International Journal of Management, IT & Engineering
Vol. 10 Issue 12, December 2020
ISSN: 2249-0558 Impact Factor: 7.119
Journal Homepage: http://www.ijmra.us, Email: editorijmie@gmail.com
Double-Blind Peer Reviewed Refereed Open Access International Journal - Included in the International Serial Directories Indexed & Listed at: Ulrich's Periodicals Directory ©, U.S.A., Open J-Gate as well as in Cabell's Directories of Publishing Opportunities, U.S.A

An application of Data Envelopment Analysis to evaluate the technical efficiency and the performance of selected commercial banks from the Indian banking sector

Prof.Bimal Jaiswal[1]
Ms. Shrinjika Rastogi[2]
Dr. Leena S. Shimpi[3]

Abstract

The Data envelopment analysis uses liner programming methods to construct the efficiency frontier. DEA employs different models to evaluate different forms of efficiencies. In the paper technical efficiency of commercial banks is determined by using the CCR model. The objective of this paper is to determine the technical efficiency and the performance of commercial banks during the period of 2009 to 2018. The equal numbers of public and private sector banks are selected on the basis of stratified random sampling to determine the efficiency of Indian banking sector. The result of the analysis showed that during the analysis period the overall efficiency of commercial banks ranged between 97% to 99%. The study highlighted the fact that efficiency is also dependent on the way investments and banks operations are managed if they are not handled properly then it will result into lower profitability and inefficiency.

Key Words: Efficiency, Technical efficiency, commercial banks, data envelopment analysis.

Author Correspondence:
Prof. Bimal Jaiswal,
Department of Applied economics, Faculty of Commerce, University of Lucknow(U.P.)
Email:bimalsiyaram@gmail.com
Ms. Shrinjika Rastogi,
Research scholar, Department of Applied economics, University of Lucknow(U.P.)
Email:shrinjika.rastogi@gmail.com

Introduction

Data Envelopment Analysis (DEA) is "a non-parametric technique that generates a comparative ratio of weighted outputs to inputs for each decision making unit i.e. a relative efficiency score". This technique was originally developed and used to investigate the relative efficiency of not for-profit organizations; looking at its significance it was quickly adopted by profit-making organizations. CRR model of DEA technique is applied in the present paper to evaluate the technical efficiency (TE) of selected banks from the Indian banking sector.

[1] Professor, Department of Applied economics, Faculty of Commerce, University of Lucknow.
[2] Research Scholar, Department of Applied economics, University of Lucknow.
[3] Assistant Professor, Department of commerce, Babasahab Bhimrao Ambedkar university- A central university, Lucknow.

International Journal of Management, IT & Engineering
Vol. 10 Issue 12, December 2020
ISSN: 2249-0558 Impact Factor: 7.119
Journal Homepage: http://www.ijmra.us, Email: editorijmie@gmail.com
Double-Blind Peer Reviewed Refereed Open Access International Journal - Included in the International Serial Directories Indexed & Listed at: Ulrich's Periodicals Directory ©, U.S.A., Open J-Gate as well as in Cabell's Directories of Publishing Opportunities, U.S.A

In the pre-liberalization era only public sector banks were allowed to operate in India. After the post-liberalization, foreign banks and domestic private banks opened up their business. The growth and efficiency of the banking sector increased after liberalization of banks. For the present paper banks belonging to public sector and private sector are selected.

Literature Review

(Kusum et al., 2003) examined the relative efficiency of nationalized, state owned, private sector and foreign banks operating in India during the period 1990 to 1995. The study analyzed the efficiency of banks during the pre and post liberalization in India. The analysis revealed that during this period foreign banks were found more stable than any other banks in India. The study also showed this fact that efficiency level of state owned banks and nationalized banks had dropped after the announcement of liberalization policy and it failed to reach pre liberalization level by the end of 1995.

(Kumar & Gulati, 2008) measured the technical, pure technical and scale efficiency of Indian public sector banks for the financial year 2004-05.for the efficiency measurement data envelopment analysis method was used in the analysis. In the analysis physical capital, labor and loan able funds were used as the input variables whereas for the output variables net interest income and noninterest income were used as the output variables. The findings reveled that seven banks were identified as the benchmark banks out of twenty seven banks. The paper suggested that inefficient banks should reduce their input level without changing the level of output to attain the efficiency level. The result of logistic regression analysis reveled that off balance sheet activities have the positive impact on the overall technical efficiency of banks.

