Efficiency and Productivity of the Indian Banks

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Abstract

The paper's aim is to decide the Banks' efficiency and productivity worldwide. To understand how input and output are affected by the efficiency score, for which three methodologies have been developed. Firstly, for the decision-making units (DMUs), which in our study are the Indian banks, is the data envelopment analysis where technological efficiency is evaluated. Secondly, is using the Malmquist Productivity Index over a time frame of 10 years, from 2010 to 2020 for 48 banks. Three input variable that is, deposits, fixed assets and staff number, and two output variables that is, net loans and non-interest income are selected for the purpose of study.

Keywords: *Banks, DEA, Efficiency, MPI.*

I. INTRODUCTION

With the advent of Economic Liberalization, early 1990s saw a transformation in the banking system. The banking sector had entered into an unprecedented growth zone, with continuous improvement in the quality assets and efficiency. Since 1990, banking sector has come a long way, from providing plain vanilla services to becoming universal banks. Banks have not just undergone various technical changes in core banking system, human resource management, enterprise risk management for improving the performance and productivity, but also has transformed the lives of people in ways like moving towards digital modes of payment, thus making their lives easier.

The growth in banking sector has never been restrictive. The regulator, Reserve Bank of India, has always encouraged NBFCs (non-banking finance companies), co-operative banks, rural banks, self-help groups, BCs (business correspondents) and micro finance companies to serve the unbanked areas.

Looking back towards 1990s, reforms were introduced because of major contribution by four major committees of that time. They were, the latest being, the second Narasimhan committee in 1998, the Khan Committee in 1997, the Verma Committee in 1996 and it started with the first Narasimhan Committee which was formed in 1991.

These reforms had taken place in two phases. While the first phase focused on policy framework improvement, institutional framework improvement and financial health of the sector, the second phase was working on reinforcing the foundation of banking system by rehabilitation of its structure, development of human resources, and technological enhancements.

The main focus of these reforms were:

- Reducing NPAs, which were caused by increasing bad debts. RBI had offered three plans to restructure bad debts. They were, (i) Debt Recovery Tribunal (DRTs), (ii) Settlement Advisory Committee (SACs), (iii) Recapitalization from the government.
- Improving the Capital Adequacy ratio as a higher CAR will helps banks improve its efficiency by bringing reduction to the operating cost and upgrading long-term viability via risk reduction.
- Diversification in bank operations with the aim to maximize profits by obtaining maximum economies of scale and scope, expanding customer base and giving various types of banking services under one roof.

Apart from these, it had been observed that investments, bank credits, exports, and leveraging external conditions such as globalization, needed priority focused and continuous reform.

II. LITERATURE REVIEW

The Government of India with the regulator called Reserve of Bank of India are constantly aim to improve the efficiency of the banks. For this government and regulators has introduced various committees who can work on various loopholes of this sector. Hence this paper's aim is to focus on the efficiency of the national banks which includes banks having different ownerships such as public, private and foreign ownerships.

1. Subrahmanyam (1993), Tyagarajan (1975) and Rangarajan and Mampilly (1972) have earlier worked on the issues influencing particularly the performance factor of Indian banks, but not exactly on the efficiency of the banks. Milind Sathye (2002) had studied the efficiency of the banks with input factors affecting the output factors, keeping the committee of 1998, IInd Narasimhan Committee, by the Government of India as the backdrop of the study. But after that, there hasn't been enough further study in this field. At the moment, measurement of bank performance is done using a current trend, which is the frontier analysis method. There are two kinds of frontier analysis approaches that can be applied to firms of financial services industry. The approaches are parametric and the non-parametric. The approach of parametric, includes the analysis by the name stochastic frontier analysis. The DEA is a type of non-parametric approach. (Molyneux et al., 1996).

2. Gandhi & Sharma (2018) studies the efficiency and productivity through DEA and measures the technical efficiency of the private hospitals in India. Dietsch 1993, Dietsch 1988 Martin and Sassenou (1992), Levy-Garboua and Renard (1977), have investigated the cost economies in French banking sector. Berg et al. (1995), Berg et al. (1993), Berg 1992, Berg 1991, studies the banking sector in the Scandinavian countries. A study by Berg et al. (1995) studies the banking of Scandinavian countries and applies DEA to estimate the inefficiencies in the banking systems. DEA technique is also used for investigating the Spanish banks. This is done to examine productivity, gauge increase in efficiency of the expenses, by calculating overall factor productivity and technical variability.

