DOI : 10.36347/sjebm.2015.v02i01.002

Scholars Journal of Economics, Business and Management e-ISSN 2348-5302

Jenny KPS *et al.*; Sch J Econ Bus Manag, 2015; 2(1A):9-15 p-ISSN 2348-8875

The Performance of Malaysia's Bank in 2011: Using Kourosh and Arash Model (KAM)

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Abstract: The banking system, comprising commercial banks, investment banks, and Islamic banks, is the primary mobiliser of funds and the main source of financing to support economic activities in Malaysia. Banking is significant in the overall economics flow to channel the fund, promotes better economic growth. This study by using Kourosh and Arash Method (KAM) in Data Envelopment Analysis (DEA), investigates the relative efficiency of 19 Malaysia's banks in 2011, with 5 inputs and 7 outputs. The results suggest Malayan Banking Berhad – May bank as the most efficient bank in both CRS and VRS followed by the Royal Bank of Scotland Berhad and Public Bank Berhad. Moreover, KAM CRS suggests My bank as a reference set for all selected banks in this practice.

Keywords: Data envelopment analysis, Kourosh and Arash model, Bank, Efficiency, Malaysia.

INTRODUCTION

Banking provides very important role in the economics system. It acts as channel to distribute the fund effectively from the lenders to the suppliers in order to raise the capital. Effective banking channel will promote economics prospect, but poor banking systems will bring the economics into a doom. Recent global financial crisis had raised many questions about banking efficiency and performance.

Lots of banking efficiency have been studied in the decade such as studies by Miller and Noulas[1],Devaney and Veber[2], Sensarma [3], Holod and Lewis [4] and others. In most of previous/current researches the conventional Data Envelopment Analysis (DEA) models such as Charnes, Cooper and Rhodes (CCR) [5] in Constant Returns to Scale (CRS), Variable Returns to Scale (VRS) Banker et al. [6], Non-Decreasing Returns to Scale (NDRS) or Non-Increasing Returns to Scale (NIRS) have been used. DEA is a linear programming technique which forms a non-parametric frontier over the data points to determine the relative efficiencies of each DMU.

The number of technically efficient DMUs increases while the number of factors increases. From this reason, unfortunately, a small number of factors have been selected, factors are merged to decrease their number in comparison with the number of DMUs, or the data of several years are considered to increase the number of DMUs. However, small number of factors does not usually represent the performance of DMUs well, and the relative efficiency scores of DMUs are not appropriate in this case. Since DEA is a non-parametric technique, merging factors with parametric techniques rises an appropriate question that if there is an available equation between factors why a non-parametric method is used? Merging the factors together may remove important differences between two DMUs. Moreover, considering data of several years for each DMU does not show a valid relative efficiency score for each DMU in each year. Indeed, the used inputs are usually the same in each year, different years might have had different nature events which may even effect on homogeneity of DMUs, and of course such scores do not represent the qualification of managers in a year.

Khezrimotlagh et al. [7] proposed a technique, called Kourosh and Arash Method (KAM), to increase the discrimination power of DEA even if the number of DMUs is not enough in comparison with the number of factors. KAM allows decisions in the target regions instead of points to benchmark DMUs without requiring any more information in the case of interval DEA methods. It simultaneously ranks and benchmarks all DMUs.

In this paper, 12 factors are considered to measure appropriate relative efficiencies of 19 banks in Malaysia in 2011. The rest of this paper is divided into fou rsections. Section 2 reviews the existing literature on using DEA for measuring bank efficiency. Section 3 describes data. Section 4 represents the results of applying DEA models and the last section concludes the paper.

LITERATURE REVIEW

The banking system plays an important role in the economic development in a country. Commercial banks, which are the main components of the banking system, have to be efficient otherwise they will create maladjustments and impediments in the process of development in any economy.

