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EFFICIENCY STUDY OF LARGE-SIZED BANKS IN INDIA – A DEA APLICATION

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ABSTRACT

The purpose of this paper is to measure and evaluate the technical efficiency - pure technical and scale - of Indian top 22 large-sized commercial banks from the cross-section data of the financial year 2009-10 using two popular data envelopment analysis (DEA) models: CCR and BCC. The results reveal that average relative technical efficiency (CCR) of entire sample is 78.8% and that only 6 banks (27%) are found to be fully technical and scale efficient. So, there is a scope of efficiency improvement of 16 banks by reducing on an average 21.2 % of input resources presently used relative to the performances of 6 efficient banks under study. The study has found that, the banks which are using more labour for providing their services with lower exposure to off-balance sheet activities are relatively more inefficient. In order to improve the efficiency; most of the inefficient banks should follow the good operating practices of four efficient banks namely Axis Bank, HDFC Bank, Corporation Bank and Indian Bank. Most efficient bank is Axis Bank while most inefficient bank is Central Bank of India followed by Bank of Maharastra, United Bank of India, UCO Bank based on the relative efficiency of 22 sample banks.

KEYWORDS

Data Envelopment Analysis (DEA), Relative technical efficiency, Reference Set.

INTRODUCTION

Banks are the highest financial intermediaries in our economy and therefore they deserve careful study. Over the years, the banking systems all over the world have witnessed a significant transformation underpinned by various factors – deregulation, globalization, technology innovation(RBI, 2008). The Indian banking industry has witnessed radial changes after the introduction of financial sector reform in 1991. With these initiations laid through the first and second generation reforms, there has been substantial improvement in efficiency and performances of the Indian scheduled commercial banks of our country (Mohan Ram, 2006, Reddy 2002). This development has resulted in increased competitive pressure among the banks in India. The resultant competitive forces, coupled with future challenges faced and more stringent regulatory framework, have created pressure on the Indian banks to perform efficiently. It has been empirically found that banks receiving high efficiency scores are much more likely to survive than banks which have relatively low scores (Barr et al., 1996). Efficiency, therefore, has become critical for banks' survival and growth (Omprakash et al., 2008) in the era of increased competition and high standard of customer oriented services. Therefore, in today's economy, efficiency analysis of banking sector attracts more and more attention of researchers, academicians, policy-makers and banks managers and customers. Thus, this paper aims at analyzing the technical efficiency of 22 banks.

In this background, the obvious questions arise whether Indian large banks utilize their resources efficiently. Which banks are relatively more efficient in utilizing their resources? How banks can improve their relative efficiencies? Pure technical inefficiency or scale inefficiency which one is the main source of overall technical inefficiency of Indian banks? Are Indian banks operating at appropriate scale of operation? Thus, this paper aims at measuring and analyzing the technical efficiency - pure technical and scale - of Indian 22 large-sized banks in relation to each other. For this, we utilize two popular Models – CCR and BCC of non-parametric, linear programming based methodology that is data envelopment analysis (DEA).

The remainder of the paper is organized in following ways. Section 2 briefly reviews the literature on the efficiency of Indian banks. Section 3 'Research Methodology' presents data and methodology used in the present study. Selection of inputs and outputs are also discussed in this Section. Section 4 presents and analysis the empirical findings. The final section concludes the findings of the study and recommends for efficiency improvement of Indian banks.

REVIEW OF LITERATURE ON EFFICIENCY OF BANKS

The measurement of financial institutions' efficiency using parametric and non-parametric frontier models has received considerable attention over the past two decades. Among the various approaches used, the use of Data Envelopment Analysis (DEA) approach has been frequent. There exists a great amount of literature on bank efficiency across the globe. But there has been little research effort in measuring and analyzing efficiency of banks in India using DEA approach. Several studies have analyzed the performance of the banking industry in developed and other countries. Berger and Humphrey (1997) reviewed the empirical studies of efficiency of banking industry in the world. Of the 130 studies of financial institutions efficiency, 116 were published between 1992 and 1997. They find that, overall depositor financial institutions/banks operate at an annual average technical efficiency level of around 77% (median 82%). The non-parametric technique has been extensively used to evaluate the efficiency of the US banking. Some notable studies on US banking efficiency are

Rangan et al. (1988), Grabowski et al. (1994) concluded that pure technical inefficiency is the main source of total technical inefficiency. Miller et al. (1996) investigated technical efficiency of 201 large-sized banks from 1984 to 1990 and suggested that large and profitable banks have higher levels of technical efficiency. Barr et al. (1999) found strong and consistent relationships between efficiency and the inputs and outputs, as well as independent measures of bank performance.

