An Efficiency Tool: Application of CCR and SBM models in measuring commercial banks' performance in Malaysia

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***Abstract*—Bank efficiency is very important in the banking industry. There are many methods involved to measure the efficiency of bank performance. This paper focuses on Slack Based Measure (SBM) and Charnes, Cooper, and Rhodes (CCR) model by comparing the result of efficiency. SBM gives the input excesses and output shortfalls for a decision many units (DMU) concerned. Meanwhile the CCR was interpreting as a reduction of the multiple outputs or multiple input situation for each DMU to a single "virtual output" and virtual input." Furthermore, the result from this research states using SBM model give a value of input excesses and output shortfalls for each bank inefficient. The result also indicates that SBM score efficiency for bank inefficient is less than CCR score efficiency.**

Keywords—Bank Efficiency, Slack Based Measure, CCR Model

I. INTRODUCTION

Efficiency analysis is essential for the evaluation of a bank's performance. A bank is considered to be efficient if it can generate the maximum of revenues by using its resources efficiently. Recently, there are many methods involved to measure the efficiency of bank performance [1]. In this study, we focus on Slack Based Measure (SBM) and Charnes, Cooper & Rhodes (CCR) models that have been introduced by Tone [2] and Charnes et al. [3]. The study uses secondary data collected from commercial banks. There are two types of data namely the input data and output data, whereby the input data refers to the banks' expenses such as labour cost, fixed financing cost, fixed financing asset and financing operating cash flow. Whereas the output data refers to the banks' incomes generated from sources such as commercial and industrial loan, housing loans, customer personal loans, other types of loans and revenue churned from customers' saving [4]. In this studies, we have two main objectives which are to measure efficiency of banks in Malaysia using input and output data of commercial bank in Malaysia and also to compare the efficiency score between Slack Based Measure (SBM) and Charnes, Cooper, and Rhode (CCR) models.

The rest of this paper is organized as follows: Section 2 discuss the detailed literature review of models involved. Then, proposed method is presented in Section 3. In section 4, we discuss the result obtained from CCR and SBM model. The conclusion are given in Section 5.

II. LITERATURE RIVIEW

Efficiency analysis is essential for the evaluation of banks' performance. A bank is considered to be efficient if it has the ability of generate the maximum of revenues and profits by using its resources efficiently and by minimize the expenses. According to [1], Data Envelopment Analysis (DEA) method has become increasingly popular in measuring bank efficiency. CCR-DEA model is a linear programming method that have been introduced by Charnes, Cooper and Rhodes [5] to measure the relative efficiency of homogeneous decision making units (DMUs) by employing multiple inputs and outputs [6]. This method is a most accurate method to measure efficiency of DMUs that are referred to a group of firms under study such as banks, hospital etc. [7],[8],[1]. The CCR-DEA model was first modified by Sherman [9] to measure banks performance in 1984, and since then, was extensively used by banking

industry around the world to measure banks operational efficiency [9]. Charnes et al. [3] imposed non-negativity restrictions to ensure inputs and outputs have positive weight values, so as the efficiency score assigned will be between 1 and 0, and no efficiency index greater than one. The less productive units or inefficiency are identified with efficiency score is < 1. Further expanding models for measuring the efficiency in DEA, Tone [2] has proposed a Slack Based Measure (SBM) model to measure performance in detailed by connecting input excesses and output shortfalls between the two continual terms. There are two types of data namely the input data and output data, whereby the input data refers to the banks' expenses such as labour cost, fixed financing cost, fixed financing asset and financing operating cash flow. Whereas the output data refers to the banks' incomes generated from sources such as commercial and industry loan, housing loans, customer personal loans, other types of loans and revenue churned from customers' saving [4]. Therefore, the aim of this article is to measure the efficiency of 11 banks performance by using CCR and SBM models that have been introduced by Charnes et al. [3] and Tone [2]. Besides that, this research also will present the results of efficiency analysis computed by both methods.

