RISKS AND EFFICIENCY IN MALAYSIAN BANKING

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Abstract

Applying a non-parametric Data Envelopment Analysis (DEA) method, this paper attempts to investigate the efficiency of Malaysian banks during the post-merger period. We further analyzed the impact of risk and problem loans on Malaysian bank efficiency, when compared to the results attained from the basic DEA model. We found that the merger has largely benefited small and medium sized banks while on the other hand, large banks suffer from scale inefficiency and have been consistently operating at declining returns to scale (DRS). We found that the inclusion of loan loss provisions has resulted in an increase in the estimated mean efficiency levels for all banks under study. Our results also suggest that the mean pure technical efficiency estimates are much more sensitive than the mean scale efficiency estimates to the exclusion of risk factors.

JEL Classification: G21; D24

Keywords: Finance and Banking, Non-Performing Loans, Efficiency Change, Data Envelopment Analysis

1. INTRODUCTION

During the past decade, Malaysian commercial banks have experienced two episodes of economic turbulence namely the economic downturn in 1985-1986 and the financial crisis of 1997-1998. In the years between the two

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turbulent episodes, (1989-1996), various measures were implemented to strengthen the commercial banks through a series of prudential reforms and strategic development to gear the banking system to meet the future challenges of greater competition.

Given the fact that much of the required financings in Malaysia were intermediated through the banking system, the risk associated with cyclical downturn in the economy would be much concentrated in the banking system. Two episodes of economic turbulence, the economic downturn of 1985-1986 and the financial crisis of 1997-1998 during the past decade, has resulted in commercial banks in Malaysia suffering high rates of non-performing loans arising from over exposure to the property sector in the early 1980s and imprudent exposure to share-based financing. The commercial banks again suffered from surging levels of non-performing loans and significant erosion of capital due to large provisions made against bad debts and interest-in-suspense resulted from the financial crisis in 1997-1998, which amounted close to 40% compared to only about 17% in 1985-1986. During this period, most banking institutions were more concentrated in preserving the quality of their balance sheets and coping with the erosion of capital, instead of generating new loans. The pullback effect as such has resulted in the disruption to the once smooth functioning intermediation process by the banking system in Malaysia.

Despite having entered the financial crisis in 1997 from a position of strength, the severity of the crisis had weakened the health of the banking sector, as reflected by the deterioration in the capitalization and asset quality. In recognizing this problem and anticipating further adverse implications of the crisis on the banking system, the central bank of Malaysia, namely the Bank Negara Malaysia (BNM), took four-pronged pre-emptive measure to strengthen the resilience of the banking sector. This involved a merger program, the setting up of an asset management company (Pengurusan Danaharta Nasional Berhad), a special purpose vehicle to recapitalize the banking institutions (Danamodal Nasional Berhad) and the Corporate Debt Restructuring Committee (CDRC).

Nonetheless, the crisis has exposed the vulnerability of small banking institutions and the need for these institutions to maintain a high level of capital as the Malaysian banking system has historically been characterized by its large number of small institutions. As is the global trend, the period of 1990s was the start of the consolidation of the Malaysian banking industry. Although BNM has always encouraged banks to merge in order to achieve economies of scale and higher level of efficiency, only a few mergers among the banking institutions have taken place. Only three mergers were instituted in 1997: DCB Bank with Kwong Yik Bank[1], DCB Finance with Kwong Yik

Finance, and United Overseas Bank with Chung Khiaw Bank. Both DCB Bank and Kwong Yik Bank were tier-1 institutions[2]. The two-tier system did not produce the desired results of consolidation of the banking system by enhancing mergers between tier-1 and tier-2 institutions. The two-tier system did not meet the primary objective; the smaller banks in tier-2 instead had been augmenting their capital to graduate to tier-1 status. In order to secure a sufficient return on capital, several tier-2 banks had been aggressively lending. The Two-tier Regulatory System (TTRS) for banking institutions was abolished on 10 April 1999.

In order to minimize the potential impact of systemic risks on the banking sector as a whole, following the deepening of the financial crisis, the Government took stronger measurers to promote (force) merging of banking institutions. A merger program was initiated in 1998 covering only the finance companies initially. Given that finance companies are highly fragmented with 39 companies and the nature of its business, which focuses mainly on hire purchase financing and consumption credit, the industry is highly vulnerable to any changes in interest rates as well as slowdown in the economy. Five finance companies were identified to be the anchor companies of mergers. It was envisaged that, by 31 March 1998, the respective finance companies identified would agree on the merger partners as well as the terms and conditions of the mergers.

The merger program was subsequently extended to include all domestic banking institutions by July 1999 and all domestic banking institutions would be restructured so that six banking groups would be formed. Based on the merger program, all domestic banking institutions were required to form their own merger groups, subject to the requirement that the minimum shareholders' funds of each merger banking groups should not be less than Ringgit Malaysia (RM) 2 billion. Despite that, banking groups which already have shareholders' funds of RM2 billion were also encouraged to participate in the merger program in order to achieve greater mass and to maintain their competitiveness and market share.

