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Technical Efficiency of Malaysia's Development Financial Institutions: Application of Two-Stage DEA Analysis

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Abstract

This paper investigates the technical, pure technical, and scale efficiency of 9 development financial institutions (DFIs) operating in Malaysia from 2006-2012 and factors affecting the efficiency of development financial institutions, using the two-stage data envelopment analysis (DEA). Results revealed that the mean technical efficiency of DFIs in Malaysia is 78 percent. Two banks namely BPMB and SCC are the benchmark banks identified by DEA scores. Results show that the role of scale inefficiency in overall technical inefficiency is comparatively less than managerial inefficiency. Results also show that only BPMB, SCC experienced constant returns to scale for the period 2006-2012, fulfilling their primary objective of contributing towards the socio-economy development of the state. BSN, a major saving institution, experienced decreasing returns to scale in 2009 and 2012. SME bank, whose mission is to develop SMEs, too experienced decreasing returns to scale during 2009-2010. CGC and Agro bank also experienced decreasing returns to scale in 2008-2009 and 2010-2012. In second stage, results of the OLS regression analysis provides that Loans to total assets, natural logarithm of total assets, Loan-Loss provision to total loans, non-interest income to total assets, return on assets and total shareholders' equity to total assets are related to technical efficiency but loans to total assets, positively related to technical efficiency and significant and shows that banks with higher loan to asset ratios tend to have higher technical efficiency scores; non-interest income to total assets is negatively related to technical efficiency and significant revealing that development financial institutions which derive a higher proportion of income from non-interest sources tend to report lower efficiency scores. Return on assets are found significant in explaining the Malaysian development financial institutions efficiency from 2006-2012.

Keywords: development financial institutions, technical efficiency, pure technical efficiency, scale efficiency, data envelopment analysis, ordinary least squares (OLS) regression analysis

1. Introduction

Financial intermediaries provide financial services like payments, liquidity, store of value, divisibility, maturity transformation, risk pooling and information economies. Banks are the main intermediaries that provide a majority of the core financial services. However, they do not provide all services efficiently equally. Non-bank financial institutions (NBFIs) particularly development financial institutions supplement banks by providing services in the form of development finance, that are not well suited to banks. Function of development finance is to categorize the cracks in establishments and markets in a country's financial sector and acts as a concealer and is thus targeted at economic agents, which are rationed out of market. The vehicle for extending the development finance is popularly known as the development financial institution (DFI) or development bank.

Development financial institutions in Malaysia are established by the government with specific mandates. DFIs not only assist the Malaysian government in developing and promoting the identified strategic sectors of the economy e.g. agriculture, micro, small and medium enterprises, infrastructure, etc. but also act as a catalyst in achieving socio-economic goals by complementing the role of the banking institutions (Chew, 2011). By 2020, Malaysia seeks to achieve a status of high value-added and high income economy and Malaysia's small and medium enterprises (SMEs) that act as a backbone of Malaysian economy, have an indispensible role to play, with nearly 99% of total establishments contributing 32% of Malaysia's GDP, generating 59% of employment and 19% of exports. By 2020, estimates show that SMEs in Malaysia will be contributing 41% of GDP,

employing 62% of population and promoting 25% of the exports. Thus, DFIs in Malaysia like Small and Medium Enterprise (SME) Development Bank Malaysia Berhad (SME Bank), Bank Simpanan Nasional (BSN), and Bank Pertanian Malaysia Berhad (Agrobank) and other DFIs that cater to the needs of entrepreneurs in the agricultural sector and focus on the provision of micro-financing to micro enterprises have a major role to play in making Malaysia a high value-added and high income economy in the future.