Efficiency studies on banking firms operating in countries other than US have also been rapidly increasing over the last few years. Some notable studies are Jackson and Fethis (2000) for Turkish banks, Rezvanian et al. (2002) for Singaporean banks, Casu and Molyneuxs (2003) for European banking, Al-Faraj et al. (2006) for Saudi commercial banking, Deng, (2007) for Chinese commercial banks, REDA (2008) for Egyptian commercial banks, Ahmed & Ahmad (2008) for Pakistan, Roberto et al. (2009) for Brazilian banks, Astor, N (2010) for Uzbekistan banks, Khalid Al Khathlan et al. (2010) for Soudi banks. They used basic DEA models i.e. CCR and BCC to evaluate the relative efficiency of banks and they in general found the average efficiency were in the range of 80% to 95%. They also explored the factors responsible for variation in the efficiency level. Empirical results appeared to vary depending on the country; bank ownership, and size.

In Indian context, the literature of efficiency of the banking sector is mainly based on traditional measures. But, the studies analyzing the efficiency of Indian banks using frontier approach in India are far fewer. However, some recent studies that use non-parametric techniques mainly DEA are discussed below briefly.

One of the first published studies using non-parametric production frontier approach was Noulas and Ketkar (1996). Some other important studies are Bhattacharya et al. (1997), Saha and Ravishankar (2000), Sathya (2003), Mohan Ram and Ray (2003), Shanmugam and Das (2004), Das A (1997, 2000), Das et al. (2004), Debasish (2006), Ray (2007). Kumar and Gulati (2008a, 2008b, 2009). There are many other studies since the 1990s in India, which have been confined to analyse the effect of deregulation on efficiency and productivity of banks.

However, the general conclusions that emerge from the above review of literature on banking efficiency in Indian context are: First, there is an increasing trend of efficiency level across all the bank groups over post reform period of time. There is still room for improvement in resource utilization by the Indian banks with the range of 5% to 30%. Second, efficiency variation among the banks is explained by exploring the various factors. Indian banking literature does not suggest a consistent relationship between size and efficiency, ownership and efficiency.

Most of the studies which use non-parametric DEA technique for Indian banks report their results at highly aggregated basis. They do not concentrate on the area of how an individual bank can improve its efficiency. Therefore, the present study will be able to throw further light on the existing banking literature in India by examining the relative technical efficiency Indian large-sized banks during the recent period of 2009-10.This study differs from other studies in at least three ways: (i) the time period (2009-10) taken in the analysis (ii) the input-output variables specification in the DEA model and (iv) Efficiency improvement analysis for individual inefficient banks and (iv) Categorization of efficient and inefficient banks and their rankings.

RESEARCH METHODOLOGY

As already pointed out, the study has followed the technique- data envelopment analysis (DEA) to estimate the technical efficiency of Indian public sector banks. DEA is a non-parametric performance assessment methodology originally designed by Charnes, Cooper and Rhodes (1978) to measure the relative efficiencies of organizational units or decision making units (DMUs) under evaluation from the identical input output data set. This technique aims to measure how efficiently a DMU uses the resources available to generate a set of outputs. The DEA approach applies linear programming techniques to constructs an efficient production frontier based on best practices over the data set. Each DMU's efficiency is then measured relative to this frontier.

Several different mathematical programming DEA models have been proposed in the literature. Essentially, these models seek to establish which of *n* DMUs determine the *envelopment surface* or *best practice frontier* or *efficient frontier*. The geometry of this surface is prescribed by the specific DEA model employed (Kumar and Gulati, 2009). There are two types of efficiencies- input oriented and output oriented. Input oriented efficiency aims at reducing input amounts as much as possible while keeping at least the present output levels and output oriented technical efficiency maximizes the output level while using at least the present input levels. In the present study, we have utilized input oriented basic DEA model- CCR (named after its developers Charnes, Cooper and Rhodes, 1978) and BCC (named after Bankers, Charnes and Cooper, 1984).

MATHEMATICAL FORMULATION: CCR MODEL

Assuming that there are n DMUs to be evaluated [DMUj (j = 1, 2… n)]. Each DMU consumes 'm' different inputs of identical nature for all DMUs [x_{ij} (i = 1,2, …..,m)] to produces 's' different outputs of identical nature for all DMUS [y_{rj} (r = 1,2, …….,s)].

$$\underset{(\theta_k, \lambda, s_i^-, s_r^+)}{\text{Min}} \ \theta_k - \varepsilon \left(\sum_{i=1}^{m} s_i^- + \sum_{r=1}^{s} s_r^+ \right)$$

Subject to

$$\sum_{j=1}^{n} x_{ij} \lambda_j + s_i^- = \theta_k x_{ik} \quad i = 1,2,\ldots,m.$$

$$\sum_{j=1}^{n} y_{rj} \lambda_j - s_r^+ = y_{rk} \quad r = 1,2,\ldots,s$$

$$\lambda_j \geq 0 \quad j = 1, 2,\ldots, n$$

s_i^-, $s_r^+ \geq 0$ for all i and r

where,

x_{ij} = Amount of input of i utilized by the jth DMU

y_{rj} = Amount of output of r produced by the jth DMU

x_{ik} = Amount of input of i utilized by DMU_k

y_{rk} = Amount of output of r produced by DMU_k

θ_k= efficiency score of DMU 'k' being evaluated

λs represent the dual variables which identify benchmarks for inefficient units.