A new merger plan was announced, urging all domestic banking institutions to form their own merger groups and choose their own leader in each group by the end of January 200l. In response to this approach, approval was granted for the formation of 10 banking groups. It was also intended to

[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 a large loss for the second half-year of 1997.

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

Table 1. Malaysian Banks Mergers and Acquisitions

Anchor Banks	Banks Acquired	Finance Companies	Merchant Banks	Anchor's 30 June '00 Total Assets RMb	Post-Merger Assets RMb	% of Systems Assets
Maybank	The Pacific Bank Phileo Allied Bank	Mayban Finance* Kewangan Bersatu Sime Finance*	Aseambankers Malaysia*	127	150	24.0
Bumiputra-Commerce Bank	N.A.	Bumiputra-Commerce Finance*	Commerce International Merchant Bankers*	63	67	10.7
RHB Bank	N.A.	Interfinance Delta Finance	RHB Sakura Merchant Bankers*	51	56	9.0
Public Bank	Hock Hua Bank	Public Finance* Advance Finance	Sime Merchant Bankers	43	50	8.0
Arab-Malaysian Bank[3]	N.A.	Arab-Malaysian Finance*	Arab-Malaysian Merchant Bank*	11	39	6.2
Hong Leong Bank	Wah Tat Bank	Hong Leong Finance* Credit Corporation		29	35	5.6
Multi-Purpose Bank	International Bank Malaysia Sabah Bank	Sabah Finance Bolton Finance	Bumiputra Merchant Bankers Amanah Merchant Bank	9	14	2.2
Affin Bank[4]	BSN Commercial Bank	Affin Finance* BSN Finance	Perwira Affin Merchant Bankers* BSN Merchant Bank	15	30	4.8
Southern Bank	Ban Hin Lee Bank	Perdana Finance Cempaka Finance United Merchant Finance	Perdana Merchant Bankers	24	25	4.0
EON Bank	Oriental Bank	EON Finance* City Finance Perkasa Finance	Malaysia International Merchant Bankers	14	25	4.0

* – Originally part of the anchor bank's wider group
Source: **Bank Negara Malaysia**

avoid the turmoil in the financial markets due to the drastic reduction of financial institutions. The 10 anchor banks are: 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 minimum shareholders' funds of RM2 billion and an asset base of at least RM25 billion. Among these 10 anchor banks, the asset quality of Hong Leong Bank Berhad is of market's concern. With the formation of these 10 banking groups, the number of domestic banking institutions was reduced substantially to 29 banking institutions consisting of 10 commercial banks, 10 finance companies, and 9 merchant banks.

The merger program for domestic banking institutions initiated in 1999 was finally concluded in 2001. The ten anchor banks emerged having complied with all the requirements of anchor bank status, such as minimum capitalization, total asset size, and other prudential requirements. The focus of the domestic banking groups entered the next stage to complete the business integration processes and rationalization exercises, e.g., branch, workforce, etc.

By applying the non-parametric Data Envelopment Analysis (DEA) methodology, we attempt to investigate the efficiency of the Malaysian banking sector post-merger. We further analyzed the impact of the inclusion of loan loss provisions in the definition of banks' input when estimating for the efficiency changes. The paper is also aimed to fill the gap in the literature on efficiency of Malaysian commercial banks as well as to provide the most recent evidence on the efficiency of Malaysian commercial banks post-merger.

Compared to earlier papers, this paper has the following merits: Firstly, unlike Katib and Mathews (2000) and Okuda and Hashimoto (2004), who investigated Malaysian banks efficiency during the 1989-1995 and 1991-1997 period respectively, we investigate the efficiency of Malaysian banks on a more recent data during the period of 2001-2003. Secondly, although Krishnasamy *et al.* (2004) investigated Malaysian banks productivity changes during the 2000-2001 period, they have not examined the efficiency changes.

This paper is set out as follows: Section 2 reviews the main literature. Section 3 outlines the approaches to the measurement and estimation of efficiency change. Section 4 discusses the results and Section 5 concludes.

[3] 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.

[4] Another merger that failed to materialize 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.

2. RELATED STUDIES

In the past few years, DEA has frequently been applied to banking industry studies. The first application analyzed efficiencies of different branches of a single bank. Sherman and Gold (1985) studied the overall efficiency of 14 branches of a U.S. savings bank. DEA results showed that six branches were operating inefficiently compared to the others. A similar study by Parkan (1987) suggested that eleven branches out of thirty-five were relatively inefficient. The samples in these studies were however quite small so that some of the DEA's large sample discriminatory power could have been lost.

Rangan *et al.* (1988) shifted the unit of assessment from branches to consolidated banking institutions. They applied DEA to a larger sample of 215 U.S. banks and attempted to break down inefficiency to that stemming from pure technical inefficiency and scale inefficiency. They employed the intermediation approach by using three inputs (labor, capital, and purchased funds) and five outputs (three types of loans and two types of deposits). Their results indicated that banks could have produced the same level of output with only 70% of the inputs actually used, while scale inefficiencies of the banks were relatively small, suggesting the sources of inefficiency to be pure technical rather than scale.