A number of studies has applied DEA to measure the relative efficiency of banks.Berger andHumphery[8] explained that there were three alternative methods of choosing bank outputs which included the asset, user cost, and value-added approaches. They argued that the value added approach, which defines outputs as those activities that have substantial value added (that is, large expenditures on laborand physical capital), is best for accurately estimating changes in bank technology and efficiency over time.Miller and Noulas[1] focus mainly on technical efficiency of 201 large banks from 1984-1990. Isik and Hassan [9] investigated input and output efficiency in the Turkish banking industry over the 1988-1996 period using intermediation approach to understand the impact of size, international variables, ownership, control and governance on profits, cost, allocative, technical and scale efficiency measures by employing DEA. They used labor, capital and deposit as input vector while output vector includes: short-term loans, long-term loans, risk-adjusted off-balance items and other earning assets. Devaney and Veber[2] applied production approach in measuring banking efficiency for a random sample of bank from 1994-1999. Output employed included: loans, securities and transaction account deposits while inputs consist of labor, physical capital and no transaction account deposits. Chen et al. [10] applies DEA to examine the cost efficiency of Chinese banks. Dabla-Norris and Floerkemeier[11] found that bank-specific factors, such as bank size, liquidity, and market power, and the market structure within which banks operate, explain a large proportion of cross-bank, cross-time variation in spreads and margins. They found that interest spreads are influenced by bank size, the extent of market power as measured by market share in deposits, overall market concentration, liquidity and loan portfolios. Tahir and Baka[12] used DEA to estimate the overall, pure technical and scale efficiencies for 22 commercial banks in Malaysian during the period 2000-2006. The results suggest that domestic banks were relatively more efficient than foreign banks.Banker et al. [13] also employed intermediation approach to investigate the Korean banking efficiency. Input choices were: interest expenses and operating expenses and respective outputs were: interest income and operating income. Glass et. al. [14] used producer-specific approach to measure Irish credit union efficiency. Inputs employed were: salaries and related expenditure, capital expenditure and other management expenses and outputs used were: investments and loans to members. Karim [15] also used the cost function to determine a financial intermediary in channelling funds from depositors to borrowers

DEA is a non-parametric approach to measure the relative efficiency of a set of homogenous Decision Making Units (DMUs). The basic DEA model, Charnes, Cooper and Rhodes (CCR) [5] considers the assumption of Constant Returns to Scale (CRS). This assumption was later relaxed to allow Variable Returns to Scale (VRS) and scale economies by Banker et al. [6]CCR becomes Banker, Charnes and Cooper (BCC) by replacing VRS with CRS. The models in Input-Oriented (IO) consider only possible input decreases while keeping at least the present output levels and in Output-Oriented (OO) maximize the outputsvalues under at most the present input consumption. CCR and BCC are invariant to the units of measurement and they describe a technical efficiency score of between 0 and 1. The unit invariance property means the technical efficiency scores of DMUs are independent of the units in which the inputs and outputs are measured provided these units are the same in every DMU.

Tone [16] proposed a robust model, called Slack-Based Measure (SBM) which considers both IO and OO similar to Additive model (ADD) proposed by Charnes et al.[17]. However, none of these models where able to discriminate between technically efficient DMUs. There are a good number of studies on discriminating between technically efficient DMUs based on Andersen and Petersen [18] methodology, called super-efficiency models. However, Khezrimotlagh et al. [19, 20] commented that super-efficiency models are not appropriate to discriminating DMUs. Khezrimotlagh et al. [7] proposed a new technique called Kourash and Arash Method (KAM) to assess the performance of DMUs with flexible linear programming based on the Weighted Additive DEA model. KAM is able to discriminate between technically efficient DMUsappropriately as well as measuring cost-efficiency, revenue-efficiency and profit efficiency of DMUs when costs information and units' prices are available.

KAM considers a very small negligible thickness for the estimated DEA efficient frontier. When the thickness of the estimated DEA efficient frontier is zero, KAM is the weighted ADD and its score is almost completely the same as SBM.The ε-KAM in CRS for n DMUs with m inputs and p outputs is given by [7]:

$$\max \sum_{j=1}^{m} w_j^- s_j^- + \sum_{k=1}^{p} w_k^+ s_k^+,$$
Subject to
$$\sum_{i=1}^{n} \lambda_i x_{ij} + s_j^- = x_{lj} + \varepsilon_j^-, \text{for } j = 1,2,\dots,m,$$
$$\sum_{i=1}^{n} \lambda_i y_{ik} - s_k^+ = y_{lk} + \varepsilon_k^+, \text{for } k = 1,2,\dots,p,$$
$$\lambda_i \geq 0, \text{for } i = 1,2,\dots,n,$$
$$s_j^- \geq 0, \text{for } j = 1,2,\dots,m,$$
$$s_k^+ \geq 0, \text{for } k = 1,2,\dots,p.$$