(Li & Wang, 2012) determined the cost and profit efficiency by using the stochastic frontier approach (SFA) and data envelopment analysis (DEA) approach as there is no evidence that indicate relationship among them. The study made the static profit model with double constrains to determine the efficiency from both the models. The result of the analysis showed that there was no liner relationship among the capital regulation, monetary policy, and bank efficiency.

(Malhotra et al., 2014) measured the cost efficiency of commercial banks operating in India for the period of seven years. In the study translog function is used to estimate the cost efficiency. The paper estimated the cost efficiency of Indian banks during and after the global financial meltdown so as to compare the effects of global financial crisis on the Indian banking sector. The finding showed that public sector banks enjoy higher cost efficiency in comparison to the private sector banks. The result highlighted that ownership plays a very important role in determining the cost efficiency in the Indian banking sector.

(Depren & Depren, 2016) analyzed the performance of Turkish deposit banks. In the study data envelopment analysis and malmquist productivity index measures were used to determine the performance of the banks. The study used productivity as well as the intermediation approach to

International Journal of Management, IT & Engineering
Vol. 10 Issue 12, December 2020
ISSN: 2249-0558 Impact Factor: 7.119
Journal Homepage: http://www.ijmra.us, Email: editorijmie@gmail.com
Double-Blind Peer Reviewed Refereed Open Access International Journal - Included in the International Serial Directories Indexed & Listed at: Ulrich's Periodicals Directory ©, U.S.A., Open J-Gate as well as in Cabell's Directories of Publishing Opportunities, U.S.A

determine the efficiency of Turkish banks for both the approaches different sets of inputs and outputs were taken in the study to determine the big picture of efficiency the banking sector. The efficiency estimation showed the positive result of the productivity approach than the intermediate approach and it also determined the factors which highly affected the efficiency in comparison to other factors.

(Sahin et al., 2016)assessed the effects of global crisis on the banks performance operating in Turkey. The paper used data envelopment analysis (DEA) measure the efficiency of the bank and for the productivity analysis malmquist total factor productivity index has been used. In the study capital adequacy, deposit rate, liquidity rate and size of assets were used as the input variables and for the output variable quantity of assets, loan rate, riskiness, return on assets, management effectiveness and shareholders equity profitability were used. The result of the analysis showed that Turkish banking efficiency does not had any important inefficiency due to the global financial crisis.

Research Methodology

For this research work after an exploratory research about numerous various banks belonging to public and private ownership in the banking sector is carried out. Total 16 banks were selected for analysis purpose. 8 banks belong to public sector while 8 banks belong to private sector. The present study is based on the following major objective- 'to compute and study Technical Efficiency (TE) of selected commercial banks'. The study period is for last 10 years; i.e. from 2009-10 to 2018-19. Data of the selected commercial banks is collected for a time period of ten years; beginning from 2009 up to 2019. Data on the selected variable is collected for carrying out the present study.

Secondary data collection method is employed for collection of data for the present study. Thus the study completely relies on the secondary data collected from various sources, and website of commercial banks. Annual reports of selected commercial banks are thoroughly studied and analysed for seeking the necessary information.

Data Sources: data for the present study is collected from the Original website of Selected Commercial Banks, Website of Reserve Bank of India (RBI), Annual Reports of selected Commercial Banks and Annual Reports of Reserve Bank of India (RBI).

Sample Size & Sample Selection: The sample size of the present study is the number of commercial banks selected from the total population. 16 (sixteen) commercial banks in total belonging to public sector banks and private sectors banks are selected for the present study. 08 (eight) banks form public sector and 8 (eight) banks from private sector are selected for the present study. They form the sample size for the study. Based on the rule of thumb generally found in the DEA literature stats that two times the number of input and output when added should not be less than total number of DMU's(Tamatam, R., Dutta, P., Dutta, G. and Lessmann

International Journal of Management, IT & Engineering
Vol. 10 Issue 12, December 2020
ISSN: 2249-0558 Impact Factor: 7.119
Journal Homepage: http://www.ijmra.us, Email: editorijmie@gmail.com
Double-Blind Peer Reviewed Refereed Open Access International Journal - Included in the International Serial Directories Indexed & Listed at: Ulrich's Periodicals Directory ©, U.S.A., Open J-Gate as well as in Cabell's Directories of Publishing Opportunities, U.S.A

2019) Stratified Random Sampling is used for choosing commercial banks from the public sector and private sector of the Indian banking sector.

