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DEA TECHNIQUES FOR MEASURING EFFICIENCY OF INDIAN PUBLIC SECTOR BANKS

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ABSTRACT

The main purpose of the study is, measuring the efficiency of Indian public sector banks. One may have a challenging task to evaluate the efficiency in the banking system, because every bank has its own policies with varying management philosophical attitudes. In the present scenario, measuring efficiency is necessary for commercial bank as well as for investors. Data Envelopment Analysis (DEA) is a linear programming-based technique for measuring relative efficiency assessment called DEA efficient, for a group of decision making units (DMUs) with multiple inputs and multiple outputs. As DEA is non-parametric method, it does not require any assumptions as in parametric approach. Using DEA technique, we calculate Global technical Efficiency, Local pure technical efficiency and scale efficiencies for 26 public sector banks operating on Indian soil.

KEYWORDS: Data Envelopment Analysis, Decision Making Unit, Global Technical Efficiency, Local Pure Technical Efficiency and Scale Efficiency

1. INTRODUCTION

The main purpose of the study is, measuring the efficiency of an Indian public sector banks. One may have a challenging task to evaluate efficiency in the banking system, because every bank has its own policies with varying management philosophical attitudes. In the present scenario, measuring efficiency is necessary for commercial banks as well as for investors. Commercial banks are organizations and controlled by Government regulations, which changes from time to time. The banking industry is also influenced by the monetary policies of the Reserve bank of India. In India, commercial banks remained for many years as protected industry, lending and deposit collection were its main activities. In recent years, significant improvements are noticed in the performance of commercial banking, measured in terms of profitability and marketability.

2. MODELING A COMMERCIAL BANK

Two popularly used methods to model a commercial bank are the intermediation approach and the production approach. Under intermediation approach, banks are viewed as intermediate between depositors and borrowers (Piyu, Yue, 1992). The production approach was discussed by Berg, S.A., Forsund, F.R. and Jansen, E.S. 1991, in this approach; a commercial bank's resources produce services to the customers. Data Envelopment Analysis (DEA) is a linear programming-based technique for measuring relative efficiency assessment, called DEA efficient for a group of decision making units (DMUs) with multiple inputs and multiple outputs. As DEA is non-parametric method, it does not require any assumptions as in parametric approach. Specially, we consider calculating efficiency scores of the commercial banks by using inputs (Number of employees and Total Assets) and outputs (Advances and Non-interest income). Data was collected from RBI Bulletin 2014-15.

3. DEA INPUTS AND OUTPUTS

Adding too many inputs and outputs to DEA list of variables, in the presence of too small number of commercial banks, leads to loss of the discriminatory power of DEA because, in this case, a large number of banks will fall under 100% efficient score (Hughes and Yaisawarng, 2004), meaning that inefficient bank also becomes efficient. Thus, whoever is the analyst; he shall be objective oriented and parsimonious while choosing in inputs and outputs. In studying efficiency on banks, different authors used different sets of variables: Labour or Employees, Assets, Deposits, Number of branches, Stock holder's equity, Establishment expenditure, Non-establishment expenditure, Interest expenditure, Fixed assets, work space, Number of tellers Operational Costs and Rent and so on.

In the present context, we are confined to inputs reduction by keeping outputs are remain same, so input oriented DEA models are utilized. To measure global technical efficiency, local pure technical efficiency and to assign target settings for inefficient DMUs, one can use CCR and BCC models, and are postulated as below.

$\min \lambda - \varepsilon(\sum_{i=1}^{m} s_i^- + \sum_{r=1}^{s} s_r^+)$

Subject to $\sum_{j=1}^{n} x_{ij}\lambda_j + s_i^- = \lambda x_{i0}$ $\quad i = 1,2, \ldots \ldots, m$; (m / number of inputs)

$\sum_{j=1}^{n} u_{rj}\lambda_j - s_r^+ = u_{r0}$ $\quad r = 1,2, \ldots \ldots, s$; ………. **(3.1)**

$\lambda_j \geq 0$ $\quad j = 1,2, \ldots \ldots \ldots, n.$ (s, n / number of outputs, number of DMUs)

The model 3.1 is called envelopment model, one can easily get dual of the above model called multiplier model as below.

