

## Measuring Efficiency of Commercial Banks in India - A DEA Study

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### Abstract

In today's era of advanced technology, the role of banking industry has become utmost important for everyone for managing their monetary transactions. Due to the new technological inventions, there has been an enhancement in the working quality of the banks and this has led to an increase in the competition among the banks. The more proficiently a bank is able to turn its resources into revenue, the more efficient it is and in order to survive in the market they will have to work on increasing their efficiency on continuous basis. Therefore, the efficiency analysis in the banking industry is attracting more and more attention.

The objective of this paper is to measure the productive efficiency of commercial banks in India. The study intends to be acquainted with the efficient banks amongst all major commercial banks, operating in India. In addition to this, we also highlight the problems faced by other researchers in measuring efficiency, basically, related to data availability and methodology. To best of our knowledge, the studies done in this area do not cover different sectors segregating different individual banks and the analysis is done for the latest years only.

Efficiency is always measured in terms of the combination of the inputs and outputs. Many researchers have proposed various methods for measuring efficiency of banks. However, we use a popular linear programming technique, Data Envelopment Analysis (DEA). DEA can deal with multiple inputs and multiple outputs in a single structure, illustrating the change in efficiency score with respect to the changes in input/output variable. In order to identify the most efficient commercial banks operating in India, DEAOS software has been used.

The present paper measures the operating efficiencies of 41 commercial banks operating in India, and the period of study is 2002 to 2014. Here, the operational efficiency of DMUs (Decision Making Units) is compared using the deterministic or stochastic input-output data. For the analysis, DEA model with two inputs and two outputs is used. The selection of inputs/outputs in real world in itself is a complicated task, since every bank treats their resources as input/output. So, taking into consideration the ownership as well as the functioning of the banks, we have chosen the number of employees and deposits as the inputs; advances and interest income as the outputs. Further, to validate the consistency between the rankings obtained from DEA, the nonparametric statistical tests are also employed.

The results are quite surprising, as they reveal that merely generating more profits and expanding the spread is not sufficient to prove the efficiency of the banks, the path of growth is also important. It all depends upon how the banks get maximum output from minimum inputs. A new ranking based on DEA will more completely and accurately represent a bank's efficiency. The results obtained from this study suggest the different ways through which the bankers, managers, policy makers and researchers could structure the working model of the banks in order to increase their efficiency.