Table 1
List of Selected Public Sector and Private Sector Commercial Banks

Name of the Bank	Category	Name of the Bank	Category
State Bank of India	Public sector	ICICI	Private sector
Punjab National Bank	Public sector	HDFC	Private sector
Canara Bank	Public sector	Axis Bank	Private sector
UCO	Public sector	Kotak Mahindra Bank	Private sector
Bank of Baroda	Public sector	Federal Bank	Private sector
Union Bank of India	Public sector	IndusInd Bank	Private sector
Bank of India	Public sector	Karur Vysya	Private sector
Indian Overseas Bank	Public sector	South India Bank	Private sector

Data Analysis: The present section deals with the measures, statistical techniques and econometric models employed to analyse the collected data. For computing the efficiency of the selected banks Data Envelopment Analysis (DEA) Technique is employed. DEA Software – DEAP Version 2.1 is employed to process the data and get the results of analysis.

Data Envelopment Analysis (DEA) Technique: DEA is "a non-parametric technique that generates a comparative ratio of weighted outputs to inputs for each decision making unit i.e. a relative efficiency score". This technique was originally developed and used to investigate the relative efficiency of not for-profit organisations; looking at its significance it was quickly adopted by profit-making organisations. DEA method is simpler method of computing efficiency, wherein it requires making a prior choice of entities that are to be evaluated and the variables of *Input and Output* that are used for evaluation.

The entities that are to be evaluated for their efficiency are termed as 'Decision Making Units (DMUs)'. DMUs are evaluated because they are regarded as being responsible for converting inputs into outputs, deciding their efficiency of operation. DEA is a non-parametric technique that generates a relative efficiency score for each DMU. The relative efficiency score is usually reported as a number between 0-1. The number 1 denotes 100% efficiency. A unit with a score less than 100% is regarded as inefficient as compared to other units/ DMUs in the sample. The list of decision making units selected for the DEA model in the present study is presented in table 2.

International Journal of Management, IT & Engineering
Vol. 10 Issue 12, December 2020
ISSN: 2249-0558 Impact Factor: 7.119
Journal Homepage: http://www.ijmra.us, Email: editorijmie@gmail.com
Double-Blind Peer Reviewed Refereed Open Access International Journal - Included in the International Serial Directories Indexed & Listed at: Ulrich's Periodicals Directory ©, U.S.A., Open J-Gate as well as in Cabell's Directories of Publishing Opportunities, U.S.A

Table 2
List of Decision Making Units (DMUs) for DEA Model

DMU	Name of the Bank	DMU	Name of the Bank
DMU 1	SBI	DMU 9	ICICI
DMU 2	PNB	DMU 10	HDFC
DMU 3	Canara Bank	DMU 11	Axis Bank
DMU 4	UCO	DMU 12	Kotak Mahindra Bank
DMU 5	BOB	DMU 13	Federal Bank
DMU 6	Union Bank of India	DMU 14	IndusInd Bank
DMU 7	BOI	DMU 15	Karur Vysya
DMU 8	Indian Overseas Bank	DMU 16	South India Bank

For the purpose of DEA analysis, Linear equations are to be framed based on the variables selected as Input variables & Output variables. Thus the above variables are categorised into 'Input' and 'Output' as given below.

Table 3
List of variables defined as Inputs & Outputs for DEA analysis

Input Variable	***Output Variable***
Deposits	Loans & Advances
Borrowings	Investments
Fixed Assets	Interest & other income
Number of Employees	
Number of Branches	

DEA based CRR Model

The CCR model was initially proposed by Charnes, Cooper and Rhodes in the year 1978. This model assumes constant return to scale. Under the CCR model, overall efficiency of DMU is calculated; in which its Technical efficiency and Scale efficiency, both are aggregated. For application of CCR model it is assumed that a DMU operate under constant return to scale. In other words, an increase in Input will results in proportionate increase in Output of the DMU under consideration. Envelopment surface obtained by the CCR model for all the DMUs has shape of a convex cone. Efficient DMU will fall on the top of the curve, whereas inefficient DMUs will be covered under the cone. Under the CCR model, overall efficiency of DMU is calculated; in which its Technical efficiency (TE) and Scale efficiency (SE), both are aggregated. This method evaluates the overall efficiency (OE) of DMU and identifies the efficient DMU and non- efficient DMU from the total DMUs under consideration.