III. METHODOLOGY

A. CCR and SBM model for efficiency

In figure 2 show that several steps in methodology for measure efficiency using CCR and SBM model. The detail about every step also explains below.

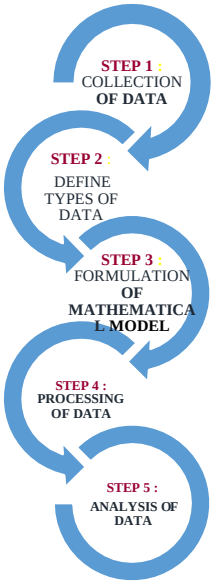

Figure 2: Flow of the methodology

STEP 1: COLLECTION OF DATA

There are two types of bank ownership, namely the local ownership and foreign ownership. However, as for this study, the focus will be on local bank ownership in Malaysia. In this step, the Decision Maker Unit (DMU) will decide the types of banks _expenses and income.

STEP 2: DEFINE TYPES OF DATA

There are two types of data, namely the input data and output data. The input data comprises of labor cost, fixed financing asset, and financing operating cash flow, while the output data consist of commercial and industrial loans, housing loans, customer personal loans, other loans and increase of customers' savings.

STEP 3: FORMULATION OF MATHEMATICAL MODEL

In this study, there are two models used to measure the efficiency of commercial banks' in Malaysia. The model are Charnes, Cooper & Rhodes (CCR) and Slack Based Measure (SBM) model.

1) CCR Model

$$\text{Minimum } t$$

$$\text{subject to}$$

$$\sum_{l=1}^{n} x_{im}\, l_m \le t x_{i0} \qquad i = 1,\ldots,r$$

$$\sum_{j=1}^{n} y_{jm}\, l_m \ge y_{i0} \qquad j = 1,\ldots,s$$

$$l_m \ge 0 \qquad m = 1,\ldots,n$$

2) SBM Model

$$\text{Minimum } \tau = t - \frac{1}{m}\sum_{=1} \frac{m S^{-}}{x_{i0}}$$

$$\text{subject to}$$

$$1 = t + \frac{1}{s}\sum_{r=1}^{s} \frac{S^{+}}{y_{r0}}$$

$$tx_0 = XL + S^{-}$$

$$ty_0 = YL - S^{+}$$

$$L \ge 0,\ S^{-} \ge 0,\ S^{+} \ge 0,\ t \ge 0$$

$$\text{with } S^{-} = ts^{-},\ S^{+} = ts^{+}, \text{ and } tL = tl.$$

where

$y_{j0} = j^{th}$ is total output of DMU_0

$y_{jm} = j^{th}$ is output of DMU_m

$x_{i0} = i^{th}$ is total input of DMU_0

$x_{im} = i$ is input of DMU_m

n = number of DMU

r = number of output

s = number of input

STEP 4: PROCESSING OF DATA

All the inputs and outputs are coded under LINGO 17.0 Software. The score efficiency result will be generated for both CCR and SBM model.

STEP 5: ANALYSIS OF DATA

Efficiency is measured on a scale of 0 to 1, where a value of 1 indicated the unit is relatively efficient and a value less than 1 indicates the unit is in efficient.

B. *Case study: Commercial Bank In Malaysia*

We use year-end secondary data for Malaysia commercial bank. To measure efficiency for this commercial bank, we consider three input and five output of banks that effect the growth of the bank organizations.

1) Input Data

Input data that we consider in this research from the bank expenses. The three inputs generally resource required to operate a bank: labor cost, fixed financing asset and financing operating cash flow [4]. The input data of commercial bank as shown in Table I.

2) Output Data

For output data that we consider from the bank income. The five output primarily represent: commercial and industry loan, housing loans, customer personal loans, other types of loan and revenue churned from customers‘ saving [4]. The output data of commercial bank as shown in Table II.