**Keywords:** Financial sector, Banks Efficiency, DEA, Productivity, Input – Output Variables

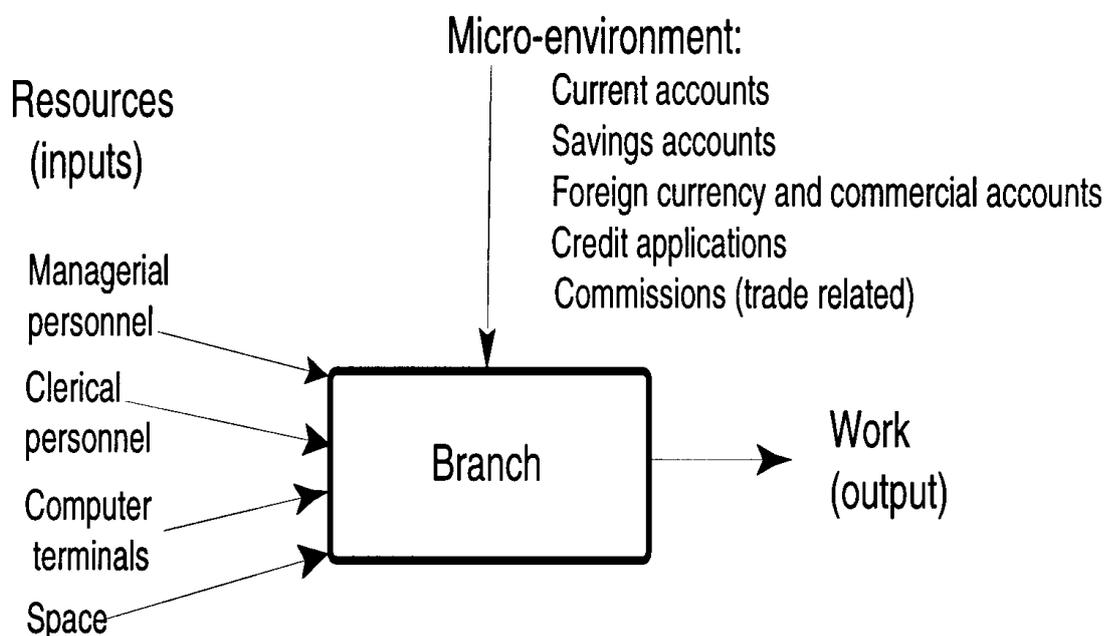
### **Introduction:**

Performance of any bank can be evaluated through its efficiency, but efficiency in itself is very complicated and technical parameter which simplifies through ratio of input/output of the banks. The importance of measuring banking sector performance has been in discussions since long. Initially that was measured by analyzing different ratios like Return on investments (ROI), Return on assets (ROA) and return on equity etc but these parameters are considered as partial measures for productivity whereas data envelopment analysis can be considered as an effective tool for measuring productivity in total.

India is the biggest developing country in South Asia with a strong financial system composed of different financial instruments and services provided by various financial institutions. Indian banking sector started its growth after nationalization of major commercial banks in 1969 and is now spreading and expanding its impact in every segment of the country. In the past few years banking industry has faced growing competition from other financial services and simultaneously has undergone various deregulation policies and removal of barriers that have enhanced the competition and viability of banks. Impact of changes in regulation can be judged by gross performance like failures and their profitability. Banks in India having strong networks and good reach in density of branches along with quick updating of technology have pressurized this sector to enhance its performance as a whole.

Reserve bank works as controller of all the banks and its functions. After 1980's public sector came out as ruler in Indian financial system.

Figure A



Source:( From different resources mention in reference section)

The objective of this paper is to measure and compare performance and efficiency of banks in India using Data Envelopment Analysis to classify efficient bank and less efficient banks on basis of efficiency score.

This study has been explained the performance variation and input/output efficiency of commercial banks. Measuring the efficiency of bank branches, using new mathematical DEA techniques, have received a great deal of attention in recent years,

Recently, many DEA researchers analyzed the dynamic structure of production in models where actions taken in one period can affect the efficiency of firms in future periods. **Bader, Mohamad, Ariff (2008), Shahooth, Hussein (2006), Oberholzer, Westhuizen (2009)** contributed in this field . Some of the articles written about the use of DEA to investigate branch efficiency have been intended toward specific applications of DEA where the mathematical formulations have been incorporated in the body of the text. While such studies would each be of some interest to the manager, the consultant, or the novice researcher, their individual scopes are limited. Above said studies were not focused on efficiency measurement of different sectors dominating in India involving long study period. In this paper, a special effort has been made to highlight the DEA theory needed and those key issues that need to be considered in designing DEA models and interpreting results. The reason behind this study was competitive environment under which banks are performing their functions and are having the chances of bankruptcies because of greater uncertainty in market. So this study analyzed the relative efficiency of Indian banks using DEA. The duration of this study has been taken as 2002 to 2014. Sample size of 41 banks has been selected from major dominating banking sectors in India comprise of SBI and its associates, Public sector banks, Private sector banks and foreign banks.

The remainder of the paper is organized as follows: in section 2 we describe literature review of DEA, methodology, data analysis followed by findings and discussions. Conclusion will be in the last section.