Slack variables - s_i^- (input slacks), s_r^+ (output slacks)

Here ε >0 is non-Archimedean element defined to be smaller than any real number and to be accommodated without having to specify the value of ε.

The above model is an input-oriented model and assumes constant returns to scale of operation to measure overall technical efficiency (OTE). Optimal value θ_k reflects the OTE score of DMU 'K'. It needs to solve 'n' times to get efficiency score for each DMU under evaluation. If $\theta_k = 1$ and $s_i^- = s_r^+ = 0$, then DMU_K is CCR efficient otherwise CCR inefficient.

MATHEMATICAL FORMULATION: BCC MODEL

BCC model differs slightly yet remarkable from CCR model with an additional constraint

$$\sum_{j=1}^{n} \lambda_j = 1$$

in the above CCR envelopment model. This constraint is called convexity constraint in mathematics literature. It imposes of assessing the efficiency under variable returns to scale.

SELECTION OF INPUT AND OUTPUT VARIABLES

The most challenging task to the researchers for estimating efficiency of banks through DEA methodology is to select appropriate and relevant inputs and outputs. The choice of inputs and outputs largely affects the derived efficiency level. There is no consensus on what constitutes inputs and outputs of banks. However, in the context of banking efficiency measurement, there are mainly two approaches to deal with this problem: Production Approach and Intermediation Approach. The main difference between these two approaches is the use of deposit as input or output. Berger and Humphrey (1997) pointed out that neither of these two approaches is perfect because they can not fully capture the dual roles of banks as intermediaries of financial services as well as service providers. Therefore none is universally accepted approach. Berger and Humphrey (1997) suggested that intermediation approach is best suited for analyzing bank level efficiency where Production Approach for branch level efficiency. Though, in a customers' oriented market economy particularly after 1996, Indian banks play both the role as intermediaries as well as providers of services but still now Indian commercial banks primarily mediate funds between depositors and creditors i.e., they play intermediating role much more than the service providing role. Therefore, given this and as a majority of the empirical literature, present study adopts Intermediation Approach for selecting input and output variables for estimating bank level efficiency.

Literature on inputs and outputs specification for measuring bank efficiency in India summarizes that most of the studies rely on three inputs: a) Fixed assets as a proxy of physical capital b)No. of Employees as labour c) Deposit and two outputs : a) Interest Income b) Non-interest Income. In place of interest income some studies choose advance and investment in the output vectors. With this existing literature, the study selects three input and three output variables (Box No.: 1). The choice of input and output variables is mainly guided by operational pattern, objectives of the Indian banking system in the post reform period and the availability of data.

BOX NO: 1

Input Variables	Output Variables
1. Fixed Assets	1. Net Interest Income
2. Number of Employees	2. Non-interest Income
3. Loanable Fund	3. Net Profit

'Fixed assets' are included in input variables as a proxy of physical capital. The variable *'No. of Employees'* is selected in this study as a proxy of labour like previous researches. '*Loanable Fund*' includes deposit plus borrowing. *'Deposit'* includes all types of deposit: demand, savings and time. Most of the studies in India use it as an input.

'Net Interest Income' is also called spread computed by subtracting interest expenses from interest income. This variable represents the performance of the traditional activities of banking. The output variable *'Non-interest Income'* accounts for income from off-balance sheet activities such as commission, brokerage and so on. The inclusion of this variable enables the capturing of recent changes in banking services. Most of the studies in India use it as an output.

The above input output variables set is almost same as in the study of Kumar and Gulati, 2008b with only exception of accommodating an output variable – net profit. This variable helps to capture the profitability aspect of Indian banks. This also incorporates indirectly non labour operating expenses which the banks are incurring heavily for technology upgradation.

SAMPLING AND DATA

SAMPLE BANKS

Yeh, Quey-Jen (1996) states that it is important to take into account the homogeneity condition during the choice of DMUs to make the DEA result more realistic. Giving more emphasis on the criteria of homogeneity condition, the present study selects top 22 large-sized commercial banks in India operating in 2009-10. Large –sized banks are determined based on two criterions – value of total assets greater than of Rs 59000 core and number of branches more than 1000. Though Axis bank has 966 branches it is also taken in the sample because of its 8^{th} position as per total assets value. Selected 22 sample banks with their codes used have been provided in Table 4.1

DATA SOURCE

All the data are annual and secondary in nature. Annual bank level data are obtained from the published annual accounts (Balance Sheet and P&L Account) in Annual Reports of the individual banks, collected mainly from the 'Statistical Tables relating to Banks in India' and 'Report on Trend and Progress of banks in India' for the financial year 2009-10, available on the official website of Reserve Bank of India (http://rbi.org.in.).

EMPIRICAL FINDINGS AND ANALYSIS

In this section, we examine the content of efficiency scores obtained by utilizing DEA models – CCR and BCC model. DEA scores are derived by using DEA software 'DEA-Solver Learning Version 3' designed by Cooper, W.W. et al., 2007.