2. Literature Review

There is a plethora of literature evaluating the performance of financial institutions particularly banking institutions. Financial ratio analysis, data envelopment analysis, and the stochastic frontier analysis are the few frequently and widely used approaches to analyze the financial performance of the banks. Hamid & Azmi (2011), Bader Shamser & Taufiq (2007), Hassan and Bashir (2003); Rosely, Mohd. Afandy (2003); Samad (1999); Akkas (1996); and Arif (1989), in their study used financial ratio analysis to assess the financial performance of banks. DEA, another approach led by Charnes et al. (1978), utilized by researchers as a methodology for performance evaluation (Gregoriou & Zhu, 2005). Applying DEA, Sherman and Gold (1985), and Parkan (1987) analyzed the efficiency of branches of US and Canadian banks, respectively. Rangan et al. (1988) analyzed the pure technical inefficiency and scale inefficiency of 215 US banks. Their results showed that the same amount of output could have been produced by banks with 70 per cent of the inputs and the cause of inefficiency was primarily technical. Yue (1990) examined the efficiency of banks in Missouri, US (1984-1990), and found that the major source of overall technical inefficiency was pure technical inefficiency. Efficiency of 143 Japanese banks was examined by Fukuyama (1993) using the DEA method. Findings showed that the banks were more scale efficient compared to pure technical efficient (PTE). Study by Yudistria (2003) who also applied DEA to examine the technical, pure technical, and scale efficiency of Islamic banks found that diseconomies of scale for small-to-medium Islamic banks existed and therefore mergers were encouraged; and Drake et al. (2006) used a combination of slack-based Tobit regression approach with DEA to examine the impact of macroeconomic and regulatory factors on the efficiency of Hong Kong banking system. This study concluded that there was an existence of high level of technical inefficiency for many institutions and also differential impacts of environmental factors on different size groups and financial sectors. Studies focusing on Malaysian development financial institutions are few; among them was a study by Islam (2012) who utilized the most commonly traditional financial ratio approach to assess the financial performance of two DFIs in Malaysia and found that the financial health of the two DFIs was sound but comparatively, Bank Rakyat was in a better position than its peer, Bank Simpanan Nasional (BSN). Ong et al. (2005) used a non-parametric technique to determine the scale and technical efficiency of four development financial institutions and CGC in Malaysia over a period of 1981-1998 and found that the DFIs were operating satisfactorily in extending their services to small and medium local enterprises. Fadzlan (2006) utilized DEA to investigate the efficiency of Malaysian non-bank financial institutions over a period of 2000-2004 and found that the finance companies' mean overall efficiency was greater than merchant banks' mean overall efficiency and also showed that pure technical inefficiency rather than scale inefficiency resulted in Malaysian NBFIs overall inefficiency.

Among the above mentioned studies, few studies have focused on efficiency of DFIs in Malaysia. Therefore, our study is going to use the two stage analysis of DEA, where in the first stage the technical efficiency of nine DFIs in Malaysia over a period of 2006-2012 will be examined and then in the second stage, OLS will be applied to determine the factors affecting the efficiency.

3. Research Methodology

The non-parametric DEA method, first introduced by Charnes et al. (1978), will be used to measure the input-oriented technical efficiency of the DFIs in Malaysia. The CCR (Charnes, Cooper and Rhodes) model calculates an overall efficiency for the unit in which both its pure technical efficiency and scale efficiency are amassed into a single value assuming constant returns to scale (CRS) and CRS hypothesis is acceptable when all decision making units (DMUs) are functioning at an optimal scale. But, institutions like banks face either economies or diseconomies of scale. Thus, assuming Constant Returns to Scale, the calculated measures of TE will be contaminated with scale efficiency (SE) when all DMUs are not functioning at an optimal scale. Beyond CCR, Banker et al. (1984) introduced another model BCC (Banker, Chames and Cooper) by relaxing the CRS assumption. Assumption of Variable Returns to Scale provides the measurement of PTE. An observable deviance among the Technical efficiency and Pure Technical Efficiency scores of DMUs shows the presence of Scale inefficiency, i.e., Technical Efficiency = Pure Technical Efficiency × Scale efficiency. Pure Technical Efficiency is related to the capability of managers to use banks' given resources, and scale efficiency is related with exploiting scale economies by operating at constant returns to scale.

3.1 Multivariate Regression Analysis

One drawback with the DEA methodology is that it infers random errors as inefficient, that makes it complex to outliers and degrees of freedom. Studies by Banker (1993) and Banker and Natarajan (2004) stated that the efficiency θ_i is a consistent estimator and was found that the use of a two-stage procedure using DEA followed by an ordinary least square (OLS) regression gives consistent estimators of the regression coefficients (Banker & Natarajan, 2008). Following Sufian (2010), equation (1) is estimated by using the Ordinary Least Square method. Technical efficiency scores are used as the response variable, and the subsequent multivariate model is estimated:

$$\lambda jt = \delta_0 + \beta_1 \text{LN(LOANS/Total Assets)}jt + \beta_2 \text{LN(Total Assets)}jt + \beta_3 \text{LN(Loan-Loss Provision/Total Loans)}jt + \beta_4 \text{LN(Non-Interest Income/Total Assets)}jt + \beta_5 \text{LN(EQASS)}jt + \beta_6 \text{LN(ROA)}jt + \varepsilon jt \quad (1)$$

where '*i*' depicts the DMU(bank), '*t*' the time period, and is the disturbance term. In order to measure bank's loans intensity, LOANS/Total Assets, calculated as the ratio of total loans to total assets; LNTA is used as a proxy measure of bank size in terms of total bank assets; Loan Loss Provision/Total Loans, a measure of bank's credit risk is calculated as the ratio of total loan loss provisions divided by total loans; Non-Interest Income/Total Assets, a measure of bank diversification towards non-interest income; EQASS is used as a representation measure of bank's capitalization level and ROA is a representation measure for bank's profitability.

3.2 Specifications of Bank's Input, Output and Data

Two popular approaches normally used to evaluate efficiency in banking are production and the intermediation approach. Benston in 1965 introduced Production approach, that consider banks provide services to customers whereas Intermediation approach accepts that financial firms act as an intermediary between savers and borrowers and posits total loans and securities as outputs, and deposits along with labor and physical capital are defined as inputs. Charnes et al. (1990), Bhattacharyya et al. (1997) and Sathye (2001) adopted intermediation approach. Berger and Humphery (1997) proposed that the intermediation approach is best suited for analyzing bank level efficiency, whereas the production approach is well suited for measuring branch level efficiency.

This proposed study will be using the secondary data of nine Development Financial Institutions (Bank Pertanian Malaysia Berhad (Agrobank), Bank Kerjasama Rakyat Malaysia Berhad (Bank Rakyat), Bank Pembangunan Malaysia Berhad Bank (BPMB), Bank Simpanan Nasional (BSN), Malaysian Industrial Development Finance Berhad (MIDF), Sabah Credit Corporation, Bank Perusahaan Kecil & Sederhana Malaysia Berhad (SME Bank), Credit Guarantee Corporation Berhad (CGC), and EXIM Bank) annual reports for the period of 7 years (2006-2012). This study is restricted to nine DFIs because of data unavailablity. Under intermediation approach, 2 inputs and 2 outputs are chosen for each development financial institutions.

Input A (x_1) = Total deposits,

Input B (x_2) = Total expenses,

Output A (y_1) = Loans, financing and advances,

Output B (y_2) = Net investments.

4. Empirical Finding

This section is going to discuss the technical efficiency (TE) of the development financial institutions, through DEA method and further breaking down to Pure Technical efficiency (PTE) and Scale efficiency (SE) components. Table 1, 2, 3 and 4 provides a summary of technical, pure technical and scale efficiency estimate results. Table 1 (refer appendix) findings show that the mean TE of the Malaysian Development financial institutions ranges between 71 percent in 2009 to 87.1 percent in 2010. Findings suggest that relative to their cost frontier, DFI's of Malaysia have been operating at 12.9 percent to 29 per cent above minimum cost levels. Findings of Table 1 show that BPMB and SCC are the most efficient development financial institutions with mean technical efficiency of 100 percent. BSN is close to efficiency frontier with mean technical efficiency of 94 percent. Development financial institutions that require improvement to be efficient are the SME, MIDF, Bank Rakyat, Agro Bank, CGC and EXIM Bank.

Breakdown of TE into Pure Technical efficiency (PTE) and Scale efficiency (SE) shows that Scale inefficiency (SIE) has major implication as a source of inefficiency than Pure Technical Inefficiency (PTIE). It is observed from Table 2 (refer appendix) that Malaysian development financial institutions have exhibited a mean PTE that lies between 90 percent in 2010 to 78 percent in 2009. Findings of Table 2 suggest that Bank Rakyat, BPMB, MIDF and SCC are the most efficient development financial institutions with 100 percent mean score. BSN is close to efficiency frontier with 98 percent and SME bank, Agro Bank, CGC and EXIM bank requires

improvement to become efficient. Pure technical inefficiency (PTIE= 1-PTE/100) ranges from 22 (2006) percent to 10 (2010) percent.

Findings of Table 3 (refer appendix) show that the average estimates of Scale efficiency (SE) ranges from 84 percent to 97 percent. BPMB and SCC are scale efficient and SME and BSN are close to efficiency frontier with 98 and 95 percent. CGC, Agro Bank, EXIM Bank, MIDF and Bank Rakyat are inefficient and need improvement. Scale inefficiency among the Malaysian DFIs ranges between 3 percent to16 percent.