In addition to the heavy concentration on the US, DEA has fast become a popular method in assessing financial institutions efficiency among banking researchers in other nations. Fukuyama (1993 and 1995) was among the early researchers, particularly among countries in Asia, to employ DEA to investigate banking efficiency. Employing labor, capital, and funds from customers as inputs and revenue from loans and revenue from other business activities as outputs, Fukuyama (1993) considered the efficiency of 143 Japanese banks in 1990. He found the pure technical efficiency to average around 0.86 and the scale efficiency around 0.98, implying that the major source of overall technical inefficiency is pure technical inefficiency. The scale inefficiency is found to be mainly due to increasing returns to scale. He also found that banks of different organizational status perform differently with respect to all efficiency measures (overall, scale, pure technical). Scale efficiency is found to be positively but weakly associated with bank size.

2.1 The effects of non-performing loans on bank's efficiency

For the past several years, most research conducted on explaining the causes of bank or thrift industry failures found that failing institutions carried large proportions of non-performing loans in their books prior to

failure[5]. Berger and Humphrey (1992), Barr and Siems (1994) and Wheelock and Wilson (1995) found that banks approaching failure tend to have low cost efficiency and experience high ratios of problem loans and that failing banks tend to be located far from the best practice frontiers. In addition, even among banks that do not fail, Kwan and Eisenbeis (1994), Resti (1997) and Barr *et al.* (2002) have found negative relationship between problem loans and efficiency.

Although the issue of controlling for risk in respect of efficiency analysis is still controversial, many studies have attempted to control for the exogenous impact of problem loans on efficiency. As noted by Berger and Humphrey (1997):

> *"Whether it is appropriate to include non-performing loans and loan losses as the bank's costs depends on the extent to which these variables are exogenous i.e. caused by negative economic shocks and endogenous i.e. either because the management is inefficient in managing its portfolio or because it has made a conscious decision to reduce short-run expenses by cutting back on loan origination and monitoring resources".*

Among earlier researches that incorporated and studied the impact of non-performing loans on bank's efficiency are of those by Hughes and Mester (1993, 1998), Hughes *et al.* (1996, 1999), and Mester (1997), which include the volume of non-performing loans as a control for loan quality in studies of U.S. banks. Berg *et al.* (1993) on the other hand, included loan losses as an indicator of the quality of loan evaluations in DEA study of Norwegian bank productivity.

Recent studies have also found negative relationship between the level of non-performing loans and bank's efficiency. Havrylchyk (2003) reveals that foreign owned banks in Poland displayed higher efficiency than domestic banks, which is attributed to higher loan portfolio quality. The higher efficiency of the foreign banks is supported by its superior knowledge of risk management systems, which has allowed them keep the risks of their loan portfolios in check and hence was not burdened by high non-performing loans.

In their studies on the determinants of Italian banks efficiency, Girardone *et al.* (2004) employed the Fourier-Flexible Stochastic Cost Frontier and followed the intermediation approach to investigate the Italian banking industry for the period of 1993-1996 using an unbalanced panel data. They found

[5] See Dermiguc-Kunt (1989); Whalen (1991); Barr and Siems (1994).

that inefficiencies are positively correlated with the level of non-performing loans in the banks balance sheet.

Drake and Hall (2003) in their investigation on Japanese banks using a DEA approach found that when risk factors are excluded, potential economies of scale may be overestimated, which is in line with Altunbas *et al.* (2000). They found that the mean pure technical efficiency level of all banks increased significantly from 78.1 to 89.4 after controlling for problem loans, while the mean score for scale efficiency only improved marginally from 92.8 to 96.6. This has resulted the mean overall technical efficiency to improve substantially to 86.3 from 72.4. In contrast to Altunbas *et al.* (2000), who applied the Fourier Flexible Stochastic Cost Frontier in their studies, Drake and Hall (2003) found that pure technical efficiency is much more sensitive when risk factors are excluded compared to the scale efficiency estimates.

2.2 Studies on Malaysian commercial banks efficiency and productivity

Despite the substantial studies performed on U.S., Europe and other Asia-Pacific banking industry in regard to the efficiency and productivity of financial institutions, there has been limited study aimed at this area with respect to the Malaysian banking sector, partly due to the lack of available data sources and the small sample of banks compared to developed countries. As pointed by Kwan (2003), the reason for the lack of research on the efficiency of Asian banks is due to the lack of publicly available data for non-publicly traded Asian financial institutions.

The most notable research conducted on Malaysian banks was by Katib and Mathews (2000), who studied the characteristics of the management structure and technical efficiency of the banking industry in Malaysia by DEA from 1989 to 1995. Okuda and Hashimoto (2004) conducted a research on the production technology of Malaysian domestic commercial banks with Stochastic Cost Functions approach adjusted to non-performing loans from the year 1991 to 1997.