3. Richard J. Sullivan, Kenneth Spong, and Robert DeYoung had well investigated and clarified the influence of various banking variables on its performance. Bank specific variables look at expenses of banks (interest plus non-interest expenses), which act as a feature of selected variables, affecting bank's expense structure. This may also include some unspecified cost that are assumed to be a measure of a bank's excess expense. The explanatory variables relate to the output it produces. The output variables here include net loans that banks produce (this could be commercial or agricultural or consumer or real estate loans), transaction and liquidity services (volume of transaction deposits is used as a proxy), and fee related activities (using revenue based financial service as proxy). Certain explanatory factors include communication costs, after-tax earnings, bank ownership and management, wages, opportunities to succeed, risk management skills.

4. Using the above details, this model estimates an efficiency limit, which reflects the amount of expenses that would prevail for the most efficient bank, taking into account different production mixes, input prices, and other variables. The efficiency of the bank will be predicted by the closeness of its expenses to the frontier. Banks that would be on the border would have "1" as cost-effectiveness index and that index would then decrease as banks operate at higher costs and travel outside the border.

5. This means that bank management and employees are making efforts to reduce costs and produce profits in efficient banks, and they also have lower fixed costs, payroll expenses, and other non-interest expenses. Bank ownership also plays a role in the operation of bank, which includes stockholders, whether the bank is public sector (government having over 50 percent share) or private sector (privately owned). Under bank ownership, dispersion of the ownership into widely spread and closely

held banks, responsibility of setting policy play a role in the deciding factor. And it was understood that in terms of dispersion, closely held banks were considered more efficient than widely spread. And for latter, if the responsibility of setting policy was seen to lie with the DMO and /or other policy makers, there would be a rise in the efficiency. Performance incentives, which are decided by the directors to be provided to the managers, seem to play a positive role in the efficiency. Hence, banks were considered more efficient, where the managers were paid better incentives. A bank's risk management skills also suggest the efficiency of banks, though their analysis is difficult. Because depending on various factors, banks which take more risk are considered efficient, but this may also be contradicted, depending on the ownership structure of the bank.

III. OBJECTIVE

a. Identifying the input-output variables combination for measuring efficacy

b. Identifying and comparing the constant scale returns and variable scale returns models

c. Identifying and measuring the overall bank productivity factor across the years.

IV. RESEARCH METHODOLOGY

a) Efficiency:

Farrell (1951) expanded the work done by Debreu (1951) and Koopmans' (1951). They study the efficiency of the firm, they study the two major types of the efficiencies one is technical productivity, which implies a firm's capability to attain maximum output from the set of inputs provided. On the other hand, Allocative productivity implies a company's ability to make optimal use of the inputs, provided their respective prices and production technologies.

The fraction of outputs to inputs measures efficiency. This fraction is derived from the weighted outputs and weighted inputs.

b) DEA in Efficiency of banks:

As per our literature survey, efficiency of financial institutions, especially banks, have been a hot topic

in the recent scenario. There have been various approaches for the evaluation of the same, and these approaches are generally divided into two types: parametric and non-parametric approach.

In this paper we have used, Data Envelopment Analysis (DEA). This technique was introduced by Charnes, Cooper and Rhodes (1978). This proposed technique is a non-parametric, linear programming approach which is now commonly known as the CCR model. This method was initially used by Charnes, Cooper and Rhodes (CCR) for determining performance of non-profit public sector organizations. The benefit of this approach is that, without the need for standardization, it fits well for variables of different units (e.g. currency, number of transactions, or number of workers that may be considered together), which ensures that the unit difference does not affect the output values.

Sherman and Gold (1985) studies the banking sector the first time while applying the DEA approach. Kuosmanen and Post (2001), Hartman et ale (2001), Athanassopoulos (1997) Seiford and Zhu (1999), Saha and Ravishankar (2000), and others, have also used efficiency measure technique while, there has been many extensions to this model as well.

