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Technical Efficiency of Public Sector Banks in India Using Data Envelopment Analysis

M. Sravani
Asst Professor Krishna University Machilipatnam

I. Introduction

Indian financial services sector is dominated by the banking sector and the structure of banking in India is broadly classified into public sector banks, private sector banks and foreign banks. The public sector banks continue to dominate the banking industry, in terms of lending and borrowing, and it has widely spread out branches which help greatly in pooling up of resources as well as in revenue generation for credit creation. The Indian financial sector reform of 1991 has greatly changed the face of Indian Banking system.

The economic and political environment in the country greatly influences the banking sector. Also in the face of increased competition, the banks have to operate more efficiently in order to sustain and perform better. In the context of increased competition and the importance of banks in financial markets, it becomes very much essential to evaluate whether these banks operate efficiently. Primarily, there are two chief reasons to measure the efficiency of banking institutions. Firstly, this assists to identify the most efficient banks and benchmarks the relative efficiency of individual banks against the most efficient banks. Secondly, it helps to evaluate the impact of various policy measures on the performance of banks. The objective of this paper is to estimate technical efficiency of public sector banks in India for the period 2009-2013. The paper is structured as follows: the first section will discuss review of literature in banking followed by methodology, data and specification of bank inputs and outputs. Empirical findings are discussed in the next section followed by the suggestions.

II. Literature Review

During the late 1980s and particularly in the 1990s, the DEA method has been used extensively to evaluate banking institutions. Sathye (2003) used DEA to study the relative efficiency of Indian banks in the late 1990's with that of banks operating in other countries. He found that the public sector banks have a higher mean efficiency score as compared to the private sector banks in India, but found mixed results when comparing public sector banks and foreign commercial banks in India.

Kumbhakar and Sarkar (2004) estimated the cost efficiency of public and private sector banks in India by using the stochastic cost frontier model with specification of translog cost function. The study used data of 50 banks for the analysis and necessary information have been collected from the various issues of the annual reports published by the Indian Banks' Association for the period 1986-2000. The empirical results revealed that deregulation not only increased the cost inefficiency but also affected the rate of fall in inefficiency of banks. During this period private banks were more efficient than the public sector banks according to study.

Rammohan and Ray (2004) compared the revenue maximizing efficiency of banks in India in 1990's. Deposits and operating costs were taken as inputs while loans, investments and other income were taken as outputs. Their research found that public sector banks were significantly better than private sector banks on revenue maximization efficiency. However it was found that the difference in efficiency between public sector banks and foreign banks was not significant.

Das et al, (2004) examined the efficiency of Indian banks by using DEA model. Four input measures: deposits and other borrowings, number of employees, fixed assets and equity, and three output measures: investments, performing loan assets and other noninterest fee based incomes were used in the analysis. He found that Indian banks did not exhibit much of a difference in terms of input or output oriented technical and cost efficiency. However, in terms of revenue and profit efficiencies prominent differences were seen. He also found that size of the bank, ownership of the bank, and listing on the stock exchange had a positive impact on the average profit and revenue efficiency scores.

Soori et al, (2005) analyzed efficiency of Iranian banking system and the main Purpose of the study was to investigate the comparative efficiency of commercial banks in Iran using stochastic frontier function as a parametric and data envelopment analysis as a non-parametric approaches. The data used cover the period 1996-2004. The findings of this paper show that there is a significant difference between non–parametric and parametric methods in measuring the efficiency in the commercial banks of Iran.

Debasish (2006) also attempted to measure the relative performance of Indian banks, using the output-oriented CRR DEA model. The analysis used nine variables and seven output variables in order to examine the relative efficiency of commercial banks over the period 1997 – 2004.

Mostafa, M. (2007) investigated the efficiency of top 85 Arab banks using DEA and Neural networks for the year 2005. He found that, eight banks as per the CCR Score and four banks as per BCC Score were positioned on the efficient frontier. He suggested that future studies should test the existence of positive rank-order correlations between efficiency scores obtained from DEA analysis and traditional efficiency measures such as financial ratios. His results further demonstrate that, Al-Rajhi Bank and National Commercial Bank were placed among the top ten Arab banks with a relative ranking of eight and ten respectively.

