IJEAST

INTERNATIONAL JOURNAL
OF ENGINEERING APPLIED SCIENCE
AND TECHNOLOGY

VOLUME : 5 ISSUE : 1 Print / Issue Publication Date: 29-Jul-2020

ISSN : 2455-2143

DOI : 10.33564/IJEAST.2020.v05i01.122

Indexed In

Google SCHOLAR OPEN ACCESS doi Crossref

WWW.IJEAST.COM

editor@ijeast.com

International Journal of Engineering Applied Sciences and Technology, 2020
Vol. 5, Issue 1, ISSN No. 2455-2143, Pages 683-689
Published Online May 2020 in IJEAST (http://www.ijeast.com)

MEASURING TECHNICAL EFFICIENCY OF INDIAN BANKS BASED ON THE PERIOD OF PRE-GLOBAL ECONOMIC CRISIS, GLOBAL ECONOMIC CRISIS AND POST-GLOBAL ECONOMIC CRISIS (1995-2016) BY USING DEA (DATA ENVELOPMENT ANALYSIS)

Subodh Wagle
Kathmandu, Nepal

***Abstract*— This research paper analyses the technical efficiency of 66 Indian Scheduled Commercial banks operating in India between the period 1995 and 2016 and I applied Data Envelopment Analysis (DEA), across three economic eras. And the comparison between the average technical efficiency by applying the CRS model and the VRS model year-wise, period-wise and as a whole 22-years period. All of the determinants of the efficiencies are chosen under an intermediation approach.**

Keywords— **Bank Efficiency, Technical Efficiency, Data Envelopment Analysis, Intermediation Approach, Constant Return to Scale (CRS), Variable Return to Scale (VRS)**

I. INTRODUCTION

Banking and financial institutions are known as the backbone or the important pillar for economic development of any country. Banks play the role of intermediary between savers and borrowers, customers who deposit money can benefit from interest and customers who borrow money from the bank have to pay interest. The differences between the interest amounts are one of the main source of income of banks and financial institutions. In this 21st century, banking and financial institutions have spread almost all of the countryside of India to collect money as deposits as well as to lend money as loans. Besides the great efforts of banking and financial institutions to show their presence in rural India, there are still some lacks. There are 21 Public Sector Banks, 21 Private Banks, and 44 Foreign Banks are operating in India as per 8 October 2018. Altogether 86 Scheduled Commercial Banks are facilitating Indians inside the Indian territory. Total Employment facilitated from all Scheduled Commercial Banks in India is 1,380,461 as per March 2018. In addition to this, the total Capital of scheduled commercial banks as per March 2018 is INR. 116,127 crore and total Reserve & Surplus is INR. 1,079,770. However, Non-performing Assets amounted to INR. 520,679 crore as per March 2018 and the total Branches of scheduled commercial banks in India is 145,426.

Scheduled Commercial Banks of India has ownership of central government securities amounted to INR. 2,384,770 crore on 31 March, 2019. Similarly, ownership amounted to INR. 940,656 crore on state governments' securities and INR. 237,543 crore on treasury bills. Indian commercial bank's external debt accounted for US$ 95,490 million as of 31 March 2019. As per June 2019 data published by RBI, the Indian Scheduled Commercial banks' aggregate assets are INR. 320,878 crore. There is also fraud cases found, the total number of fraud cases is 6,801 and the amount is IRS. 715,429.3 million. According to October 11, 2019, investment amount in commercial paper from scheduled commercial banks is INR. 9,822.4 crore. Total money invested in shares by scheduled commercial banks is INR. 8,395.9 crore. Similarly, INR. 54,208 crore money is invested in Bonds and Debentures by Indian scheduled commercial banks. According to March 2019 data, aggregate deposits money of Scheduled Commercial Banks of India is INR. 12,573,772 crore. And borrowing from RBI by Scheduled Commercial Banks of India is INR. 180,688 crore, total Cash in hand INR. 74,877 crore and Balances with RBI INR 565,707 crore.