More recently, Krishnasamy *et al.* (2004) have investigated Malaysian banks post-merger productivity changes. Applying two inputs, namely labour and total assets and loans and advances and total deposits as outputs, they found that during the period 2000-2001, post-merger Malaysian banks have achieved a total factor productivity growth of 5.1%. They found that during the selected period, eight banks posted positive total productivity growth ranging from 1.3% to 19.7%, one bank exhibited a total factor productivity regress of 13.3%, and a bank was stagnant. The merger has not re-

sulted in better scale efficiency of Malaysian banks as all banks exhibit scale efficiency regress with the exception of two banks. The results also suggest rapid technological change of post-merger Malaysian banks ranging from 5.0% to 16.8%. Two banks however, experienced technological regress during the period of study.

3. METHODOLOGY

Following Drake and Hall (2003), Fukuyama (1993, 1995) and Berg *et al.* (1992), among others, a non-parametric method, DEA, will be used in measuring the efficiency of the Malaysian banks. The methods allows for the decomposition of the efficiency and productivity differences into one representing the banks' efficiency and productivity levels relative to their peers best practice frontiers. The DEA is a linear (mathematical) programming technique which forms a non-parametric surface / frontier (more formally a piecewise-linear convex isoquant) over the data points to determine the efficiencies of each DMU relative to this frontier.

The main reason to choose the DEA is the expressed interest in the Malaysian banking industry of reducing costs in recent years owing to the increased competition fostered by liberal policies. Furthermore, DEA allows the study to focus on the input saving (cost) efficiency, which can be detailed into technical and allocative efficiency components. It also permits one to further detail technical efficiency into its pure technical and scale efficiency components. Hence, through input-oriented DEA, a researcher can dwell on the sources of input waste in Malaysian banking and draw some policy conclusions.

Nevertheless, DEA is less data demanding as it works fine with small sample size and does not require knowledge of the proper functional form of the frontier, error, and inefficiency structures (Evanoff and Israelvich (1991), Grifell-Tatje and Lovell (1997), Bauer *et al.* (1998)). The stochastic models on the other hand, necessitate a large sample size to make reliable estimations. Although the sample includes the universe of Malaysian banks, the total number of banks in the sample is relatively small, motivating us to adopt DEA in this study.

The study by Farrell (1957) created basic concepts for efficiency measurement and discussion of frontiers. Farrell posited that the overall cost efficiency (CE) of a firm could be decomposed into two components; technical efficiency (TE) and allocative efficiency (AE). Technical efficiency reflects the ability of a firm to generate maximum output from a given set of factors of

production while, allocative efficiency reflects the ability of a firm to use the factors of production in optimal proportions, given their respective prices. His idea was to measure efficiency as a relative distance from the efficient frontier by keeping the input proportions fixed. In his analysis, Farrell assumed that production technology is known and that returns to scale are constant.

Farrell's concept are best illustrated, for the single output/two input case, in the unit isoquant diagram, Figure 1, where the unit isoquant (yy') shows the various combinations of the two inputs (x1, x2), which can be used to produce 1 unit of the single output (y). The DMU at E is productively (or overall) efficient in choosing the cost minimizing production process given the relative input prices (represented by the slope of WW'). As illustrated in Figure 1, the ratio OQ/OR measures the technical efficiency of the production at point R, whereas, OQ/OR compares the minimum input required for production of one unit to the observed input usage in the firm. Thus, 1-OQ/OR measures the proportion of inputs that could be reduced without reducing output. Hence,

$$TE = OQ/OR$$

The ratio OP/OQ measures allocative efficiency of the firms input usage. The costs in point P are equal to the costs in the overall productively efficient point E but lower than in point Q. The ratio of 1-OP/OQ then measures the possible input savings that could be reduced if the inputs were used in the right proportions. Hence,

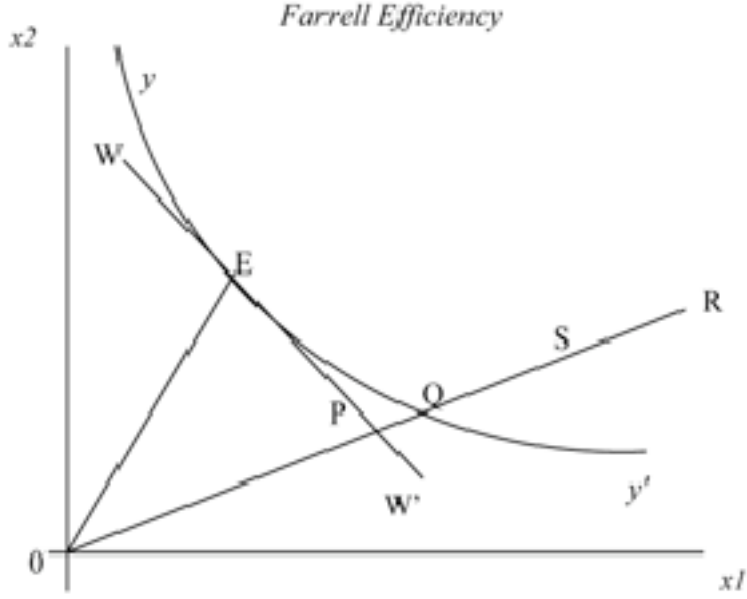
$$AE = OP/OQ$$

A measure for overall efficiency (productively efficient) can be obtained by adding technical and allocative efficiency together. In Figure 1, the total efficiency is represented by the ratio of OP/OR. Total inefficiency reveals total waste of inputs, thus shows how much costs could be reduced if the firm operated in the efficient point E instead of point R. Hence,