**2. Literature Review:** Data envelopment analysis (DEA) is a non-parametric linear programming technique that measures the efficiency of decision making units (DMUs) which use multiple inputs to produce multiple outputs and has been applied by various research communities across a wide range of industries. Concept of DEA starts by stating that **Charnes** (1978) in which he introduced “fractional programming” in which ratios were playing very important role. That extended the single output-to-single input ratio measure of efficiency to multiple inputs and outputs without requiring recourse to a priori prescribed weights. **Golany, Storbeck (1999)** discussed multi period data envelopment analysis (DEA) study of the efficiencies of selected branches of a large US bank (which we will call Big Bank) over six consecutive quarters. Paid attention to the interface with the end users and, in particular, developed presentation tools to make the outcomes of the analysis available to managers at different levels of the bank. **Phelps, Figueira, Nellis (2003)** discussed the issues of data availability and methodological problems that occur when trying to obtain realistic local and global efficiency indicators for banks. **Bader, Mohamad, Ariff (2008)** assessed the average and overtime efficiency of those banks based on their size, age, and region using static and dynamic panels. The findings suggest that there are no significant differences between the overall efficiency results of conventional versus Islamic banks. **Hays, Lurgio (2009)** discussed to differentiate between low efficiency and high efficiency community banks (less than \$1 billion in total assets) based upon the efficiency ratio, a commonly used financial performance measure that relates non-interest expenses to total operating income. This includes periods of high performance as well as deteriorating industry conditions associated with the current financial crisis. The model’s classification accuracy ranges from approximately 88% to 96% for both original and cross-validation datasets. **Shahooth, Hussein (2006)** discussed and analyzed relative cost efficiency of 24 Islamic banks. Their study shows that most Islamic banking institutions which were sample of the paper were efficient and rest were struggling to improve their efficiency. **Tahir, Bakar (2009)** examined whether the domestic and foreign banks are drawn from the same environment by performing a series of parametric and non-parametric tests. The results from the parametric and non-parametric tests suggest that for the years 2000-2004, both domestic and foreign banks possessed the same technology whereas results for 2005 and 2006 suggest otherwise. This implies that banks in recent years have had access to different and more efficient technology. **Oberholzer, Westhuizen (2009)** discussed changes in the efficiency estimates lead to changes in the EVAs of the banks. This study found that the overall regression model is statistically significant for only one of the three banks. The main purpose of the study was to determine, by means of multiple regression analysis. **Qayyum, Riaz (2012)** examined the issue and applied bootstrapping procedure proposed to construct confidence intervals using data on 28 Commercial Banks including six Islamic banks for the period of 2003-2010. The study found that public conventional banks were the most efficient banks followed by private conventional and private Islamic banks with an average bias of 10%. Moreover, the results suggest that conventional banks were more efficient compared to Islamic banks. **Maletic, Kreca, Predrag (2013)** analyzed application of DEA methodology in measuring efficiency in banking sector. Two models with different input, output indicator with sample size of 30 banks were selected. First model define interest and non interest expense model B observe employment and deposits. **Gordo (2013)** estimates the ‘best-performing frontier’ to compute for the relative efficiencies of different bank groups (e.g., universal, commercial, thrift, rural and cooperative) in the Philippines over the period 1999-2009. Their study shows that Philippine banks have undergone technological progress but this did not necessarily increase total factor productivity because of the decline in technical efficiencies (TEs).

### 3. METHODOLOGY

It is usual to measure the performance of banks using financial ratios. In recent years, there is a trend towards measuring bank performance using one of the frontier analysis methods. In frontier analysis, the institutions that perform better relative to a particular standard are separated from those that perform poorly. Present study adopts analytical and descriptive research design. In this paper, the DEA approach has been used. This approach has been used since recent research has suggested that the kind of mathematical programming procedure used by DEA for efficient frontier estimation is comparatively robust (**Seiford and Thrall, 1990**). DEA is specially designed technique for measuring of the efficiency of complex entities with diverse inputs and outputs. Increasingly it is being used for evaluation and improvement the operation of numerous business entities, and its use is expanded on evaluation the efficiency of schools, hospitals, bank branches, production facilities, etc. The analysis provides results based on which we can determine how much are some units inefficient compared to efficient units. In this way, it is possible to determine also how much is necessary to reduce the input and/or to increase the output of unit to become efficient. The efficiency has been calculated using variable returns to scale (VRS) input oriented model of the DEA methodology. To measure efficiency as directly as possible, that is, management's success in controlling costs and generating revenues. Selection of Input-output variables is always been a debatable issue. Two approaches are generally used to choose the variables called production approach and intermediation approach. Most of the DEA studies follow an intermediation approach. Within the intermediation approach, the exact set of inputs and outputs used depends largely on availability of data.

DEA does not require the predetermined weights to be attached to each input and output and it also does not require prescribing the functional forms that are needed in statistical regression approaches.

Since DEA can deal with multiple inputs vs. multiple output relations in a single framework, it has been becoming a method of choice for efficiency evaluation in recent days. DEA modeling allows the analyst to select inputs and outputs in accordance with a managerial focus. This is an advantage of DEA since it opens the door to what-if analysis. Furthermore, the technique works with variables of different units without the need for standardization (e.g. dollars, number of transactions, or number of staff). **Fried and Lovell (1994)** have given a list of questions that DEA can help to answer.