Moh'd Al-Jarrah (2007) is used Data Envelopment Analysis (DEA) approach to investigate cost efficiency levels of banks operating in Jordan, Egypt, Saudi Arabia and Bahrain over 1992-2000. The estimated cost efficiency is further decomposed into technical and allocative efficiency at both variable and constant return to scale. Later on, the technical efficiency is further decomposed into pure technical and scale efficiency. Cost efficiency scores ranged

From 50 to 70% with some variations in scores depending on bank's size and its geographical locations. The results suggested that the same level of output could be produced with approximately 50- 70% of their current inputs if banks under study were operating on the most efficient frontier.

Chansarn (2008) conduct a study aimed to examine the relative efficiency of Thai commercial banks during 2003 – 2006 by utilizing Data Envelopment Analysis (DEA). Based on the sample of 13 commercial banks, findings revealed that the efficiency of Thai commercial banks via operation approach is very high and stable while the efficiency via intermediation approach is moderately high and somewhat volatile. In term of size, large, medium and small banks, in average, were efficient via operation approach with the average efficiencies of 100%. However, small banks were the most efficient banks via intermediation approach

AlKhathlan and Abdul Malik (2008) used basic DEA models i.e. CCR and BCR to evaluate the relative efficiency of Saudi Banks using annual data from 2003 through 2008. The results showed that, on a relative scale, Saudi banks were efficient in the management of their financial resources. In addition, the results would provide crucial information about Saudi banks' financial conditions and management performance for the benefit of bank regulators, managers and bank stock investors.

Kumar and Gulati (2008) conducted a study to measure the extent of technical, pure technical, and scale efficiencies in 27 public sector banks (PSBs) operating in India in the year 2004/05. The empirical findings of study revealed that PSBs (Public sector banks) operate at 88.5 percent level of overall technical efficiency i.e., inputs could be reduced by 11.5 percent without sacrificing output if all banks were efficient as 7 benchmark banks identified by DEA. Further, the contribution of scale inefficiency in overall technical inefficiency has been observed to be smaller than what been observed due to managerial inefficiency (i.e., pure technical inefficiency). The findings pertaining to returns-to scale in Indian public sector banking industry highlight that the predominant form of scale inefficiency is decreasing returns-to-scale. The results of logistic regression analysis also provide that the exposure of the banks to off-balance sheet activities (i.e., non-traditional activities) has a strong and positive impact on the overall technical efficiency of banks in India.

San O et al, (2011) in their study utilizes non parametric Data Envelopment Analysis (DEA) to analyze and compare the efficiency of foreign and domestic banks in Malaysia. The analysis was based on a panel data set of 9 domestic banks and 12 foreign banks in Malaysia over the period of 2002-2009. Intermediation approach is used to define the inputs and outputs in computerizing the efficiency scores. Surprisingly, the findings are inconsistent with most of the findings of previous studies where the foreign banks were outperforming their domestic peers in term of efficiency. Conversely, the finding of this study shows that domestic banks have a higher efficiency level than foreign banks, this imply that domestic banks are relatively more managerially efficient in controlling their costs. The second stage of the empirical results was based on the Tobit model, which suggests that the pure technical efficiency (PTE) of banks in Malaysia is mainly affected by capital strength, loan quality, expenses and asset size.

Bjectives of The Study

- To measure the technical efficiency of Indian public sector banks using data envelopment analysis, a non parametric method during the period between 2009-2013
- To identify the most efficient banks using Data envelopment analysis by ranking the banks on the basis of efficiency scores obtained.
- To suggest for measures for improving the efficiency of banks selected.

Scope Of The Study

The study covers only Indian public sector banks for which the data on selected inputs and outputs is available continuously for the period between 2009 and 2013. As such the number of public sector banks

selected for the study is limited to 20.The study is confined to measurement of technical efficiency of selected public sector banks and thereby identifying the efficient banks.