The KAM best technical efficiency score and target with ε degree of freedom (ε-DF) are as follows:

$$x_{lj}^* = x_{lj} - s_{lj}^{-*} + \varepsilon_j^-, \text{for } j = 1,2,\dots,m,$$
$$y_{lk}^* = y_{lk} + s_{lk}^{+*} - \varepsilon_k^-, \text{for } k = 1,2,\dots,p,$$

$$KA_\varepsilon^{*l} = \frac{\sum_{k=1}^{p} w_k^+ y_{lk} / \sum_{j=1}^{m} w_j^- x_{lj}}{\sum_{k=1}^{p} w_k^+ y_{lk}^* / \sum_{j=1}^{m} w_j^- x_{lk}^*}.$$

The weights in KAM are defined as $w_j^- = 1/x_{lj}$and $w_k^+ = 1/y_{lk}$, where $x_{lj} > 0$ and$y_{lk} > 0$, and if $x_{lj} = 0$ or $y_{lk} = 0$, the weights are defined as 1. The components of epsilon vector, $\varepsilon_j^-$and ε_k^+, are defined as $\varepsilon \times \min\{x_{ij}: x_{ij} \neq 0, i = 1,2,\dots,n\}$ and $\varepsilon \times \min\{y_{ik}: y_{ik} \neq 0, i = 1,2,\dots,n\}$, respectively, where ε is a nonnegative real number. Indeed, the value of ε is considered as a very small nonnegative real number in order to have a negligible thickness of the efficient frontier. A technically efficient DMU is called KAM efficient with ε-Degree of Freedom (ε-DF) if $KA_0^* - KA_\varepsilon^* < \delta$, otherwise, it is called inefficient with ε-DF. The value of δ depends on the aim of measuring the efficiency scores of DMUs and would be defined by $\varepsilon/(m+p)$ or $\varepsilon/10$ or less/greater value to have at least one efficient DMU with ε-DF in the sample.

The score of KAM score is between 0 and 1 for those DMUs which require improving its inputs and/or outputs. If the score of KAM is greater than 1 for a DMU, KAM represents that the DMU has a good combination of data, shouldn't change its data except by CRS technology or highest KAM-efficient targets

DATA SELECTION

Data of banking inputs and outputs are taken from BANKSCOPE[21]. BANKSCOPE is global database of bank financial statements, rating and intelligence. Banking sector is a service sector, which unlike to other physical goods manufacturing sectors, main input of banking sector is human capital and operating expenses. The input therefore will be limited compared to those physical goods manufacturing sectors. Many of the past researches use labor, capital, loanable funds, interest expenses and other expenses. Similarly, a good number of inputsis employed in this study such as: personnel expenses as a proxy for labor cost, equity hold by the banks as proxy for capital, deposit and short-term funding as loanable funds, total interest expenses and other operating expenses. In the context of the output, many researches also used loans, securities, interest incomes and operating incomes in output vector. Thus, the outputs in this study are consideredas loans, other earning assets as a proxy of securities, net interest revenue and other operating incomes.

Profit is also very important output to the bank performance and it's selected as an output in this study. Many researches focus only on interest income on loans while ignore other interest income which also significant profit driver to the bank. Therefore, the non-loan interest income is added into output vector in this practice. In this study, 19 different banks of Malaysia are considered as show in Table 1.

Table 2 illustrates the values of selected inputs and outputs. The selected factors are introduced as follows:

IN1: Personnel expenses, that is, one of the costs that a bank incurs as a result of performing its normal business operations.

IN2: Equity, that is, total assets of the bank minus total liabilities of it. Due to the return on equity can be pushed higher by increasing the leverage, therefore the bank will keep the equity capital as low as possible.

IN3: Deposits & Short term funding, that is, a form of asset that bank taking the saving from its client.

IN4: Total Interest Expense, that is, one of the operating expenses of bank that pay to their client or shareholder due to taking asset.

IN5: Other Operating Expenses, that is, the efficiency of the bank achieved when the lowest operating expenses can be reduced without significantly affecting the firm's ability to compete with its competitors.

