | | **MBB + PAC** | | |
| Maybank | Acquirer | **YES** | 0.998 | 0.998 | 0.519 |
| Pacific Bank | Target | | 0.758 | 0.984 | 0.423 |
| | | | **PBB + HHB** | | |
| Public Bank | Acquirer | **YES** | 0.959 | 0.990 | 0.428 |
| Hock Hua Bank | Target | | 0.733 | 0.987 | 0.355 |
| | | | **SBB + BHL** | | |
| Southern Bank | Acquirer | **YES** | 0.916 | 0.964 | 0.492 |
| Bank Hin Lee Bank | Target | | 0.759 | 0.959 | 0.413 |

CE – Cost Efficiency; AE –Allocative Efficiency; TE – Technical Efficiency
Font in bold indicates banking group that is relatively more efficient

significant at the 1 per cent level ($p$-value = 0.000), mainly attributed to a higher TE (0.49852 > 0.41695) and is statistically significant at the 5 per cent level ($p$-value = 0.015). The target banks were also found to be relatively less allocatively efficient compared to the acquiring banks (0.97981 > 0.95029) although this was not statistically significant at any conventional level. The $t$-test results were further confirmed by the results derived from the Mann-Whitney [Wilcoxon] and Kruskal-Wallis tests. We therefore can conclude that the acquiring banks were relatively more cost efficient compared to the target banks, mainly attributed to a higher technical efficiency.

*5.3 Determinants of Bank Efficiency*

Regression results focusing on the relationship between bank efficiency and the explanatory variables are presented in Table 8. The equations are based on 193 bank year observations during the period 1997-2003. As pointed out by Saxonhouse (1976), heteroscedasticity can emerge when estimated parameters are used as dependent variables in the second stage analysis. Thus, following Hauner (2005) and Pasiouras (2008) among others, QML (Huber/

**Table 7.** Summary of parametric and non-parametric tests

| | Test Groups | | | | | |
|---|---|---|---|---|---|---|
| | Parametric test | | Non parametric test | | | |
| Individual tests | $t$-test | | Mann-Whitney [Wilcoxon Rank-Sum] test | | Kruskall-Wallis Equality of Populations test | |
| Hypotheses | | | $\text{Median}_{\text{Pre-merger}} = \text{Median}_{\text{Post-merger}}$ | | | |
| Test statistics | | | | | | |
| | $t$ (Prb > $t$) | | $z$ (Prb > $z$) | | $\chi^2$ (Prb > $\chi^2$) | |
| | Mean | $t$ | Mean rank | $z$ | Mean rank | $\chi^2$ |
| Cost Efficiency (CE) | | | | | | |
| Acquiring Banks | 0.92395 | -6.137*** | 30.74 | -4.897*** | 30.74 | |
| Target Banks | 0.69910 | | 12.26 | | 12.26 | 23.980*** |
| Allocative Efficiency (AE) | | | | | | |
| Acquiring Banks | 0.97981 | -1.348 | 24.02 | -1.338 | 24.02 | 1.790 |
| Target Banks | 0.95029 | | 18.98 | | 18.98 | |
| Technical Efficiency (TE) | | | | | | |
| Acquiring Banks | 0.49852 | -2.546** | 25.93 | -2.340** | 25.93 | 5.474** |
| Target Banks | 0.41695 | | 17.07 | | 17.07 | |

Note: Test methodology follows among others, Aly *et al.* (1990), Elyasiani and Mehdian (1992), and Isik and Hassan (2002).

***, **, * indicates significance at the 0.01%, 0.05%, and 0.10% levels respectively

White) standard errors and covariates were calculated. Several general comments regarding the test results are warranted. The model performs reasonably well in at least two respects. For one, results for most variables remain stable across the various regressions tested. Secondly, the findings suggest that all explanatory variables have the expected signs and in most cases are statistically different from zero.