Further analysis has been done by calculating the efficiency of different banks operating in India Models has been specified below.

#### **Model Used:**

The following model was specified:

**Outputs:** Y1 = Advances

Y2 = Interest Income

**Inputs:** X1 = Number of employees

X2 = Deposits

Number of employees is considered as input because without human resource all efforts made in form of acquiring land, loans, fixed assets are worthless. Human resource is having the capability to converge maximum output from minimum input. Total deposits (a Liability item on balance sheet) are considered as an input from economics point of view because banks are supposed to perform intermediation function to transform loans out of the deposits. Interest income is considered as one of the output because that is mostly taken as a parameter to evaluate the banking performance in context of contribution to banks current earnings. Loan is being accepted as output having the same reason deposits is accepted as input.

Efficiency =1 considered efficient

**Efficiency score nearest to 1 considered efficient**

The efficiency score is usually expressed as either a number between zero and one or 0 and 100 per cent. A decision-making unit with a score less than one is deemed inefficient relative to other units.

Present study has examined 41 banks of all major sectors of banks of private, public and foreign players. Banks has been selected from every financial banking sector excluding NBFC's. Performances of the banks were measured on the basis of expansion and other variables. Time Period for the study has been considered for 12 years i.e. from 2002-14 deliberately because of availability of data and interest in banking efficiency of last year's which suffered from recession, financial crisis. The RAW DATA has been derived from RBI WEBSITE for all banking sectors that has been compiled with the help of excel. Initially data has been arranged for year 2002-14 afterwards on the basis DEA model study with the usage of input-output variable efficiency of individual banks for all years has been calculated. Number of employees and deposits has been considered as input whereas advances and interest on income has been considered as output. For calculating the efficiency DEAOS software has been used.

While compiling the data it was found that some of the banks started their banks in late years. So their performance was measure from their initiating years.

**4. Data Analysis and Results:**

In the Table 1.1 propositions is based on comparison of banks' efficiency with respect to multiple inputs (Number of employee, Deposits) and multiple outputs (Advances, Interest income). And these propositions are validated by applying DEA technique.

DEA offers three possible orientations in efficiency analysis (**Charnes et al., 1994**):

- (a) Input-oriented models are models, where DMUs are deemed to produce a given amount of output with the smallest possible amount of input.
- (b) Output-oriented models are models, where DMUs are deemed to produce the highest possible amount of output with the given amount of input.
- (c) Base-oriented models are models, where DMUs are deemed to produce the optimal mix of Input and Output.

**Table 1.1**  
**Efficiency score of Different DMU**

Dmu	Banks	Eff 02	Eff 03	Eff 04	Eff 05	Eff 06	Eff 07	Eff 08	Eff 09	Eff 10	Eff 11	Eff 12	Eff 13	Eff 14	Avg.
dmu1	SBI	93%	93%	99%	50%	83%	58%	83%	84%	97%	93%	97%	100%	99%	87%
dmu2	State Bank of B&J	95%	95%	99%	52%	86%	57%	81%	95%	95%	88%	93%	94%	92%	86%
dmu3	State bank of Hyderabad	90%	90%	91%	46%	89%	55%	80%	89%	95%	86%	97%	100%	100%	85%
dmu4	State Bank of Mysore	100%	100%	97%	49%	91%	55%	83%	96%	100%	92%	93%	95%	98%	88%
dmu5	State Bank of Patiala	98%	98%	94%	46%	94%	53%	81%	94%	100%	93%	92%	98%	95%	87%
dmu6	State bank of Travancore	95%	95%	94%	47%	100%	59%	88%	96%	94%	91%	90%	93%	90%	87%
dmu7	Allahabad Bank	89%	89%	87%	44%	90%	56%	80%	84%	86%	82%	88%	88%	88%	81%

