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DETERMINANTS OF COST EFFICIENCY IN MALAYSIAN BANKING

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ABSTRACT

This study estimates the cost efficiency and its decompositions of Malaysian banks over the period of 1995 to 2010 by utilising data envelopment analysis (DEA) method. Instead of estimating efficiency based on DEA separate frontiers approach; this study departs from practice of many previous studies by pooling the data set to build a DEA common frontier. This study contributes to the existing literature by integrating determinants of banking efficiency into the areas of DEA methodology in the context of Malaysian banking system across individual domestic banks. The first objective of this study is to estimate cost efficiency and its decompositions, which are technical and allocative efficiency as well as to estimate sources of technical efficiency namely pure technical efficiency and scale efficiency. Next, Tobit regression analysis is undertaken to identify the determinants of various measures of banking efficiency. The results indicate that government ownership, population density, demand density and market concentration are positively associated with several measures of efficiency while year that merger takes place, macroeconomic condition, capitalization, credit risk, asset quality and management quality have a negative relationship with various measures of efficiency. However, the size of banks is found to have mixed sign, positive coefficient with technical and pure technical efficiency while the negative relationship with scale efficiency, cost and allocative efficiency.

Keywords: Determinants, Cost efficiency, Malaysian banking

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1. INTRODUCTION

Within a competitive environment, financial institutions are forced to examine their performance as their survival depends upon their productive efficiencies. It has been argued that factors hindering the ability of emerging economies to adopt optimal stabilization policies are ranged from recurring credit reversals in the global capital market; constraints of political economy; inappropriate exchange rate regimes; financial instability; inefficiencies; and financial market imperfections (Blejer, 2006). Financial efficiency is the root of a successful economy and countries should bring to light the issues of financial efficiency as it would enhance banking stability. Lozano-Vivas & Pastor (2006) claim that financial development is fundamental to economic growth; the technical change in banking productivity in particular, has a significant effect on economic productivity and its convergence. The aforementioned study concur with the role of financial institutions in the nation's growth, as asserted by Schumpeter (1969) that the more efficient the financial system, the better the economy.

Thus, an improvement in the banking performance represents a better allocation of financial resources which results in higher private investments that favours economic growth. One of the main challenges of 10th Malaysian Plan is to stimulate private investment; additionally, the New Economic Model of Malaysia has also listed private investments as one of the core of strategic reform initiatives to transform Malaysia to a high income economy. On top of that, the second thrust of 10th Malaysian Plan states the urgency to create conducive environment to unleash economic growth, by emphasizing on 12 sectors of National Key Economic Areas and financial services sector is listed as one of the areas to be exploited. In this vein, measurement of the performance of financial institutions is important.

The investigation of financial institutions efficiency is important from both a microeconomic and macroeconomic point of view (Berger & Mester, 1997). From the micro perspective, the issue of inefficient banking system is crucial given increasing competition and improvements in the institutional, regulatory and supervisory framework. From the macro perspective, the efficiency of banking sector influences the cost of financial intermediation and the soundness of financial market. Basically, existing studies on banking efficiency can be grouped into three categories - event studies, operating performance studies and frontier analysis studies. Firstly, event studies approach analyses the effects of an event on the value of a firm. In the bank merger context, the shareholders of target banks relish the positive wealth effects as a result of the merger announcement. Secondly, operating performance studies refer to the analysis of financial ratios, which allows for comparisons among different size banks. Nevertheless, both approaches have been criticised; it is argued that the financial ratios analysis does not represent economic value-maximising behaviours of the firms (Kohers, Huang & Kohers, 2000) while the former only reflects market expectations on future performance and it does not portray actual performance of firms (Nail & Parisi, 2005). In light of criticism of both methods, this study employs frontier analysis to measure banking efficiency. Specifically, data envelopment analysis (DEA) is utilised to measure efficiency of Malaysian banking sector.

Apart from that, the study embraces the environmental variables and banking variables to see their impacts on the various measures of efficiency of Malaysian domestic banks. This paper

contributes to government policy with an empirical evaluation of the impact of government initiated merger on the efficiency of a banking system given a market which is more national in scope and highly concentrated. This paper is structured as follows. Following the introduction, Section 2 presents the review of related literature while Section 3 presents the sample of banks with data on inputs and outputs as well as the DEA methodology. Last but not least, the empirical results are presented and discussed in Section 4 whilst Section 5 concludes the paper.

2. PREVIOUS STUDIES

Stream of efficiency studies on the Malaysian banking sector has been initiated by Katib & Mathews (2000). The study employs DEA to estimate the efficiency of 20 Malaysian commercial banks from 1989 to 1995 and find out that the trend in efficiency is decreasing. Unlike the former study, Okuda *et al*. (2002) employ a parametric approach to estimate Malaysian bank cost efficiency between 1991 and 1997. However, the study confirms Katib & Matthews (2000) that small and medium size banks are more cost efficient than large sized banks. On the other hand, Sufian (2003) states that in Malaysian banking sector; the small bank is too small to reap the benefits of economies of scale, while the largest bank is too large to be scale efficient. The results further suggest that Malaysian banking sector have exhibit productivity regress of 6.3% and it is mainly attributed to technological (6.1%) rather than technical efficiency (0.2%) regress.