International Journal of Management, IT & Engineering
Vol. 10 Issue 12, December 2020
ISSN: 2249-0558 Impact Factor: 7.119
Journal Homepage: http://www.ijmra.us, Email: editorijmie@gmail.com
Double-Blind Peer Reviewed Refereed Open Access International Journal - Included in the International Serial Directories Indexed & Listed at: Ulrich's Periodicals Directory ©, U.S.A., Open J-Gate as well as in Cabell's Directories of Publishing Opportunities, U.S.A

The model can be put to use in two ways:
(a) Input oriented way: Input oriented model, focus on increasing the efficiency of a DMU by decreasing the inputs keeping the output level constant. This is the *Minimization* model.
(b) Output oriented way: Output oriented model focus on increasing the output keeping the input level constant. This is the *Maximisation* model.

As per Bitran & Novaes, (1973), The basic *CCR* model is a fractional programming problem whose solution yields, for each *DMU k* separately, the values of the variables represented by the input "weights" *vi* (i =1,2,...,M) and by the output "weights" *u j* (j =1,2,...,S). The single virtual model of CCR is designed by Cooper *et al.*, (2000) is follows:

Let,

Vector of output = yk = {$y1k$, $y2k$,..., $yS\,k$} and Vector of input = xk = {$x1k$, $x2k$,..., $xM\,k$}; for,

DMU k (k = 1, 2,.., n), where,S = number of output, and, M = number of input

The single virtual output for DMU k is as follows:

$Yk = u1\ y1k + u2\ y2k + ... + uS\ yS\ k$

The single virtual output for DMU k is as follows:

$Xk = v1\ x1k + v2\ x2k + ... + vM\ xM\ k$

The CCR maximisation model:

$$Max\ \theta_k = \frac{u_1 y_{1k} + u_2 y_{2k} + ... + u_S y_{Sk}}{v_1 x_{1k} + v_2 x_{2k} + ... + v_M x_{Mk}},$$

Subject to

$$\frac{u_1 y_{1j} + u_2 y_{2j} + ... + u_S y_{Sj}}{v_1 x_{1j} + v_2 x_{2j} + ... + v_M x_{Mj}} \le 1, \qquad (j = 1,2,....,n)$$

$$v_1, v_2, ..., v_M \ge 0$$

$$u_1, u_2, ..., u_S \ge 0,$$

Where, k is the generic DMU and its efficiency is Θ_k.

International Journal of Management, IT & Engineering
Vol. 10 Issue 12, December 2020
ISSN: 2249-0558 Impact Factor: 7.119
Journal Homepage: http://www.ijmra.us, Email: editorijmie@gmail.com
Double-Blind Peer Reviewed Refereed Open Access International Journal - Included in the International Serial Directories Indexed & Listed at: Ulrich's Periodicals Directory ©, U.S.A., Open J-Gate as well as in Cabell's Directories of Publishing Opportunities, U.S.A

Solving this fractional problem for each *DMU*, one gets the efficiency scores of

$$0 \le \theta_k \le 1\,,\ (k = 1.2,....,n)$$

Efficient *DMUs will have the* score:

$$\theta_k = 1$$

Non-efficient DMU will have the score:

$$\theta_k < 1$$

Envelopment surface obtained by the CCR model for all the DMUs has shape of a convex cone. Efficient DMU will fall on the top of the curve, whereas inefficient DMUs will be covered under the cone.

International Journal of Management, IT & Engineering
Vol. 10 Issue 12, December 2020
ISSN: 2249-0558 Impact Factor: 7.119
Journal Homepage: http://www.ijmra.us, Email: editorijmie@gmail.com
Double-Blind Peer Reviewed Refereed Open Access International Journal - Included in the International Serial Directories Indexed & Listed at: Ulrich's Periodicals Directory ©, U.S.A., Open J-Gate as well as in Cabell's Directories of Publishing Opportunities, U.S.A