dmu8	Andhra Bank	97%	97%	100%	47%	100%	55%	79%	88%	90%	89%	97%	95%	92%	86%
dmu9	Bank of Baroda	89%	89%	87%	45%	90%	49%	71%	81%	88%	86%	87%	80%	83%	79%
dmu10	Bank of India	100%	100%	100%	44%	88%	51%	75%	84%	89%	82%	91%	88%	88%	83%
dmu11	Canara Bank	92%	92%	91%	44%	86%	55%	84%	89%	88%	83%	85%	87%	88%	82%
dmu12	Central bank of India	88%	88%	93%	49%	87%	52%	66%	78%	81%	83%	88%	88%	89%	79%
dmu14	Corporation bank	0%	0%	0%	47%	100%	54%	74%	80%	83%	86%	86%	84%	82%	78%
dmu13	IDBI	100%	100%	100%	100%	96%	100%	100%	100%	100%	100%	100%	100%	98%	100%
dmu15	Oriental bank of commerce	100%	100%	100%	42%	98%	55%	80%	88%	93%	85%	91%	91%	90%	86%
dmu16	Punjab And Sind Bank	86%	86%	97%	94%	94%	92%	100%	98%	95%	100%	100%	100%	99%	84%
dmu17	PNB	51%	51%	93%	89%	89%	92%	98%	100%	100%	100%	98%	100%	97%	89%
dmu18	UCO bank	46%	46%	84%	82%	82%	95%	95%	95%	91%	92%	97%	97%	99%	85%
dmu19	Vijaya Bank	51%	51%	96%	88%	88%	89%	94%	95%	98%	94%	94%	96%	94%	87%
dmu20	Union bank of India	52%	52%	94%	90%	90%	99%	100%	98%	95%	100%	100%	100%	97%	90%
dmu21	City Union Bank	52%	52%	100%	100%	100%	96%	100%	95%	100%	100%	96%	96%	92%	91%
dmu22	DhanLaxmi Bank	53%	53%	93%	90%	90%	85%	90%	87%	94%	86%	100%	99%	97%	86%
dmu23	ING Vyasya Bank	55%	55%	100%	100%	100%	100%	99%	94%	96%	99%	100%	100%	100%	92%
dmu24	J&K Bank	50%	50%	89%	81%	81%	94%	93%	90%	93%	94%	85%	89%	88%	83%
dmu25	Nainital Bank	52%	52%	95%	84%	84%	85%	94%	84%	95%	95%	87%	90%	98%	84%
dmu26	Ratnakar Bank	63%	63%	100%	92%	92%	89%	97%	86%	98%	100%	100%	95%	90%	90%
dmu27	South Indian Bank	49%	49%	89%	93%	93%	89%	96%	92%	96%	92%	97%	95%	92%	86%
dmu28	Axis Bank	77%	77%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	96%
dmu29	Development credit Bank	62%	62%	90%	86%	86%	85%	100%	100%	99%	100%	100%	97%	94%	89%
dmu30	HDFC Bank	53%	53%	100%	100%	100%	100%	100%	96%	100%	100%	100%	100%	100%	93%
dmu31	Kotak Mahindra Bank	0%	0%	81%	25%	66%	93%	100%	100%	81%	81%	67%	20%	57%	70%
dmu32	ICICI Bank	100%	100%	74%	62%	55%	79%	100%	96%	84%	78%	62%	25%	59%	75%
dmu33	IndusInd Bank	66%	66%	57%	60%	47%	59%	78%	70%	72%	62%	53%	25%	49%	59%
dmu34	Yes Bank	0%	0%	0%	71%	52%	71%	76%	79%	92%	70%	54%	51%	42%	66%
dmu35	Bank of America	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	89%	99%
dmu36	Bank of Ceylon	61%	61%	53%	43%	66%	74%	100%	82%	53%	56%	73%	25%	68%	63%
dmu37	Barclays Bank	100%	100%	100%	100%	100%	86%	100%	99%	100%	100%	100%	100%	100%	99%

dmu38	Citi Bank	94%	94%	100%	83%	74%	81%	100%	91%	84%	66%	60%	66%	47%	80%
dmu39	Deutsche Bank	73%	73%	72%	100%	79%	88%	76%	82%	100%	88%	70%	68%	64%	80%
dmu40	Royal bank of Scotland	0%	0%	0%	0%	0%	0%	0%	100%	76%	61%	60%	44%	59%	67%
dmu41	Standard Chartered Bank	55%	55%	68%	64%	64%	82%	99%	88%	81%	70%	54%	46%	60%	68%