DOI : 10.36347/sjebm.2015.v02i01.002

Table-1: List of 19 Banks in Malaysia.

Name of Bank	Abbreviation
Affin Bank	AFF
Alliance Bank Malaysia Berhad	ALL
AmBank (M) Berhad	AMB
Bangkok Bank Berhad	BANG
Bank of America Malaysia Berhad	BAM
Bank of Nova Scotia Berhad	BNS
Bank of Tokyo-Mitsubishi UFJ (Malaysia) Berhad	BTM
CIMB Bank Berhad	CIMB
Hong Leong Bank Berhad	HLB
HSBC Bank Malaysia Berhad	HSBC
Industrial and Commercial Bank of China (Malaysia) Berhad	ICBC
JP Morgan Chase Bank Berhad	JPCB
Malayan Banking Berhad - Maybank	MAYB
OCBC Bank (Malaysia) Berhad	OCBC
Public Bank Berhad	PUBB
RHB Bank Berhad	RHBB
(The) Royal Bank of Scotland Berhad	RBSB
Standard Chartered Bank Malaysia Berhad	SCBM
United Overseas Bank (Malaysia) Berhad	UOB

Table 2: The selected input and output values in 2011

BANK	IN1	IN2	IN3	IN4	IN5	OUT1	OUT2	OUT3	OUT4	OUT5	OUT6	OUT7
AFF	91.53	1133.46	13898.77	381.40	76.46	9346.02	2489.42	303.49	61.76	192.98	508.34	173.50
ALL	104.72	1031.28	9776.60	202.33	65.78	6860.60	3871.58	274.82	80.99	176.20	342.43	133.55
AMB	164.04	1560.22	3124.77	640.37	382.67	17417.65	2064.10	628.39	431.28	580.89	1062.21	206.56
BANG	5.63	171.40	645.40	17.80	3.86	547.91	58.47	14.57	4.20	9.20	24.63	7.72
BAM	3.81	154.30	317.94	2.64	7.84	58.83	25.12	9.25	7.21	5.73	1.89	10.01
BNS	4.34	215.96	756.31	24.58	3.46	1131.97	117.97	32.64	6.48	28.20	50.49	6.74
BTM	16.08	444.54	1768.11	31.35	7.68	1251.75	610.83	38.50	39.06	54.83	36.86	32.96
CIMB	698.48	6027.15	62387.29	1274.87	515.10	43912.07	16125.66	1719.69	655.96	1069.46	2274.52	699.46
HLB	189.45	2349.75	39734.74	587.41	165.47	25794.83	8625.81	593.73	272.68	444.38	758.70	414.95
HSBC	188.89	1625.68	21607.21	355.30	193.39	12476.68	5254.86	337.61	544.35	447.78	500.94	191.60
ICBC	3.93	109.51	424.71	6.01	2.74	113.38	157.54	6.86	5.95	5.92	1.79	11.08
JPCB	10.17	230.75	1362.32	13.25	9.57	10.07	741.20	21.21	21.69	23.23	0.50	33.96
MAYB	7.10	174.80	1351.14	83.02	7.56	1079.48	346.11	40.50	11.37	19.11	2208.81	123.47
OCBC	119.99	1523.58	17735.79	386.06	114.89	13335.98	3956.81	391.12	198.33	325.43	596.41	173.53
PUBB	470.82	4897.89	68703.45	1556.83	224.39	55021.40	15930.38	1879.15	453.79	1451.23	2870.61	515.42
RHBB	328.86	3377.78	39470.92	911.08	206.55	30002.49	7586.02	1058.01	264.59	727.07	1579.29	386.28
RBSB	9192.63	190972.30	739696.25	20611.27	58908.40	115861.82	889444.13	2275.73	82874.72	17035.25	5026.13	17842.30
SCBM	83.85	1095.09	12996.16	252.47	178.63	9697.61	3348.63	270.07	299.02	263.36	409.13	102.49
UOB	128.61	1531.22	18625.09	387.32	90.21	14787.82	1817.60	414.45	175.54	347.28	660.56	141.01