In India, the banking sector dominating the Indian financial services sector. Banks are classified into public banks, private banks, and foreign banks in India. In terms of lending and borrowing, public banks still dominate the banking industry, and also a large number of branches spread-out throughout India. Indian banking and financial system is in a new era after adapting Indian financial sector reform in 1991. Directly or

International Journal of Engineering Applied Sciences and Technology, 2020
Vol. 5, Issue 1, ISSN No. 2455-2143, Pages 683-689
Published Online May 2020 in IJEAST (http://www.ijeast.com)

indirectly, the overall economic and political environment in the country affects the banking and financial sectors. It is very important for banks to operate more efficiently to cope with the gradually rising competition in the market in order to sustain and perform better. It is very crucial and important to evaluate the performance of banks because of growing tough competition in the market, moreover to find the effectiveness of fund allocation and day to day business. It is very difficult to choose a suitable methodology to measure the efficiency of banks. In 2008-2009, the global financial crisis rocked the market globally, which have resulted in stringent efficiency measurement requirements. Although, there is a necessity of the Indian banking sector to the domestic level, regional level as well as international economies too, but there is a lack in the microeconomic studies in this coverage. This paper examines the Indian banking sector by applying the non-parametric technique called Data Envelopment Analysis (DEA), which was first proposed by Charnes, Cooper, and Rhodes in 1978 and later extended by Banker, Charnes, and Cooper in 1984. Banks are the major intermediaries. In the growing competitive market globally, banks have sharpen their vision and spread throughout the corner of markets.

A. Efficiency-

According to the N'Gbo (1991) et. Atkinson et. Cornwell (1994), the production unit is technically effective if, it produces maximum outputs from inputs. The efficiency of a firm can be analysed by using the parametric approach, the non-parametric approach, and financial ratios.

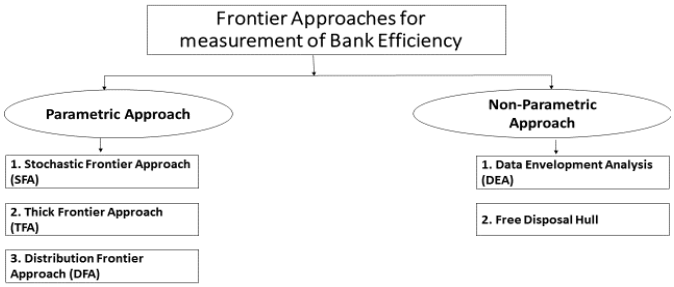

Fig. 1. Frontier Approaches for measurement of Bank Efficiency

According to the CCR-Model, introduced by Charnes, Cooper, and Rhodes (1978), this model measures the efficiency of each DMU which is obtained as a weighted sum of outputs to the weighted sum of inputs. It can be shown as:-

$$\text{Efficiency} = \frac{\textbf{Weighted sum of Outputs}}{\textbf{Weighted sum of Inputs}}$$

B. DEA (Data Envelopment Analysis)-

DEA (Data Envelopment Analysis) is introduced by Charnes et al. (1978) as an efficiency measurement technique. This technique mainly depends upon the relationship between inputs and outputs. DEA is a linear programming technique which converts multiple inputs and outputs (measured in any units) of each DMU (Decision Making Unit) into a scalar measure of efficiency by assigning weights to inputs and outputs of a DMU that gives it the best possible efficiency. DEA is a popular technique to analyze bank performance and productivity which combines all input and output data of the bank in a single measure. This powerful tool i.e., DEA can handle multiple inputs as well as outputs, and no need to be homogeneous in nature.

C. Models of DEA-

1) CCR Model

In this model by using a linear combination, various inputs and outputs can be changed into one virtual input and output.

CRS Model

The CCR model assumes CRS (Constant Return to Scale). Under this CRS model, if an increase in the inputs results in a proportionate increase in the outputs.

2) BCC Model

In contrast to constant yield (CCR Model), the BCC's model (Banker et al (1984) assume a variable output with respect to the scale.

VRS Model

The BCC Model assumes VRS (Variable Returns to Scale). Under this VRS model, if it suspected that an increase in inputs does not result in a proportional change in the outputs.

D. Input Oriented and Output Oriented DEA-

In the input orientation, we explore the possibilities of reducing inputs to produce a given level of output level. In the output orientation, we explore the possibilities of expansion of outputs for a given set of input variables.

The rest of the paper is organized as follows. Research Objectives are explained in section II. Review of Literatures is presented in section III. In section IV, Data and Methodology is discussed. Analysis and Interpretation is presented in section V. Findings and Conclusions remarks are given in section VI. Section VII comprised of References.