Present study has selected three inputs (m = 3) and three outputs (s = 3) with a sample size of 22 (n = 22). Therefore, the sample size in this study exceeds the desirable size as per the rule of thumb (22>18) i.e. n (number of DMUs) equal to or greater than max {m × s, 3 x (m + s)} (Cooper, W.W. et al., 2007). Thus, selected number of input and output variables allows accepted number of degree of freedom i.e. efficiency discriminatory powers. It is also found that there is a high correlation between selected input and output variables. So, with this appropriate number of inputs and outputs, sample banks selected taking into account of more homogeneity condition and reasonable validation by high degree of correlation between input and output variables, the present study can demand more robust and reliable results.

EXAMINATION OF RELATIVE EFFICIENCY

TABLE: 4.1: EFFICIENCY SCORES OF BANKS DURING 2009-10

No.	DMUs	DMUs Code	OTE	PTE	SE
1	ALLAHABAD BANK	ALB	0.6680	0.8155	0.8191
2	ANDHRA BANK	ANB	1	1	1
3	BANK OF BARODA	BOB	0.7483	0.8019	0.9332
4	BANK OF INDIA	BOI	0.6825	0.6904	0.9886
5	BANK OF MAHARASHTRA	BOM	0.5091	0.9662	0.5269
6	CANARA BANK	CAB	0.7532	0.8119	0.9276
7	CENTRAL BANK OF INDIA	CBI	0.4270	0.5574	0.7660
8	CORPORATION BANK	COB	1	1	1
9	INDIAN BANK	INB	1	1	1
10	INDIAN OVERSEAS BANK	IOB	0.6568	0.7464	0.8801
11	ORIENTAL BANK OF COMMERCE	OBC	0.8186	0.9938	0.8237
12	PUNJAB NATIONAL BANK	PNB	0.9035	1	0.9035
13	SYNDICATE BANK	SYB	0.7206	0.7217	0.9986
14	UCO BANK	UCB	0.6158	0.6540	0.9416
15	UNION BANK OF INDIA	UNI	0.7065	0.7068	0.9995
16	UNITED BANK OF INDIA	UBI	0.5185	0.9244	0.5609
17	VIJAYA BANK	VJB	0.6741	1	0.6741
18	STATE BANK OF INDIA	SBI	0.9997	1	0.9997
19	STATE BANK OF HYDERABAD	SBH	0.9509	1	0.9509
20	AXIS BANK	AXB	1	1	1
21	HDFC BANK	HFB	1	1	1
22	ICICI BANK	ICB	1	1	1

NOTE: OTE – Overall Technical Efficiency measured by CCR model, PTE- Pure Technical Efficiency measured by BCC model and SE- Scale Efficiency measured by OTE/ PTE

From the descriptive statistics of OTE presented in Table 4.2 calculated from Table 4.1, only 6 of 22 banks under evaluation are found to be 100% technical and scale efficient i.e. OTE = 1. They together construct efficient frontier i.e. providing best practices among the sample banks. Efficiencies of other 16 banks which are inefficient (i.e. OTE < 1) are measured relative to this frontier. Average OTE score is 78.8%. This mean OTE (78.8%) suggests that inefficiency in resource utilization of the Indian banks is 21.2% implying that Indian banks (based on sample) could have saved 21.2% of present level of inputs used to produce present level of outputs.

TABLE: 4.2: THE SUMMARY STATISTICS OF THREE TYPES DEA EFFICIENCIES

	OTE	PTE	SE
No. of DMUs evaluated	22	22	22
Average score	0.788	0.881	.895
SD	0.183	.146	.145
Maximum	1	1	1
Minimum	0.4270	0.557	.527
No of Efficient Banks	6	10	6

The results also indicate that there is still asymmetry between Indian large banks as regards their OTE as evidenced from the range between 42.7% and 100% and SD 18.3%. PTE (BCC scores) indicates 4 banks in addition to 6 CCR fully efficient banks are 100% technical efficient but not 100% scale efficient with a mean score 88.1%. Indian banks as represented by the sample banks have been experiencing slightly higher scale efficiency (89.5%) than PTE (88.1%).

EFFICIENT AND INEFFICIENT BANKS

TABLE 4.3: EFFICIENT AND INEFFICIENT BANKS

Categories	**Banks**
I. CCR and BCC efficient (OTE = PTE =1)	ANB, COB, INB, AXB, ICB, HFB
II. BCC efficient but not CCR efficient (PTE = 1 but OTE <1)	PNB, VJB, SBI, SBH
III. CCR as well as BCC inefficient (OTE & PTE < 1)	ALB,BOB,BOI,**BOM,** CAB,**CBI**,IOB, **OBC,** SYB, UBI, UCB, UNI,

Specialty of the DEA methodology is to discriminate the DMUs (banks) into efficient (efficiency score = 1 or 100%) and inefficient (efficiency score < 1) status. Thus, in this section, we segregate the 22 selected banks into efficient and inefficient banks based on CCR and BCC efficiency scores. Banks are categorized into three groups (Table 4.3).