OUT1: Loans, that is, a specific amount that has a specified repayment schedule and a floating interest rate.
OUT2: Other Earning Assets, that is, total represents earning assets other than loans to customers. It consists of the Federal Funds Sold, FHLB Stock, Total Investment Securities, and Trading Account Assets.
OUT3: Net Interest Revenue, that is, the excess revenue that is generated from the spread between interest paid out on deposits and interest earned on assets is the net interest income.
OUT4: Other Operating Income, which consists of Gains less losses on disposal of financial assets, Dividend income, Gains arising on assets fair valued at acquisition, Rental income from operating lease assets, Gains on disposal of property, plant and equipment, and Gain arising on change of control.
OUT5: Profit before Tax, that is, Revenue minus expenses equals earnings it provides investment analysts with useful information for evaluating a company's operating performance without regard to tax implications.
OUT6: Interest Income on Loans, that is, the excess revenue that is generated from the spread between interest paid out on deposits and interest earned on Loan.
OUT7: Other Interest Income, that is, Include deposit and transaction fees, insufficient funds (NSF) fees, annual fees, monthly account service charges, inactivity fees, check and deposit slip fees, etc.

The results of applying DEA models are illustrated in the next section.

RESULTS AND DISCUSSION

Since the minimum values of each factor in Table 2 are 3.81, 109.51, 317.94, 2.64, 2.74, 10.07, 25.12, 6.86, 4.2, 5.73, 0.5 and 6.74, by introducing epsilon value as 10^{-4} the components of epsilon vector are $\varepsilon_1^- = 0.000381$, $\varepsilon_2^- = 0.010951$, $\varepsilon_3^- = 0.031794$, $\varepsilon_4^- = 0.000264$, $\varepsilon_5^- = 0.000274$, $\varepsilon_1^+ = 0.001007$, $\varepsilon_2^+ = 0.002512$, $\varepsilon_3^+ = 0.000686$, $\varepsilon_4^+ = 0.000420$, $\varepsilon_5^+ = 0.000573$, $\varepsilon_6^+ = 0.000050$ and $\varepsilon_7^+ = 0.000674$ which are completely negligible according to each factor.KAM with these very small negligible values consider a very small negligible diameter for the estimated efficient DEA frontier. In other words, KAM make the DEA frontier a bit thicker.

Table 3 illustrates the results of applying different DEA models in CRS and VRS. Since the number of factors is 12 in comparison with the number of 19 selected banks, there are 15 technically efficient banks and only 4 inefficient banks. AFF, BANG, OCBC and RHBB are clearly inefficient as can be seen by applying all the models.

Table 3: The results of DEA models in CRS and VRS.

Banks	CCR-IO (OO)	BBC-IO	BBC-OO	ADD CRS	ADD VRS	10^{-4} KAM CRS	Rank	10^{-4} KAM VRS	Rank
AFF	0.821	0.833	0.839	0.32	0.516	0.3196638	19	0.5160293	18
ALL	1	1	1	1	1	0.9999906	9	0.9999948	9
AMB	1	1	1	1	1	0.9999979	5	1.0000000	2
BANG	0.741	0.897	0.767	0.321	0.378	0.3207179	18	0.3782082	19
BAM	1	1	1	1	1	0.9990564	13	0.9994585	13
BNS	1	1	1	1	1	0.9999581	10	0.9999592	11
BTM	1	1	1	1	1	0.9999540	11	0.9999545	12
CIMB	1	1	1	1	1	0.9999972	6	0.9999994	6
HLB	1	1	1	1	1	0.9999979	4	0.9999994	5
HSBC	1	1	1	1	1	0.9999963	7	0.9999981	7
ICBC	1	1	1	1	1	0.9874941	15	0.9991270	14
JPCB	1	1	1	1	1	0.9974124	14	0.9974348	15
MAYB	1	1	1	1	1	1.0000011	1	1.0000004	1
OCBC	0.944	0.959	0.960	0.668	0.733	0.6681125	17	0.7329592	17
PUBB	1	1	1	1	1	0.9999980	3	1.0000000	2
RHBB	0.951	0.974	0.978	0.718	0.820	0.7180589	16	0.8201099	16
RBSB	1	1	1	1	1	0.9999997	2	1.0000000	2
SCBM	1	1	1	1	1	0.9999959	8	0.9999964	8
UOB	1	1	1	1	1	0.9998468	12	0.9999825	10

None of CCR, BCC, ADD and SBM are able to rank these 19 DMUs and find an appropriate relative efficiency scores for technically efficient DMUs. However, as the last four columns of Table 3 illustrates, KAM ranks these DMUs with 10^{-4}-DF in both CRS and VRS.

