An Analysis of Efficiency and Profitability of Indian banks Using DEA Approach

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ABSTRACT

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 prediction for banks profits and NPA has been done and compared with the actual result to judge the efficiency utilization of banks.

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. In second part neural Tool 7.5 software has been used to make prediction and comparison for NPA and Net profit.

The present paper measures the operating efficiencies of 24 commercial banks operating in India, and the period of study is 2007 to 2016. 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 Net profit and deposits as the outputs and investments and operating expenses as inputs. The results are quiet 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 suggests 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: Banks, Input/Output, Efficiency, Non performing assets, Profitability.

1. INTRODUCTION

Performance of any bank can be evaluated through its efficiency, but efficiency in itself is very complicated and technical parameter which simplify through ratio of input/output of the banks. The importance to 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 theses parameters are considered as partial measures for productivity whereas data envelopment analysis can be considered as effective tool for measuring productivity in total.

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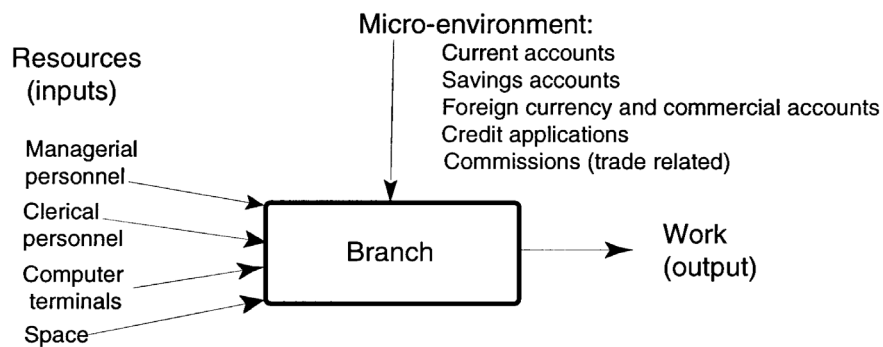

Figure A

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 2007 to 2016. Sample size of 24 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 constant returns to scale (CRS) 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 = Net Profit

Y2 = Deposits

Inputs: X1 = Investments

X2 = Operating Expenses

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 24 banks of all major sectors of banks of private and public. 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 9 years i.e. from 2007-16 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 2007-16 afterwards on the basis DEA model study with the usage of input-output variable efficiency of individual banks for all years has been calculated. Investment and operating expenses has been considered as input whereas net profit and deposits 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.

In second part of paper Neural Tools software 7.5 has been use to predict and compare Nonperforming assets and net profits. Software gives prediction on the basis of previous data and results good or bad are given after adjustment of 10-20% movement. That has helped to know that are banks able to use their resources fully and are able to reach at expected level of profits.

4. DATA ANALYSIS AND RESULTS

In the Table 1 propositions is based on comparison of banks' efficiency with respect to multiple inputs (investments, operating expenses) and multiple outputs (Net profit and deposits). 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
Efficiency score of Different DMU