$$OE = OP/OR$$

In short, a DMU at Q is allocatively inefficient in choosing an appropriate inputs mix, while a DMU at R is both allocatively (in the ratio of OP/OR) and technically inefficient (in the ratio of OQ/OR), resulted from excessive amount of both inputs usage (x1 and x2), compared to the DMU at Q in producing the same level of output (y).

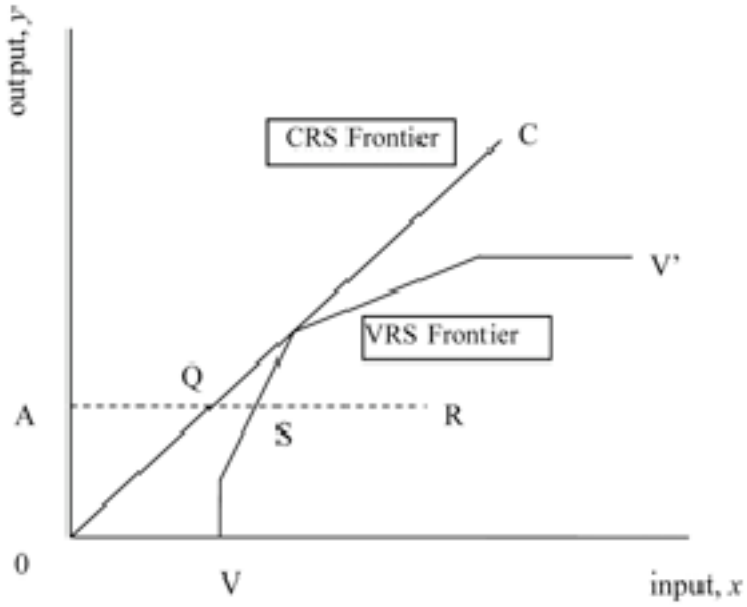
Figure 1: Farrell Technical Efficiency



The term Data Envelopment Analysis (DEA) was first introduced by Charnes *et al.* (1978), (CCR model), to measure the efficiency of each Decision Making Units (DMUs), that is obtained as a maximum of a ratio of weighted outputs to weighted inputs. This denotes that the more the output produced from given inputs, the more efficient is the production. The weights for the ratio are determined by a restriction that the similar ratios for every DMU have to be less than or equal to unity. This definition of efficiency measure allows multiple outputs and inputs without requiring pre-assigned weights. Multiple inputs and outputs are reduced to single 'virtual' input and single 'virtual' output by optimal weights. The efficiency measure is then a function of multipliers of the 'virtual' input-output combination.

The CCR model presupposes that there is no significant relationship between the scale of operations and efficiency by assuming constant returns to scale (CRS) and it delivers the overall technical efficiency (OTE). The CRS assumption is only justifiable when all DMUs are operating at an optimal scale. However, firms or DMUs in practice might face either economies or diseconomies of scale. Thus, if one makes the CRS assumption when not all DMUs are operating at the optimal scale, the computed measures of technical efficiency will be contaminated with scale efficiencies.

Figure 2: Scale and Technical Efficiency



Banker *et al.* (1984) extended the CCR model by relaxing the CRS assumption. The resulting "BCC" model was used to assess the efficiency of DMUs characterized by variable returns to scale (VRS). The VRS assumption provides the measurement of purely technical efficiency (PTE), which is the measurement of technical efficiency devoid of the scale efficiency effects. If there appears to be a difference between the TE and PTE scores of a particular DMU, then it indicates the existence of scale inefficiency.

To further illustrate this, a DMU at point R in Figure 2 is technically inefficient under both the CRS and VRS assumption. The technical inefficiency of point R under the CRS assumption is thus the distance QR, while under the VRS would only be SR. Hence, the difference between these two measures, QS, is attributable to scale inefficiency, which indicates that the DMU at point R can produce its current level of output with fewer inputs if it attains CRS.