In addition to that, Sufian & Abdul Majid (2006) state that the large banking groups are on average more x-efficient whereas the smaller banking groups were found to be more price efficient. Matthew & Mahadzir (2006) examine the technical efficiency and productivity with respect to domestic and foreign commercial banks in Malaysia 1994-2000. The results rule that the main source of productivity growth is technical change and foreign banks have a higher efficiency level than domestic banks. Using the same approach (Malmquist productivity indices), Krishnasamy *et al*. (2005) investigate the nature and extent of productivity change of ten commercial banks in Malaysia over the period 2000-2001 as the results of merger. The results indicate that total factor productivity increased in all eight banks except for two banks (EON and Public banks). The growth in productivity is attributed to technological change rather than technical efficiency change.

There is some concern that previous studies had tended to measure efficiency by constructing DEA frontiers pertaining to respective periods such as by Sufian (2004) and Mohd Said et al. (2008). The former estimates efficiency levels based on three sub-periods: 1998-1999, referring to the pre-merger period; 2000, considered the merger period; and 2001-2003, representing the post-merger period. The results illustrate that Malaysian banks' efficiency levels deteriorated significantly in the merger year but were higher during the post-merger period, relative to the pre-merger period. Mohd Said *et al*. (2008) reports contradictory results. On average, the merger scheme did not enhance the productive efficiency of the banks in Malaysian banking industry. The efficiency scores are estimated based on three year periods each, to represent pre-merger and post-merger periods, between 1998 and 2003. The aforementioned studies measure efficiency by constructing a separate frontier pertaining to respective periods. Efficiency scores

are then compared between the respective periods in quantifying the effects of mergers on efficiency. This study contributes to the past studies by constructing a DEA common frontier, enveloping the data sets for all banks in the sample throughout the study period.

Most of the domestic banking studies had focused on measuring efficiency and productivity of the banking industry while studies on determinants of banking efficiency appears to be very limited. As far as this study is concerned, there is only one paper by Sufian (2009) that incorporates a set of explanatory factors (bank size, profitability and ownership) into Malaysian banking efficiency. Nevertheless, this study departs from the aforesaid study as a set of environmental variables and banking variables are incorporated into several measures of banking efficiency to give insights of the variation in banking efficiency.

3. DATA AND METHODOLOGY

3.1. Data

This study includes all domestic banks in Malaysia and covers the period from 1995 to 2010. The bank level data used are taken from BankScope spreadsheets published by Bureau Van Dijk (BVD), supplemented with the published balance sheet and income statement information in annual reports of individual banks. All financial variables reported are in nominal values (Ringgit Malaysia), so to facilitate comparison over time; all the variables are deflated by the consumer price index (CPI) to obtain real values in 2000 price constant.

The definition and measurement of inputs and outputs in the banking function remains a contentious issue among researchers. In the banking theory literature, there are two main approaches which are the production and intermediation approaches (Sealey & Lindley, 1977). Under the production approach, a financial institution is defined as a producer of services for account holders, that is, they perform transactions on deposit accounts and process documents such as loans. The intermediation approach on the other hand assumes that financial firms act as an intermediary between savers and borrowers and posits total loans and securities as outputs, whereas deposits along with labour and physical capital are defined as inputs. This study employs intermediation approach in choosing the variables. Based on the list of inputs and outputs in the preceding studies as well as data availability; the input variables used are personnel expenses, capital which is the book value of premises and fixed assets, deposits and short term funding (hereafter denoted as deposits) whereas the output variables are represented by total loans, total securities and off-balance sheet items. The input prices are calculated as price of labour (the total expenditures on employees such as salaries, employee benefits and reserves for retirement pay is divided by the total assets); price of capital (the book value of premises and fixed assets is divided by the total of fixed assets) and price of deposits (the total of interest expenses divided by the total deposits and short-term funding).

3.2. Methodology

The frontier approach, DEA was introduced by Charnes, Cooper & Rhoades (1978) and it is an analytical tool used to measure relative efficiency of firms throughout the process of transforming inputs into outputs. Technical efficiency measures of how well a firm is able to

minimize its inputs to produce a given set of outputs or to obtain maximal outputs from a given set of inputs. The technical efficiency measure can be further decomposed into pure technical efficiency and scale efficiency. Pure technical efficiency refers to the capability of managers to utilize the proportional reduction in input so inputs are not wasted. Scale efficiency determines the least cost scale given that the firms are on the efficient frontier. It denotes that the banks experienced scale efficiency where the production frontier exhibits constant returns to scale. Cost efficiency is the combination of technical efficiency and allocative efficiency; it provides a measure of how close a bank's actual cost would be for producing an identical output bundle under the same conditions. Allocative efficiency measure of how well a firm is able to choose the optimal amount of inputs to produce the most optimal mix of outputs. (Definitions of efficiency concepts come from various sources include Coelli, Rao & Battese (2000) and Thanassoulis (1999)).