III. Methodology Of The Study

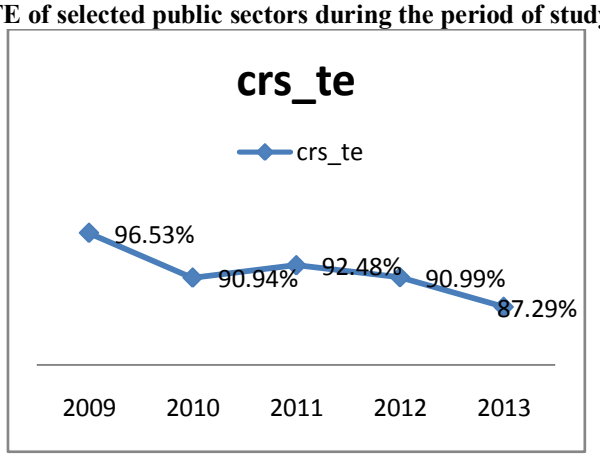
The study is carried out by taking secondary data in to consideration. For efficiency related concepts and about Data Envelopment Analysis, data from journals, websites, books and etc was taken, while to measure the technical efficiency, software developed by Tom Coelli on DEA was used for the purpose of analysis and thereby to identify the efficient banks. The efficiency scores are calculated using Data envelopment analysis, a non parametric technique. The output oriented DEA was adopted for analysis. The inputs and outputs selected for the study were based on intermediation approach .The inputs for the study are fixed assets, deposits, number of employees and number of offices while outputs selected for the study were loans and investments..The sample size for the study is 20 banks which belong to the category of public sector banks. The list of banks for the study is as follows:

LIST OF PUBLIC SECTOR BANKS	
Allahabad Bank	Indian Bank
Andhra Bank	Indian Overseas Bank
Bank of Baroda	Oriental Bank of Commerce
Bank of India	Punjab National Bank
Bank of Maharashtra	State Bank of India
Canara Bank	Syndicate Bank
Central Bank Of India	UCO Bank
Corporation Bank	Union Bank of India
Dena Bank	United Bank of India
IDBI Bank	Vijaya Bank

Technical efficiency according to Constant Returns to Scale Assumption(CRSTE)						
Name of the Bank	2009	2010	2011	2012	2013	AVERAGE
Allahabad Bank	1	1	0.766	0.656	1	0.8844
Andhra Bank	1	1	0.974	1	0.445	0.8838
Bank of Baroda	1	1	**1**	1	1	1
Bank of India	0.993	1	0.78	0.92	1	0.9386
Bank of Maharashtra	0.926	0.805	1	0.774	0.869	0.8748
Canara Bank	0.912	0.933	0.843	1	1	0.9376
Central Bank of India	1	0.853	0.869	0.819	1	0.9082
Corporation Bank	0.983	0.75	1	0.742	1	0.895
Dena Bank	1	1	1	1	1	1
IDBI Bank	1	0.736	1	1	0.707	0.8886
Indian Bank	0.899	0.838	0.703	0.757	0.997	0.8388
Indian Overseas Bank	1	0.8	1	1	1	0.96
Oriental Bank of Commerce	0.919	1	1	1	1	0.9838
Punjab National Bank	1	1	1	1	1	1
State Bank of India	1	1	1	1	0.19	0.838
Syndicate Bank	1	1	1	1	0.734	0.9468
UCO Bank	1	0.787	0.774	0.848	0.677	0.8172
Union Bank of India	0.831	0.867	1	1	0.84	0.9076
United Bank of India	0.905	0.819	0.787	0.682	1	0.8386
Vijaya Bank	0.938	1	1	1	1	0.9876
AVERAGE	**0.9653**	**0.9094**	**0.9248**	**0.9099**	**0.87295**	**0.91647**

It was evident from the DEA analysis that the overall average technical efficiency of selected public sector banks for the period between 2009 and 2013 was found to be 91.6% under CRS approach. That means still the selected public sector units can maximize their output by 8.4% at the given level of inputs. Among the 20 public sector banks selected for the study, Bank of Baroda, DENA Bank and Punjab National Bank have recorded 100% average technical efficiency during the period from 2009 to 2013. Among the 20 public sector banks selected for the study, about 8 banks have average technical efficiency scores more than 90%. Vijaya Bank has recorded an average technical efficiency of 98.76%, followed by Oriental Bank of Commerce, Indian Overseas Bank, Syndicate Bank, Bank of India, Canara Bank and Union Bank of India with average efficiency scores of 98.38%,96%,94.68%,93.86%, ,93.76% and 90.76% respectively. That means still the banks can maximize their outputs at the given level of inputs by 1.24%, 1.62%, 4%, 5.32%, 6.14%, 6.24% and 9.24% respectively. Among the selected banks, UCO Bank recorded lowest average efficiency score of 81.72%, followed by State Bank of India, United Bank of India, and Indian bank with average efficiency scores of 83.8%, 83.6% and 83.88% respectively. Here from the observations, it can be inferred that the UCO Bank can maximize their output at the given level of inputs by 18.28%, SBI by 16.2%, United bank of India by 16.4% and Indian bank by 16.22%.The average technical efficiency of selected banks for the year 2009 was 96.53%, 90.94% in 2010, 92.48%, 90.99% and 87.29% in the years 2011, 2012 and 2013 respectively.