TABLE I. INPUT DATA OF COMMERCIAL BANK

TABLE II. OUTPUT DATA OF COMMERCIAL BANK

IV. RESULTS AND DISCUSSION

The summary results for the analysis via operating approach (for both CCR and SBM models) are represent in Table III and Figure 1.

TABLE III. CCR AND SBM SCORE FOR ALL BANKS

No	Name of Bank	Efficiency Score, ρ using CCR Model	Efficiency Score, ρ using SBM Model
1.	Bank A	0.7264217	0.4982464
2.	Bank B	1.0000000	1.0000000
3.	Bank C	1.0000000	1.0000000
4.	Bank D	0.6076928	0.4987553
5.	Bank E	1.0000000	1.0000000
6.	Bank F	0.9545454	0.7308603
7.	Bank G	1.0000000	1.0000000
8.	Bank H	0.8172656	0.3863394
9.	Bank I	0.7969327	0.4404905
10.	Bank J	0.8060983	0.5603653
11.	Bank K	1.0000000	1.0000000

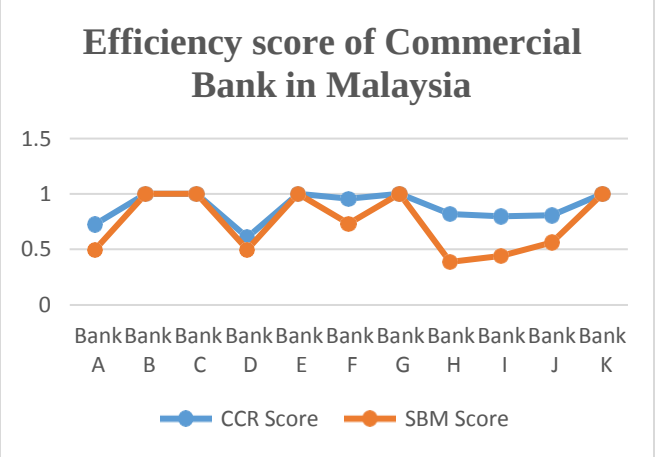

Fig. 1. *Efficiency score of Commercial Bank in Malaysia using CCR and SBM model*

Both models indicate the same result whereby 5 banks are considered to be efficient while another 6 banks are considered inefficient. However, the SBM model provide more detailed and accurate result for inefficiency score from the perspective of input excess and output shortfall.

From table III, negative value in input variable indicate the bank should reduce certain amount. On the other hand,

No	Name of Bank	Input Variable		
		Labor Cost (Million RM) Input 1	Fixed Financing Asset (Million RM) Input 2	Fixed Financing Cash Flow (Million RM) Input 3
1.	Bank A	178.328	762.592	650.88
2.	Bank B	102.505	433.517	359.018
3.	Bank C	55.555	143.316	122.35
4.	Bank D	583.351	1549.841	1444.62
5.	Bank E	60.085	111.628	97.274
6.	Bank F	137.097	305.24	262.018
7.	Bank G	138.975	421.969	357.057
8.	Bank H	791.219	3431.442	3102.395
9.	Bank I	307.085	1330.401	1254.863
10.	Bank J	354.419	1108.159	1005.736
11.	Bank K	124.423	527.732	458.263

No	Name of Bank	Output Variable				
		Commercial & Industry Loan (Hundred Million RM) Output 1	Housing Industry Loan (Hundred Million RM) Output 2	Customer Loan (Hundred Million RM) Output 3	Other Loans (Hundred Million RM) Output 4	Demand of saving customers (Hundred Million RM) Output 5
1.	Bank A	10.347321	4.44989	580.664	953.284	15.08925
2.	Bank B	5.818783	4.577328	533.008	195.573	11.13838
3.	Bank C	5.265357	2.565088	189.422	432.961	6.55384
4.	Bank D	23.332887	11.738798	1417.327	2424.122	42.54504
5.	Bank E	3.659408	1.508959	1.299	525.178	6.951964
6.	Bank F	5.833946	3.986763	696.302	481.894	10.03132
7.	Bank G	6.252395	4.042842	1448.645	688.329	17.25165
8.	Bank H	48.017919	18.035724	2814.78	1631.712	77.92641
9.	Bank I	9.353147	8.296077	1648.241	1150.953	29.95333
10.	Bank J	24.821081	8.512109	1177.495	1252.248	33.9831
11.	Bank K	6.773848	4.524215	1206.798	361.048	11.86788