International Journal of Engineering Applied Sciences and Technology, 2020
Vol. 5, Issue 1, ISSN No. 2455-2143, Pages 683-689
Published Online May 2020 in IJEAST (http://www.ijeast.com)

II. RESEACH OBJECTIVES

Globally, researchers have been showing great interest in the field of analysing the efficiency of the banking sector. There are lots of published research-papers relate to the Indian Banking sector. However, this study comprises the technical efficiency of the Indian Scheduled Commercial Banks after the financial liberalization in 1991. In this paper I divide the time period of my study annually from 1996 to 2016 in the first, then I divide time period into three economic eras: pre-economic global crisis (1995-2005), economic global crisis (2006-2011) and post-economic global crisis(2012-2016) and compare between CRS and VRS average technical efficiency value of Indian Scheduled Commercial banks operating in India.

III. REVIEW OF LITERATURE

Marina Maniati and Evangelos Sambracos (2017), measured the Technical efficiency of 71 banks involved in shipping finance banks operating globally from 2005 to 2010 by using DEA. Intermediate approach with output orientation is applied, while models are executed with constant and variable return to scale (CRS and VRS approaches) in order to detect any differences in banks' TE in terms of technology. Data were derived from Bloomberg's professional database and Bank scope database provided by Bureau van Dijk. The study identified banks are not technically efficient over the time period examined.

Nand Kumar and Archana Singh (2015), measured the technical and scale efficiency of 10 Indian commercial banks over the years 2006-2010. The study used the CRR model and BCC model to estimate technical and scale efficiency. Data were obtained from RBI website (www.rbi.org.in). They found mean technical and scale efficiency improved from 2006 to 2008 and then declined during the period 2008 to 2010. The performance of private sector banks found better than public banks during the period of investigation.

Emilia Zimkova (2014), analysed the technical and super efficiency of the 16 commercial banking institutions in Slovakia. Intermediation approach is applied with the input-oriented BCC model, SBM model, and super efficiency SBM model. Inputs are taken as a number of full-time employees, deposits and property and equipment of the banking institutions, and the outputs are loans and commercial papers held to maturity. More than half of institutions were found technically efficient.

Nand Kumar and Archana Singh (2014), estimated the technical efficiency of 10 commercial banks in India during the period 2006-2010. The paper considered three input variables are deposits, number of employees, operating expenses and three output variables are investments, other income, and advances. Data taken from RBI website (www.rbi.org.in). They found mean technical efficiency improved in the initial period but later it declined. Five banks found very efficient and consistent in their performance. The performance of private sector banks found better than public sector banks during the period of study.

Kristina Kocisova (2013), studied the overall technical, pure technical efficiency and scale efficiency of top 50 world banks in 2011. The study distinguished three main approaches in evaluating efficiency: production, overall technical, pure technical and scale efficiency of top 50 commercial banks in the world and to identify the reason of efficiency. Second, compared the average efficiency of banks in different regions. Third, defined input and output variables (strength and weakness), that influence efficiency to find out the factors positively and negatively related to pure technical efficiency. Personal costs, non-interest expenses and number of employees are taken as input variables while the output variables are total deposits received and total loans dispersed. The study found the highest level of average overall efficiency (CCR model) was obtained in the operating approach. The average pure technical efficiency (BCC model) was highest under the intermediation approach. The average efficiency under the production approach was the lowest one in both CRR and BCC model.

Dipayan Roy (2014), analysed the technical efficiency of 62 scheduled commercial banks in India using DEA across three economic eras i.e., pre-Basel era (1999-2002), Basel I era (2003-2008) and base II era (2009-2012) on the basis of intermediation approach. Output variables are net interest income and non-interest income and input variables are operating expenses, number of employees, physical capital and loanable funds. Private sector banks were found to be the highest in all the eras on the basis of average OTE, whereas, Nationalised banks found increased over the three eras.