Studies suggest that to measure efficiency the output and input combinations are used. Various researchers have used various input-output combination for measuring the efficiency in the Indian context. Sathye (2000) had been working on two versions. First approach considers interest and non-interest expenses as inputs with output as interest income and non-interest income. While the other approach with deposits and worker's numbers as outputs and net loans as well as non-interest incomes. Kumar and Verma (2003) regarded loanable funds, physical property, and labor as inputs, and spread and non-interest as outputs. Mohan and Ray (2004) attempted to learn as outputs the relationship between, deposits and operating costs as inputs and, loans, investments and other profits.

c) Sampling:

We considered two inputs, deposits and workers number, two outputs, non-interest income and net loans to perform technical analysis from the literature survey discussed. This data is fetched

over a sample size of 48 National Banks, extracted from RBI website, which are our DMUs (decision making units). The input and output data for the respective banks for the past 10 years, have been extracted from ProwessIQ software. As mentioned by Dyson et ale (1998), in case of DEA, the sample size is preferred to be larger than the product of the summation of inputs and outputs. The reason behind choosing 48 banks, is the unavailability of all the data for these banks for the past 10 years, which is the time period that we have considered. DEA approach basically gives comparative results. It would suggest, among our sample size, which firm has better efficiency. The input variables are deposits, fixed assets and staff number. The output for the study are net loans and net interest income.

Table 1 explains the descriptive statistics of the input and output variables. It measures the minimum, maximum, mean and std. deviation. Table 2 explains the correlation matrix of all the variable used for the efficiency scores. The variables are significantly correlated which supports the fact that the variables are good fit to run the DEA and MPI.

Table 1 Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Net loans	480	7013.80	20603785.55	1103118.16	2035557.00
Non-Interest income	480	126.19	502378.89	24653.04	48797.88
Deposits	480	14460.40	28088646.50	1437121.67	2583712.41
Fixed Assets	480	89.6	423449.9	15937.597	35141.2038
Staff number	480	676.0	264041.0	21004.563	34452.0954

Source: Authors calculation.

		Net loans	Non-Interest income	Deposits	Fixed Assets	Staff number
Net loans	Pearson Correlation	1	.957**	.994**	.868**	.944**
	Sig. (2-tailed)		.000	.000	.000	.000
Non-Interest income	Pearson Correlation	.957**	1	.944**	.867**	.914**
	Sig. (2-tailed)	.000		.000	.000	.000
Deposits	Pearson Correlation	.994**	.944**	1	.886**	.930**
	Sig. (2-tailed)	.000	.000		.000	.000
Fixed Assets	Pearson Correlation	.868**	.867**	.886**	1	.753**
	Sig. (2-tailed)	.000	.000	.000		.000
Staff number	Pearson Correlation	.944**	.914**	.930**	.753**	1
	Sig. (2-tailed)	.000	.000	.000	.000	

**. Correlation is significant at the 0.01 level (2-tailed).

Table 2 Correlation Matrix of input and output variables.

d) MPI (Malmquist Productivity Index):

Malmquist productivity index, a quantity index was originally coined by Malmquist (1953). After which, it was further defined by Caves, Christensen and Diewert (1982), and was especially used in case where non-parametric approach is applied to the data. This index helps in assessing efficiency shifts in the presence of fluctuations in scale returns.

Malmquist productivity index is defined to have two natural approaches, one is productivity index based on output and another productivity index which is based on input. Output based productivity index approach considers productivity differences as differences in maximum output conditional on a given level of inputs. And input-based approach to the productivity index considers variations in productivity as variations in minimum input requirements conditional on a given production level. That means increases in productivity can be calculated as the ratio between the index of output quantities and the index of input quantities. The total factor productivity (TFPCH) is disintegrated into technical efficiency (EFFCH) and technological efficiency (TECHCH) changes. Technical efficiency change (EFFCH) is disintegrated into pure technical efficiency change (PECH) and scale efficiency (SECH). The EFFCH is derived form of CCR and PECH is derived from BCC model.