DMU	2008	2009	2010	2011	2012	2013	2014	2015	2016	Average
State Bank of India	79%	75.30%	68.90%	73.90%	72.30%	84.90%	7.10%	61.90%	40.70%	63%
Allahabad Bank	91.10%	85.50%	91.20%	81.90%	77.80%	77.90%	68.90%	66.50%	83.10%	80%
Andhra Bank	92.50%	96.20%	100%	89%	78.50%	82.30%	76.40%	70.30%	87.20%	86%
Bank of Baroda	96.60%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Bank of India	100%	100%	93.80%	87.50%	85.70%	100%	89.20%	84%	100%	93%
Canara Bank	88.20%	92%	100%	100 % *	91.10%	85.50%	85.90%	81%	93.10%	90%
Central Bank of India	100%	97.20%	100 % *	76.90%	100%	77.10%	58.10%	56.90%	62.90%	79%
Corporation Bank	100%	96.70%	100%	100%	97.80%	100%	100%	100%	100%	99%
IDBI Bank Ltd.	100%	100%	100%	100%	100%	87.20%	87%	80.10%	89.80%	94%
Oriental Bank of Commerce	100%	100%	100%	98.50%	87.40%	82.20%	82.30%	77.70%	87.80%	91%
Punjab & Sind Bank	81.80%	77.30%	92.80%	87.60%	72.60%	80%	84%	80.80%	94.70%	84%
Punjab National Bank	85.90%	90.60%	100 %	78.40%	72.40%	99%	64.10%	63.90%	83.70%	80%
UCO Bank	95.10%	98.50%	99.10%	98.70%	97.30%	98.20%	100%	100%	100%	99%
Vijaya Bank	94.20%	89.20%	83.80%	75.20%	89.10%	88.20%	90.50%	82%	86.30%	87%
Union Bank of India	93%	92.40%	97.70%	81%	77.30%	82%	68%	71.10%	83.80%	83%
City Union Bank	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Dhanalakshmi Bank	89.70%	92.60%	100%	96.40%	76%	62%	73.20%	72.90%	100%	85%
UTI Bank	69.50%	76.70%	92.80%	79.10%	74.50%	84.10%	94.10%	100%	69.70%	82%
Development Credit Bank	76.10%	100%	79.10%	68.40%	70.60%	64.60%	76.80%	77.60%	100%	79%
HDFC Bank	54.60%	73.80%	100%	93.10%	86.80%	98.60%	100%	72.50%	80.20%	84%
Kotak Mahindra Bank	54.30%	56.80%	89.70%	80.40%	50.10%	77.10%	84.10%	99.50%	77.60%	74%
ICICI Bank	63%	71.10%	71.90%	76.40%	81.10%	100%	100%	66.40%	63%	77%
IndusInd Bank	80.30%	79.90%	78.40%	71%	90.10%	71.40%	75.90%	79%	94.20%	80%
Yes Bank	69.70%	83.80%	100%	100%	100%	92.50%	88.30%	84.20%	69.40%	88%

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

It is observed from the Table 1 that for the year 2007-16, that out 24 bank 8 banks were found most efficient. Which are bank of baroda, bank of India, IDBI Ltd. Uco bank and city union bank are at top of

the list. It was also revealed that public sector banks were more efficient as compared to private sector. One shocking result was about SBI that inspite of having huge capital and resources efficiency of SBI was very less as compared to other banks.

Table 2
NPA prediction for the year 2016
Testing Report: "Net Trained on Data Set #1"

Tag Used	Prediction	Good/Bad	Residual
State Bank of India	567460	Good	-206
Allahabad Bank	101830	Good	-18251
Andhra Bank	67972	Good	793
Bank of Baroda	162817	Good	-203
Bank of India	219743	Good	2190
Canara Bank	110971	Good	19428
Central Bank of India	127588	Good	-8858
Corporation Bank	45537	Bad	25530
IDBI Bank Ltd.	129557	Good	-2707
Oriental Bank of Commerce	77432	Good	-770
Punjab & Sind Bank	26644	Good	4178
Punjab National Bank	244150	Good	12798
UCO Bank	115361	Good	-12710
Vijaya Bank	28023	Good	-3590
Union Bank of India	65757	Good	-228
City Union Bank	-1608	Bad	4967
Dhanalakshmi Bank	2280	Bad	3303
UTI Bank	46457	Good	-5355
Development Credit Bank	-2184	Bad	4045
HDFC Bank	25747	Good	8637
Kotak Mahindra Bank	8205	Bad	4167
ICICI Bank	151717	Good	-770
IndusInd Bank	4801	Good	828
Yes Bank	-4056	Bad	7190

In Table 2 prediction of NPA for the year 2016 was made on the basis of previous years (2007-15). And result shows residual between expected and actual NPA that shows UCO bank, Allahabad bank and Axis bank were successful in reducing the NPA as compared to other banks. Whereas canara bank and corporation bank reached at highest point of NPA as compared to prediction.