Even though technical efficiency of banks is widely researched, there is no literature which studies the 66 Indian Scheduled Commercial banks year-wise from year 1995 to 2016 and period-wise: pre-Global Economic Crisis (1995-2005), Global Economic Crisis (2006-2011) and post-Global Economic Crisis (2012-2016). In this paper, I try to compare the technical efficiency of Indian Scheduled Commercial banks according to:-

1) year-wise (1995-2016)
2) period-wise (pre-Global Economic Crisis, Global Economic Crisis, and post-Global Economic Crisis)
3) model-wise (Constant Return to Scale and Variable Return to Scale)

International Journal of Engineering Applied Sciences and Technology, 2020
Vol. 5, Issue 1, ISSN No. 2455-2143, Pages 683-689
Published Online May 2020 in IJEAST (http://www.ijeast.com)

IV. DATA AND METHODOLOGY

Data for this study is collected from 66 Indian Banks, which include, Nationalised Banks, Foreign Banks, State Banks, and Private Banks. The secondary source for financial data is obtained from the central bank of India i.e., Reserve Bank of India (RBI) website.

A. Choices of Input Variables and Output Variables-

There are different views regarding the selection of input variables and output variables. The choice depends on two different approaches used in banking studies namely, Production Approach and Intermediation Approach. According to the Production Approach, banks are producers of loan services and deposits accounts using capital and labor as inputs. Outputs are measured by the number and type of transactions or documents processed over a given time period (Berger and Humphre, 1997). However, it is very hard to find such data. According to the intermediation approach, banks and financial intermediaries that converts deposits and purchased funds into the loans and financial investments. As per this approach, loans are taken as output variables, while deposits and other liabilities are taken as input variables. This study also literally uses the intermediation approach, which is the most commonly practiced approach.

Table -1 Choices of Input Variables and Output Variables

Input variables			**Output variables**		
Fixed Assets	**Number of Employees**	**Loanable Fund= Deposits + Borrowings**	**Advances**	**Investments**	**Non-Interest Income**

V. ANALYSIS AND INTERPRETATION

Table -2 Number of Efficient Banks and Year-wise Mean Technical Efficiency under CRS model

Years	DMUs	No. of Efficient DMUs	Mean Technical Efficiency
1995	61	18	0.9
1996	65	19	0.92
1997	66	21	0.93
1998	66	14	0.85
1999	65	16	0.91
2000	64	11	0.89
2001	63	18	0.92
2002	62	16	0.92
2003	60	13	0.92
2004	61	13	0.92
2005	61	12	0.8
2006	60	14	0.92
2007	57	15	0.87
2008	55	13	0.82
2009	53	10	0.89
2010	53	8	0.82
2011	51	8	0.86
2012	51	8	0.87
2013	51	9	0.81
2014	51	10	0.93
2015	51	5	0.91
2016	50	7	0.9

The average technical efficiency in the year 1997 and 2014 found 0.93 which is the highest one. In the year 2005, the average technical efficiency saw the lowest i.e., 0.80. After the financial liberalization in India in the period 1995-1997, the mean value of technical efficiency increased from 0.90 to 0.93 respectively before a dramatic decline in the year 1998 i.e., 0.85. From 2001 to 2004 average technical efficiency remained stable at 0.92, after that, it dipped to 0.80 in the later year i.e., 2005. Then the trend started to fluctuate from 2006 to 2013. In the post-Global Economic Crisis period, the trend of average technical efficiency starts to rise again. In the year 1997, out of 66 banks 21 banks showed efficient i.e., 1.0 and also mean technical efficiency 0.93, which is the highest one in the 22-years period. There were only 5 efficient banks out of 51 banks in the year 2015. In the pre- Global Economic Crisis period, there were more efficient banks as compared to Global Economic Crisis period and post- Global Economic Crisis period.

Table -3 Period-wise Average Technical Efficiency under CRS model

Periods	Years	Average Technical Efficiency
Pre Global Economic Crisis Period	1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005	0.90
Global Economic Crisis Period	2006 2007	0.86

International Journal of Engineering Applied Sciences and Technology, 2020
Vol. 5, Issue 1, ISSN No. 2455-2143, Pages 683-689
Published Online May 2020 in IJEAST (http://www.ijeast.com)

	2008	
	2009	
	2010	
	2011	
Post Global Economic Crisis Period	2012	0.88
	2013	
	2014	
	2015	
	2016	

The pre-Global Economic Crisis period is selected from 1995 to 2005 and the average technical efficiency found 0.90 which is the best one among three periods. Then comes the Global Economic Crisis period, taken from 2006 to 2011, shows 0.86 average technical efficiency, which is the lowest one. From 2012 to 2016, the post-Global Economic Crisis period shows the mean technical efficiency of 0.88. Before the Global Economic Crisis period banks were in a better condition. The banks' performance started to decrease after experiencing the global economic crisis, which means Indian banks also are affected negatively by this crisis.