This study employs input-oriented DEA as it is believed that domestic commercial banks should dwell well on the sources of input waste (Isik & Hassan, 2003). Input-oriented DEA is defined as the maximum possible proportional reduction in input with output held constant whilst output-oriented DEA seeks the maximum proportional increase in output with fixed levels of input. Data is analysed using the DEA Excel Solver (Zhu, 2003). DEA efficiency score is obtained by taking the maximum ratio of weighted outputs to weighted inputs. This measurement allows multiple outputs and inputs to be reduced to single "virtual" input (x_i) and single "virtual" output (y_i) by optimal weighs. The envelopment form of the 'virtual' input-output combination is as below:

$$\begin{aligned} &\min\theta,\lambda && \theta, && (1)\\ &\text{s.t.} && -yi + Y\lambda \geq 0,\\ &&& \theta xi - X\lambda \geq 0\\ &&& \lambda \geq 0, \end{aligned}$$

where θ is the efficiency score for the ith DMU and it should be solved n times. Under the assumption of variable returns to scale (Banker *et al*. 1984), the convexity constraint $N1'\lambda=1$ is applied to equation (1).

$$\begin{aligned} &\min\theta,\lambda && \theta, && (2)\\ &\text{s.t.} && -yi + Y\lambda \geq 0,\\ &&& \theta xi - X\lambda \geq 0\\ &&& N1'\lambda=1\\ &&& \lambda \geq 0, \end{aligned}$$

where $N1$ is an $N \cdot 1$ vector of ones. To account for allocative efficiency, the vector of input prices wi is inserted in equation (2), shown as below:

$$\begin{aligned} &\min_{\lambda, xi^*} && wi'xi^*, && (3)\\ &\text{s.t.} && -yi + Y\lambda \geq 0,\\ &&& xi^* - X\lambda \geq 0,\\ &&& N1'\lambda=1\\ &&& \lambda \geq 0, \end{aligned}$$

where $xi*$ is the cost minimizing vector of input quantities for the ith DMU, given the input prices wi and the output levels y_i. The total cost efficiency or overall efficiency of the ith DMU is calculated as:

$$OE = wi'xi*/wi'xi$$

thus, the allocative efficiency is calculated as AE = OE/TE.

It is interesting to find out what firms can do to improve their efficiency so that scarce resources are allocated to their best uses and not wasted during the production of services and goods. To meet the aim, this study employs two-stage DEA method to tackle the issue by incorporating environmental variables into the model via a regression. The first stage involves the computation of the efficiency indices by solving the DEA problem using the chosen inputs and outputs. In the second stage, the efficiency scores are regressed upon explanatory variables using Eviews 7.0. In practice, the direct regression is used whereby a set of explanatory variables are regressed on the efficiency scores. As the values of the efficiency scores are bounded by zero and one, ordinary least squares is not appropriate and a model which explicitly accounts for limited dependent variable are favoured in this case (Lovell, Walters & Wood, 1995); thus, Tobit regression model is preferred. The regression is obtained by making the mean in the preceding correspond to a classical regression model (Tobin, 1958). Following Coelli, Rao & Battese (2000), this study employs two-stage regression on the efficiency scores. In this approach, the efficiency of each firm is expected to depend on a set of environmental variables and banking conditions that characterize its operations. The estimation of Tobit regression is as below:

$$\theta itj = \beta 0 + \beta 1GOVit + \beta 2MERGERit + \beta 3POPDit + \beta 4DDDit + \beta 5HHIit + \beta 6EQTAit + \beta 7GDPit + \beta 8LTAit + \beta 9LOANTAit + \beta 10LLPTLit + \beta 11LNIEit + \varepsilon it \quad (6)$$

The dependent variable θ consists of five types of efficiency scores (*j = technical efficiency, pure technical efficiency, scale efficiency, cost efficiency, allocative efficiency*) for *i*th DMU (*i = AFFIN, ALLIANCE, AMBANK, CIMB, EON, HONG LEONG, MAYBANK, PUBLIC, RHB, SOUTHERN*) at time *t* during the period of 1995–2010. Meanwhile, the parameters β_0 through β_{12} indicate β are parameters to be estimated, $Var\mu it + vit = \sigma 2\mu + \sigma 2v = Var\varepsilon it \sim N0, \sigma 2$ and $i = 1, \ldots, N$ and $t = 1, \ldots, T$ and ε_{it} is the disturbance term.

The set of explanatory variables selected are presented in Table 1. Two dummy variables are created; the first dummy variable is GOV that takes a value of 1 for government ownership in banks, 0 otherwise; while the second dummy variable (MERGER) refers to the year that merger takes place. The latter is intended to capture the merger effects, it takes a value of 1 in the year merger occurs, 0 otherwise. The GOV variable is an indicator of the government ownership in the banks. It is interesting to highlight that, this study suggests that the relationship between government ownership and banking efficiency is expected to have a positive sign; if the bank has link with the government, it provides a good environment for the firm to operate (Johnson & Mitton, 2003; Ahmad, Ariff & Skully, 2007).

Four environmental variables that represent the main economic conditions of domestic banks operating are population density (POPD), demand density (DDD), gross domestic products per capita (GDP) and market concentration (HHI). The population density, POPD is taken as a ratio of total population per square kilometre. It is postulates that the coefficient of the relationship between population density and banking efficiency is positive, the high levels of POPD will lower down the costs of retail banking services; as a result, the efficiency performance of banks will improve. Another factor is demand density, DDD which is measured as the ratio of total deposits per square kilometre. In a lower demand density, banks tend to spend more expenses because the low DDD may create a ceiling to the banking efficiency performance. Next, the GDP variable which is proxied by gross domestic products per capita is included to indicate the economic growth of a nation. This indicator is supposed to reflect the state of economic development of banking market. Next, market concentration on total assets is measured by Hirschman-Herfindahl indexes, labelled as HHI. Structurally, the negative sign indicates that concentrated market leads to reduced efficiency (Leibenstein, 1966). All the aforesaid variables take form of log-transformation.