V. RESULTS AND DISCUSSION

Part 1: DEA Efficiency estimation of the Indian Banks

The study uses 3 input and 2 outputs to estimate the technical efficiency on the DEAP 2.1. DEA tests investigate the input-output orientation, and provides the returns to scale and weights recognition. The estimates of the DEA CCR model suggests that out of 48 banks 4 banks are efficient. The model of BCC 13 out of 48 banks are efficient. An average of 0.833 under the BCC model is measured while an average value of 0.746 under the CCR model. A mean value of 0.896 is estimated under scale efficiency of the Indian banks is 0.896. There are nine banks which shows less than 100 % efficiency in the CCR model and 100%

efficiency in the BCC model. This implies that these banks lack the scale of operations.

Estimates also measures that 42 banks are working on declining return to scale (RTS) and four banks shows constant returns to scale and only two banks are showing the rising returns to scale. The banks which shows RTS increasing or decreasing are unable to utilize the economic scale. The four banks are the most productive which utilizing the scale of operations to the fullest. The banks with rising returns to scale implies that the bank size is small and that is why they utilize the scale. The decreasing rate of return implies that the banks are big in size.

S.N.	Bank	CCR	BCC	Scale Efficiency	RTS
1	State Bank Of India	**0.76**	**1**	0.760	-1
2	I C I C I Bank Ltd.	**0.908**	**1**	0.908	-1
3	H D F C Bank Ltd.	**0.879**	**1**	0.879	-1
4	Canara Bank	0.73	0.851	0.858	-1
5	Bank Of Baroda	0.765	0.913	0.838	-1
6	Axis Bank Ltd.	**0.962**	**1**	0.962	-1
7	I D B I Bank Ltd.	0.92	0.926	0.994	-1
8	Union Bank Of India	0.758	0.858	0.883	-1
9	Central Bank Of India	0.615	0.653	0.942	-1
10	Indian Overseas Bank	0.675	0.694	0.973	-1
11	Oriental Bank Of Commerce	**0.991**	**1**	0.991	-1
12	Allahabad Bank	0.67	0.672	0.997	-1
13	Syndicate Bank	0.751	0.778	0.965	-1
14	Uco Bank	0.524	0.525	0.998	-1
15	Corporation Bank	0.767	0.77	0.996	-1
16	Indian Bank	0.812	0.813	0.999	1
17	Andhra Bank	0.693	0.693	1.000	1
18	United Bank Of India	1	1	1.000	0
19	Bank Of Maharashtra	0.631	0.644	0.980	-1
20	Kotak Mahindra Bank Ltd.	0.887	0.891	0.996	-1
21	Yes Bank Ltd.	1	1	1.000	0
22	Punjab & Sind Bank	0.722	0.752	0.960	-1
23	Vijaya Bank [Merged]	0.699	0.703	0.994	-1
24	Indusind Bank Ltd.	1	1	1.000	0
25	Federal Bank Ltd.	0.788	0.799	0.986	-1
26	Dena Bank [Merged]	0.604	0.612	0.987	-1
27	State Bank Of Travancore [Merged]	0.672	0.683	0.984	-1
28	State Bank Of Bikaner & Jaipur [Merged]	0.769	0.784	0.981	-1
29	South Indian Bank Ltd.	0.74	0.758	0.976	-1
30	State Bank Of Mysore [Merged]	0.747	0.768	0.973	-1
31	Karur Vysya Bank Ltd.	0.773	0.802	0.964	-1
32	Karnataka Bank Ltd.	0.748	0.771	0.970	-1
33	Saraswat Co-Operative Bank Ltd.	0.667	0.723	0.923	-1
34	City Union Bank Ltd.	0.817	0.875	0.934	-1
35	Lakshmi Vilas Bank Ltd.	0.745	0.819	0.910	-1
36	I N G Vysya Bank Ltd. [Merged]	0.814	0.86	0.947	-1
37	Dhanlaxmi Bank Ltd.	0.555	0.82	0.677	-1
38	Cosmos Co-Operative Bank Ltd.	0.711	0.898	0.792	-1
39	State Bank Of Indore [Merged]	0.723	0.836	0.865	-1
40	C S B Bank Ltd.	0.662	0.837	0.791	-1
41	Shamrao Vithal Co-Op. Bank Ltd.	0.669	0.834	0.802	-1
42	Bank Of Rajasthan Ltd. [Merged]	0.513	0.62	0.827	-1
43	R B L Bank Ltd.	1	1	1.000	0
44	Bharat Co-Op. Bank (Mumbai) Ltd.	**0.694**	**1**	0.694	-1
45	Abhyudaya Co-Op. Bank Ltd.	0.547	0.771	0.709	-1
46	Punjab & Maharashtra Co-Op. Bank Ltd.	**0.706**	**1**	0.706	-1
47	Nainital Bank Ltd.	**0.453**	**1**	0.453	-1
48	United Western Bank Ltd. [Merged]	**0.577**	**1**	0.577	-1
	Average Efficiency Score	0.746	0.833	0.896	-1

