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Estimating Technical and Scale Efficiency of Malaysian Commercial Banks: A Non-Parametric Approach

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Estimates of technical and scale efficiency of commercial banks in Malaysia during the period 2000-2006 are obtained by using the non-parametric approach-Data Envelopment Analysis (DEA). The results suggest that the degree of scale efficiency was found to be lower than the degree of overall or technical efficiency which indicated that the portion of overall inefficiency is due to producing at an inefficient scale rather than producing below the production frontier. In addition, the results suggest that domestic banks were more efficient compared to foreign banks. The source of domestic banks inefficiency has been pure technical inefficiency implying that domestic banks have been producing below the production frontier. In contrast, foreign banks inefficiency was due to scale inefficiency.

Keywords: Commercial banks, DEA, Technical Efficiency, Scale Efficiency, Malaysia

I. Introduction

The structure of the Malaysian financial institutions has changed dramatically over the last twenty years. In addition, the global trend towards liberalization in banking has led to the blurring of demarcation lines separating activities of the different groups of financial institutions and the removal of artificial barriers to competition. Similarly, deposit taking, credit granting, investment, insurance and financial advisory services are being bundled into one financial conglomerate of financial supermarkets. The integration of financial markets within and across borders as well as mergers among banks, reflect attempts to increase financial industry efficiency. The Malaysian experience on the merger exercise is a good example. From 58 financial institutions, the number has reduced to 10 anchor banks and this was to be completed by 31 December 2000. This was the result of the financial crisis which weakened the domestic banking sector and the move towards consolidation is hoped to improve the efficiency of the banking sector.

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The commercial banks have undergone a tremendous development with the merger exercise. Theoretically, bank mergers could broaden the product mix and reduce costs. Large size capital and asset are crucial for a bank to become an efficient, competitive and powerful bank. These elements with good quality service will enable banks to compete with foreign banks at local as well as at international levels.

The objective of this paper is to estimate technical and scale efficiency of commercial banks in Malaysia for the period 2000-2006. The paper is structured as follows: the first section will discuss efficiency measurement in banking followed by methodology and data and specification of bank inputs and outputs. Empirical findings are discussed in the next section followed by the conclusion.

II. Efficiency Measurement in Banking

Generally, efficiency means the maximum output that can be produced from any given total given total of inputs. This refers to the efficiency of a firm which allocates resources in such a way as to produce the maximum quantity of output. Early research in the banking industry was mainly concerned with estimating the average productivity, using some sort of indices and with cost comparison (Farrell, 1957). Subsequently, researchers tended to proxy efficiency by market share. They assumed that banks with large market shares are expected to earn higher profits because of lower unit costs (Smirlock 1985 and Evanoff and Fortier 1988). In other words, banks with lower cost structures could maximize profits either by maintaining the current level of prices and size or by reducing the price levels and expanding, a positive relationship between a firm's profits and market structures being attributed to the gains made by more efficient firms.

The financial indicators of a bank's operating performance, such as operating costs divided by total assets or the return on equity or assets, have also been used to compare efficiencies, for examples, Rhoades (1986), Cornett and Tehranian (1992) and Srinivisan and Wall (1992) studied the effect of mergers among banks on efficiency. However, the use of financial ratios has its limitations. According to Berger *et. al*., (1993), the first problem is that financial ratios are regarded as misleading indicators of efficiency because they do not control for product mix or input prices. Secondly, using the cost-to-asset ratio assumes that all assets are equally costly to produce and all locations have equal costs of doing business. Finally, the use of simple ratios cannot distinguish between X-efficiency gains and scale and scope efficiency gains.

Recent approaches to measure bank efficiency include the parametric and non-parametric approach. These efficiency measurements differ primarily in how much shape is imposed on the frontier and the distributional assumptions imposed on the random error and inefficiency (Berger and Humphrey, 1997). In the research literature, both parametric and non-parametric approaches have been widely used but there is no

consensus which of these major approaches is superior (Berger and Humphrey, 1997). There are three main parametric approaches used in estimating relative efficiency; the stochastic frontier approach, the thick frontier approach as well as the thick frontier and distribution-free estimates approach. Okuda *et. al*., (2003) use SFA to estimate the cost function of the Malaysian commercial banks from 1991-1997 and its impact on bank restructuring. The study observed economies of scale but not economies of scope and suggest that Malaysian domestic banks were making unproductive capital investments.