positive value in output values represent addition of output value. It clearly be seen that, Bank A indicate inefficient score where Bank A need to reduce 4.5% labor cost (Input 1), 42.39% fixed financing asset (Input 2) and 42.38% fixed financing cash flow (Input 3) respectively. Meanwhile, Bank A should increase output for 55% of Commercial & Industry loan (Output 1), 76.50% of housing industry loan (Output 2), 39.23% of other loans (Output 4) and 33.14% of demand of saving customer (Output 5). The detailed result is presented in Table III.

TABLE III. RESULT OF SCORE EFFICIENCY WITH INPUT EXCESS AND OUTPUT SHORTFALL OF BANK

No	*Name of Bank*	*Efficiency Score, ρ*	*Output Variable*							
			s_1	s_2^-	s_3^-	s_1^+	s_2^+	s_3^+	s_4^+	s_5^+
1.	Bank A	0.4982464	8.027 (-4.5%)	323.26 (-42.39%)	275.82 (-42.38%)	5.793 (+55.98%)	3.406 (+76.50%)	0	373.94 (39.23%)	5.001 (33.14%)
2.	Bank B	1.0000000	0	0	0	0	0	0	0	0
3.	Bank C	1.0000000	0	0	0	0	0	0	0	0
4.	Bank D	0.4987553	0	44.96 (-2.9%)	159.79 (-11.06%)	31.96 (+136.97%)	15.17 (+129.2%)	571.68 (+40.33%)	2212.15 (+91.25%)	26.27 (+61.74%)
5.	Bank E	1.0000000	0	0	0	0	0	0	0	0
6.	Bank F	0.7308603	26.85 (-19.59%)	0	2.4779 (-0.95%)	2.3395 (+40.10%)	0.3202 (+8.03%)	0	247.47 (+35.54%)	3.2551 (+32.45%)
7.	Bank G	1.0000000	0	0	0	0	0	0	0	0
8.	Bank H	0.3863394	0	1382.73 (-40.30%)	1353.77 (-43.54%)	26.14 (+54.43%)	18.18 (+100.74%)	0	4487.26 (+275%)	15.516 (+19.91%)
9.	Bank I	0.4404905	0	449.08 (-37.51%)	547.12 (-43.68%)	15.484 (+165.5%)	4.4098 (+53.16%)	0	998.81 (+86.78%)	6.802 (+22.71%)
10.	Bank J	0.5603653	9.075 (-2.56%)	217.27 (-19.61%)	245.18 (-24.38%)	7.9097 (+31.87%)	7.419 (+87.16%)	0	1439.15 (+114.92%)	6.757 (+19.88%)
11.	Bank K	1.0000000	0	0	0	0	0	0	0	0

V. CONCLUSIONS

This paper utilizes the Slack based Measure (SBM) method as compared to the traditional method, Charnes, Cooper and Rhodes Model (CCR) for efficiency procedure. The SBM and CCR model allows full evaluation of efficiency in local banks‘ performance to make a report to the manager. This innovative model can resolve critical problems depends on new application efficiency tool especially for the kinds of societal problem, private, public and profit sector. It is also responsible for allows organizations to stay relevant in the competitive market with improvement of an efficiency level. For furthers aims, this model target person is manager as a high-level organization person to sustain the improvement of the company, policymaker as share partner of the company will forecast the profit in future, and researcher as a literature study to get more familiar of the efficiency method and subsequently they can improve their research method. Finally, in order to make this model more valuable, the target sales also considered by a provided consultancy for individual and group or industry committee from the expertise.

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