MAYB is the most efficient bank among these 19 banks in 2011. Since its 10^{-4}-KAM score is greater than 1, KAM says that MAYB has a very good combination of factors and it should never consider any of available combination of factors from other banks in the sample. KAM suggests MAYB to just follow its combination of factors in CRS or consider the highest efficient targets of KAM.

If the values of δ is defined as $\varepsilon/(m+p)$, that is, $10^{-4}/12$, both KAM CRS and VRS suggest 8 banks as efficient with 10^{-4}-DF. These banks are ALL, CIMB, HLB, HSBC, MAYB, PUBB, RBSB and SCBM. Moreover, KAM VRS shows AMB as efficient with 10^{-4}-DF by $\delta = 10^{-4}/12$.

However, MAYB is a reference set for all 19 selected banks in CRS. Indeed, KAM CRS suggests that all banks could follow the combination of factors which MAYB has.

As can be seen, BTM with 10^{-4}-DF might be a reference set for MAYB, however, since the efficiency score of KAM in this case is greater than 1, this reference set is rejected.

MAYB in VRS also has HSBC and PUBB as two reference sets, however, KAM score is greater than 1 and such reference sets are rejected.

Table-4: The reference sets of banks with 10^{-4}-DF.

Banks	KAM CRS Reference Sets	KAM VRS Reference Sets
AFF	BNS, HLB, MAYB, PUBB, SCBM,	MAYB, PUBB, RBSB,
ALL	ALL, BTM, HLB, JPCB, MAYB,	ALL, HLB, MAYB, RBSB,
AMB	AMB, BNS, MAYB,	AMB, MAYB, RBSB,
BANG	BNS, BTM, MAYB,	BAM, BNS, BTM, ICBC, MAYB,
BAM	BAM, MAYB, RBSB,	BAM, MAYB,
BNS	BNS, BTM, MAYB,	BAM, BNS, BTM, MAYB,
BTM	BTM, HLB, MAYB,	BNS, BTM, HLB, MAYB,
CIMB	ALL, CIMB, JPCB, MAYB, SCBM,	CIMB, MAYB, PUBB, RBSB,
HLB	BNS, HLB, MAYB,	HLB, MAYB, PUBB,
HSBC	BTM, HSBC, MAYB, RBSB,	HLB, HSBC, MAYB, PUBB, RBSB,
ICBC	BAM, BTM, ICBC, JPCB, MAYB	BAM, ICBC, JPCB, MAYB,
JPCB	JPCB, MAYB,	BAM, JPCB, MAYB,
MAYB	~~BTM~~, MAYB,	~~HSBC~~, MAYB, ~~PUBB~~,
OCBC	BNS, HLB, HSBC, MAYB, PUBB, SCBM,	AMB, HLB, HSBC, MAYB, PUBB, SCBM
PUBB	ALL, BNS, BTM, HLB, MAYB, PUBB,	PUBB,
RHBB	ALL, BNS, HLB, MAYB, PUBB,	CIMB, MAYB, PUBB, RBSB
RBSB	JPCB, MAYB, RBSB,	RBSB,
SCBM	BTM, HLB, MAYB, SCBM,	HLB, HSBC, MAYB, RBSB, SCBM
UOB	AMB, BNS, HLB, HSBC, MAYB, PUBB, UOB	AMB, BNS, HLB, HSBC, MAYB, PUBB, UOB

From Tables 3 and 4, RBSB and PUBB are the most efficient banks after MAYB. Although, both these banks have MAYB as a reference set in CRS, they are their own reference set in VRS with 10^{-4}-DF.

CONCLUSION

This paper shows the advantages of KAM to measure the relative efficiency of 19 Malaysia's banks inclusive 12 factors. It is obvious that increasing the number of factors provide an appropriate discrimination between available DMUs, and in this case, the technique of KAM easily ranks and benchmark all DMUs appropriately.

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