In summary, the technical efficiency ratio OQ/OR may be further decomposed into scale efficiency, OQ/OS, and pure technical efficiency, OS/OR, with point Q representing the case of constant returns to scale. The former arises because a DMU is at an input-output combination that differs from the equivalent constant returns to scale situation. The latter, pure technical effi-

ciency represents the failure of a DMU to extract the maximum output from its adopted input levels, and hence it may be thought of as measuring the unproductive use of resources. In summary,

Pure Technical Efficiency (PTE) = AS/AR
Scale Efficiency (SE) = AQ/AS
Technical Efficiency = Pure Technical Efficiency (PTE) x Scale Efficiency (SE) = (AS/AR) x (AQ/AS) = AQ/AR

$$\min \lambda_0 \ \theta_0 \qquad (1)$$

$$\text{subject to } \sum_{j=1}^{n} \lambda_{0j} y_{rj} \geq y_{r0} \qquad (r = 1,\ldots..,s)$$

$$\theta_0 x_{i0} \geq \sum_{j=1}^{n} \lambda_{0j} x_{ij} \qquad (i = 1,\ldots..,n)$$

$$\sum_{j=1}^{n} \lambda_{0j} = 1$$

$$\lambda_{0j} \geq 0 \qquad (j = 1, \ldots..,n)$$

The first constraint states that output of the reference unit must be at least at the same level as the output of DMU 0. The second constraint tells that the efficiency corrected input usage of DMU 0 must be greater than or the same as the input use of the reference unit. Since the correction factor is same for all types of inputs, the reduction in observed inputs is proportional. The third constraint ensures convexity and thus introduces variable returns to scale. If convexity requirement is dropped, the frontier technology changes from VRS to CRS. The efficiency scores always have smaller or equal values in the case of CRS. Efficiency can also be measured into output direction in the case of VRS.

Although the scale efficiency measure will provide information concerning the degree of inefficiency resulting from the failure to operate with CRS, it does not provide information as to whether a DMU is operating in an area of increasing returns to scale (IRS) or decreasing returns to scale (DRS). Hence, in order to establish whether scale inefficient DMUs exhibit IRS or DRS, the technical efficiency problem (1) is solved under the assumption of non-increasing returns to scale (NIRS) rather than variable returns to scale (VRS) to provide

$$\min \lambda_0 \theta_0 \qquad (2)$$

$$\text{subject to } \sum_{j=1}^{n} \lambda_{0j} y_{rj} \geq y_{r0} \qquad (r = 1,\ldots..,s)$$

$$\theta_0 x_{i0} \geq \sum_{j=1}^{n} \lambda_{0j} x_{ij} \qquad (i = 1,\ldots..,n)$$

$$\sum_{j=1}^{n} \lambda_{0j} \leq 1$$

$$\lambda_{0j} \geq 0 \qquad (j = 1, \ldots..,n)$$

The nature of the scale inefficiencies, due to either IRS or DRS can be determined by the difference between the NIRS TE and VRS TE score. If these two measures of PTE differ, this indicates that the DMUs are operating in the region of IRS. Conversely, if the two measures coincide, then DRS apply. The type of scale inefficiencies (IRS or DRS) for a specific DMU can be summarized as follows:

If the VRS TE ≠ Non-IRS TE, then the DMU is operating at IRS
If the VRS TE = Non-IRS TE, then the DMU is operating at DRS

4. DATA AND RESULTS

For the empirical analysis, ten post-merger Malaysian commercial banks from 2001-2003 are used (Table 2). Malaysian Islamic Banks, Investments Banks, and Development Banks will not be included in the sample of the analysis. Annual data were taken from published balance sheet information in annual reports of each individual bank.

The approach of input and output definition used in this study is a variation of the intermediation approach, which was originally developed by Sealey and Lindley (1977). The intermediation approach posits total loans and securities as outputs, whereas deposits along with labor and physical capital are defined as inputs. According to Berger and Humphrey (1997), the intermediation approach might be more suitable for studying efficiency of the entire financial institutions. 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.

Table 2. Malaysian Ten Commercial Banks

Bank	Abbreviation Used
Affin Bank Bhd.	AFB
Alliance Bank Bhd.	ALB
AmBank Bhd.	AMB
Bumiputra-Commerce Bank Bhd.	BCB
EON Bank Bhd.	EON
Hong Leong Bank Bhd.	HLB
Maybank Bhd.	MBB
Public Bank Bhd.	PBB
RHB Bank Bhd.	RHB
Southern Bank Bhd.	SBB

Following Drake (2003), Sathye (2001), and Fukuyama (1993, 1995) among others, the intermediation approach or asset approach to define bank inputs and outputs is adopted. Accordingly, three inputs and two outputs are used for Model 1 consisting of:

Y1: Total Loans (Loans)
Y2: Investment and dealing securities
X1: Personnel expenses (Labor)
X2: Fixed assets (Capital)
X3: Total deposits (Deposits)

Following the approach of Charnes *et al.* (1990) and Drake and Hall (2003), loan loss provisions as a proxy to non-performing loans are incorporated as an input in Model 2. Hence, the inputs and outputs for Model 2 are as follows:

Y1: Total Loans
Y2: Investment and dealing securities
X1: General and administrative expenses (Labor)
X2: Fixed assets (Capital)
X3: Retail and other financial institutions deposits (Deposits)
X4: Loan loss provisions (Non-performing loans)

The summary of data used is presented in Table 3 below.