DECOMPOSITION OF TECHNICAL EFFICIENCY

There is a relation among these three types of DEA efficiencies – OTE, PTE and SE. This relationship is popularly known as decomposition of efficiency in DEA literature. Following relationship demonstrates a decomposition of efficiency.

$$OTE = PTE \times SE$$

This decomposition depicts the sources of inefficiency i.e., whether inefficiency of a DMU is caused by inefficient operation (PTE) of the DMU itself or by the disadvantageous conditions under which the DMU is operating. Technical inefficiency of the Indian banks is found to be caused by both pure technical inefficiency (PTIE) and scale inefficiency (SIE). But it is observed that the pure technical inefficiency (PTIE) and scale inefficiency are almost equally responsible for overall technical inefficiency as indicated their summary statistics parameters.

Banks of category-I (Table: 4.3) are 100% technical and scale efficient. Inefficiency of four banks of category II and three banks bolded in category III is primarily caused by their operations with inappropriate size. That is their main source of overall technical inefficiency is scale inefficiency. While nine banks not bolded in category III are suffering mainly from inefficient operations or management.

With this analysis of the decomposition of efficiency, the study has found that the Indian CCR inefficient banks (banks of category II & III in Table 4.3) are facing the problem of mismatch between PTE and SE. 44% of the inefficient banks have higher PTE than SE by about 13.8%, while remaining 46% have higher SE than PTE by about 19.4%. This highly mismatch between PTE and SE of the inefficient banks can not increase mean OTE of all banks under study beyond 78.8%.

EFFICIENCIES AND RETURNS TO SCALE

Scale inefficiency appears to affect the overall inefficiency of Indian banks. Therefore, the issue of scale inefficiencies is explored with greater detail by considering returns-to-scale (RTS) properties of the individual banks.

TABLE 4.4: BANK WISE NATURE OF RETURNS TO SCALE

Nature of Returns-to scale	No. of Banks Belonging	Banks
Constant returns-to-scale (CRS)	8	***ANB, COB, INB,*** OBC, UNI, ***AXB, HFB, ICB***
Increasing returns-to-scale (IRS)	8	ALB, BOM, CBI, IOB, UCB, UBI, VJB, SBH
Decreasing returns-to-scale (DRS)	6	BOB, BOI, CAB, PNB, SYB, SBI

Note- Nature of returns to scale as identified by BCC mode is followed.

Returns to scale analysis suggest that globally efficient banks are 100% scale efficient and globally inefficient banks are operating in the region where IRS or DRS prevails. Banks with IRS have the possibility to improve their efficiency by scaling up their activities, whereas banks with DRS scaling down the operation to gain efficiency (OTE).

The study observes that out of 8 banks operating at CRS; only 6 banks (27%) with bold and italic which are CCR efficient are operating at most productive scale size (MPSS). Here it is also to mention that two banks namely OBC and UNI operating at CRS and three banks namely BOI, SBI, and SYB operating at DRS are very close to 100% scale efficiency. These findings indicate that 11 banks ie 50% of the sample banks under evaluation are operating at correct scale. Thus, they have a little scope of improvement of OTE by eliminating scale inefficiency. It is pointed out that SBI which is 100% BCC efficient can be 100% CCR efficiency only by increasing a little bit scale efficiency through scaling down its activities.

EFFICIENCY IMPROVEMENT PLAN FOR INEFFICIENT BANKS

DEA methodology provides how an inefficient DMU (bank) becomes fully efficient by indicating the level of inputs to be utilized and level of outputs to be produced. This is called projection in DEA literature which shows input and output improvement or input and output target for inefficient banks. Table 4.5 shows the CCR projection i.e., input output improvement plan for inefficient banks by reducing their present level of inputs and enhancing present level of outputs by the % mentioned in each of respective bank column in Table 4.5.

For interpreting the content of Table 4.5, let us consider the case of PNB (Punjab National Bank). PNB can be 100% CCR efficient through the three phases of input output improvements plan. OTE of this bank is 90.35% and OTIE = 9.65%

Phase I - It has to reduce its all inputs level by 9.65%. This proportional reduction is also known as radial adjustment in DEA. By this adjustment PNB becomes weakly efficient (fulfil the 'Farrell' or 'week' efficiency, W. Cooper et al., 2007).

Phase II – It has to reduce in addition to 9.65%, Input-II (No of Employees) by 10.99% (20.65% - 9.65%). No further reduction is required for Input I and III since slack values corresponding to these inputs are nil. Thus, the two inputs- 'Fixed Assets' and 'Loanable Fund' have the positive impact; whereas present level of input- 'No of Employees' has no any effect on efficiency evaluation of PNB during the study period.

Phase III - It has to enhance only Output II (Non- interest Income) by 57.22% as because of presence of non-zero slack corresponding to this output. No adjustment is required for other two outputs. Since we follow input oriented model, it does not need any radial adjustment for outputs by the OTIE. Thus, current level of 'Non-interest Income' of PNB has no effect while other two outputs ' Net interest income' and 'Net profit' play a positive role on the efficiency estimation procedure.