Graph showing the CRS_TE of selected public sectors during the period of study

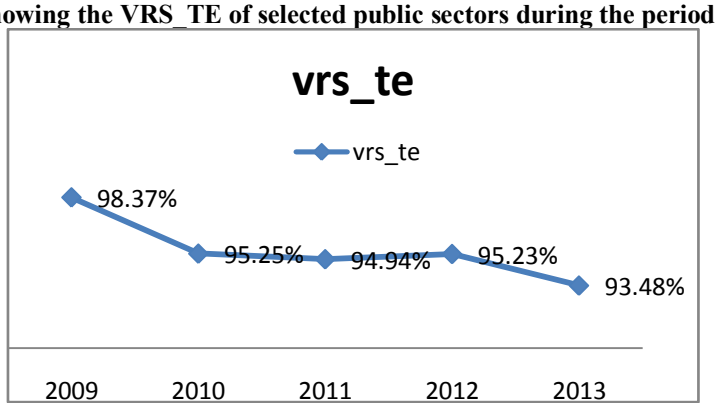


Technical efficiency according to Variable Returns to Scale Assumption(VRSTE)						
Name of the Bank	**2009**	**2010**	**2011**	**2012**	**2013**	**AVERAGE**
Allahabad Bank	1	1	0.805	0.701	1	0.9012
Andhra Bank	1	1	1	1	0.45	0.89
Bank of Baroda	1	1	**1**	1	1	1
Bank of India	0.993	1	0.816	1	1	0.9618
Bank of Maharashtra	1	0.883	1	1	1	0.9766
Canara Bank	0.913	0.946	0.855	1	1	0.9428
Central Bank of India	1	0.857	0.87	0.9	1	0.9254
Corporation Bank	1	0.854	1	0.743	1	0.9194
Dena Bank	1	1	1	1	1	1
IDBI Bank	1	0.738	1	1	0.716	0.8908
Indian Bank	1	1	1	1	1	1
Indian Overseas Bank	1	1	1	1	1	1
Oriental Bank of Commerce	1	1	1	1	1	1
Punjab National Bank	1	1	1	1	1	1
State Bank of India	1	1	1	1	1	1
Syndicate Bank	1	1	1	1	0.757	0.9514
UCO Bank	1	0.902	0.79	0.857	0.888	0.8874
Union Bank of India	0.861	0.871	1	1	0.886	0.9236
United Bank of India	0.907	1	0.853	0.846	1	0.9212
Vijaya Bank	1	1	1	1	1	1
AVERAGE	**0.9837**	**0.95255**	**0.94945**	**0.95235**	**0.93485**	**0.95458**

It can be observed from the table that the overall average technical efficiency of selected public sector banks for the period between 2009 and 2013 was found to be 95.45% under VRS approach. That means still the

selected public sector units can maximize their output by 4.55% at the given level of inputs. Among the 20 public sector banks selected for the study, Bank of Baroda, DENA Bank ,Indian Bank, Indian Overseas Bank, Oriental Bank of Commerce ,Punjab National Bank , State Bank of India and Vijaya Bank have recorded 100% average technical efficiency during the period from 2009 to 2013. Among the 20 public sector banks selected for the study,9 Banks have recorded average technical efficiency scores of more than 90%.Bank of Maharashtra has recorded average technical efficiency score of 97.66%,followed by Bank of India, Syndicate Bank, Canara Bank, Central Bank of India, Union Bank of India, United Bank of India ,Corporation bank and Allahabad Bank with average technical efficiency scores of 96.18%,95.14%,94.28%,92.54%,92.36%,92.12% 91.94% and 90.12% respectively. Among the selected banks, UCO Bank recorded lowest average efficiency score of 88.74% followed by Andhra Bank and IDBI Bank with average efficiency scores of 89% and 89.08% respectively. It can be inferred that UCO bank can maximize their output by 11.26%, Andhra Bank by 11% and IDBI Bank by 10.92%.the technical efficiency of selected public sector banks in the year 2009 was 98.37%, 95.25% in 2010, 94.94%, 95.23% and 93.48% in the years 2011,2012 and 2013 respectively.