Table -4 Number of Efficient Banks and Year-wise Mean Technical Efficiency under VRS model

Years	DMUs	No. of Efficient DMUs	Mean Technical Efficiency
1995	61	24	0.93
1996	65	30	0.95
1997	66	32	0.95
1998	66	23	0.92
1999	65	32	0.95
2000	64	26	0.94
2001	63	29	0.95
2002	62	29	0.95
2003	60	27	0.96
2004	61	24	0.96
2005	61	23	0.91
2006	60	31	0.97
2007	57	23	0.94
2008	55	21	0.91
2009	53	20	0.94
2010	53	12	0.88
2011	51	14	0.93
2012	51	15	0.93
2013	51	14	0.92
2014	51	22	0.98
2015	51	19	0.97
2016	50	21	0.97

The highest average technical efficiency is seen in the year 2014 i.e., 0.98 and the least one is 0.88 in the year 2010 during the 22-years period. In the year 2006, 2015 and 2016 the mean technical efficiency was 0.97. There were 24 efficient banks in the year 1995, which is after the financial liberalization started in India. In the years 1997 and 1999, there were 32 efficient banks were operating in India. Conversely, only 12 efficient banks were operated in 2010 which is the least one in the 22-years period. The trend in both average technical efficiency and number of efficient banks showed heavy fluctuation round the 22-years period.

Table -5 Period-wise Average Technical Efficiency under VRS model

Periods	Years	Average Technical Efficiency
Pre Global Economic Crisis Period	1995	0.94
	1996	
	1997	
	1998	
	1999	
	2000	
	2001	
	2002	
	2003	
	2004	
	2005	
Global Economic Crisis Period	2006	0.92
	2007	
	2008	
	2009	
	2010	
	2011	
Post Global Economic Crisis Period	2012	0.95
	2013	
	2014	
	2015	
	2016	

International Journal of Engineering Applied Sciences and Technology, 2020
Vol. 5, Issue 1, ISSN No. 2455-2143, Pages 683-689
Published Online May 2020 in IJEAST (http://www.ijeast.com)

There are consecutively 10 years from 1995 to 2005 in the pre-Global Economic Crisis period and the mean technical efficiency calculated 0.94. This is the time period after financial liberalization took place in India and before the economic crisis rocked all over the world. The Global Economic Crisis period i.e., 2006-2011, average technical efficiency amounted in this period is 0.92, which is decreased as compared to the previous time period. The mean technical efficiency is increased to 0.95 in the third period i.e., post-global Economic Crisis period from 2012 to 2016. Which shows banking performance is getting better after the economic crisis hit around the globe.

Table -6 Overall comparison between various outputs of CRS and VRS model

Periods	Years	DMUs	No. of efficient DMUs (CRS)	Average TE year-wise (CRS)	Average TE period-wise (CRS)	Average TE as a whole (CRS)	No. of efficient DMUs (VRS)	Average TE year-wise (VRS	Average TE period-wise (VRS)	Average TE as a whole (VRS)
Pre Global Economic Crisis Period	1995	61	18	0.9	0.90	0.94	24	0.93	0.94	0.94
	1996	65	19	0.92			30	0.95		
	1997	66	21	0.93			32	0.95		
	1998	66	14	0.85			23	0.92		
	1999	65	16	0.91			32	0.95		
	2000	64	11	0.89			26	0.94		
	2001	63	18	0.92			29	0.95		
	2002	62	16	0.92			29	0.95		
	2003	60	13	0.92			27	0.96		
	2004	61	13	0.92			24	0.96		
	2005	61	12	0.8			23	0.91		
Global Economic Crisis Period	2006	60	14	0.92	0.86		31	0.97	0.92	
	2007	57	15	0.87			23	0.94		
	2008	55	13	0.82			21	0.91		
	2009	53	10	0.89			20	0.94		
	2010	53	8	0.82			12	0.88		
	2011	51	8	0.86			14	0.93		
Post Global Economic Crisis Period	2012	51	8	0.87	0.88	0.88	15	0.93	0.95	
	2013	51	9	0.81			14	0.92		
	2014	51	10	0.93			22	0.98		
	2015	51	5	0.91			19	0.97		
	2016	50	7	0.9			21	0.97		