In models 2 and 3 regressions, when we add the other group of variables to the baseline specification that include the bank specific attribute variables, the coefficients of the baseline variables stay mostly the same: they keep the same sign, the same order of magnitude, they remain significant as they were so in model 1 regressions (albeit sometimes at different levels), and with a few exceptions, do not become significant if they were not in model 1 regressions. Therefore, for models 2 and 3 regressions, we will only discuss the results of the new variables added to the baseline specification.

The proxy for market power, LNDEPO revealed a negative relationship and was statistically significant at the 1 per cent level, suggesting that the more cost efficient banks are associated with banks with a lower market share. On the other hand, LOANS/TA revealed a positive relationship and was statistically significant at the 1% level. The findings imply that banks with higher loans-to-asset ratios tend to have higher cost efficiency scores. Thus, bank loans seem to be more highly valued than alternative bank outputs, that is, investments and securities. Likewise, LNTA shows positive coefficients suggesting that the larger the bank, the more efficient the bank will be, purely because of the economies of scale arguments. Hauner (2005) offers two potential explanations for which size could have a positive impact on bank efficiency. First, if it relates to market power, large banks should pay less for their inputs. Second, there may be increasing returns to scale through the allocation of fixed costs (e.g. research or risk management) over a higher volume of services or from efficiency gains from a specialised workforce. Thus, assuming that the average cost curve for Malaysian banks is U-shaped, the recent growth policies of the small and medium Malaysian banks seem to be consistent with cost minimisation.

The coefficient of LLP/TL entered all regression models with a positive sign, which is in consonance with Berger and DeYoung's (1997) *skimping* hypothesis. To recap, Berger and DeYoung (1997) suggests that under the *skimping* hypothesis, a bank maximising long- run profits may rationally choose to have lower costs in the short run by skimping on the resources devoted to underwriting and monitoring loans, but bear the consequences of greater loan performance problems. Similarly, the empirical findings seem to suggest that NII/TA had consistently exhibited strong positive and significant relationship with CE. The elasticity and CE with respect to NII/TA was quite high and was statistically significant at the 1 per cent level. The results imply that banks tend to become more efficient as they increase their income from non interest sources.

The results seem to suggest that NIE/TA consistently exhibited a negative relationship with bank efficiency and was statistically significant at the 1 per cent level. This finding is in consonance with the *bad management* hypotheses of Berger and DeYoung (1997). Low measure of cost efficiency is a signal of poor senior management practices, which apply to input-usage and day-to-day operations. Clearly, efficient cost management is a prerequisite for the improved efficiency of the Malaysian banking system, that is, the high elasticity of cost efficiency to this variable denotes that banks have much to gain if they improve their managerial practices.

**Table 8**. Multivariate Tobit regression analysis

| | Model 1 | Model 2 | Model 3 |
|---|---|---|---|
| CONSTANT | 0.033503 | 0.555323 | 2.851602 |
| | (0.024409) | (0.296216) | (1.398936) |
| Bank characteristics | | | |
| LNDEPO | -0.132731*** | -0.133582*** | -0.142583*** |
| | (-3.170883) | (-3.191900) | (-3.796337) |
| LOANS/TA | 0.384778*** | 0.384370*** | 0.382405*** |
| | (3.643812) | (3.641999) | (3.751492) |
| LNTA | 0.187428*** | 0.189415*** | 0.198570*** |
| | (4.122873) | (4.188661) | (4.854654) |
| LLP/TL | 0.576919*** | 0.566038** | 0.562391** |
| | (2.100929) | (2.074357) | (2.130303) |
| NII/TA | 9.804759*** | 9.699273*** | 8.573176*** |
| | (6.839889) | (6.819815) | (6.454208) |
| NIE/TA | -10.30275*** | -10.26364*** | -9.171609*** |
| | (-5.572294) | (-5.543964) | (-5.203553) |
| EQASS | 0.523860*** | 0.520757*** | 0.445261*** |
| | (3.467039) | (3.479499) | (2.993309) |
| DUMACQ | | -0.010251 | |
| | | (-0.568562) | |
| CON_GRP | | | 0.054468*** |
| | | | (3.198932) |
| Economic/ Market conditions | | | |
| LNGDP | -0.054484 | -0.097765 | -0.339190 |
| | (-0.356242) | (-0.538183) | (-1.545575) |
| CR_3 | 0.005531 | 0.004198 | 0.010315) |
| | (0.601277) | (0.419263) | (1.006072 |
| PRE_MER | | -0.012026 | |
| | | (-0.384468) | |
| POST_MER | | | 0.045627* |
| | | | (1.724996) |
| Log likelihood | 136.1750 | 136.3407 | 142.3594 |
| $R^2$ | 0.458806 | 0.459735 | 0.492401 |
| Adj. $R^2$ | 0.429070 | 0.423717 | 0.458562 |
| No. of observations | 193 | 193 | 193 |