**Source: (Author’s calculation using DEAOS Software, data available on RBI website )**

It is observed from the **Table 1.1** that for the year 2002-14, Efficiency of State Bank of Mysore among SBI and its associates range from 49-100% and become most efficient bank whereas state bank of Patiala (87%) and SBI (87%) were 2nd most efficient banks among same group. Whereas in nationalized banks IDBI Ltd. was top efficient bank with average efficiency score of 100%, Union bank of India (90%) was 2<sup>nd</sup> most efficient bank and PNB was 3rd most efficient bank with efficiency score of 100%. In the study of private bank there was surprising results that Axis Bank (96%) was more efficient bank which was followed by HDFC bank with efficiency score of 93% whereas score of ING vyaasya bank was found 92% inspite HDFC was found top performer bank among private banks in previous study. Kotak Mahindra bank and Indusind bank were found least efficient bank in same group. Among foreign bank Barclays bank and Bank of America were most efficient with efficiency score of 99 % which was followed by Citi Bank and Deutshe Bank with score of 80%.Whereas Bank of Ceylon was found least efficient bank with the score of 63% followed by royal bank of Scotland with 67% score.

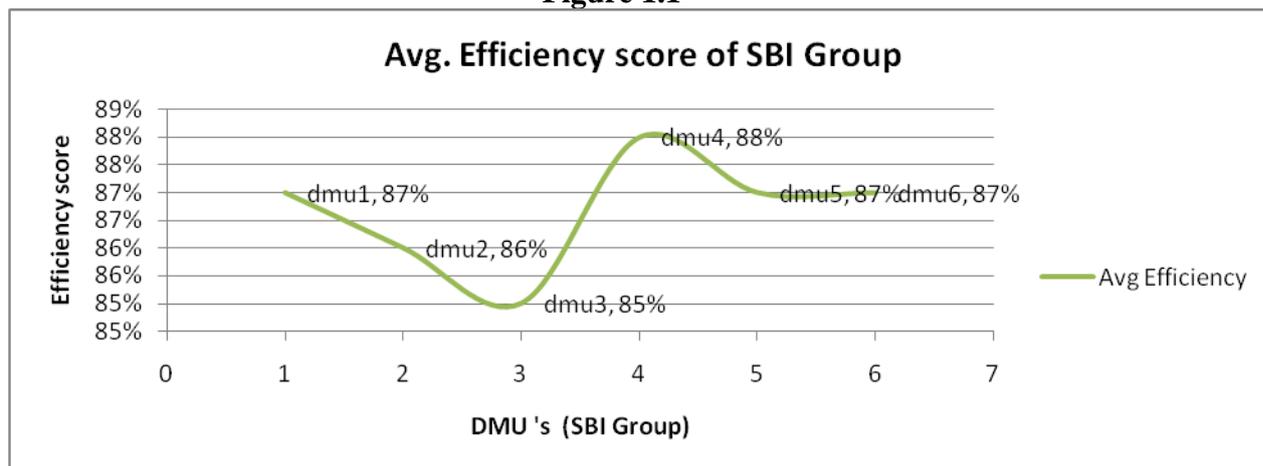
**Table 1.2**

<b>Descriptive Statistics for efficiency of different banking sectors operating in India</b>				
<b>Sectors</b>	<b>SBI Group</b>	<b>Nationalized Banks</b>	<b>Private Banks</b>	<b>Foreign Banks</b>
Mean	0.868410256	0.836721893	0.801447239	0.6995
Standard Error	0.004417004	0.024813847	0.040987407	0.093545105
Median	0.869961538	0.845230769	0.858538462	0.738269231
Range	0.031615385	0.398769231	0.459615385	0.681307692
Minimum	0.851153846	0.596384615	0.505307692	0.67
Maximum	0.882769231	0.995153846	0.964923077	0.988461538
Count	6	13	13	6
Confidence Level(95.0%)	0.011354271	0.054064729	0.089303889	0.240465348

**Source: Authors calculation using Excel correlation**

**Table 1.2** reveals the descriptive statistics of different banking sectors for the year 2002-14 which involves 6 banks in SBI group, 13 banks from nationalized banks, 13 private banks and 6 foreign banks. Study shows that among SBI group minimum average efficiency was found 0.85-0.88 where as among nationalized banks same was from 0.59-0.99. Private Banks shows the average efficiency range from 0.50-0.96 and foreign banks shows the range of 0.30-0.98.