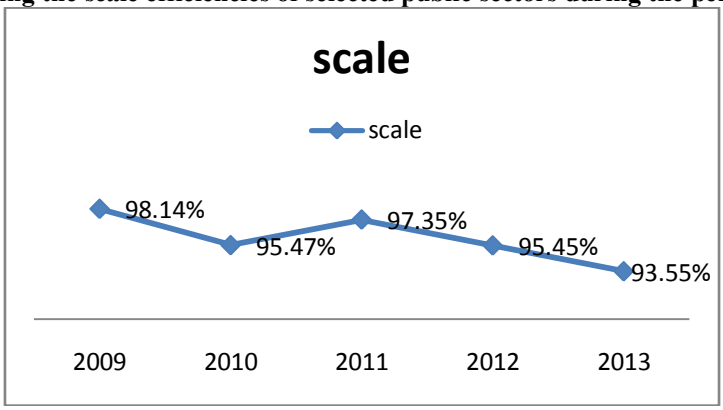
Graph showing the VRS_TE of selected public sectors during the period of study



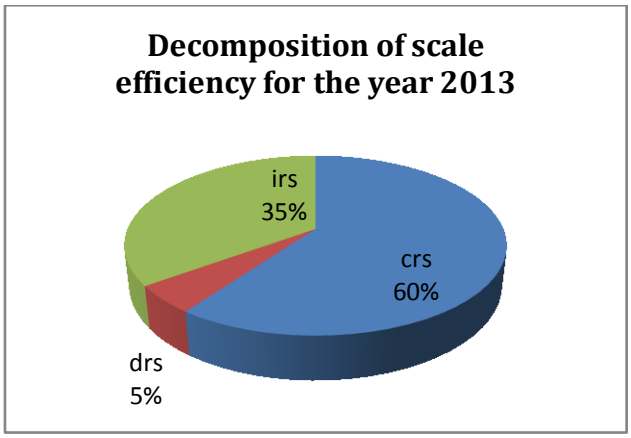
Scale efficiency of the selected public sector banks						
Name of the Bank	**2009**	**2010**	**2011**	**2012**	**2013**	**AVERAGE**
Allahabad Bank	1	1	0.952	0.935	1	0.9774
Andhra Bank	1	1	0.974	1	0.989	0.9926
Bank of Baroda	1	1	**1**	1	1	1
Bank of India	1	1	0.956	0.92	1	0.9752
Bank of Maharashtra	0.926	0.911	1	0.774	0.869	0.896
Canara Bank	0.999	0.986	0.985	1	1	0.994
Central Bank of India	1	0.995	0.999	0.911	1	0.981
Corporation Bank	0.983	0.879	1	0.999	1	0.9722
Dena Bank	1	1	1	1	1	1
IDBI Bank	1	0.998	1	1	0.987	0.997
Indian Bank	0.899	0.838	0.703	0.757	0.997	0.8388
Indian Overseas Bank	1	0.8	1	1	1	0.96
Oriental Bank of Commerce	0.919	1	1	1	1	0.9838
Punjab National Bank	1	1	1	1	1	1
State Bank of India	1	1	1	1	0.19	0.838
Syndicate Bank	1	1	1	1	0.969	0.9938
UCO Bank	1	0.873	0.979	0.99	0.763	0.921
Union Bank of India	0.966	0.995	1	1	0.947	0.9816
United Bank of India	0.998	0.819	0.923	0.805	1	0.909
Vijaya Bank	0.938	1	1	1	1	0.9876
AVERAGE	**0.9814**	**0.9547**	**0.97355**	**0.95455**	**0.93555**	**0.95995**

It is evident from the analysis that, the overall average scale efficiency of selected public sector banks for the period between 2009 and 2013 was found to be 95.99%. That means still the selected public sector units can maximize their scale efficiency by 4%.Among the 20 public sector banks, Bank of Baroda, Dena Bank and Punjab National Bank have recorded a scale efficiency of 100%. Among the selected banks for the study, about 14 banks have achieved scale efficiency of more than 90%. State Bank of India has recorded lowest average scale efficiency score of 83.8%, followed by Indian Bank and Bank of Maharashtra with average scale efficiency scores of 83.88% and 89.6% respectively. The average scale efficiency of banks in the year 2009 was 98.14%, 95.47% in 2010, 97.35% ,95.45% and 93.55% in the years 2011,2012 and 2013 respectively.

Graph showing the scale efficiencies of selected public sectors during the period of study



Decomposition of Scale efficiency for the year 2013	
Constant returns to scale(CRS)	12 Banks
Decreasing returns to scale(DRS)	1Bank
Increased returns to scale(IRS)	7Banks



From the above graph, it can be inferred that about 35% i.e. 7 Public Sector Banks are operating under increasing returns to scale, 1 bank under decreasing returns to scale and 12 banks are operating under constant returns to scale.