Table 8. Continued

$$\gamma_{it} = \alpha + \beta_1 \text{LNDEPO} + \beta_2 \text{LOANS/TA} + \beta_3 \text{LNTA} + \beta_4 \text{LLP/TL} + \beta_5 \text{NII/TA} + \beta_6 \text{NIE/TA} + \beta_7 \text{EQASS} + \beta_8 \text{DUMACQ} + \beta_9 \text{CON_GRP} + \zeta_{10} \text{LNGDP} + \zeta_{11} \text{CR_3} + \zeta_{12} \text{PRE_MER} + \zeta_{13} \text{POST_MER} + \varepsilon_j$$

The dependent variable is bank's cost efficiency scores derived from the DEA. LNDEPO is a measure of bank's market share calculated as a natural logarithm of total deposits. LOANS/TA is a measure of loans intensity calculated as the ratio of total loans to total bank assets. LNTA is a proxy measure of bank size measured as the natural logarithm of total bank assets. LLP/TL is a proxy measure of risk calculated as the ratio of total loan loss provisions divided by total loans. NIE/TA is a measure of bank management quality calculated as total non interest expenses divided by total assets. NII/TA is a measure of bank's diversification towards non interest income, calculated as total non interest income divided by total assets. EQASS is a measure of capitalisation measured by banks' total shareholders' equity divided by total assets. LNGDP is natural logarithm of gross domestic product. DUMACQ is a binary variable that takes a value of 1 if a bank is an acquiring bank, 0 otherwise. CON_GRP is a binary variable that takes a value of 1 if a bank is not involved in any merger during the years, 0 otherwise. CR_3 is the 3 bank concentration ratio. PRE_MER is a binary variable that takes a value of 1 for the pre-merger years, 0 otherwise. POST_MER is binary variable that takes a value of 1 for the post-merger years, 0 otherwise.

Values in parentheses are z-statistics

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

EQASS exhibited a positive relationship with bank cost efficiency in all regression models. The empirical findings seem to suggest that the more cost efficient banks, *ceteris paribus*, use less leverage (more equity) compared to their less efficient peers. The findings may also imply that the more efficient banks are involved in riskier operations and in the process tend to hold more equity, voluntarily or involuntarily, that is, the reason may be due to deliberate efforts by banks to increase the safety cushions.

Interestingly, after controlling for other bank specific traits and macroeconomic variables, we do not find a significant relationship between the acquiring banks (DUMACQ) and cost efficiency. It can be observed from Table 8 that the control group banks are relatively more efficient compared to the banks that have been involved in mergers and acquisitions during the period under study. A plausible reason is that more than 80 per cent of the banks in the control group are foreign banks. Thus, this should come as no surprise because of the ability of the foreign owned banks to capitalise on their access to better risk management and operational techniques, usually made available through their parent banks abroad.

During the period under study, the empirical findings seem to suggest that macroeconomic conditions (LNGDP) and the three bank concentration ratio (CR_3) do not significantly explain the variations in Malaysian banks' cost efficiency. Similarly, the binary variable PRE_MER does not enter the regression model significantly. On the other hand, the variable POST_MER entered the regression model with a positive sign suggesting that the Malaysian banking sector has been relatively more cost efficient during the post-merger period compared to the pre-merger period. However, the results should be interpreted with caution as the coefficient of the variable is weak and is only statistically significant at the 10 per cent level.