Table 3. Mean, Minimum Maximum, and Standard Deviation Values of Inputs and Outputs

Outputs		2001 (RMm)	2002 (RMm)	2003 (RMm)
Total Loans	Min	7,878,589	7,213,835	7,227,399
	Mean	28,435,762	30,003,050	33,330,238
	Max	92,653,993	95,453,158	102,488,470
	S.D	25,281,208	69,338,958	28,864,183
Investment and Dealing Securities	Min	1,363,147	615,785	1,026,492
	Mean	7,003,907	7,838,421	8,406,919
	Max	22,576,115	25,276,996	25,907,889
	S.D	6,579,009	7,378,863	7,567,520
Inputs				
Labour	Min	112,066	121,743	142,868
	Mean	685,132	718,116	757,473
	Max	2,117,955	2,180,817	2,336,117
	S.D	598,496	616,688	661,688
Fixed Assets	Min	22,402	36,116	33,479
	Mean	448,548	441,650	457,407
	Max	1,417,961	1,376,591	1,419,973
	S.D	432,766	422,148	435,674
Retail and Other Financial				
Institutions Deposits	Min	9,161,947	7,966,598	9,023,647
	Mean	35,075,365	37,172,554	39,735,022
	Max	115,573,412	116,647,100	123,065,841
	S.D	31,740,619	32,157,908	33,936,662
Loan Loss Provisions	Min	156,722	106,327	103,283
	Mean	592,682	455,672	360,952
	Max	1,995,449	1,378,755	901,140
	S.D	558,999	412,202	272,946

All computations were performed using the DEAP program (Coelli (1996). Efficiency estimates are computed using the multi-stage DEA. In Table 4 below, the overall efficiency estimates from Model 1 are presented, along with their decomposition into pure technical and scale efficiency estimates.

Table 4. Malaysian Banks Efficiency (Model 1)

Bank	OE	PTE	SE	Returns to Scale
AFB01	0.982	1.000	0.982	IRS
ALB01	1.000	1.000	1.000	CRS
AMB01	1.000	1.000	1.000	CRS
BCB01	1.000	1.000	1.000	CRS
EON01	0.971	1.000	0.971	DRS
HLB01	1.000	1.000	1.000	CRS
MBB01	0.903	1.000	0.903	DRS
PBB01	0.874	0.878	0.995	IRS
RHB01	1.000	1.000	1.000	CRS
SBB01	1.000	1.000	1.000	CRS
Mean	**0.973**	**0.988**	**0.985**	
AFB02	1.000	1.000	1.000	CRS
ALB02	0.954	0.985	0.968	IRS
AMB02	1.000	1.000	1.000	CRS
BCB02	1.000	1.000	1.000	CRS
EON02	1.000	1.000	1.000	CRS
HLB02	0.997	1.000	0.997	DRS
MBB02	0.934	1.000	0.934	DRS
PBB02	0.815	0.845	0.964	DRS
RHB02	1.000	1.000	1.000	CRS
SBB02	1.000	1.000	1.000	CRS
Mean	**0.970**	**0.983**	**0.986**	
AFB03	0.947	1.000	0.947	IRS
ALB03	0.992	1.000	0.992	IRS
AMB03	1.000	1.000	1.000	CRS
BCB03	1.000	1.000	1.000	CRS
EON03	0.974	1.000	0.974	DRS
HLB03	1.000	1.000	1.000	CRS
MBB03	0.972	1.000	0.972	DRS
PBB03	0.984	1.000	0.984	DRS
RHB03	1.000	1.000	1.000	CRS
SBB03	1.000	1.000	1.000	CRS
Mean	**0.987**	**1.000**	**0.987**	

It is apparent from Table 4 that post-merger Malaysian banks have achieved a commendable mean overall efficiency level of 97.3%, 97.0%, and 98.7% in 2001, 2002 and 2003 respectively. Hence, the results suggest the input waste among post-merger Malaysian banks is minimal at 2.7% in 2001, 3.0% in 2002, and 1.3% in 2003.

The results from Model 1 also suggest that four banks namely AMB, BCB, RHB and SBB have consistently been operating at constant returns to scale (CRS) or fully efficient during the sample period. On the other hand, MBB and PBB, the two largest banks post-merger in terms of fixed assets, have been consistently operating at below unity. With the exception of PBB in 2001, the results from Model 1 suggest that both banks have consistently been operating at declining returns to scale (DRS) since the merger took place.

In Table 4 it is also worth noting that, MBB inefficiency was solely due to scale inefficiency as the bank has been operating at 100% pure technical efficiency level post-merger. However, this was not the case for PBB. The results suggest that managerial inefficiency was largely the cause for the bank's inefficiency post-merger.

A possible explanation could be that the bank's merger partner (Hock Hua Bank (HHB)) operations were mainly concentrated in the East Malaysian market, whereas PBB operational headquarters is located in Kuala Lumpur (Peninsular Malaysia). Hence, the bank could have incurred into higher costs due to branch closures and systems integration. Despite the initial glitch in operations, the bank has managed to operate at 100% pure technical efficiency level in the third year of merger.