The Variable Return to Scale (VRS) model shows better performance of Indian Scheduled Commercial banks as compared to the Constant Return to Scale (CRS) model. There are more efficient Decision-Making Units (DMUs) in the VRS model in comparison with the CRS model. The average technical efficiency is 0.90 while applying the CRS model in the pre-Global Economic Crisis period, however VRS model shows 0.94. Similarly, the VRS model calculated 0.92 mean technical efficiency in the Global Economic Crisis period but the CRS model shows 0.86. In the post-Global Economic Crisis period, the average technical efficiency by using the CRS model is 0.88, while in the VRS model it is 0.95.

VI. FINDINGS AND CONCLUSION

By applying the non-parametric approach Data Envelopment Analysis (DEA) methodology, I have calculated technical efficiency. I have tested the performance of all scheduled commercial banks of India year-wise starting from 1995 to 2016. The results show that in the tear 1997 the number of efficient banks with 100 percent by applying Constant Return to Scale (CRS) model is 21 banks and by applying Variable Return to Scale (VRS) model is 32 banks out of 66 banks. The average technical efficiency for that year when using the CRS model is 0.93 and the VRS model is 0.95. According to the CRS model, the number of efficient DMUs is the least in 2015 i.e., 5 banks, but in this year there were 19 efficient banks by using the VRS model. However, in the year 2010, there were only 12 efficient banks with 100 percent efficiency as compared to the CRS model i.e., 8 efficient banks. Average technical efficiency by using the VRS model in the year 2010 is 0.88 which is the least one in the 22-years period. There is overall average technical by using the CRS model is 0.88 and the VRS model shows 0.94.

By using the CRS model, the pre-Global Economic Crisis period found the most efficient period among three periods because average technical efficiency is 0.90. Similarly, the VRS model shows post-Global Economic Crisis period is the most efficient period because it has 0.95 average technical efficiency.

VII. REFERENCE

[1] Almanza Ramirez, Camilo; Mora, Jhon James;Cendales, Andres .(2007). Profit efficiency of banks in Colombia with undesirable output: A directional distance funtion approach, Leibniz Information Centre for Economics, Economics Discussion Paper, No. 2017-90.

[2] Benjamin M. Tabak, Dimos M. Fazio and Daniel O. Lajueiro .(2011). Profit, Cost and Scale Efficiency for Latin American Banks: concentration-performance relationship, Banco Central do Brasil, Working paper no. 244, (pp. 1-37).

[3] Coert Erasmus; Daniel Makina .(2014). An Empirical Study of Bank Efficiency in Suth Africa Using the Standard and Alternative Approaches to Data

Envelopment Analysis (DEA), Journal of Economics and Behavioral Studies, vol. 6, no. 4, (pp.310-317).

[4] Dinesh Gajurel .(2010). Cost Efficiency of Nepalese Commercial Banks, SSRN Electronic Journal, Article, no. 1657877.

[5] Dipayan Roy .(2014) Analysis of Technical Efficiency of Indian Banking sector: An Application of Data Envelopment Analysis, International Journal of Finance & Banking Studies (IJFBS), vol. 3.

[6] Emilia Zimkova .(2014). Technical Efficiency and Super-Efficiency of the Banking Sector in Slovakia, Procedia Economics and Finance 12 (2014), (pp. 780-787).

[7] Francesco Aiello; Graziella Bonanno .(2013). Profit and Cost efficiency in the Italian banking industry (2006-2011), Economics and Business Letters, vol. 2(4), (pp. 190-205).

[8] Kristina Kocisova, .(2013). Technical Efficiency of Top 50 world banks, Journal of Applied Economic Sciences, vol. VIII.

[9] Marina Maniati and Evangelos Sambracos .(2017). Measuring the Technical Efficiency for the Shipping Banks- An Approach Using Data Envelopment Analysis, Scientific Research Publishing, 7, (pp.502-516).