In table 1.3 prediction of Net profit for the year 2017 was made on the basis of previous years (2007-16). And result shows residual between expected and actual profit that shows Yes bank, union bank, IDBI Ltd. Bank of India were successful in achieving predicted level of profit whereas some of banks exceeded the expected level of profits that is definitely a good sign for the banks even after suffering from demonetization banks are able to retain the profits level.

Table 3
Net Profit prediction for the year 2017
Testing Report: "Net Trained on Data Set #1"

Tag Used	Prediction	Good/Bad	Residual
State Bank of India	1,04,841.00	Good	0.00
Allahabad Bank	-30,367.12	Good	-984.88
Andhra Bank	22,472.83	Good	-5,039.83
Bank of Baroda	1,38,314.00	Good	0.00
Bank of India	1,38,314.00	Bad	-2,94,145.00
Canara Bank	11,209.59	Good	0.41
Central Bank of India	-24,287.67	Bad	-103.33
Corporation Bank	56,121.00	Good	0.00
IDBI Bank Ltd.	-11,636.79	Bad	-39,944.21
Oriental Bank of Commerce	-10,940.00	Good	0.00
Punjab & Sind Bank	39,881.16	Bad	-19,773.16
Punjab National Bank	13,248.00	Good	0.00
UCO Bank	1,725.53	Bad	-20,232.53
Vijaya Bank	50,172.50	Bad	24,876.50
Union Bank of India	3,41,146.21	Good	2,14,063.79
City Union Bank	37,528.14	Good	12,748.86
Dhanalakshmi Bank	18,027.54	Bad	-20,121.54
UTI Bank	3,67,928.00	Good	0.00
Development Credit Bank	19,891.25	Good	76.75
HDFC Bank	1,45,496.00	Good	0.00
Kotak Mahindra Bank	3,41,145.32	Good	4.68
ICICI Bank	9,80,109.00	Good	0.00
IndusInd Bank	25,602.41	Good	3,076.59
Yes Bank	28,293.14	Good	3,04,716.86

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 was found less efficient. Whereas among nationalized bank IDBI ltd. and bank of baroda, bank of India and Uco bank 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 and HDFC bank was most efficient.

References

Shavazipour., babooshka, P. (2014). Measuring Efficiency and Effectiveness for Non-Storable Commodities: A Mixed Separate Data Envelopment Analysis approaches with Real and Fuzzy Data. *International Journal of Data Envelopment Analysis and *Operations Research**. 1(1):1-11.

Maletić, R,. & Kreća, P. (2013). Application of DEA methodology in measuring efficiency in the banking sector: Economics of Agriculture.

Gordo. (2013). Estimating Philippine Bank Efficiencies Using Frontier Analysis: *Philippine Management Review.* 20, 17-36.

Qayyum. R., & Khalid, P. (2012). Technical Efficiency of Pakistani Banks: An Application Of Bootstrapped Data Envelopment Analysis Approach. *World Applied Sciences Journal* 16, (ISSN 1818-4952).

Oberholzer.M, Westhuizen. Gvander, P. (2009). Estimating technical and scale efficiency in banks and its relationship with economic value added: A South African study. *SA Journal of Accounting Research* 23 (1).

Bader, M,. & Ariff, P. (2008). Cost, Revenue, and Profit efficiency of Islamic versus conventional banks: international evidence using data envelopment analysis. *Islamic Economic Studies* 15 (2)

Shahooth, Hussein, P. (2006). Using data envelopment analysis to measure cost efficiency with an application on Islamic banks: *Scientific journal of administrative development.* 4: IAD.

Phelps., Figueira., & Nellis, P. (2003). International Banking Strategy and Efficiency: issues and directions.7th *International conference of the decision sciences institute.*

Golany. Storbeck, P. (1999). A Data Envelopment Analysis of the Operational Efficiency of Bank Branches: *Institute for Operations Research and the Management Sciences.* (14-26).

Adler,. Nicole, (2002). Review of ranking methods in the data envelopment analysis context: *European Journal of Operational Research* 140: 249–265.

Sathye., M. (2001). Efficiency of Banks in a Developing Economy: The Case of India"