## 6. Conclusions

Applying a non parametric frontier Data Envelopment Analysis (DEA) approach, the paper investigated the effects of mergers and acquisitions on the cost efficiency of the Malaysian banking sector. The sample period was divided into three sub-periods, that is, pre-merger, during merger, and post-merger to compare the differences in the Malaysian banking sector's mean cost, allocative, and technical efficiency levels during all periods. A multivariate Tobit model was employed to examine the relationship between cost efficiency and size, capitalisation, and risk.

The results from the DEA suggest that Malaysian banks exhibited a mean cost efficiency of 83.5 per cent during the pre-merger period, suggesting a mean input waste of 16.5 per cent. We found that during the merger year, Malaysian banks' cost efficiency level deteriorated slightly to 81.9 per cent, which was mainly due to technical rather allocative inefficiency. Despite that, during the post-merger period, Malaysian banks exhibited a higher mean cost efficiency level compared to the pre-merger period. The empirical findings seem to suggest that the improvement in cost efficiency during the post- merger period was largely attributed to the improvement in technical rather than allocative efficiency. We found the acquirers to be more cost efficient in all of the seven merger cases analysed.

The results from the multivariate regression analysis suggest that LNDEPO has a negative relationship with cost efficiency, implying that the more cost efficient banks are associated with banks with a lower market share. On the other hand, LOANS/TA reveals a positive relationship implying that banks with higher loans-to-asset ratios tend to have higher cost efficiency scores. LNTA shows positive coefficients suggesting that the larger the bank, the more efficient the bank will be, purely because of the economies of scale arguments. The coefficient of LLP/TL entered all regression models with a positive sign, which is in consonance with Berger and DeYoung's (1997) *skimping* hypothesis. Similarly, the empirical findings seem to suggest that NII/TA consistently exhibited a strong positive and significant relationship with CE. The results imply that banks tend to become more efficient as they increase their income from non interest sources.

The findings seem to suggest that NIE/TA consistently exhibited a negative relationship with bank efficiency levels. The finding is in consonance with Berger and DeYoung's (1997) *bad management* hypotheses.. Clearly, efficient cost management is a prerequisite for the improved efficiency of the Malaysian banking system. EQASS exhibited a positive relationship with bank cost efficiency suggesting that the more cost efficient banks, *ceteris paribus*, use less leverage (more equity). The findings may also imply that the more cost efficient banks are involved in riskier operations and in the process tend to hold more equity, voluntarily or involuntarily.

We did not find a significant relationship between the acquiring banks (DUMACQ) and cost efficiency. On the other hand, the findings suggest that the control group banks are relatively more efficient compared to the banks that have been involved in mergers and acquisitions. A plausible reason is that more than 80 per cent of the banks in the control group are foreign banks. Thus, the empirical findings seem to suggest that the foreign banks have succeeded in capitalising on their advantages and exhibit a higher level of cost efficiency compared to their domestic bank peers.

The results seem to suggest that Malaysian banks have been relatively more efficient during the post-merger compared to the pre-merger period. However, the coefficient of the variable was weak and only statistically significant at the 10 per cent level. On the other hand, the empirical findings seem to suggest that macroeconomic conditions, the three bank concentration ratio, and the pre-merger period do not significantly explain the variations in Malaysian banks' cost efficiency.

Due to its limitations, this research could be extended in a variety of ways. Firstly, future research into the efficiency of Malaysian banks could consider the production function along with the intermediation function used in this study. Secondly, the non parametric frontier analysis used in this paper could also be combined with the stochastic frontier analysis method of estimating the frontier. This should testify to the robustness of the results against alternative estimation methods. Finally, investigation of changes in productivity over time as a result of technical change or technological progress or regress by employing the Malmquist Productivity Index (MPI) could yet be another extension to the current study.