Table 3 Efficiency scores of Indian Banks

Table 4 Peer Summary

Banks	Peers:		
State Bank Of India	B21	B2	2
I C I C I Bank Ltd.	B2		1
H D F C Bank Ltd.	B21	B39 B2	3
Canara Bank	B21	B2	2
Bank Of Baroda	B21	B2	2
Axis Bank Ltd.	B6		1
I D B I Bank Ltd.	B7		1
Union Bank Of India	B21	B2 B7	3
Central Bank Of India	B2		1
Indian Overseas Bank	B2		1
Oriental Bank Of Commerce	B2	B21 B7	3
Allahabad Bank	B21	B2	2
Syndicate Bank	B21	B2	2
Uco Bank	B21	B2	2
Corporation Bank	B15		1
Indian Bank	B2		1
Andhra Bank	B21	B15	2
United Bank Of India	B21	B2	2
Bank Of Maharashtra	B21	B2	2
Kotak Mahindra Bank Ltd.	B2		1
Yes Bank Ltd.	B21		1
Punjab & Sind Bank	B21	B2	2
Vijaya Bank [Merged]	B21	B2	2
Indusind Bank Ltd.	B2		1
Federal Bank Ltd.	B21	B2	2
Dena Bank [Merged]	B21	B2	2
State Bank Of Travancore [Merged]	B21	B2	2
State Bank Of Bikaner & Jaipur [Merged]	B21	B2	2
South Indian Bank Ltd.	B21	B2	2
State Bank Of Mysore [Merged]	B21	B2	2
Karur Vysya Bank Ltd.	B21	B2	2
Karnataka Bank Ltd.	B21	B2	2
Saraswat Co-Operative Bank Ltd.	B2		1
City Union Bank Ltd.	B21	B2	2
Lakshmi Vilas Bank Ltd.	B21	B2	2
I N G Vysya Bank Ltd. [Merged]	B2		1
Dhanlaxmi Bank Ltd.	B21	B2	2
Cosmos Co-Operative Bank Ltd.	B21	B2	2
State Bank Of Indore [Merged]	B39		1
C S B Bank Ltd.	B21	B2	2
Shamrao Vithal Co-Op. Bank Ltd.	B2		1
Bank Of Rajasthan Ltd. [Merged]	B2		1
R B L Bank Ltd.	B21	B2	2
Bharat Co-Op. Bank (Mumbai) Ltd.	B2		1
Abhyudaya Co-Op. Bank Ltd.	B2		1
Punjab & Maharashtra Co-Op. Bank Ltd.	B2		1
Nainital Bank Ltd.	B21	B15	2
United Western Bank Ltd. [Merged]	B39	B2	1

Source: Author's calculation using DEAP 2.1

It's difficult to identify the efficient unit. DEA scores are relative scores, with reference to the peer table 4, if a bank appear frequently in the peer set,

the unit is said to be benchmarked. And the bank which appear less frequent either have unusual input output combinations or it does not have the quality to become the benchmark (Mostafa, 2009). In the table 4 ICICI Bank appears the most (41 times) and second most appeared is Yes bank appears most frequently (30 times). These banks are noted to be highly robust and with highest peer count.

Part 2: Estimates of the productivity.