The Thick Frontier Approach (TFA) has been applied to banking by Berger and Humphrey (1991, 1992) while the DFA has been applied to banking by Berger (1993) in the study of the US banking industry. Yildrim and Philippatos (2007) use both SFA and DFA to examine the cost and profit efficiency of banking sectors in twelve countries in Europe and find that the average cost efficiency level was 72 percent by DFA and 77 percent by SFA.

Unlike the parametric approach, the non-parametric approach assumes that random error is zero so that all unexplained variations are treated as reflecting inefficiencies. Non-parametric approaches such as Data Envelopment Analysis and Free Disposal Hull, put relatively little structure on the specification of the best-practice frontier. DEA was first introduced by Charnes, Cooper and Rhoades (1978) to describe an application of mathematical programming to observe data to locate a frontier which can then be used to evaluate the efficiency of each of the organizations responsible for the observed output and input quantities.

There are a number of studies examining relative efficiency using DEA (Sufian and Abdul Majid 2007; Li 2006; Sufian 2006; Sufian 2004). Sufian and Abdul Majid (2007) analyse efficiency change of Singapore commercial banks during the period of 1993-2003. They find that commercial banks in Singapore exhibited an average overall efficiency of 95.4 percent. Li (2006) investigates the scale-efficiency and technology-efficiency of 14 Chinese commercial banks. She concludes that most banks have low comparative-efficiency. She also finds that inefficient banks generally have input surplus. Sufian (2006) investigates the efficiency of non-bank financial institutions in Malaysia for the period 2000-2004. The study finds that finance companies were more efficient than merchant banks and that the inefficiency was the result of pure technical inefficiency rather than scale inefficiency. Using DEA to examine the efficiency effects of bank mergers and acquisition in Malaysia, Sufian (2004) finds that Malaysian banks exhibited a commendable overall efficiency level of 95.9 percent during 1998-2003 which indicates that the merger programme was successful.

III. Methodology

This study uses non-parametric approach-Data Envelopment Analysis (DEA) to estimate technical and scale efficiency of Malaysian commercial banks. The main objective of DEA is to determine which firms are operating on their efficient frontier and which firms are not. If the firm's input-output combination lies on the DEA frontier, the

firm is considered efficient; and the firm is considered inefficient if the firm's input-output combination lies inside the frontier.
Consider a general situation where we have n decision making units (DMUs) and each consumes the same m inputs to produce the same s outputs. Precisely, DMU_j uses x_{ij} *(I = 1, 2, 3…., m)* of input *i* to produce y_{rj} *(r = 1, 2……, s)* of output *r* assuming that $x_{ij} > 0$ *and* $y_{rj} > 0$ (Seiford and Thrall, 1990). The specific DMU being evaluated has to solve the following optimization problem:

$$Max h_0 = \sum_{r=1}^{s} u_r y_{ro} / \sum_{i=1}^{m} v_r x_{i0} \qquad (1)$$

subject to the constraints:

$$\sum_{r=1}^{s} u_r y_{rj} / \sum_{i=1}^{m} v_i x_{ij} \leq 1 \ , \ u_r \geq 0 , \ v_i \geq 0 \quad (2)$$

for $i = 1,2, …., m; r = 1, 2,…. s; j = 1, 2, …., n$. where h_o is the ratio of virtual outputs to virtual inputs, the u_r's and the v_j's are the variables an the y_{ro}*'s* and the x_{jo}*'s* are the observed output and input values of the DMU to be evaluated. A set of normalizing constraints guarantees that no DMU, including the one evaluated, can obtain an efficiency score that exceeds unity. Thus, DEA establishes a benchmark efficiency score of unity that no individual firm can exceed. If the efficiency score h_o = 1, DMU_o satisfies the necessary condition to be DEA efficient; otherwise it is DEA inefficient.