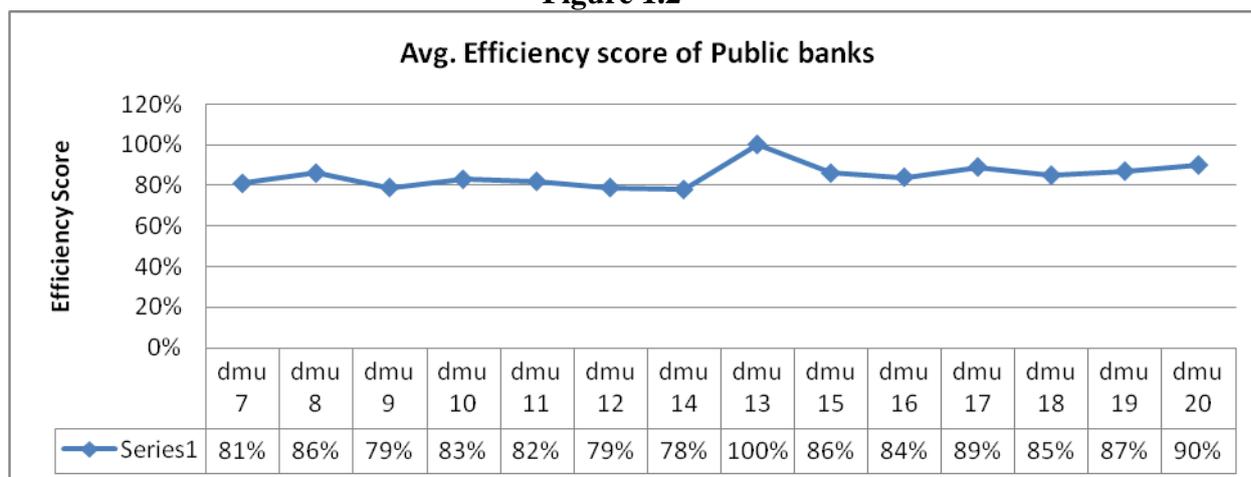
Figure 1.1



Source: (Author's calculation using Excel Charts)

Graph 1.2 defines the variation among average efficiency score of SBI Group. That was found that there was not huge difference between the efficiency scores. Upward and downward movement was found in number of employees and its deposits that has direct impact on its efficiency. Along with number of employees, another input i.e. deposits was also found rising trend. It was found in the study that with what ratio inputs (number of employees and deposits) are rising, advances and interest income were found unmatched.

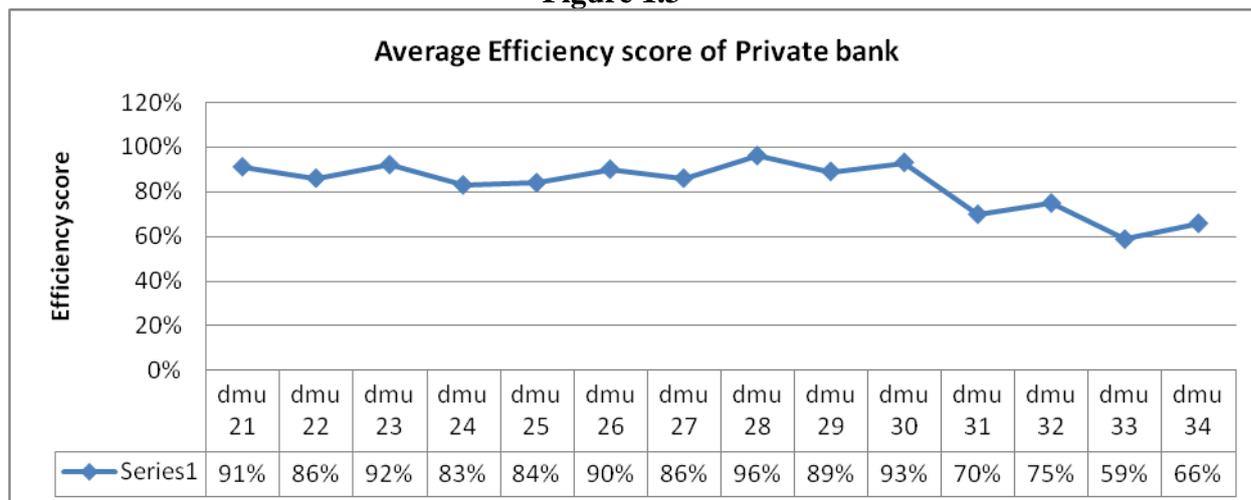
Figure 1.2



Source: (Author's calculation using Excel Charts)