Max Z = $\sum_{r=1}^{s} \mu_r u_{r0}$

Subject to $\sum_{i=1}^{m} v_i x_{i0} = 1$

$\sum_{r=1}^{s} \mu_r u_{rj} - \sum_{i=1}^{m} v_i x_{ij} \leq 0$ ………. **(3.2)**

$\mu_r, v_i \geq 0$

BCC model: $\min \lambda - \varepsilon(\sum_{i=1}^{m} s_i^- + \sum_{r=1}^{s} s_r^+)$

Subject to $\sum_{j=1}^{n} x_{ij}\lambda_j + s_i^- = \lambda x_{i0}$ $\quad i = 1,2, \ldots \ldots, m$; (m / number of inputs)

$\sum_{j=1}^{n} u_{rj}\lambda_j - s_r^+ = u_{r0}$ $\quad r = 1,2, \ldots \ldots, s$; ………. **(3.3)**

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

$\lambda_j \geq 0$ $\quad j = 1,2, \ldots \ldots \ldots, n.$ (s, n / number of outputs, number of DMUs)

The model 3.3 is called envelopment model, dual of the above model called multiplier model is postulated as below.

Max Z = $\sum_{r=1}^{s} \mu_r u_{r0}$

Subject to $\sum_{i=1}^{m} v_i x_{i0} = 1$

$\sum_{r=1}^{s} \mu_r u_{rj} - \sum_{i=1}^{m} v_i x_{ij} \leq 0$ ……….. **(3.4)**

$\mu_r, v_i \geq 0$

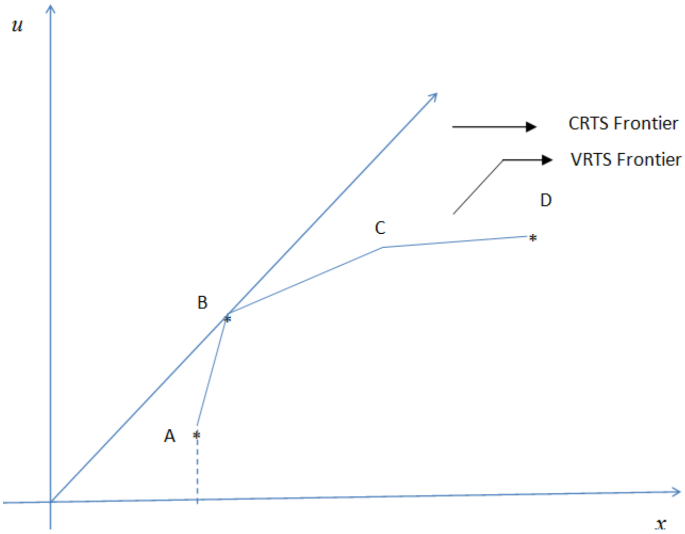

Figure 1

The segments AB, BC and CD of variable returns to scale frontier representing increase and decrease of returns to scale. However, returns to scale at B are constant. The straight line that emanates from origin represents a frontier that admits constant returns to scale alone. DMU D is weakly efficient, does not possess any super efficiency. By using 3.1 and 3.3, one may get efficient DMUs with a 100 % score, but it is difficult to rank among efficient DMUs. To rank the Banks according to their super efficiency scores, the following linear programming problem is solved;

$\lambda^{super} = \min \lambda$

Subject to $\sum_{j=1}^{n} \lambda_j x_{ij} \leq \lambda x_{i0}$ $\quad i = 1,2, \ldots \ldots .., m$

$\sum_{j=1}^{n} \lambda_j u_{rj} \geq u_{r0}$ $\quad r = 1,2, \ldots \ldots .., s,$

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

4. MODEL SUMMARY

Table 1: Global Technical Efficiency, Pure Technical Efficiency and Scale Efficiencies of Dmus

DMU No.	DMU	GTE	LPTE	Scale
1	State Bank of Bikaner & Jaipur	1.00	1.00	1
2	State Bank of Hyderabad	1.00	1.00	1
3	State Bank of India	1.00	1.00	1
4	State Bank of Mysore	0.98	1.00	0.9812
5	State Bank of Patiala	0.99	0.99	0.999798
6	State Bank of Travancore	0.97	0.97	0.996089
7	Allahabad Bank	0.97	0.98	0.995599
8	Andhra Bank	1.00	1.00	1
9	Bank Of Baroda	0.94	1.00	0.9358
10	Bank of India	1.00	1.00	1
11	Bank of Maharashtra	1.00	1.00	1
12	Canara Bank	0.90	0.91	0.98609
13	Central Bank of India	0.89	0.90	0.99008
14	Corporation Bank	0.98	0.99	0.98927
15	Dena Bank	0.89	0.91	0.986419
16	Idbi Bank Limited	1.00	1.00	1
17	Indian Bank	0.96	0.96	0.998751
18	Indian Overseas Bank	0.88	0.89	0.992145
19	Oriental Bank of Commerce	0.96	0.96	0.993656
20	Punjab And Sind Bank	0.97	1.00	0.9722
21	Punjab National Bank	0.96	0.96	0.997823
22	Syndicate Bank	1.00	1.00	1
23	Uco Bank	0.89	0.89	0.998206
24	Union Bank of India	1.00	1.00	1
25	United Bank of India	1.00	1.00	1
26	Vijaya Bank	0.90	0.91	0.988497