Phase II & III are known as slack adjustments in DEA. However these slack adjustments in Phase II & III after radial adjustment in Phase-I makes PNB strongly efficient (fulfil the 'Pareto- Koopmans' or 'strong' efficiency, Cooper et al., 2007). The similar explanation can also be extended for other inefficient banks.

Most of the inefficient banks have slack value corresponding to input – II and output- II. thus, efficiency improvement plan as a whole indicates that banks which are using more labour with lower exposure to off-balance sheet activities are relatively less efficient.

TABLE 4.5: INPUT & OUTPUT IMPROVEMENT PLAN FOR 16 CCR INEFFICIENT BANKS

	Banks	ALB	BOB	BOI	BOM	CAB	CBI	IOB	OBC
	OTE	66.80%	74.83%	68.25%	50.91%	75.32%	42.70%	65.68%	81.86%
	OTIE (100% - OTE)	33.20%	25.17%	31.75%	49.09%	24.68%	57.30%	34.32%	18.14%
Inputs	I. Fixed Asset	-33.20%	-25.17%	-39.84%	-51.02%	-24.68%	-73.16%	-53.36%	-49.06%
	II. No of Employees	-35.60%	-28.10%	-31.75%	-49.09%	-28.06%	-61.05%	-34.32%	-18.14%
	III. Loanable Fund	-33.20%	-25.17%	-31.75%	-49.09%	-24.68%	-57.30%	-34.32%	-26.43%
Outputs	I.Net Interest Income	0.00%	3.43%	0.00%	0.00%	8.92%	0.00%	0.00%	0.00%
	II. Non-Interest Income	10.01%	58.80%	60.65%	31.70%	29.06%	0.00%	56.20%	91.02%
	III. Net Profit	0.00%	0.00%	57.44%	23.19%	0.00%	9.28%	79.72%	28.75%

	Banks	PNB	SYB	UCB	UBI	UNI	VJB	SBI	SBH
	OTE	90.35%	72.06%	61.58%	51.85%	70.65%	67.41%	99.97%	95.09%
	OTIE (100% - OTE)	9.65%	27.94%	38.42%	48.15%	29.35%	32.59%	0.03%	4.91%
Inputs	I. Fixed Asset	-9.65%	-27.94%	-38.42%	-48.15%	-39.54%	-32.59%	-0.03%	-4.91%
	II. No of Employees	-20.64%	-31.08%	-38.42%	-48.15%	-29.35%	-32.59%	-37.27%	-12.36%
	III. Loanable Fund	-9.65%	-27.94%	-38.42%	-48.15%	-29.35%	-32.59%	-0.03%	-4.91%
Outputs	I.Net Interest Income	0.00%	0.00%	0.00%	0.00%	0.83%	0.00%	0.00%	0.00%
	II. Non-Interest Income	57.72%	3.98%	14.98%	35.65%	34.88%	29.10%	0.00%	1.77%
	III. Net Profit	0.00%	50.15%	1.98%	73.51%	0.00%	26.51%	30.32%	10.39%

Note -Input projection (%) = [Input Improvement */ Actual Input used] × 100.
Output Projection (%) = [Output Improvement** / Actual Output produced] × 100.
* = Actual Input values x (1 – efficiency score obtained) + Input Excess/ Input Slack if any.
** = Output shortfall (slack) if any.
Input projection is presented with a negative sign and output projection with positive sign as because of inputs to be reduced and output to be enhanced for efficiency improvement philosophy.
OTE - Overall Technical Efficiency, OTIE – Overall Technical Inefficiency,
Input reduction in excess of OTIE indicates presence of non-zero input slacks and output augmentation indicates presence of non-zero output slacks since we follow input oriented model.

PEER BANKS FOR INEFFICIENT BANKS

TABLE: 4.6: INEFFICIENT BANK WISE PEER BANKS WITH CORRESPONDING LAMBDA VALUES

			Peer Banks					
	SN		1	2	3	4	5	6
		Banks	ANB	COB	INB	AXB	HFB	ICB
Inefficient Banks	1	ALB			0.1203	0.3008	0.0891	
	2	BOB			0.2706	1.0489		
	3	BOI				0.9502	0.1193	
	4	BOM				0.1136	0.0868	
	5	CAB			0.8314	0.6875		
	6	CBI				0.3463	0.0968	
	7	IOB				0.2076	0.2538	
	8	OBC				0.5810		
	9	PNB			0.2177	1.0903	0.2799	
	10	SYB	0.9407				0.0805	
	11	UCB	0.2802	0.3516			0.1111	
	12	UNI			0.4678	0.5359		
	13	UBI		0.0425		0.0708	0.1124	
	14	VJB		0.1075		0.1193	0.0733	
	15	SBI		5.5332		1.9172	0.2202	
	16	SBH	0.6742	0.1735				
		frequency	**3**	**5**	**5**	**13**	**11**	**0**