[10] Nand Kumar and Archana Singh .(2015). Measuring Technical and Scale Efficiency of Banks in India Using DEA, ISOR Journal of Business and Management (ISOR-JBM), vol. 17, (pp. 61-71).

[11] Nand Kumar and Archana Singh .(2014). A study of Technical Efficiency of Banks in India Using Dea, ISOR Journal of Business and Management (ISOR-JBM) Volume 16, Issue 9. ver. I, (pp. 37-43).

[12] Raoudha Bejaoui Rouissi .(2011). Cost and Profit efficiency of frencch commercial banks, NPRA, no. 34245.

[13] Roberta B. Staub; Geraldo Souza and Benjamin M. Tabak.(2009). Evolution of Bank Efficiency in Brazil: A DEA Approach, Banco Central do Brasil, working paper no. 200, (pp. 1-48).

[14] Rossazana Ab Rahim .(2015). Ranking of Malaysian Commercial Banks: Super-Efficiency Data Envelopment Analysis (DEA) Approach, Asian Academy of Management Jurnal of Accounting and Finance (AAMJAF), vol. 11, no. 1, (pp. 123-143).

[15] Rossazana Ab Rahim .(2016). DOES COMPETITION FOSTER EFFICIENCY? EMPIRICAL EVIDENCE FROM MALAYSIAN COMMERCIAL BANKS, Assian Academy of Management Journal of Accounting and Finance (AAMJAF), vol. 12, no.1, (pp. 1-23).

[16] Serhat Yuksel; Shahriyar Mukhtorov; Elvin Mommadov .(2016). Comparing the Efficiency of Turkish and Azerbaijani Banks: An Application with Data Envelopment Analysis, International Journal of Economics and Financial Issues, vol. 6(3), (pp. 1059-1067).

[17] Shamaila Ishaq .(2015). A NOVEL APPLICATION OF DATA ENVELOPMENT ANALYSIS AND PRODUCTION TRADE-OFFS FOR EFFICIENCY EVALUATION OF BANKING INSTITUTIONS-THE CASE FOR PAKISTAN, The University of Warwick, Thesis, no. 72828.

[18] Sunil Kumar; Rachita Gulati .(2008). An examination of Technical, Pure Technical, and Scale Efficeiencies in Indian Public Sector Banks using Data Envelopment Analysis, Eurasian Journal of Business and Economics, vol. 1(2), (pp. 33-69).

[19] Tamer Mohamed Shahwan; Yousef Mohammed Hassan .(2013). Efficiency analysis of UAE banks using data envelopment analysis, Journal of Economic and Administrative Sciences, vol. 29 Iss 1, (pp. 4-20).

[20] Tanko Muhammad .(2008). A DEA Analysis of Bank Performance in Nigeria, MPRA, paper no. 33560.

[21] Vijay Kumar Varadi; Pradeep Kumar Mavaluri and Nagarjuna Boppana .(2006). Measurement of Efficiency of Banks in India, MPRA, paper no. 17350.

[22] Zeji Yu .(2017). Efficiency and Competition Analysis in Nine Asian Banking Industries, Loughborough University Institutional Repository, A Doctoral Thesis, paper no. 2134/24135.

IJEAST

INTERNATIONAL JOURNAL
OF ENGINEERING APPLIED SCIENCE
AND TECHNOLOGY

ABOUT IJEAST

International Journal of Engineering Applied Science and Technology (IJEAST) is a peer-reviewed, open access journal that publishes high-quality research papers in the field of Engineering, Applied Science and Technology.

IJEAST aims to provide a platform for researchers, academicians, and professionals to share their innovative ideas, research findings, and practical experiences with the global scientific community.

FOCUS AREAS

- Engineering
- Applied Science
- Technology
- Innovation & Development
- Interdisciplinary Studies

PEER REVIEWED
All submissions are rigorously peer reviewed to ensure quality.

OPEN ACCESS
Free and unrestricted access to research for all.

GLOBAL REACH
Connecting researchers and professionals worldwide.

TIMELY PUBLICATION
We ensure a swift and efficient publication process.

For more information, visit our website
www.ijeast.com

INTERNATIONAL JOURNAL
OF ENGINEERING APPLIED SCIENCE
AND TECHNOLOGY

editor@ijeast.com
www.ijeast.com
India

2455-2143