The productivity change is relative to the previsions year that is why only nine periods are estimated. A TFPCH value >1 means a progress and improvement while a value < 1 means a regress in the performance. A value of productivity equal to zero means constant change relative to the previous period. Except for two years 2017 and 2019 all the years show a value greater than 1 for the change in total productivity. The average productivity is greater than 1, which is a positive sign for the Indian banking sector. But this positivity is coming from the technological efficiency. The banks are unable to use the resources optimally, as the change in technical efficiency. The effect on the change in technical efficiency is more due to pure technical efficiency changes and less because of scale efficiency changes, which means that the banks are optimally utilizing its scale of operation but it's not being to its fullest (Table 5).

Table 5 MALMQUIST INDEX SUMMARY OF ANNUAL MEANS- INDIAN BANKS

Year	Technical efficiency change (effch)	Technological change (techch)	Change in pure technical efficiency (pech)	Change in scale efficiency (sech)	Total factor productivity change (tfpch)
2010-2011	1.06	0.984	1.047	1.012	1.043
2011-2012	1.013	1.007	1.011	1.002	1.02
2012-2013	0.965	1.065	0.999	0.966	1.028
2013-2014	0.99	1.009	0.99	1	0.999
2014-2015	0.974	1.016	0.99	0.984	0.989
2015-2016	1.029	0.977	1.011	1.017	1.005
2016-2017	1.004	0.993	1.011	0.994	0.997
2017-2018	0.921	1.099	0.945	0.974	1.012
2018-2019	0.965	1.035	0.974	0.991	0.999
Average Efficiency Score	0.99	1.02	0.997	0.993	1.01

Source: Authors calculation from DEAP 2.1

Table 6 MALMQUIST INDEX SUMMARY OF FIRM MEANS- INDIAN BANKS

Banks	Technical efficiency change (effch)	Technological change (techch)	Change in pure technical efficiency (pech)	Change in scale efficiency (sech)	Total factor productivity change (tfpch)
B1	**0.976**	**1.023**	**1**	**0.976**	**0.998**
B2	**0.989**	**1.002**	**1**	**0.989**	**0.992**
B3	1.012	1.035	1.023	0.989	1.047
B4	0.991	1.01	1.008	0.984	1.001
B5	0.99	1.021	0.996	0.994	1.011
B6	0.996	1.014	1	0.996	1.01
B7	0.991	1.011	0.992	0.999	1.001
B8	1.002	1.024	1.016	0.987	1.026
B9	**0.988**	**1.01**	**0.995**	**0.993**	**0.998**
B10	**0.986**	**1.005**	**0.989**	**0.997**	**0.991**
B11	1.023	1.01	1.018	1.006	1.034
B12	0.986	1.016	0.985	1.001	1.001
B13	0.979	1.033	0.978	1.001	1.011
B14	**0.95**	**1.02**	**0.944**	**1.007**	**0.969**
B15	0.971	1.032	0.971	1	1.002
B16	1.01	1.024	1.01	1	1.034
B17	0.967	1.042	0.963	1.004	1.007
B18	1.038	1.057	1.036	1.001	1.097
B19	0.985	1.029	0.987	0.998	1.014
B20	**0.987**	**1.012**	**0.987**	**1**	**0.999**
B21	1	1.043	1	1	1.043
B22	0.996	1.027	1	0.996	1.023
B23	0.992	1.016	0.991	1	1.008
B24	1.028	1.012	1.026	1.002	1.04
B25	0.992	1.06	0.993	0.999	1.051
B26	**0.974**	**1.025**	**0.975**	**0.999**	**0.998**
B27	**0.963**	**1.019**	**0.963**	**1**	**0.981**
B28	**0.983**	**1.015**	**0.985**	**0.999**	**0.998**
B29	0.991	1.027	0.993	0.998	1.018
B30	**0.981**	**1.013**	**0.984**	**0.997**	**0.994**
B31	0.993	1.029	0.996	0.997	1.022
B32	1.004	1.021	1.007	0.997	1.025
B33	0.999	1.027	1.004	0.995	1.026
B34	1	1.026	1.004	0.996	1.026
B35	0.988	1.021	0.994	0.994	1.008
B36	1.012	1.014	1.016	0.996	1.026
B37	**0.963**	**1.019**	**0.999**	**0.964**	**0.981**
B38	1.004	1.017	1.024	0.98	1.021
B39	**0.965**	**1.009**	**0.98**	**0.984**	**0.974**
B40	0.997	1.013	1.017	0.98	1.01
B41	0.999	1.015	1.013	0.986	1.014
B42	0.991	1.009	0.998	0.993	1
B43	1.036	1.02	1	1.036	1.057
B44	0.996	1.024	1.001	0.995	1.02
B45	**0.994**	**1.004**	**1.007**	**0.987**	**0.997**
B46	**0.989**	**1.01**	**1**	**0.989**	**0.999**
B47	**0.946**	**1.039**	**1**	**0.946**	**0.983**
B48	**0.955**	**0.951**	**1**	**0.955**	**0.908**
Average efficiency scores	0.99	1.02	0.997	0.993	1.01