Finally, the set of banking variables consists of capitalization (EQTA), size of banks (LTA), credit risk (LOANTA), asset quality (LLPTL) and management quality (NIETA). The proxy for capital adequacy (EQTA) is taken as a ratio of total equity and total assets and the variable is expected to have positive link with banking efficiency, whereby a higher level of equity provides safety net for future losses. The banking variables namely size enters the regression model in log-transformation and it is labelled as LTA. Next, the ratio of total loans to total assets is a proxy of credit risk and it is reported as LOANTA in the regressions. Credit risk variable is expected to have a positive relationship with efficiencies which implies that banks with higher loans to asset ratio tend to have higher efficiency scores. Mukherjee, Ray & Miller (2002) state that loans is the most risky and the least liquid asset yet it constitutes the most crucial element of operating income. Last but not least, the asset quality variable (LLPTL) is measured as the ratio of loan loss provisions over total loans while the management quality (NIETA) is taken as the ratio of non-interest expenses over total assets. Both of the coefficients of the asset quality and management quality variables are postulated to have negative sign. The higher the non-performing loans of banks, the lower the efficiency scores while the lower the non-interest expenses, the higher the efficiency of banks.

4. RESULTS AND DISCUSSION

This section starts with the descriptive statistics of the input and output variables as well as explanatory variables employed in the data analysis. Table 1 presents the summary statistics of the variables employed throughout the study period (1995 – 2010), which consists of the mean, median, the minimum and maximum values and the standard deviations. From Table 1, input variables consist of personnel expenses as a proxy for labour input while fixed assets serve as a proxy for capital input and total deposits as the third input. The output variables are represented by total loans and advances, securities portfolio and off-balance sheet items. The inputs and outputs are employed to compute efficiency scores. Next, at the second stage of analysis; the explanatory variables are regressed upon the efficiency scores. The explanatory variables are grouped into environmental variables and banking variables. The environmental

variables chosen are the dummy variable for government ownership (GOV), the dummy variable for year the merger takes place (MERGER), the population density (POPD), the demand density (DDD), the GDP per capita (GDP) and the market concentration (HHI). The banking variables consist of capitalization (EQTA), size of banks (LTA), credit risk (LNTA), asset quality (LLPTL) and management quality (NIETA). Table 1 presents the summary statistics of the variables employed throughout the study period (1995 – 2010), which consists of the mean, median, the minimum and maximum values and the standard deviations.

Table 1: Descriptive statistics for inputs, outputs and explanatory variables (1995-2010)

Variable Description	Mean	Median	Minimum	Maximum	Standard Deviation
Inputs:					
Personnel expenses	184.29	95.50	5.49	825.20	213.19
Fixed assets	293.28	118.10	5.38	1,042.20	329.18
Total deposits	22,311.28	12,452.30	1,321.99	97,934.30	24,544.88
Outputs:					
Total loans and advances	16,450.76	9,551.00	1,159.12	77,852.13	18,248.47
Securities portfolio	4,345.59	2,169.54	211.55	20,491.90	5,081.44
Off-balance sheet	15,208.83	9,054.10	1,664.00	78,698.30	18,355.79
Input Price:					
Price of labour	0.0069	0.0069	0.0018	0.0150	0.0026
Price of capital	1.4223	1.5199	0.2582	5.3662	0.8146
Price of deposits	0.0583	0.0544	0.0237	0.0947	0.0164
*Explanatory Variables:**					
GOV	0.6122	1.0000	0.0000	1.0000	0.4923
MERGER	0.0612	0.0000	0.0000	1.0000	0.2422
POPD	65.74	65.68	62.72	68.86	2.21
DDD	67.64	37.75	4.01	296.91	74.41
GDP	14,399.69	14,438.91	13,654.60	15,393.89	602.94
HHI	2245.41	2337.34	1812.47	2540.59	278.25
EQTA	0.0819	0.0796	0.0009	0.1370	0.0241
LTA	26,568.17	15,012.27	3,115.50	117,478.53	29,406.65
LOANTA	0.63712	0.66064	0.37205	0.89400	0.08743
LLPTL	0.0105	0.0080	0.0001	0.0580	0.0098
NIETA	367.10	190.00	9.95	1,626.57	409.57

Notes: *GOV = Dummy Variable for Government Ownership; MERGER = Dummy Variable for Merger; POPD = Population Density; DDD = Demand Density; GDP = Gross Domestic Products per Capita; HHI = Hirschman-Herfindahl Index; EQTA = Total Equity over Total Assets; LTA = Total Assets; LOANTA = Total Loans and Advances over Total Assets; LLPTL = Loan Loss Provisions over Total Loans; NIETA = Non-interest Expenses over Total Assets.

4.1. Cost Efficiency Performance of Domestic Banks

Next, Table 2 reports the results of the efficiency scores with respect to the DEA common frontier approach. The common frontier is built by pooling the data set for all banks in the sample, throughout the study period.