Consistent with the findings of Rhoades (1998) that all gains should be realized within three years after the merger year, our findings also suggest that Malaysian banks have benefited from the merger. From Table 4 it is clear that Malaysian bank's efficiency has increased from 97.3% in the first year of merger to 98.7% in the third year of merger. However, the results suggest that the merger has greater positive impact on small and medium size banks. However, after the third year of merger, larger banks are still suffering from scale inefficiency.

4.2 Controlling for problem loans

Having established the basic DEA model, we now analyze the potential impact of risk and problem loans on Malaysian banking efficiency. As indicated previously, these results are obtained by modifying the initial DEA model to incorporate an additional (but non-discretionary) input in the form of provisions of loan losses.

Table 5. Malaysian Banks Efficiency (Model 2)

Bank	OE	PTE	SE	Returns to Scale
AFB01	0.982	1.000	0.982	IRS
ALB01	1.000	1.000	1.000	CRS
AMB01	1.000	1.000	1.000	CRS
BCB01	1.000	1.000	1.000	CRS
EON01	1.000	1.000	1.000	CRS
HLB01	1.000	1.000	1.000	CRS
MBB01	0.903	1.000	0.903	DRS
PBB01	1.000	1.000	1.000	CRS
RHB01	1.000	1.000	1.000	CRS
SBB01	1.000	1.000	1.000	CRS
Mean	**0.989**	**1.000**	**0.989**	
AFB02	1.000	1.000	1.000	CRS
ALB02	0.988	1.000	0.988	IRS
AMB02	1.000	1.000	1.000	CRS
BCB02	1.000	1.000	1.000	CRS
EON02	1.000	1.000	1.000	CRS
HLB02	1.000	1.000	1.000	CRS
MBB02	0.965	1.000	0.965	DRS
PBB02	0.850	0.904	0.941	DRS
RHB02	1.000	1.000	1.000	CRS
SBB02	1.000	1.000	1.000	CRS
Mean	**0.980**	**0.990**	**0.989**	
AFB03	0.947	1.000	0.947	IRS
ALB03	0.999	1.000	0.999	IRS
AMB03	1.000	1.000	1.000	CRS
BCB03	1.000	1.000	1.000	CRS
EON03	1.000	1.000	1.000	CRS
HLB03	1.000	1.000	1.000	CRS
MBB03	1.000	1.000	1.000	CRS
PBB03	0.984	1.000	0.984	DRS
RHB03	1.000	1.000	1.000	CRS
SBB03	1.000	1.000	1.000	CRS
Mean	**0.993**	**1.000**	**0.993**	

Table 5 presents the results. It is apparent that controlling for problem loans raises the mean pure technical efficiency level of all banks from 97.7% to 98.7%. The inclusion of loan loss provisions has also in higher level of scale efficiency for all banks, which increased from 98.6% to 99.0%. The combination of these two factors is such that the mean overall efficiency level increased to 98.7% from 97.7%.

These results are in line with the findings of Drake and Hall (2003) and Altunbas *et al.* (2000) and suggest that potential economies of scale may well be overestimated when risk factors are excluded. Further, in line with the findings of Drake and Hall (2003) we found that the mean pure technical efficiency estimates are much more sensitive than the mean scale efficiency estimates to the exclusion of risk factors.

5. CONCLUSIONS

Applying a non-parametric Data Envelopment Analysis (DEA) method, this paper attempts to investigate the efficiency of Malaysian banks during the post-merger period. We further analyzed the impact of risk and problem loans on Malaysian bank efficiency, when compared to the results attained from the basic DEA model.

We found minimal mean input waste among Malaysian banks during the post-merger period of 2.7% in 2001, 3.0% in 2002, and 1.3% in 2003. Our results also suggest that the merger which has taken place in 2000 has largely benefited the small and medium sized banks while on the other hand, large banks suffers from scale inefficiency and have been consistently operating at declining returns to scale (DRS).

Our results also suggest that the inclusion of loan loss provisions has resulted in an increase in the estimated mean efficiency levels for all banks under study. We found that the mean pure technical efficiency estimates are much more sensitive than the mean scale efficiency estimates to the exclusion of risk factors, hence indicating that potential economies of scale among Malaysian banks may well be overestimated when risk factors are excluded.

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Résumé

Par l'application d'une méthode non paramétrique de *Data Envelopment Analysis* (DEA), cet article essaie d'étudier l'efficience des banques de Malaisie durant la période de post-fusion. On a aussi analysé l'impact du risque et des prêts problématiques sur la performance des banques, en faisant la comparaison avec les résultats du modèle de base DEA. On a trouvé que les fusions entre banques ont bénéficié les banques petites et moyennes tandis que les banques grandes souffrent d'inéfficiences d'échelle et ont opéré avec des rendement d'échelle en diminution. On a trouvé que l'inclusion des provisions pour pertes sur prêts a entraîné une augmentation des niveaux de efficience moyenne pour toutes les banques étudiées. Les résultats suggèrent aussi que les estimations purement de l'efficience technique moyenne sont beaucoup plus sensibles que les estimations de l'efficience d'échelle moyenne à l'exclusion des facteurs de risque.