Source Authors calculation using DEAP 2.1

Table 6 estimates the banks average productivity over the ten years. Out of 48 banks 16 banks (B1, B2, B9, B10, B14, B20, B26, B27, B28, B30, B37, B39, B45, B46, B47 and B48) show regress performance over the 10 years. The highest factor productivity is of the HDFC Bank Ltd and Yes Bank. The banks which are larger are not optimally utilizing the resources, and are showing a regressed productivity, like SBI, ICICI bank. ICICI Bank was one among B1, B2, B9, B10, B14, B20, B26, B27,

B28, B30, B37, B39, B45, B46, B47 and B48 which can be benchmarked but is showing a regressed productivity. The average productivity is positive and is due to the technological efficacy of the banks.

Therefore, banks should use the resources optimally to enhance the productivity and scale of operations.

VI.   CONCLUSION, LIMITATION AND FUTURE SCOPE

For our analysis, we have chosen the input-output variables pair which would be optimal for the efficiency test, by performing Pearson correlation test on all the variables. This test was conducted to understand whether the variables are significantly suitable for conducting the DEA and MPI test. The correlation was defined significant if the value is less the 0.02. Thus all values being within the range, all variable combinations were significant for further testing.

Analysing economies of scale, helps us determine the scale of production of the firm and its ability to be more efficient. In our study, we captured 91.67% of the firms, from our sample, to be having increasing or diminishing returns of scale. Out of which, 95.4% of firms have decreasing returns of scale, which indicates that these firms have large market capitalization, having increasing long run average cost. Only 8.3% of firms have shown constant returns of scale, where any change in input has shown proportional change in output, thus utilizing their scale of operations to fullest.

Due to technological advances in banking services, their competition in financial market has increased, thus making efficiency an important analysing aspect in banking sector. Here we have identified the frequently occurring firm as the efficient one, which in our case is ICICI bank followed by Yes bank. From our analysis, the average technical efficiency is approaching 1, but hast reached even 1. This means that, the firms are not utilizing their scales of operations to their maximum capacity. But its productivity factor indicates good use of its resources, and also its technological efficacy.

DEA approach being sensitive to measurement error, is a key limitation. Due to unavailability of data, our sample size had to be kept as small as 48 banks. When sample size is small, there is a possibility of more number of banks being efficient by default, as it's a comparative analysis. Though we have addressed this point by following a thumb rule of keeping the sample size being more than the sum of inputs and outputs. But if the sample size is even bigger, it would give us a wider prospects.

The banks on which we have conducted our research, are all mostly public and private sector banks. This is mostly because of our reliability on secondary data, which was available for the specific duration in these ownership banks only. In other cases, based on the availability of data, scope of banks taken into consideration can be increased to more ownerships, like foreign banks.

This paper can have further scope as well, like reaching out to more banks with diverse ownerships. Some firms have shown tfpch greater than 1, but that may not be the case with their actual status in the market. So, apart from the variables considered here, it can still further be regressed with other variables such as disclosures, governance as suggested by Sharma et al 2019, to achieve another aspect.