The basic DEA model (CCR model) implied the assumption of constant returns to scale. This assumption was later relaxed to allow for the evaluation of variable returns to scale and scale economies. Specifically, the efficient frontier may be derived using four alternative returns to scale assumptions; constant returns to scale (CR); variable returns to scale (VR), non-increasing returns to scale (NI); and non-decreasing returns to scale (ND). Yue (1992) defines the following assumptions. A bank exhibits increasing returns to scale if a proportionate increase in inputs and outputs places it inside the production frontier; and constant returns to scale if a proportionate increase or decrease in inputs or outputs move the firm either along or above the frontier. A bank which is not on the frontier is defined as experiencing non-increasing returns to scale if the hypothetical bank with which it is compared, exhibits either constant or decreasing returns to scale. A similar definition applies for non-decreasing returns to scale. A firm which is efficient under the assumption of variables return to scale (VRS) is considered technologically efficient; the VRS score represents pure technical efficiency (PT), whereas a firm which is efficient under the assumption of constant returns to scale (CRS) is technologically efficient and also uses the most efficient scale of operation. Hassan *et. al.,* (1990), suggests that, from the measures of technical (T) and pure technical (PT) efficiency, it is possible to derive a measure of scale efficiency:

$$S = T / PT \qquad (3)$$

or

$$S = CRS / VRS \qquad (4)$$

Where 0 ≤ S ≤ 1 since CR ≤ VR. If the value of S equals 1, the firm is scale efficient and all values less than 1 reflect scale inefficiency. If scale inefficiency exists *(S < 1)*, the source of inefficiency is the result of operating at either increasing *(NI < VR)* or decreasing *(NI = VR)* return to scale.

IV. Data and Specification of Bank Inputs and Outputs

This study includes all commercial banks where data is available. 9 domestic banks and 13 foreign banks were included (See Appendix 1). The annual balance sheet and income statement used were taken from BANKSCOPE – Fitch's International Bank Database.

This study uses the intermediation approach to define bank inputs and outputs. Under the intermediation approach, banks are treated as financial intermediaries that combine deposits, labour and capital to produce loans and investments. The values of loans and investments are treated as output measures; labour, deposits and capital are inputs; and operating costs and financial expenses comprise total cost. Accordingly, two inputs and one output would be used consisting of:

Y: Total Earning Assets
X_1: Total Deposits
X_2: Total Overhead Expenses

Table I presents the descriptive statistics of output and inputs used in the study.

Table I
Descriptive Statistics for Input and Output, 2000-2006 (In RM Million)

Variable	N	Mean	Median	Minimum	Maximum	Std. Dev.
All Banks						
Y	147	28300.14	19669.00	508.90	189518.10	34256.54
X_1	147	24477.63	17172.50	190.10	164392.60	29819.88
X_2	147	1073.91	825.20	6.60	2784.00	1212.98
Domestic banks						
Y	59	53196.17	38644.60	8826.00	189518.10	40747.25
X_1	59	46037.12	33733.30	6955.90	164392.60	35478.75
X_2	59	761.70	571.90	124.20	2784.00	572.60
Foreign Banks						
Y	88	11608.48	3124.30	508.90	39324.00	12660.97
X_1	88	10022.98	2614.20	190.10	35417.30	11249.28
X_2	88	191.09	63.25	6.60	875.10	231.24

Notes: Y = Total earning assets, X_1= Total deposits, X_2= Total overhead expenses

V. Empirical Findings

All computation was performed using DEAFrontier program. The efficiency of commercial banks in Malaysia was first examined by applying the DEA approach for each year by using a common frontier. We then examine the analysis by examining the efficiency of domestic banks only, foreign banks only and a pooled common frontier for all banks for all years. Table II reports the means, standard deviations and extreme values of the various efficiency scores for the years 2000, 2001, 2003, 2004, 2005, 2006, domestic banks, foreign banks and all banks for all years.

Based on the constructed frontiers, commercial banks exhibited a mean overall efficiency score of 84.3 percent in 2000, increased to 86 percent in 2001, declined to 77.5 percent in 2002 and improved to 82.1 percent in 2003 before gradually decreasing slightly to 81.8 percent, 81.3 percent and 81.5 percent in years 2004, 2005 and 2006 respectively. For each year, it appears that pure technical efficiency is higher than scale efficiency, and that bank inefficiency was attributed to scale rather than pure technical inefficiency.