Ranking of Selected Banks under different approaches(2009-2013)						
Name of the bank	**CRSTE_AVG**	**RANK**	**VRSTE_AVG**	**RANK**	**SCALE_AVG**	**RANK**
Allahabad Bank	0.8844	12	0.9012	10	0.9774	10
Andhra Bank	0.8838	13	0.89	12	0.9926	5
Bank of Baroda	**1**	**1**	**1**	**1**	**1**	**1**
Bank of India	0.9386	6	0.9618	3	0.9752	11
Bank of Maharashtra	0.8748	14	0.9766	2	0.896	16
Canara Bank	0.9376	7	0.9428	5	0.994	3
Central Bank of India	0.9082	8	0.9254	6	0.981	9
Corporation Bank	0.895	10	0.9194	9	0.9722	12
Dena Bank	**1**	**1**	**1**	**1**	**1**	**1**
IDBI Bank	0.8886	11	0.8908	11	0.997	2

Indian Bank	0.8388	15	1	1	0.8388	17
Indian Overseas Bank	0.96	4	1	1	0.96	13
Oriental Bank of Commerce	0.9838	3	1	1	0.9838	7
Punjab National Bank	**1**	**1**	**1**	**1**	**1**	**1**
State Bank of India	0.838	17	1	1	0.838	18
Syndicate Bank	0.9468	5	0.9514	4	0.9938	4
UCO Bank	0.8172	18	0.8874	13	0.921	14
Union Bank of India	0.9076	9	0.9236	7	0.9816	8
United Bank of India	0.8386	16	0.9212	8	0.909	15
Vijaya Bank	0.9876	2	1	1	0.9876	6
AVERAGE	**0.91647**		**0.95458**		**0.95995**	

The table above shows the ranks given to the selected public sector banks under CRS (technical efficiency), VRS (pure technical efficiency) and Scale efficiency on the basis of efficiency scores obtained using DEA analysis. It can be observed that Bank of Baroda, Dena Bank and Punjab National Bank have ranked first under three assumptions.

IV. Findings

- From the study, it was observed that the overall average technical efficiency of selected public sector banks for the period 2009 to 2013 was found to be 91.64% under CRS assumption and 95.45% under VRS assumption. The overall average scale efficiency of selected banks was found to be 95.99%.
- It was observed from the study that Bank of Baroda, DENA Bank and Punjab National Bank have recorded 100% average technical efficiency under CRS assumption while Bank of Baroda, DENA Bank ,Indian Bank, Indian Overseas Bank, Oriental Bank of Commerce ,Punjab National Bank , State Bank of India and Vijaya Bank have recorded 100% average technical efficiency under VRS assumption.
- From the study it can be evident that Bank of Baroda, Dena Bank and Punjab National Bank have highest efficiency score of 100% under two assumptions CRS and VRS and the scale efficiency also was found to be 100%.
- The overall average efficiency score under VRS approach was found to be higher than CRS approach.
- There is a declining trend of CRS_TE, VRS_TE and Scale efficiency scores of sample public sector banks during the period of the study.
- From the study, by decomposing the efficiency in to pure technical efficiency and scale efficiency, it was observed that the decrease in efficiency of State Bank of India is due to scale inefficiency rather than pure technical inefficiency.
- The decomposition of scale efficiency for the year 2013 reveals that about 60% of banks are operating under CRS, 35% banks under IRS and 5% banks are operating under DRS.

V. Suggestions

- The selected public sector units can maximize their output by 8.4% under CRS assumption and 4.55% under VRS assumption at the given level of inputs by making effective utilization of inputs.
- The selected public sector units can maximize their scale efficiency by 4%.
- As 35% of banks are operating under increasing returns to scale, they can increase their scale of operations so that they can increase their returns.
- As SBI has recorded more than 95% of pure technical efficiency, the major problem is scale inefficiency and hence it should strive to improve its scale efficiency. So it should take necessary measures to increase its returns by properly planning its scale of operations and effective utilization of inputs.
- Out of 20 banks selected for the study, Bank of Baroda, DENA bank and Punjab National Bank have recorded highest efficiency scores under all assumptions (CRS, VRS and SCALE).Hence the rest of the banks need to take these banks as benchmarks in terms of their process of operations and should strive to achieve efficiency.

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