One of the important advantages of DEA methodology is to identify the reference banks or peer banks for each inefficient bank based on the positive lambda values of the efficient banks for an inefficient bank under consideration. The banks which provide the best practice of input utilization form a reference set of the inefficient banks. In DEA literature, these banks are called peer banks. Now, we mention inefficient bank-wise reference banks or peer banks i.e. a set of efficient banks (Table 4.6) based on CCR model

Peer banks for say PNB (SL No 9, Table 4.6) are AXB, HFB and INB since their lambda values are positive corresponding the efficiency score of the bank PNB. To improve efficiency, PNB bank should follow the good operating practices of AXB, HFB and INB since their input output configuration is similar with PNB, an inefficient bank. Lambda values of AXB, HFB and INB approximately 1.09, 0.2799 and 0.2177 respectively show the proportion contributed to the point used to evaluate PNB.

That is projected inputs value of PNB =

(Input value of AXB) × 1.09 + (Input value of HFB) × 0.2799 + (Input value of INB× 0.2177)

Similarly projected output value =

(Output value of AXB) × 1.09 + (Output value of HFB) × 0.2799 + (Output value of INB× 0.2177)

PNB has more similarity to AXB and then HFB, INB from magnitude of lambda values. This explanation for reference set of other inefficient banks is similar. However, in order to improve efficiency, most of the inefficient banks should follow the good operating practices of four banks namely AXB, HFB, INB and COB, which are frequently appeared in the reference set i.e. peer group.

CATEGORIES AND RANKING OF EFFICIENT AND INEFFICIENT BANKS

We categorise the CCR efficient banks on the basis of frequency count in reference set. Magnitude of frequency in reference sets measures the extent of robustness of efficient banks relative to other efficient banks. In other words, higher the frequency the more robust is.

TABLE: 4.7: CATEGORIES OF 6 CCR EFFICIENT BANKS

Category	N	Banks
I. Highly Efficient Banks (f ≥ 10)	2	AXB(13), HFB (11),
II. Efficient Banks (f >3)	3	COB (5), INB (5) ANB (3)
III. Efficient by default (f =0)	1	ICB (0)

Note: N – number of banks within a group, f = frequency count of efficient banks in reference sets of inefficient banks, average frequency is 6.The figures in the parentheses are number of frequency in reference sets of the respective efficient banks.

Two banks -AXB and HFB of category I (Table 4.7) are appeared frequently in the reference set of inefficient banks and they are likely to remain efficient unless there are major shift in their fortunes. These banks are highly efficient banks and may be termed as 'well round performer' or 'global leader' (Kumar Gulati 2008b) among the selected banks under study with specified input and output variables. Banks of category II appear seldom in the reference sets of inefficient banks. They are relatively less efficient than the banks of category I so far as robustness of efficiency is concerned. Therefore, they are weakly efficient bank or efficient. ICB with zero frequency are termed as 'efficient by default' in DEA terminology because it is somewhat odd or peculiar institution with characteristics. That is, this bank is like to possess a very uncommon input and output mix and thus they are not good examples of operating practice to emulate for inefficient banks. So, inefficient banks should not follow them to improve their efficiency. ICB may strike out from the efficient frontier in the coming years unless there is a substantial improvement in their operations.

An attempt is made to segregate the CCR inefficient banks (OTE<1) into three groups based on the OTE score distribution. This segregation helps to find better insights into efficiency of inefficient banks.

TABLE: 4.8: CATEGORIES OF 16 CCR INEFFICIENT BANKS

I. Marginally Inefficient (from 0.759 to < 1)	Banks	SBI, SBH, PNB, OBC,CAB,
	N	5
	MS	.885
II. Inefficient (from 0.699 to < 0.759)	Banks	BOB, SYB,UNI,BOB, VJB,ALB
	N	6
	MS	0.699
III. Distinctively Inefficient (from 0.426 to < 0.699)	Banks	IOB, UCB, UBI,BOM,CBI
	N	5
	MS	0.545

Note: N = No of Banks belonging to the group, MS = Mean Score (OTE) of the respective group, categorizations are based on percentile at 33.3 and 67.7 point of OTE distribution. Banks are listed in each group according to descending order of OTE score.

The group of marginally inefficient banks (Table 4.8) will have an efficiency rating in excess of 88.5% but less than 100% and could raise their score towards 100% with a relatively small amount of improvement in their operating results. Here, it is pointed out that SBI of this category is very close to 100 % CCR efficiency. Banks of this category can reach the efficient frontier by making radial reduction on an average 11.5% (1- 0.885) of the inputs they currently use where as banks of inefficient group by 30.1% (1- 0.699) and banks of distinctively inefficient by 45.5% (1- 0.545). Distinctively inefficient banks would have significant difficulties making them efficient in the short term. Banks of this group are required to reduce current input usage by 45.5% which is much higher than that of other two groups.