Table 4
CCR score and Rank for each DMUs from 2009-10 to 2018-19

DMU	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Year 2009-10																
Score	1	1	1	1	0.9652	1	0.962	0.7674	1	1	1	1	1	0.9312	1	1
Rank	1	1	1	1	13	1	14	16	1	1	1	1	1	15	1	1
Reference Set					2, 3, 6, 11		2, 3, 6, 11	2, 3, 6, 11,12						2,11 12		
Year 2010-11																
Score	1	0.976	1	1	0.9779	1	1	0.9384	0.953	1	1	1	1	0.9686	1	1
Rank	1	13	1	1	12	1	1	16	15	1	1	1	1	14	1	1
Reference Set		6,12, 13,15			3,6,12, 13, 15			6,12,13, 15	11,12					10,11, 12,15		
Year 2011-12																
Score	0.9966	0.979	1	1	1	1	0.985	0.9457	0.999	1	1	1	1	0.9504	1	1
Rank	12	14	1	1	1	1	13	16	11	1	1	1	1	15	1	1
Reference Set	6,10,12	3,4,6 12,13,15					5,6, 11,12	3,5,6 12,13	11,12					3,5,10 11,12		
Year 2012-13																
Score	1	0.993	1	1	1	1	1	0.9879	1	1	1	1	1	1	0.9793	1
Rank	1	14	1	1	1	1	1	15	1	1	1	1	1	1	16	1
Reference Set		1,4,6 10,11						1,6,9 11,14							4,6,10, 11,13,16	
Year 2013-14																
Score	1	0.968	1	1	1	1	1	0.9686	1	1	1	1	1	0.9112	1	1
Rank	1	15	1	1	1	1	1	14	1	1	1	1	1	16	1	1
Reference Set		1,4,6,10 12,16						1,6,12 16						1,10,12		

International Journal of Management, IT & Engineering
Vol. 10 Issue 12, December 2020
ISSN: 2249-0558 Impact Factor: 7.119
Journal Homepage: http://www.ijmra.us, Email: editorijmie@gmail.com
Double-Blind Peer Reviewed Refereed Open Access International Journal - Included in the International Serial Directories Indexed & Listed at: Ulrich's Periodicals Directory ©, U.S.A., Open J-Gate as well as in Cabell's Directories of Publishing Opportunities, U.S.A

Year 2014-15																
Score	1	0.96	1	1	1	1	1	0.9348	1	1	1	1	1	0.8908	1	1
Rank	1	14	1	1	1	1	1	15	1	1	1	1	1	16	1	1
Reference Set		1,4,6, 10,15						4,10,12, 13,15						10, 12,15		
Year 2015-16																
Score	1	0.937	1	1	1	1	1	0.9513	1	1	1	1	1	0.9432	1	1
Rank	1	16	1	1	1	1	1	14	1	1	1	1	1	15	1	1
Reference Set		4,6,10 12,13						3,4,6 12						12,15		
Year 2016-17																
Score	1	0.935	0.952	1	1	1	1	0.9706	1	1	1	1	1	1	1	1
Rank	1	16	15	1	1	1	1	14	1	1	1	1	1	1	1	1
Reference Set		1,4,10 16	1,6,10 16					4,10,12 15								
Year 2017-18																
Score	0.9583	1	0.973	1	1	1	1	1	0.935	1	1	1	1	0.9459	1	1
Rank	14	1	13	1	1	1	1	1	16	1	1	1	1	15	1	1
Reference Set	6,10,13 16		2,4,5 12,16						6,11 12					12,13 15		
Year 2018-19																
Score	1	1	0.923	1	0.98	1	0.963	1	0.908	1	0.965	1	1	0.9507	1	0.94
Rank	1	1	15	1	10	1	12	1	16	1	11	1	1	13	1	14
Reference Set			4,10 13,15		1,4 13		4,6,10 13		10 12		1,10 12			10 12		4,10, 13,15

International Journal of Management, IT & Engineering
Vol. 10 Issue 12, December 2020
ISSN: 2249-0558 Impact Factor: 7.119
Journal Homepage: http://www.ijmra.us, Email: editorijmie@gmail.com
Double-Blind Peer Reviewed Refereed Open Access International Journal - Included in the International Serial Directories Indexed & Listed at: Ulrich's Periodicals Directory ©, U.S.A., Open J-Gate as well as in Cabell's Directories of Publishing Opportunities, U.S.A

Analysis of table 4 reveals that for the year 2009-10, out of the 16 DMUs - 12 DMUs are found to be efficient and 4 are found to be inefficient. The efficient DMUs had a score of 1.The inefficient DMUs are 5, 7, 8 and14: namely BOB, BOI, Indian Overseas and IndusInd. Out of the inefficient DMUs, Indian overseas bank had the least overall efficiency score of 0.7674. In other words the inputs of Indian overseas bank are able to give output equivalent to 76.74% only. The other inefficient scores ranged between 0.9312 and 0.962; i.e. it ranged from 93% to 96%. For the year 2010-11, out of the 16 DMUs - 11 DMUs are found to be efficient and 5 are found to be inefficient. The inefficient DMUs are 2,5,8,9, and 14; namely PNB, BOB, Indian Overseas, ICICI and IndusInd. The DMU with least overall efficient score is IndusInd Bank with 0.9384. Even though IndusInd remained on the 16th position, as compared to the financial year 2019-10, the efficiency score of IndusInd bank improved from 76.74% to 93.84%.