Our results from Table II suggest that domestic banks exhibited a mean overall efficiency of 88.7 percent compared to foreign banks (73.3 percent). Our results also suggest that domestic banks exhibited higher pure technical and scale efficiency (92.4 percent and 96.1 percent) than foreign banks (91.5 percent and 80.3 percent) respectively, implying that domestic banks were more managerially efficient in controlling costs and have been operating at the right scale of operation compared to foreign banks. The decomposition of the overall efficiency into pure technical and scale efficiency suggest that domestic banks inefficiency was attributed to pure technical inefficiency rather than scale inefficiency. In contrast, foreign banks inefficiency was attributed to scale rather than pure technical inefficiency.

The results for all commercial banks for all years suggest that commercial banks exhibited a mean overall efficiency of 70.9 percent. Further, the decomposition of the overall efficiency into pure technical efficiency and scale efficiency suggest that scale inefficiency (20.6 percent) dominates pure technical inefficiency (10.7 percent) of Malaysian commercial banks during all years under investigation. This implies that during 2000 to 2006, commercial banks in Malaysia were operating on an inefficient scale.

Most technical inefficiency exhibited by the banks stem from operating at the wrong scale; ether operating at a scale that was too large (DRS) or operating at a scale that was too small (IRS). This study then examines further the trend in the returns to scale of Malaysian commercial banks. As Table III shows, 198 banks or 87.1 percent experienced either increasing returns to scale (11 banks or 7.5 percent) or decreasing returns to scale (117 banks or 79.6 percent). The number of banks experiencing increasing returns to scale has decreased from 3 in the year 2000 to 0 in 2006, whereas

the number of banks experiencing decreasing returns to scale has increased from 12 in the year 2000 to 21 in 2006.

Table II
Descriptive Statistics of the Efficiency Measures

	Mean	Median	Minimum	Maximum	SD
(a) 2000 (N = 18)					
Overall efficiency	0.843	0.864	0.723	1.000	0.087
Pure technical efficiency	0.948	0.962	0.741	1.000	0.066
Scale efficiency	0.889	0.890	0.747	1.000	0.070
(b) 2001 (N = 20)					
Overall efficiency	0.860	0.845	0.740	1.000	0.080
Pure technical efficiency	0.957	0.994	0.799	1.000	0.058
Scale efficiency	0.898	0.880	0.822	1.000	0.059
(c) 2002 (N = 21)					
Overall efficiency	0.775	0.776	0.609	1.000	0.114
Pure technical efficiency	0.937	0.965	0.762	1.000	0.073
Scale efficiency	0.828	0.804	0.649	1.000	0.103
(d) 2003 (N = 22)					
Overall efficiency	0.821	0.793	0.654	1.000	0.118
Pure technical efficiency	0.930	0.962	0.776	1.000	0.080
Scale efficiency	0.881	0.882	0.763	1.000	0.076
(e) 2004 (N = 22)					
Overall efficiency	0.818	0.769	0.680	1.000	0.107
Pure technical efficiency	0.937	0.950	0.802	1.000	0.069
Scale efficiency	0.872	0.846	0.766	1.000	0.080
(f) 2005 (N = 22)					
Overall efficiency	0.813	0.788	0.633	1.000	0.114
Pure technical efficiency	0.948	0.978	0.835	1.000	0.062
Scale efficiency	0.856	0.830	0.730	1.000	0.084
(g) 2006 (N = 22)					
Overall efficiency	0.815	0.774	0.738	1.000	0.088
Pure technical efficiency	0.952	0.973	0.868	1.000	0.053
Scale efficiency	0.856	0.854	0.744	1.000	0.071
(h) Domestic banks (N = 59)					
Overall efficiency	0.887	0.879	0.788	1.000	0.049
Pure technical efficiency	0.924	0.925	0.807	1.000	0.054
Scale efficiency	0.961	0.975	0.862	1.000	0.036
(i) Foreign Banks (N = 88)					
Overall efficiency	0.733	0.718	0.516	1.000	0.126
Pure technical efficiency	0.915	0.917	0.732	1.000	0.073
Scale efficiency	0.803	0.777	0.574	1.000	0.132
(j) Overall (2000-2006; N = 147)					
Overall efficiency	0.709	0.692	0.516	1.000	0.105
Pure technical efficiency	0.893	0.895	0.726	1.000	0.069
Scale efficiency	0.794	0.771	0.608	1.000	0.098