Table 2: Summary of efficiency scores (1995 - 2010)

Bank/ Period	Technical efficiency	Pure technical efficiency	Scale efficiency	Cost efficiency	Allocative efficiency
1995	0.6784	0.7291	0.9352	0.6136	0.8837
1996	0.7220	0.7881	0.9216	0.5992	0.8228
1997	0.7523	0.8411	0.8995	0.5844	0.7808
1998	0.8056	0.8897	0.9108	0.6231	0.7778
1999	0.7523	0.8200	0.9214	0.5575	0.7421
2000	0.7258	0.8560	0.8464	0.5922	0.7998
2001	0.7083	0.8736	0.8111	0.5493	0.7748
2002	0.7211	0.8951	0.8005	0.6191	0.8395
2003	0.7203	0.9032	0.7993	0.4907	0.6959
2004	0.6849	0.8663	0.7922	0.4835	0.7172
2005	0.6918	0.8993	0.7689	0.5339	0.7675
2006	0.6809	0.8953	0.7639	0.5756	0.8450
2007	0.6157	0.8368	0.7423	0.5493	0.9027
2008	0.6370	0.8718	0.7331	0.5720	0.9075
2009	0.6877	0.9127	0.7505	0.5930	0.8605
2010	0.7216	0.9519	0.7571	0.6343	0.8895
Mean	0.7066	0.8644	0.8221	0.5732	0.8129

Results in Table 2 present the mean efficiency scores of Malaysian domestic banks with respect to technical efficiency, pure technical efficiency, scale efficiency, cost efficiency and the allocative efficiency. The results illustrate that, the overall efficiency of all domestic banks in Malaysia over the period of 1995 to 2010 is quite low, at 57 per cent (%) with the major source of cost efficiency comes from allocative efficiency (81%) while 71% is contributed by technical efficiency. Interestingly, further decomposition of technical efficiency components reveals that pure technical efficiency dominates scale efficiency of domestic banks throughout the study period. The results seem to suggest that Malaysian domestic banks are managerially efficient even though they are not operating at the optimal scale of efficiency.

The results further reveal that, throughout the study period 1995 to 2010; the domestic banks' efficiency is on a mixed trend. For instance, the overall efficiency registers a decline from year 1995 to 1997, improves by 4% in year 1998 before declines again in year 1999. The up and down trend is imitated from year 2000 to year 2007. However, the overall efficiency is at increasing trend from year 2008 to 2010; steadily increase by 2% to 4%. In fact, all types of efficiency show an increasing trend from year 2008 to 2010 whereby the increment is registered

between 2% and 5%. Next, the discussion of efficiency performance for individual domestic banks for selected years (1995, 1999, 2005 and 2009) is based on the results presented in Table 3. The banks are Affin bank, Alliance bank, AMBank, CIMB bank, EON bank, Hong Leong bank, Maybank, Public bank, RHB bank and Southern bank.[1]

Table 3: Summary of efficiency scores for domestic banks, selected years*

Bank/Period		Technical efficiency	Pure technical efficiency	Scale efficiency	Cost efficiency	Allocative efficiency
Affin:	1995	1.0000	1.0000	1.0000	1.0000	1.0000
	1999	0.6923	0.7098	0.9753	0.5388	0.7783
	2005	0.6714	0.8133	0.8256	0.5468	0.8144
	2009	0.6269	0.8419	0.7447	0.6235	0.9946
	Mean	**0.7421**	**0.8238**	**0.8967**	**0.6516**	**0.8791**
Alliance:	1995	0.6539	0.6561	0.9967	0.5538	0.8468
	1999	0.6695	0.6761	0.9903	0.5686	0.8493
	2005	0.6948	0.8081	0.8598	0.5318	0.7655
	2009	0.7223	0.8595	0.8404	0.7157	0.9909
	Mean	**0.6775**	**0.7704**	**0.8820**	**0.5538**	**0.8254**
AMBank:	1995	1.0000	1.0000	1.0000	1.0000	1.0000
	1999	0.8949	0.9407	0.9513	0.6604	0.7380
	2005	0.7455	0.9316	0.8002	0.3813	0.5114
	2009	0.9272	1.0000	0.9272	0.6103	0.6582
	Mean	**0.9224**	**0.9735**	**0.9458**	**0.6502**	**0.6958**
CIMB:	1995	0.6909	0.8238	0.8387	0.5632	0.8152
	1999	1.0000	1.0000	1.0000	0.7491	0.7491
	2005	0.7517	1.0000	0.7517	0.7395	0.9839
	2009	0.6343	0.8719	0.7275	0.6051	0.9541
	Mean	**0.7296**	**0.9299**	**0.7832**	**0.6487**	**0.8974**
EON:	1995	0.5484	0.5484	1.0000	0.4552	0.8300
	1999	0.7150	0.7346	0.9733	0.5500	0.7693
	2005	0.6043	0.8348	0.7239	0.4505	0.7455
	2009	0.4908	0.8299	0.5914	0.2926	0.5961
	Mean	**0.6335**	**0.7848**	**0.8174**	**0.4960**	**0.7809**
Hong Leong:	1995	0.4140	0.4140	1.0000	0.3574	0.8632
	1999	0.6253	0.6932	0.9020	0.4205	0.6725
	2005	0.8825	1.0000	0.8825	0.6984	0.7914
	2009	0.7575	0.9381	0.8075	0.7088	0.9358
	Mean	**0.6490**	**0.7826**	**0.8387**	**0.5341**	**0.8194**

[1] Prior to 2006; CIMB bank is known as Bumiputra-Commerce bank; Southern Bank merges voluntarily with Bumiputra-Commerce Bank in 2006. As a result, the merged entity changes its name to CIMB Bank Berhad. For the purpose of simplicity, this study uses the name of CIMB bank to refer to Bumiputra-Commerce bank (prior to year 2006) and CIMB bank (year 2006 onwards).