Analysis of findings for the year 2011-12 reveals that, out of the 16 DMUs - 10 DMUs are found to be efficient and 6 are found to be inefficient. The inefficient DMUs are 1, 2,7,8,9 and 14; namely SBI, PNB, BOI, Indian Overseas and IndusInd. SBI bank and Indian overseas Bank are showing inefficient scores but still there is nothing much to worry for these two DMUs as their overall efficiency score is almost 0.996 and 0.999; which is almost 1. Over the three years period, the number of inefficient DMUs has increased. This may be due to the increase in Non-performing assets (NPA) reported in these financial years. For the year 2012-13, out of the 16 DMUs - 13 DMUs are found to be efficient and 3 are found to be inefficient. The inefficient DMUs are 2, 8and 15; namely PNB, Indian overseas and Karur Vysya. The overall efficiency score of these DMUs ranged from 0.9793 to 0.933, which indicates that the output to input ratio of these banks were above 90% though not 100%.

Analysis of results for three consecutive years 2013-14, 2014-15 and 2015-16 reveals that out of the 16 DMUs - 13 DMUs are found to be efficient and 3 are found to be inefficient. The inefficient DMUs are 2, 8 and 14, namely PNB, Indian overseas and UCO bank. These three banks have consistently performed below the efficiency level for these years. The overall efficiency score of DMU 2- PNB is 0.968 in 2013-14, which decreased to 0.937 in 2015-16. The overall efficiency of Punjab National Bank decreased by, almost, 3 % in three years. The performance of Indian Overseas bank also decreased in this three year time period. The efficiency score of Indian Overseas Bank is 0.9686 in the year 2013-14 which decreased to 0.9513 in the year 2015-16.The overall efficiency of IndusInd Bank however showed a dip and then a rise. Its overall efficiency score in 2013-14 is 0.9112 which decreased to 0.8908 in the year 2014-15 and then increased to 0.9432 in year 2015-16.

Analysis for the year 2016-17 reveals that out of the 16 DMUs - 13 DMUs are found to be efficient and 3 are found to be inefficient. The inefficient DMUs are 2, 3 and 8; namely PNB, Canara and Indian overseas. The overall efficiency score lies from 0.935 to 0.9706. Punjab National Bank has the least efficiency with 93%. For 2017-18, out of the 16 DMUs - 12 DMUs

International Journal of Management, IT & Engineering
Vol. 10 Issue 12, December 2020
ISSN: 2249-0558 Impact Factor: 7.119
Journal Homepage: http://www.ijmra.us, Email: editorijmie@gmail.com
Double-Blind Peer Reviewed Refereed Open Access International Journal - Included in the International Serial Directories Indexed & Listed at: Ulrich's Periodicals Directory ©, U.S.A., Open J-Gate as well as in Cabell's Directories of Publishing Opportunities, U.S.A

are found to be efficient and 4 are found to be inefficient. The inefficient DMUs are 1, 3,9 and 14; namely SBI, Canara, ICICI and IndusInd bank, with overall efficiency ranging from 0.935 to 0.973. ICICI bank is the least efficient DMU from the sample.

For the year 2018-19, out of the 16 DMUs – only 9 DMUs are found to be efficient and 7 are found to be inefficient. The inefficient DMUs are 3,5,9,11,14 and 16; namely Canara, BOB, ICICI, Axis, IndusInd and South Indian Bank. The least efficiency score is 0.908 of ICICI bank; the output of ICICI bank was only 90% of its inputs. The overall efficiency score of the inefficient DMUs range from 0.908 to 0.98. The statistics of CRR analysis is presented in table 4.7. It shows the number of efficient units, number of inefficient units, Average score of all DMUs for a particular year, the Maximum value, minimum value and Standard Deviation year-wise for all the 10 years (2009-10 to 2018-19) under the consideration of the present study. Analysis of the table is followed by the table.