REFERENCES

[1]   Allen N. Berger, "Distribution Free Estimates of Efficiency in the U.S. Banking Industry and Tests of the Standard Distributional Assumptions," Journal of Productivity Analysis 4, (September 1993): 261-92.

[2]   Allen Berger, William Hunter, and Stephen Timme, "The Efficiency of Financial Institutions: A Review and Preview of Research Past, Present, and Future", Journal of Banking and Finance 17, (April 1993): 221-249.

[3]   Aradhana Vikas Gandhi and Dipasha Sharma, "Technical efficiency of private sector hospitals in India using data envelopment analysis", Vol. 25 No. 9, 2018, pp. 3570-3591

[4]   Banker, R.D., Charnes, A., Cooper, W.W., Swarts, J., Thomas, D.A., "An introduction to Data Envelopment Analysis with some of its models and their uses", in Chan, J.L., Patton, J.M. (Eds.), Research in Governmental and Non-Profit Accounting, Vol. 5. Jai Press, Greenwich CN, 1989, pp. 125–163.

[5] Bhattacharyya, Arunava and Lovell, C.A.K., "The impact of Liberalization on the Productive Efficiency of Indian Commercial Banks", European Journal of Operational Research, Vol. 98, 1997, pp. 332-345.

[6] Charnes, A.; Cooper, W.W. and L. Edwardo Rhodes, "Measuring the Efficiency of Decision Making Units", European Journal of Operational Research, Vol. 2, No.6, 1978, pp. 429-444.

[7] Dahlberg, Matz; Johansson, Eva (2002-03-01). "On the Vote-Purchasing Behavior of Incumbent Governments". American Political Science Review. null (1): 27–40, ISSN 1537-5943

[8] Das, Abhiman, "Technical, Allocative and Scale Efficiency of Public Sector Banks in India," Reserve Bank of India, Occasional Papers. Vol. 18, Nos. 2&3, 2000, pp. 279-301.

[9] Dekker, D. and Post, T., "A Quasi-Concave DEA Model With an Application for Bank Branch Performance Evaluation", European Journal of Operational Research, Vol. 132, 2001, pp. 296-311.

[10] Dubois, Hans F. W.; Fattore, Giovanni (2011-07-01). "Public Fund Assignment through Project Evaluation". Regional & Federal Studies. 21 (3): 355–374.

[11] Eugene F. Fama, "Agency Problems and the Theory of the Firm," Journal of Political Economy 88 (April 1980): 288-307

[12] Hans Bjurek, "The Malmquist Total Factor Productivity Index", The Scandinavian Journal of Economics, Vol. 98, No. 2, Jun. 1996, pp. 303-313

[13] Hartman, T.E.; Storbeck, J.E. and Byrnes, P., "Allocative Efficiency in Branch Banking", European Journal of Operational Research, Vol. 134, 2001, pp. 232-242.

[14] Kenneth Spong, Richard J. Sullivan, and Robert DeYoung; "What makes a bank efficient? A look at financial characteristics and bank management and ownership structure", 1994

[15] Kumar, Sunil and Verma, Satish, "Technical efficiency, Benchmarks and Target: A Case Study of Indian Public Sector Banks", Prajnan, Vol. 31, No.4, 2003, pp. 275-300.

[16] Kuosmanen, T. and Post, T., "Measuring Economic Efficiency with Incomplete Price Information: With an Application to European Commercial Banks", European Journal of Operational Research, Vol. 134, 2001, pp. 43-58.

[17] List of Scheduled Commercial Banks, Accessed on: March 8, 2020. [Online]. Available: https://m.rbi.org.in/scripts/bs_viewcontent.aspx?Id=3657

[18] Mostafa, M.M. (2009), "Benchmarking the US specialty retailers and food consumer stores using data envelopment analysis", International Journal of Retail & Distribution Management, Vol.37No.8, pp. 661-679.

[19] Sathye, Milind, "Efficiency of banks in a developing economy: The case of India", European Journal of Operational Research, Vol. 148, 2003, pp. 662–671.

[20] Sharma, A., Bansal, S., Deepam, S., Pais, S., & Pandey, S. (2019). A Review of Literature on Corporate Governance in Business. SAMVAD, 18, 18-24.