## References


Aly, H.Y., R. Grabowski, C. Pasurka and N. Rangan. 1990. Technical, scale and allocative efficiencies in US banking: an empirical investigation. *Review of Economics and Statistics* 72: 211-218.

Avkiran, N.K. 1999. The evidence on efficiency gains: the role of mergers and the benefits to the public. *Journal of Banking and Finance* 23: 991-1013.

Bank Negara Malaysia. 1999. Annual Report.

Beitel, P. and D. Schiereck. 2001. Value Creation at the Ongoing Consolidation of the European Banking Market, Working Paper, University of Witten/Herdecke.

Berger, A.N. and DeYoung . 1997. Problem loans and cost efficiency in commercial banks. *Journal of Banking and Finance* 21: 849-870.

Berger, A.N. and L.J. Mester. 2003. Explaining the dramatic changes in performance of U.S. banks: technological change, deregulation and dynamic changes in competition. *Journal of Financial Intermediation* 12: 57-95.

Berger, A.N., R. Demsetz and P. Strahan. 1999. The consolidation of the financial services industry: causes, consequences and implications for the future. *Journal of Banking and Finance* 23: 135-194.

Charnes, A., W.W Cooper and E. Rhodes. 1978. Measuring the efficiency of decision making units. *European Journal of Operational Research* 2: 429-444.

Coelli, T., D.S.Prasada-Rao and G.E. Battese. 1998. *An Introduction to Efficiency and Productivity Analysis.* Boston: Kluwer Academic Publishers.

Coelli, T. 1996. A Guide to DEAP Version 2.1: A Data Envelopment Analysis (Computer Program), Working Paper, CEPA, University of New England, Armidale.

Elyasiani, E. and S. Mehdian. 1992. Productive efficiency performance of minority and non-minority owned banks: a non-parametric approach. *Journal of Banking and Finance* 16: 933-948.

Fare, R., S. Grosskopf and C.A.K. Lovell. 1985. *The Measurement of Efficiency of Production.* Boston: Kluwer-Nijhoff Publishers.

Hauner, D. 2005. Explaining efficiency differences among large German and Austrian banks. *Applied Economics* 37: 969-980.

Isik, I. and M.K. Hassan. 2002. Technical, scale and allocative efficiencies of Turkish banking industry. *Journal of Banking and Finance* 26: 719-766.

Liu, B. and D. Tripe. 2002. New Zealand bank mergers and efficiency gains. *Journal of Asia Pacific Business* 4: 61-81.

Okuda, H. and H. Hashimoto. 2004. Estimating cost functions of malaysian commercial banks: the differential effects of size, location and ownership. *Asian Economic Journal* 18: 233-259.

Pasiouras, F. 2008. Estimating the technical and scale efficiency of Greek commercial banks: the impact of credit risk, off-balance sheet activities and international operations. *Research in International Business and Finance* 22(3): 301-318.

Prager, R.A. and T.H. Hannan. 1998. Do substantial horizontal mergers generate significant price effects? Evidence from the banking industry. *Journal of Industrial Economics* 46: 433-454.

Rhoades, S.A. 1998. The efficiency effects of bank mergers: an overview of case studies of nine mergers. *Journal of Banking and Finance* 22: 273-291.

Sathye, M. 2001. X-Efficiency in Australian banking: an empirical investigation. *Journal of Banking and Finance* 25: 613-630.

Saxonhouse, G.R. 1976. Estimated parameters as dependent variables. *American Economic Review* 66: 178-183.

Sufian, F. and M.Z.A.Majid. 2007. Deregulation, consolidation and banks efficiency in Singapore: evidence from event study window approach and Tobit analysis. *International Review of Economics* 54(2): 261-283.

Sufian, F. 2007. Mergers and acquisitons in the Malaysian banking industry: techncial and scale efficiency effects. *International Journal of Financial Services Management* 2(4): 304-326.