Table 3: Summary of efficiency scores for domestic banks, selected years* *(Cont)*

Bank/Period		Technical efficiency	Pure technical efficiency	Scale efficiency	Cost efficiency	Allocative efficiency
Maybank:	1995	0.5917	0.8375	0.7065	0.5244	0.8862
	1999	0.7278	1.0000	0.7278	0.6437	0.8844
	2005	0.6178	0.9659	0.6396	0.4879	0.7898
	2009	0.7604	1.0000	0.7604	0.7495	0.9857
	Mean	**0.6492**	**0.9647**	**0.6732**	**0.5770**	**0.8886**
Public:	1995	0.4382	0.5024	0.8722	0.3386	0.7726
	1999	0.7429	0.8084	0.9189	0.5570	0.7498
	2005	0.5969	0.8145	0.7328	0.4083	0.6841
	2009	0.6459	0.9513	0.6789	0.4465	0.6913
	Mean	**0.6326**	**0.8407**	**0.7606**	**0.4678**	**0.7327**
RHB:	1995	0.9382	1.0000	0.9382	0.9105	0.9705
	1999	0.8951	1.0000	0.8951	0.5293	0.5913
	2005	0.7964	0.9663	0.8241	0.6979	0.8764
	2009	0.6238	0.9213	0.6771	0.5849	0.9378
	Mean	**0.7761**	**0.9715**	**0.7967**	**0.6548**	**0.8501**
Southern:	1995	0.5085	0.5085	1.0000	0.4334	0.8522
	1999	0.5604	0.6373	0.8794	0.3580	0.6387
	2005	0.5566	0.8583	0.6484	0.3963	0.7121
	Mean	**0.6368**	**0.7488**	**0.8615**	**0.4486**	**0.7037**

Notes: *Throughout the study, the observation for Alliance bank for year 2000 is dropped from the analysis. The observation for EON bank for year 2010 and Southern bank for year 2006 to 2010 are also dropped from the data analysis. The former is due to the merging of EON bank and Hong Leong bank in year 2010 while the latter is due to the merging of Southern bank and CIMB bank.

The results in Table 3 are based on chosen years 1995, 1999, 2005 and 2010 (the rest of the findings are available upon request). With respect to technical efficiency and its decompositions, the results suggest that AMBank scores the highest efficiency performance relative to other domestic banks for all chosen year. However, other smaller bank which is Affin bank is the top performer for overall efficiency while CIMB bank leads in terms of allocative efficiency. The results suggest that in year 1999, all domestic banks except one (EON bank) register a decline in allocative efficiency. Nevertheless, the bank which is EON bank only record 0.25% increment of allocative efficiency in year 1999, as compare with its performance in year 1995. The three worst performers in year 1999 are Affin bank, AMBank and RHB bank which record a decline in all types of efficiency, as compares to their performance in year 1995. A decade after year 1999, it is striking to note that all banks (except Maybank) record a declining trend in scale efficiency context with EON bank records the highest decline (almost 40%) in scale efficiency scores. The results imply that Malaysian domestic banks experience scale problem. The declining trend is also found in technical efficiency context, whereby there are only four banks (Alliance, AMBank, Hong Leong and

Maybank) register an improvement in technical efficiency scores. However, the increment figure in efficiency score (3% to 13%) is far from the decline figure in technical efficiency (10% to 37%). Excess uses of resources, output shortfalls and serious scale problem of banks have resulted in their poor performance in terms of technical and scale efficiency. Overall, the top performers are Maybank, Alliance and Hong Leong banks which register increment in four measures of efficiency whilst the worst performers are CIMB, EON and Public banks.

4.2. The Determinants of Cost Efficiency

It is interesting to find out what firms can do to improve their efficiency. With respect to five types of efficiency, an investigation on the explanatory variables related to the firms' efficiency scores is important. A two-stage procedure is undertaken, at the first stage, efficiency scores for each firm are obtained; then, a set of explanatory variables are regressed upon the estimated efficiencies. The results are presented in Table 4 below.

Table 4: Tobit censored regression estimates

Variables	Technical Efficiency	Pure Technical Efficiency	Scale Efficiency	Cost Efficiency	Allocative Efficiency
Constant	0.3692	0.4755	1.4448	-0.0110	-0.6377
	(0.7873)	(0.6364)	(0.1159)	(0.9929)	(0.5660)
GOV	0.0157	0.0082	0.0002	0.0268	0.0579
	(0.4690)	(0.5665)	(0.9891)	(0.1384)	(0.0000)*
MERGER	-0.1333	-0.0525	-0.0694	-0.1201	-0.0099
	(0.0003)*	(0.0467)**	(0.0045)*	(0.0014)*	(0.7351)
POPD	2.1361	1.0002	1.1937	1.9024	0.9154
	(0.0001)*	(0.0036)*	(0.0021)*	(0.0001)*	(0.0288)**
DDD	0.0412	0.0466	0.0007	0.0569	0.0256
	(0.3943)	(0.2587)	(0.9807)	(0.2259)	(0.4699)
GDP	-1.0841	-0.5565	-0.6591	-0.8850	-0.3443
	(0.0017)*	(0.0168)**	(0.0076)*	(0.0036)*	(0.0916)***
HHI	0.1900	0.0205	0.2119	0.1994	0.2245
	(0.1317)	(0.8134)	(0.0155)*	(0.0815)***	(0.0142)**
EQTA	-1.1033	-0.0393	-1.1342	-1.8581	-1.6277
	(0.0461)**	(0.9133)	(0.0020)*	(0.0000)*	(0.0000)*
LTA	0.1203	0.2110	-0.0597	-0.0386	-0.0792
	(0.0214)**	(0.0000)*	(0.0492)**	(0.4323)	(0.0376)**