Table 5
Statistics by CRR Model of 16 DMUs

Result Analysis	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19
No. of Efficient Units	12	11	10	13	13	13	13	13	12	9
No. of Inefficient Units	4	5	6	3	3	3	3	3	4	7
Average	0.9766	0.9884	0.991	0.9975	0.9905	0.9866	0.9895	0.9911	0.9769	0.9769
Maximum	1	1	1	1	1	1	1	1	1	1
Minimum	0.7674	0.9384	0.9457	0.9793	0.9112	0.8908	0.9371	0.9352	0.9082	0.9082
Standard Deviation	0.0593	0.0198	0.0179	0.0059	0.0237	0.0315	0.0228	0.0202	0.0314	0.0314

Figure 1

International Journal of Management, IT & Engineering
Vol. 10 Issue 12, December 2020
ISSN: 2249-0558 Impact Factor: 7.119
Journal Homepage: http://www.ijmra.us, Email: editorijmie@gmail.com
Double-Blind Peer Reviewed Refereed Open Access International Journal - Included in the International Serial Directories Indexed & Listed at: Ulrich's Periodicals Directory ©, U.S.A., Open J-Gate as well as in Cabell's Directories of Publishing Opportunities, U.S.A

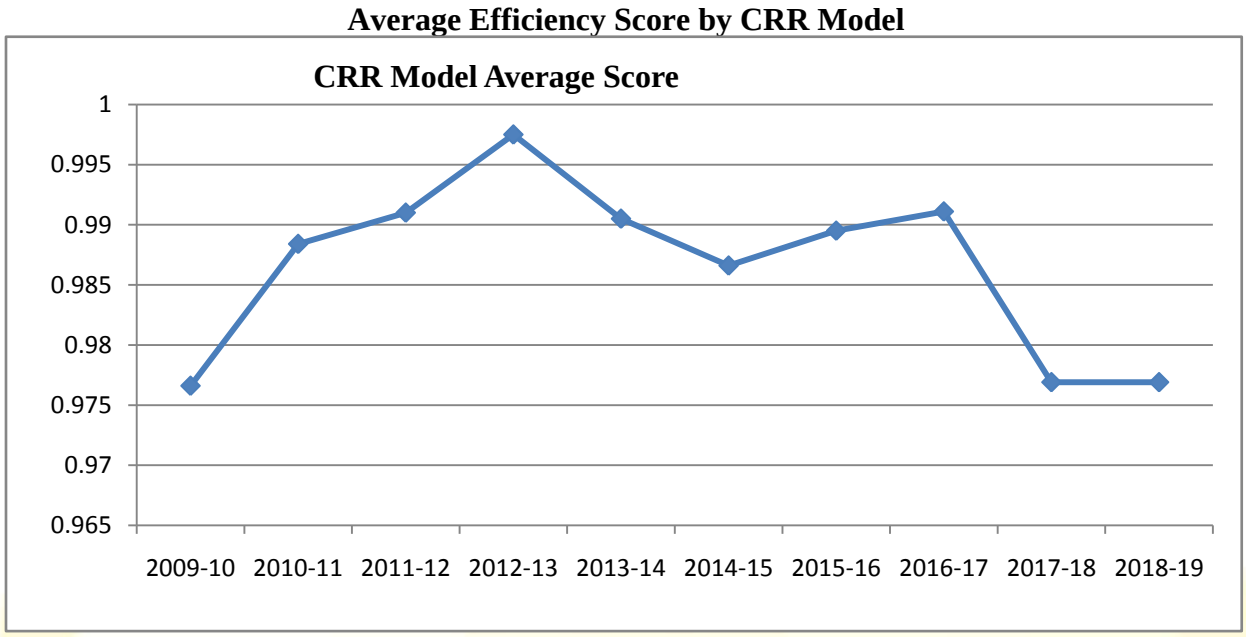

Figure 1 shows the average efficiency score as per CRR model. The average efficiency shown in table 5 reveals that the overall efficiency of the DMUs ranged from 97% to 99%. The table also show maximum efficiency, minimum efficiency and Standard deviation of the DMUs selected for the present study.