Table 4 (refer appendix) findings show that during the period of study (2006-2012), DFIs mean pure technical efficiency is 84 percent and scale efficiency 91.14 percent. The mean PTE during the period is higher than the mean TE. This result is supported with the findings of Banker *et al.* (1984) that stated that technical efficiency scores obtained under VRS (PTE) are higher than or equal to those obtained under CRS (TE). Findings indicate that the bank inefficiency is attributed to pure technical/managerial efficiency rather than scale efficiency. This also implies that during the period of study, development financial institutions have been found inefficient in controlling or reducing their costs rather than operating at the wrong scale of operations.

4.1 Determinants of Development Financial Institutions of Malaysia's Technical Efficiency

As can be seen in Table 5, (refer appendix) result of OLS regression shows that the independent variable Loans to total assets is positively related to technical efficiency and is significant, indicating a negative relationship between bank efficiency and the level of liquid assets held by banks. Result shows that banks with higher loan to asset ratios incline to reveal greater technical efficiency scores; therefore bank loans carry additional weightage to other bank outputs. Regarding the influence of bank size, LNTotal Assets is negatively related to the efficiency of development financial intuitions but it is insignificant. Negative coefficient indicates that larger(smaller) banks tend to exhibit lower (higher) efficiency levels and provides support to other studies that found economies of scale and scope for smaller banks or diseconomies of scale for larger banks (Pasiouras & Kosmidou, 2007; Staikouras et al., 2008). The coefficient of the LLP/TL is negative, reflecting that development financial institutions with higher credit risks tend to exhibit lower efficiency scores. The empirical findings imply that the banks should focus more on credit risk management. The impact of NII/TA on efficiency is negative and is significant. Results imply that development financial institutions which derive a higher proportion of income from non-interest sources tend to report lower efficiency levels. Total shareholders' equity to total assets is positively related to efficiency; imply that development financial institutions that possess capital strength are also efficient.

5. Conclusion

Although, in Malaysia's financial system, development financial institutions comprise only 5.8% of total financial system, yet they are expected to act as a promoter in realizing socio-economic objectives in the economy. This paper assesses the technical efficiency of Malaysia's nine developmental financial institutions over a period of 2006-2012 from the perspective of intermediary role. Using the intermediation approach, two inputs namely total deposits, total expenses and two outputs: loans, financing and advances and net investments are used to calculate the technical efficiency (TE) which further broken down into pure technical efficiency (PTE) and scale efficiency (SE). The analysis is being conducted based on malaysian development financial institutions efficiency scores per year and on average during the period of study. Later, the study used the OLS regression analysis to regress the technical efficiency scores obtained from the first stage over several internal variables reflecting bank characterstic and stratagic decisions.

The results of the data development analysis (DEA) indicates that the average technical efficiency (TE) scores over the entire period equal to 78 percent which indicates that banks could have saved 22 percent of inputs. Hence, between 2006 and 2012 development financial institutions could improve pure technical efficiency by 16 percent and scale efficiency by 8.86 percent on average. Pure Technical efficiency scores provide that all the inefficiencies directly result from managerial underperformance (i.e., managerial inefficiency) in organizing the bank's inputs hence the development financial institutions (EXIM Bank, CGC Bank, SME Bank and Agro Bank) whose Pure Technical efficiency (PTE) scores are less than Scale efficiency (SE) scores are considered as managerial inefficient in resource utilization. The result also shows that Development Financial Institutions (Bank Rakyat, BSN) are scale inefficient and are not functioning at an optimal scale. Bank Rakyat and BSN are functioning at decreasing returns to scale i.e., proportionate increase in output is less than the proportionate increase in inputs. Bank Rakyat and BSN need to reduce the proportion of inputs to outputs to function at an optimal level. Findings of the determinants that affect the technical efficiency of Development Financial institutions shows that Loans to total assets, natural logarithm of total assets, Loan-Loss provision to total loans, non-interest income to total assets, return on assets and total shareholders' equity to total assets have correlation to technical efficiency but

loans to total assets, non-interest income to total assets, return on assets are found significant in explaining the Malaysian development financial institutions efficiency from 2006-2012.