Table 4: Tobit censored regression estimates *(cont)*

Variables	Technical Efficiency	Pure Technical Efficiency	Scale Efficiency	Cost Efficiency	Allocative Efficiency
LOANTA	-0.0111 (0.9122)	-0.1348 (0.0996)	-0.1100 (0.1009)	-0.7187 (0.0000)*	-0.6969 (0.0000)*
LLPTL	-3.1801 (0.0834)***	-2.1340 (0.0634)***	-0.2733 (0.8257)	-0.4406 (0.7741)	-2.3042 (0.0389)**
NIETA	-0.1753 (0.0000)*	-0.1948 (0.0000)*	-0.0173 (0.4114)	-0.1048 (0.0014)*	-0.0574 (0.0297)**

Notes: * - significant at 1% level, ** - significant at 5% level and *** - significant at 10% level

Table 4 presents the results based on the Tobit regression. Following Lozano-Vivas, Pastor & Pastor's (2002), the stepwise procedure is undertaken; this approach helps to minimize the number of variables by statistically selecting only the influential variables. The regression results are based on 152 bank year observations during the 1995-2010 periods. Following Hauner (2005), QML (Huber/White) standard errors and covariates are calculated. For the effect of environmental variables on efficiency scores, several findings can be highlighted. First, the results indicate that the influence of GOV variable (government ownership) on efficiency scores is positive; if a firm has links with the government, the relationship between government and the firm would provide a good environment for the firm to operate. Even though the GOV variable has the expected sign but this variable is found to be significant only in cost efficiency case. Contrary to findings of previous efficiency studies on government ownership, the positive signs of government-linked banks in this study imply that the close relationship between banks and the government had definitely made the banks more efficient. Johnson & Mitton (2003) claim that politically connected non-financial and financial institutions are the major gainers of capital control in the case of Malaysian financial system.

Next, the second dummy variable which is the MERGER variable consistently shows negative sign across various measures of efficiency, which mean that the merger causes a decline in efficiency performance. The variable is found to be highly significant at 1% and 5% level for all types of efficiency but allocative efficiency. This finding implies that bank merger has resulted in lower efficiency performance of banks (Berger & Humphrey, 1992; Shaffer, 1993; Rhoades, 1998; Garden & Ralston, 1999). Berger (2003) states that mergers can decrease bank efficiency due to an increase in costs (e.g. consultation fees, severance pay and legal expenses) as well as downsizing disruptions, conflict of organizational cultures and managerial turf battles. Interestingly, the POPD variable which represents the population density maintains its expected sign and the variable is found to be highly significant at 1% and 5% level in all measures of efficiency. Nevertheless, another variable DDD (demand density) which is proxied by a ratio

of total deposits over total population of a nation is found to be insignificant in all types of efficiency. However, the variable maintains its expected positive sign; the higher the demand density of population, the higher the efficiency scores.

This study uses the log-transformation of gross domestic product (GDP variable), which represents the economic development of the market. The conjecture is that banks operating in a high-income environment are more likely to be more efficient. However, this study reports contradictory outcomes with the results indicating that the better the economic conditions, the lower the efficiency levels. It is noteworthy that, the striking results are found to be statistically different from zero for all types of efficiency. The findings could be due to the relatively volatile rates of national income growth during the period of analysis, whereby the demand for financial services tended to grow as economies expanded and societies became wealthier (Sufian & Chong 2008). Another justification is provided by Williams & Nguyen (2005), the authors claim that due to a luxury environment, bank customers set very high expectations on banking goods and services; however, the bank management has not been successful in meeting the challenge. Even though this finding is contrary to Hahn's (2007) study, which found that economic development had a positive relationship with efficiency; the results are not new to the Malaysian banking industry, as Sufian (2009) discloses that the economic conditions has a negative impact on banking efficiency. Next, the results indicate further that that market concentration which is represented by HHI variable is statistically significant only in the context of scale efficiency, cost and allocative efficiency; however, the signs appear positive in all types of efficiency. Structurally, the results of this study seem to suggest that market concentration leads to efficiency gains. From another point of view, the regression results do not offer support to a quiet-life hypothesis, which predicts a negative relationship between concentration and efficiency. Market concentration is the reverse indicator of market competition, thus, a highly concentrated market not necessarily to signify an uncompetitive market, as advocated by Demsetz (1973).