Conclusion

State Bank of India is inefficient in 2011-12 and 2017-18. In the year 2011-12 RBI had taken the initiative to focus on financial inclusion which diverted funds of many public sector banks. In the year 2017-18 major bank scams surfaced in the banking industry which led to low efficiency performance of public sector banks. Inefficiency of SBI shows low utilisation of its inputs (fixed assets and deposits) for enhancing its output (income revenue).

The efficiency of the bank also depends on how well the investments are handled and how well the operations of the bank are managed. Banks like PNB and Indian Overseas bank has performed below efficiency for many years in the present study. This indicated that the funds of the banks are mismanaged. The operations of the bank are mishandled which resulted into low profitability and inefficiency. Banks like Punjab National Bank have high level of NPAs and therefore the credit policy of banks, especially the public sector banks should be revised. Strict recovery measures should be adopted by banks for speedy recovery of loans and focus should be on reduction of NPAs.

References:

I. Abbott, M. and Doucouliagos, C. (2003), 'The efficiency of Australian universities: a data envelopment analysis', *Economics of Education Review*, 22, 89-97.

II. Agasisti, T., Catalano, G., Landoni, P., and Verganti, R. (2012), 'Evaluating the performance of academic departments: an analysis of research-related output efficiency', *Research Evaluation*, 21, 2-14.

III. Banker, R. D., Charnes, A., and Cooper, W. W. (1984), 'Some models for estimating technical and scale inefficiencies in data envelopment analysis', *Management Science*, 30(9), 1078-1092.

IV. Belfield, C.R. (2000), *Economic Principles for Education – Theory and Evidence*, Edward Elgar Publishing,Inc, Cheltenham, UK and Northampton, MA, USA.

V. Bitran, G.R. & Novaes, A.G. (1973). Linear programming with a fractional objective function. *Operations Research*, **21**, 22-29.

VI. Charnes, A., Cooper, W. W., and Rhodes, E. (1978), 'Measuring the efficiency of decision making units',*European Journal of Operational Research*, 2, 429-444.

VII. Cooper, W.W.; Seiford, L.M. & Tone, K. (2000). *Data Envelopment Analysis*. Kluwer Academic, Boston, Mass

VIII. Cooper, W. W., Seiford, L.M., and Tone, K. (2007), *Data Envelopment Analysis – A Comprehensive Text with Models, Applications, References and DEA-Solver Software*, 2nd edition, Springer Publishing, New York, USA

IX. Depren, S. K., & Depren, O. (2016). Measuring efficiency and total factor productivity using data envelopment analysis: An empirical study from banks of Turkey. *International Journal of Economics and Financial Issues*, *6*(2), 711–717.

X. Johnes, J. (2006), 'Data envelopment analysis and its application to the measurement of efficiency in higher education', *Economics of Education Review*, 25, 273-288.

XI. Kumar, S., & Gulati, R. (2008). An examination of technical, pure technical and scale efficiencies in GCC banking. *Eurasian Journal of Business and Economics*, *1*(2), 33–69. https://doi.org/10.1504/ajfa.2008.019950

XII. Kusum, W. K., Athanasios, G. N., & Man Mohan, A. (2003). An analysis of efficiency

and productivity growth of the Indian banking sector. *Finance India*, *17*(2), 511–521.

XIII. Li, Y., & Wang, M. (2012). Capital regulation, monetary policy and asymmetric effects of commercial banks' efficiency. *China Finance Review International*, *2*(1), 5–26. https://doi.org/10.1108/20441391211197438

XIV. Malhotra, D. K., Poteau, R., & Malhotra, A. (2014). An empirical analysis of cost efficiencies in the Indian banking industry. *International Journal of Business*, *19*(4), 361–380.

XV. Sahin, G., Gokdemir, L., & Ozturk, D. (2016). Global Crisis and its Effect on Turkish Banking Sector: A Study with Data Envelopment Analysis. *Procedia Economics and Finance*, *38*(October 2015), 38–48.

XVI. Tamatam, R., Dutta, P., Dutta, G. and Lessmann, S. (2019). 'efficiency analysis of indian banking industry over the period 2008-2017 using data envelopment analysis'. *Benchmarking: An International Journal*, *26*(8), 2417–2442. https://app.myloft.xyz/browse/article/cka7nxb6a4l2d0782wr2hpfk1

XVII. Tomkins, C. and Green. R. (1988), 'An experiment in the use of data envelopment analysis for evaluating the efficiency of UK university departments of accounting', *Financial Accountability & Management*, 4, 147-164. https://doi.org/10.1016/s2212-5671(16)30174-5