Graph 1.2 reveals that Andhra bank, corporation bank and IDBI ltd. bank were found continuous rise in their number of employees while rest of other banks were found adopting retrenchment and recruitment policies. Again it was found that in case of public sector too deposits and number of employees were growing at fast rate but as comparison to inputs, outputs were not rising. So that is very much necessary to match the growing speed of input and output equally otherwise that will directly have impact on cost structure.

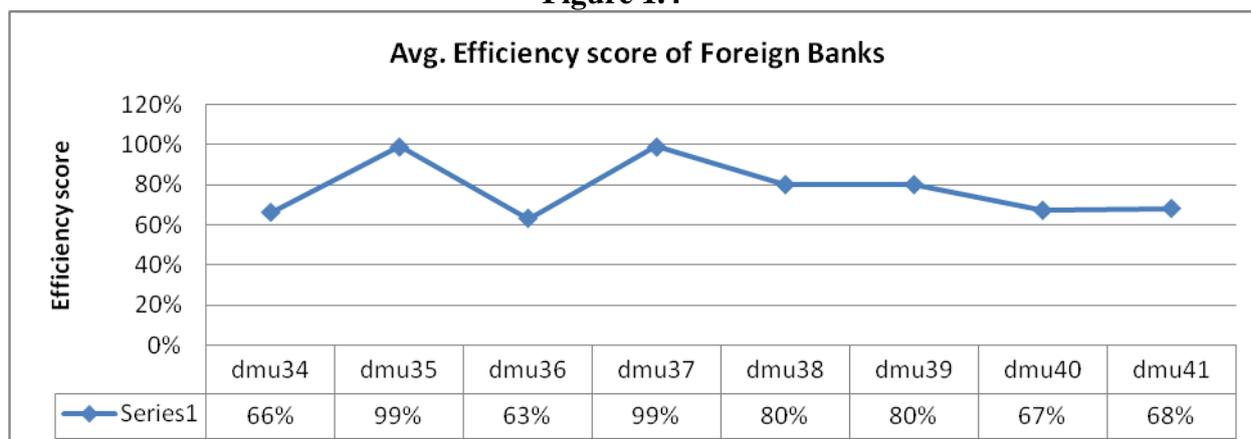
Figure 1.3



Source: (Author’s calculation using Excel Charts)

Graph 1.3 reveals private banks were found with more lenient policies in recruitment of the employees as compare to public banks. In private banks mixed variation was found for deposits trends but their advances and interest income was increasing at good level. Because of which few private banks were performing very well whereas few could not match the balance between input output growth ratio.

Figure 1.4



Source: (Author’s calculation using Excel Charts)

Graph 1.4 reveal Bank of America and citi bank were having continuous rise in there number of employees. Bank of America was also most efficient bank in their respective sector. When it comes to foreign banks few foreign banks such as bank of America and Barclays bank maintain very good balance between input output growth and achieved good efficiency where Yes bank, bank of cylon and royal bank of Scotland were least efficient banks.

**5. Discussions:** The results of all banks for efficiency score was found very interesting that revealed that it’s not necessary all the time that bank giving more profit will always will efficient. Efficiency is tool that help in measuring how banks are using and converting their inputs for producing maximum output. Bank who is able to generate maximum output with minimum input will be most efficient. In current study banks efficiency was measured on some parameters that involve key input and key output. In the present study SBI and state

bank of Mysore were found very efficient. Whereas among nationalized bank IDBI ltd. and PNB were found more efficient and almost same results we got in our previous study in which PNB was found top performer in nationalized banks. In the case private banks ICICI, Kotak Mahindra bank and HDFC bank were more efficient. This was quite surprising because in previous study HDFC bank was top performer whereas in efficiency score HDFC was 3<sup>rd</sup> efficient banks. Among foreign banks Barclays bank and Bank of America were found most efficient but in previous study bank of America was top performer whereas in this study bank of America was led by Barclays bank in efficiency score.

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