As for the effects of banking conditions on various measures of efficiency, the capitalization or capital adequacy variable (EQTA) has a negative relationship with banking efficiency. The variable is found to be statistically significant in all types of efficiency except for pure technical efficiency case. The finding suggests that inefficient banks possess a high capital asset ratio which indicates low leverage and low risk, as compares to their peers. The total assets variable (LTA) is included in the regressions to account for the differences in efficiency due to the size of banks and it can be considered as a proxy for economies of scale (De Bandt & Davis 2000; Shaffer 2002). It is conceived implicitly that larger banks are more likely to perform better than smaller banks, due to them being more professionally managed with better-diversified asset portfolios. However, this positive image could be countervailed by the bank's capability to diversify and spread its risks (Shyu & Reichert 2002). Apparently, bank size is statistically significant in all cases except cost efficiency; however, the signs are mixed. The LTA variable is found to be positive in the case of technical and pure technical efficiency while appears to be negative in the case of scale, cost and allocative efficiency. The negative sign suggests that as the banks get larger, it has resulted in higher inefficiency of banks. This could be due to higher coordinating costs, complex organizational structure and moral hazard behaviour or because the banks are experiencing the diseconomies of scale benefit. The results also suggest

that domestic banks have already increased in size, thus, their further growth in total assets leads to diseconomies of scale as evidenced in the scale efficiency. Such a finding is consistent with Isik & Hassan (2002) and Darrat, Topuz & Yousef (2002). Both studies suggested that strong competition intensifies market discipline on small banks, which need to be cost efficient and managerially aggressive in order to survive.

The credit risk variable or liquidity which is represented by LOANTA variable reveals a negative relationship with efficiencies in all regressions. However, this variable appears to be significant in only cost and allocative efficiency. The findings imply that banks with higher loans to asset ratios tend to have lower efficiency scores. High credit risk is more costly to maintain, thus, it put pressures on bank management to improve its efficiency. Relatively efficient banks may have lower production costs, which enable them to offer more reasonable loan terms and ultimately, gain larger market shares over inefficient banks (Sufian & Abdul Majid 2006). This finding is in line with Sufian & Abdul Majid (2007); nevertheless, the results are contradicted with findings by Isik & Hassan (2002) and Hahn (2007). Proxy for asset quality variable which is LLPTL retains its expected negative relationship with banking efficiency; the variable is found to be statistically significant in the case of technical, pure technical and allocative efficiency. The poor asset quality is the main contribution of bank failures (Cooper, Jackson and Patterson, 2003); the finding is consistent with earlier findings such as Resti (1997) and Barr et al. (2002). Lastly, the NIETA variable which provides information of the management quality shows negative relationship with banking efficiency; the results are significant in all cases except scale efficiency. The results imply that higher ratios of non-interest expenses over total assets results in less efficient management.

5. CONCLUSION

The present study has analysed the bank efficiency estimates of Malaysian domestic banks over the period of 1995 to 2010 by utilising data envelopment analysis (DEA) method. The efficiency estimates of individual domestic banks consist of measuring cost efficiency and its components which are technical efficiency and allocative efficiency. Next, technical efficiency is further decomposed into its sources namely pure technical efficiency and scale efficiency. To determine variations in banking efficiency; environmental and banking variables are incorporated into Tobit regression analysis to identify the determinants of various measures of banking efficiency. The environmental variables consist of government ownership; year of merger; population density; demand density; gross domestic products per capita and market concentration. The set of banking variables consist of capitalization; size of banks; credit risk; asset quality and management quality.

The results find out that throughout the period of year 1995 to year 2010, the level of cost efficiency is estimated at 57%; it suggests that it would be possible for banks to reduce costs by approximately 70%. Approximately half of the estimated inefficiency is due to technical inefficiency while 26% of inefficiency scores are contributed by allocative inefficiency. These suggest that the management has been efficient in allocating resources to other sources of income such as fee-based income to generate higher profits. However, there still a great potential for the industry to increase efficiency through higher utilization of technology and

technological knowledge dispersion. Additionally, further decomposition of technical efficiency reveals that scale efficiency scores are lower than pure technical efficiency. With respect to scale efficiency, the results of individual banks suggest that scale efficiency is at decreasing trend over the period of 1995-2010.

The Tobit regression results demonstrate that government ownership, population density, demand density and market concentration are consistently positive with various measures of efficiency. However, demand density is insignificant across all types of efficiency while government ownership appears to be statistically significant only in the case of cost efficiency. Other environmental variables, which are the macroeconomics condition and the merger variable; the signs of coefficient across various types of efficiency are consistently negative. Perhaps, the relatively volatile rates of national income growth, during the study period, contributed to this finding. The volatile economic growth had caused banks to endure a lesser demand for their services, loan defaults increased and lower outputs (Sufian, 2009).

With respect to banking variables, the results indicate that capitalization, credit risk, asset quality and management quality are found to have negative relationship with various measures of efficiency; while, the size of banks yields mixed sign of relationship with banking efficiency. In respect of size variable, it is found that size is significant in all types of efficiency (except cost efficiency) and the negative sign of coefficients are reported in three cases of efficiency. This finding suggests that the banking inefficiency appears to run at the expense of large banks, as perhaps the domestic banks had already gained in terms of size thus further growth in total assets might have led to diseconomies of scale (Isik & Hassan 2002; Darrat, Topuz & Yousef 2002). Sufian (2003) suggests that the smallest banks in Malaysia are too small to reap the benefits of economies of scale, yet the largest bank is too large to be scale efficient.

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