RANKINGS

Ranking is a well established approach in social science and thus it is a pertinent issue in the banking efficiency study. In DEA context, ranking of organizational units has become also a well established approach in the last decade. The present study has developed a humble approach for category wise ranking of the selected Indian banks.

TABLE: 4.9: CATEGORY WISE RANKINGS OF BANKS

Highly Efficient	Efficient	Efficient by Default	Marginally Inefficient	Inefficient	Distinctively Inefficient
1. AXB	1. COB	1. ICB	1. SBI	1. BOB	1. IOB
2. HFB	2. INB		2. SBH	2. SYB	2. UCB
	3. ANB		3. PNB	3. UNI	3. UBI
			4. OBC	4. BOB	4. BOM
			5. CAB	5. VJB	5. CBI
				6. ALB	

Note - Rankings of efficient banks within each category are based on their frequency count in reference set. Rankings of inefficient banks are based on level of OTE score.

CONCLUSIONS AND RECOMMENDATIONS

It is to be pointed that DEA measures relative efficiencies. Thus, all the results, comparisons, categorizations, rankings of this study are based on the relative efficiency scores derived from the selected 22 sample banks.

The objective of this paper is to measure and analyse the technical efficiency of the Indian commercial banks. For this, the study has adopted two DEA models - CCR and BCC to estimate efficiency of the selected 22 large sized banks for the financial year 2009-10. The results reveal that 6 out of 22 banks (ANB, COB, INB, AXB, ICB, and HFB) are found to be fully technical and scale efficient banks with an average overall technical efficiency of 78.8%. Thus, Indian large-sized banks still have the opportunity to save on an average 21.2% of present input resources to produce the current level of outputs relative to the performances of 6 efficient banks. The study has also found out 4 other banks (PNB, VJB, SBI, SBH) are 100% technical efficient but not 100% scales efficient. Other 12 banks (Table

4.3 - Category III) are neither technical nor scale efficient. They are BCC inefficient banks. The study has observed that that pure technical inefficiency as well as scale inefficiency is both responsible for overall technical inefficiency as indicated their almost equal mean scores. The decomposition of technical efficiency analysis indicates the Indian CCR inefficient banks (banks of category II & III in Table 4.3) are facing the problem of mismatch between PTE and SE. 44% of the inefficient banks have higher PTE than SE by about mean score of 13.8%, while remaining 46% have higher SE than PTE by about 19.4%. This highly mismatch between PTE and SE of the inefficient banks can not increase mean OTE of all banks under study beyond 78.8%. This finding also makes a support of earlier observation that pure technical inefficiency is the main source of overall technical inefficiency. Nature of returns to scale analysis provides that 11 banks i.e. 50% of the sample banks (6 banks have 100% SE and 5 banks have very close to 100 % SE) are operating at appropriate size while out of remaining 50% banks, scale inefficiencies of 72% are caused by their operation with increasing returns to scale and only 28% for decreasing returns to scale. So, increasing returns to scale is the predominant form of scale inefficiency based on the evaluation of 22 top most large-sized banks of the present study. (See bank wise nature of returns to scale in Table 4.4). SBI fails to obtain 100% CCR efficiency status only because of its slight scale inefficiency which is caused by decreasing returns to scale of operation. Efficiency improvement plan as a whole indicates that banks which are using more labour for providing services with lower exposure to off-balance sheet activities are relatively less efficient. The study has found AXB as most efficient while CBI as most inefficient.

The study first recommends that all inefficient banks should follow their respective input output improvement plan (Table.4.5) and operating practices of peer banks (Table.4.6) for efficiency improvement. The study recommends that banks of distinctively inefficient banks should utilize their labour effectively and should go for adopting the strategy of 'capital substituted for labour' heavily by using more technology in operation which helps them to increase non-interest income. The regulators may consider these banks for capitalization scheme to enhance their efficiency level which ultimately will increase the overall efficiency position in resource utilization of the Indian banks. The study also recommends that banks of marginally inefficient group should concentrate on the effective use of labour and physical capital with higher exposure to off balance sheet activities. All other inefficient banks should concentrate more for generating income from other sources.

Particularly CBI should be very much careful about proper utilization of physical capital and labour for increasing managerial efficiency and should go for scaling up activities by opening new branches for gaining scale economies. BOM also should increase it size to a large extent which may remove its lowest scale efficiency. UCO and UBI which are using right proportion in their input output configuration should put emphasis on management efficiency and scale efficiency respectively. SBI should not go for opening new branches and be careful regarding new recruitment of employees. ICB should follow the practice of AXB with respect to proportion in which it utilizes its input resources.

We sincerely hope that this study opens a broad horizon for further researches to evaluate the relative efficiency of Indian banking sector, using frontier approach and in turn will contribute for the development of Indian banks particular large sized banks. The future research could extend our works by considering data for a longer period and other DEA models. Their analysis may go further by decomposing technical efficiency change and technological progress using DEA-based Malmquist productivity index and looking into determinants of technical efficiency by considering bank-specific and economic factors. In this regard we advise to use Tobit regression model for this analysis.

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