Note: SD = Standard Deviations

Table III
Returns to Scale (RTS) in Malaysian Commercial Banks

Year	No. of banks/ Percentage share	RTS			Total
		IRS	CRS	DRS	
2000	No. of banks	3	3	12	18
	% Share	16.7	16.7	66.7	100.0
2001	No. of banks	4	3	13	20
	% share	20	15	65	100
2002	No. of banks	1	2	18	21
	% Share	4.8	9.5	85.7	100.0
2003	No. of banks	0	4	18	22
	% Share	0	18.2	81.8	100.0
2004	No. of banks	2	3	17	22
	% Share	9.1	13.6	77.3	100.0
2005	No. of banks	1	3	18	22
	% Share	4.5	13.6	81.8	100.0
2006	No. of banks	0	1	21	22
	% Share	0	4.5	95.5	100.0
All (2000-2006)	No. of banks	11	19	117	147
	% Share	7.5	12.9	79.6	100.0

Note: RTS = Returns to scale, IRS = Increasing returns to scale, CRS = Constant return to scale, DRS = Decreasing return to scale.

VI. Conclusions

This study attempts to investigate the efficiency of Malaysian commercial banks during the period of 2000-2006. Using non-parametric approach Data Envelopment Analysis (DEA) methodology enable us to distinguish between technical, pure technical and scale efficiencies. We have run tests for each year, domestic banks, foreign banks, and for all banks for all years.

The results suggest that the mean overall or technical efficiency was 84.3 percent in 2000, increasing to 86 percent in 2001, decreasing to 77.5 percent in 2002, increasing again to 82.1 percent in 2003, and remained stable in 2004 to 2006 with 81.8 percent, 81.3 percent and 81.5 percent respectively.

During the period of study, we found that overall or technical efficiency of domestic banks is 88.7 percent, slightly higher than the foreign banks overall or technical efficiency (73.3 percent). The results suggest that domestic banks pure technical efficiency is lower than the degree of scale efficiency implying that during the period of study, domestic banks have been inefficient in controlling their costs rather than operating at the wrong scale. In contrast, foreign banks pure technical efficiency is higher than scale efficiency indicating that foreign banks were operating at the wrong scale of operations rather than producing below the production frontier.

Overall, for all the years (2000-2006), pure technical efficiency dominates the scale efficiency effects in determining the Malaysian commercial banks overall or technical efficiency. 79.6 percent of the banks experienced decreasing returns to scale, 7.5 percent experienced increasing returns to scale while 12.9 percent were operating at optimal scale.

Further research should take into consideration the issue whether it is appropriate to have a separate frontier for domestic banks and foreign banks or to have a combined frontier for both.

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Appendix I
List of Commercial Banks and Abbreviations

Banks	Abbreviations Used
Domestic banks	
Affin Bank Berhad	AFB
Alliance Bank Malaysia Berhad	ALB
AmBank Malaysia Berhad	AMB
CIMB Bank Berhad	CIMB
EON Bank Berhad	EON
Hong Leong Bank Berhad	HLB
Malayan Banking Berhad	MBB
RHB Bank Berhad	RHB
Public Bank Berhad	PUB
Foreign Banks	
The Royal Bank of Scotland	RBS
Bangkok Bank Berhad	BBB
Bank of America	BOA
The Bank of Nova Scotia	BNS
Bank of China (Malaysia) Berhad	BOC
Bank of Tokyo-Mitsubishi UFJ (Malaysia) Berhad	BOT
Citibank Berhad	CTB
HSBC Bank Malaysia Berhad	HSBC
United Overseas Bank (Malaysia) Bhd.	UOB
Standard Chartered Bank Malaysia Berhad	SCB
JP Morgan Chase Bank Berhad	MCB
OCBC Bank (Malaysia) Berhad	OCBC
Deutsch Bank	DB

Source: Bank Negara Malaysia