This study is constrained by unavailability of data because there is no organized database for non-bank financial institutions in Malaysia. In future, this research can be expanded to look into the potential ability of development financial institutions towards achieving their profitable commitments and expansion of socio-economic targets of Malaysia and can be expanded to examine the risk and efficiency in DFIs in Malaysia.

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Appendix A

Table A1. Technical efficiency scores (IA) (constant returns to scale)

	Year							
Banks	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**Mean**
Agro Bank	64.9	81	100	63.4	85	55	33	69
Bank Rakyat	78.6	82	79.2	76	96	36	100	78
BPMB	100	100	100	100	100	100	100	100
BSN	100	100	100	80	100	100	75	94
MIDF	73.6	82.3	100	100	100	100	5.1	80.1
SCC	100	100	100	100	100	100	100	100
SME Bank	100	100	100	77	56.1	49.3	100	83.2
CGC	12.7	12.4	10.6	21	100	100	62	45.5
EXIM Bank	NA	NA	18.3	19.4	48	31.1	72.3	38
Mean	79	82.2	79	71	87.1	75	72	78

Source: Authors own calculation

Table A2. Pure technical efficiency scores (IA) (variable returns to scale)

	Year							
Banks	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**Mean**
Agro Bank	66.2	82	100	64	96	79.4	36	75
Bank Rakyat	100	100	100	100	100	100	100	100
BPMB	100	100	100	100	100	100	100	100
BSN	100	100	100	100	100	100	86.2	98
MIDF	100	100	100	100	100	100	100	100
SCC	100	100	100	100	100	100	100	100
SME Bank	100	100	100	79	60	53	100	85
CGC	13.5	12.5	100	26	100	100	82	62
EXIM Bank	NA	NA	27.4	30.3	52	36	86.2	46
Mean	79	87	82.1	78	90	85.3	87	84

Source: Authors own calculation

Table A3. Scale efficiency scores (IA)

	Year							
Banks	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**Mean**
Agro Bank	98	99.1	100	99.2	89	69	93	92.4
Bank Rakyat	79	82	79.2	76	96	36	100	78.31
BPMB	100	100	100	100	100	100	100	100
BSN	100	100	100	80	100	100	87	95
MIDF	74	82.3	100	100	100	100	5.1	80.2
SCC	100	100	100	100	100	100	100	100
SME Bank	100	100	100	97.1	94	93.1	100	98
CGC	94.2	99.5	91.3	79.2	100	100	76	91.45
EXIM Bank	NA	NA	67	64.1	92.4	88	97	82
Mean	93.1	95.4	93	88.3	97	87.2	84	91.14

Source: Authors own calculation

Table A4. Mean technical efficiency-decomposition into pure technical efficiency and scale efficiency

	2006	2007	2008	2009	2010	2011	2012	Mean (2006-2012)
PTE	79	87	82.1	78	90	85.3	87	84
SE	93.1	95.4	93	88.3	97	87.2	84	91.14
TE	79	82.2	79	71	87.1	75	72	78

Source: Authors own calculation

Table A5. OLS regression result

Efficiency	Coef.	Robust Std. Err.	T	P>|t|	[95% Conf.	Interval]
L_TA	36.17274**	12.97257	2.79	0.007	10.15305	62.19243
LNTA	-3.436257	2.871897	-1.20	0.237	-9.196554	2.324039
LLP_TL	-28.64984	69.05024	-0.41	0.680	-167.1471	109.8474
NII_TA	-431.9783***	121.1579	-3.57	0.001	-674.9902	-188.9664
ROA	-.4545815***	.0991884	-4.58	0.000	-.6535283	-.2556348
TSE_TA	20.26842	24.58826	0.82	0.413	-29.04939	69.58622
_cons	143.5796*	70.19261	2.05	0.046	2.791077	284.3682

t statistics in parentheses; * p<0.05, ** p<0.01, *** p<0.001; L_TA= Loans to total assets is a measure of banks loans intensity. LNTA= Natural Logarithm of Total Assets is a size of the bank's total assets. LLP_TL= Loan Loss provision to total loans is a measure of banks risk; NII_TA= Non-interest income to total assets is a measure of banks diversification towards non-interest income; ROA= Return on assets is a proxy for banks profitability; TSE_TA= Total shareholders' equity to total assets is a measure of banks leverage intensity.

Note: robust standard errors number of obs = 61; F(7, 53) = 38.50; Prob> F = 0.0000; R-squared = 0.2748; Root MSE = 25.896