The global technical efficiency score was obtained from input oriented CCR analysis, while local pure technical efficiency score by using input oriented BCC model for 26 commercial banks. Scale efficiency score for each DMU was obtained by taking the ratio between CCR and BCC models. According to CCR analysis, DMU_1, DMU_2, DMU_3, DMU_8, DMU_{10}, DMU_{11}, DMU_{16}, DMU_{22}, DMU_{24} and DMU_{25} are found to be efficient. By using super efficiency model to break tie among these 10 efficient DMUs in order to rank them, in which, the scores would get greater than 100 percent for efficient DMUs. Accordingly, IDBI Bank Ltd has emerged to be with highest efficiency score. United Bank of India and State Bank of India stands at second and the third places, respectively. The rest are, Bank of India, State Bank of Bikaner and Jaipur, Union bank of India, State Bank of Hyderabad, Syndicate Bank, Bank of Maharashtra and Andhra Bank, respectively. DMU_1, DMU_2, DMU_3, DMU_8, DMU_{10}, DMU_{11}, DMU_{16}, DMU_{22}, DMU_{24} and DMU_{25} have been found efficient according to both CCR and BCC models. DMU4, DMU_9 and DMU_{20} are found to be efficient in terms of BCC (Local Pure Technical Efficient) but are not efficient in terms of CCR (Global Technical Efficient). The inefficiency in these units is due to inefficiency in scale size, i.e., due to disadvantageous conditions. DMU_5, DMU_6, DMU_7, DMU_{12}, DMU_{13}, DMU_{14}, DMU_{15}, DMU_{17}, DMU_{18}, DMU_{19} DMU_{21}, DMU_{23} and DMU_{26} are efficient in terms of neither CCR nor BCC. These DMUs are poor in terms of both scale efficiency and local pure technical efficiency. These DMUs should make improve in terms both inputs and outputs that are under the control of decision makers. Apart from studying global efficiency, peers have been specified for each inefficient DMU along with weights (in brackets) in terms of efficient DMUs as shown in the following table.

Table 2: Bench Marks for Inefficient DMUs

DMU	Name of the DMU	Benchmarks
4	State Bank of Mysore	1 (0.55) 3 (0.01)
5	State Bank of Patiala	1 (0.31) 8 (0.45)
6	State Bank of Travancore	1 (0.84) 3 (0.01)
7	Allahabad Bank	1 (0.43) 2 (0.94) 24 (0.08)
9	Bank of Baroda	10 (0.91) 16 (0.29)
12	Canara Bank	1 (0.63) 3 (0.02) 24 (1.04)
13	Central Bank of India	8 (1.50)
14	Corporation Bank	10 (0.22) 22 (0.27)
15	Dena Bank	2 (0.36) 8 (0.32)
17	Indian Bank	2 (0.60) 8 (0.50)
18	Indian Overseas Bank	1 (0.28) 8 (1.21)
19	Oriental Bank of Commerce	3 (0.00) 16 (0.07) 24 (0.50)
20	Punjab And Sind Bank	11 (0.33) 22 (0.15)
21	Punjab National Bank	1 (1.06) 3 (0.13) 24 (0.52)
23	Uco Bank	2 (0.45) 22 (0.04) 24 (0.36)
26	Vijaya Bank	11 (0.65) 22 (0.11)

Target values are calculated with the help of reference set and coefficients for inputs and outputs of inefficient DMUs.

For instance, from Table 1, one can easily find a target value of total assets i.e. one of the inputs of Indian Overseas Bank (DMU_{18}) has a lowest CCR efficiency score (0.88), which can be calculated as a convex combination of its peer commercial banks as below.

Target value of total assets for $DMU_{18} = TS_{18}$

$TS_{18}=A_1\,(0.28)+A_8\,(1.21)$

$= 329364$

Actual Total assets= 1928360

Technical inefficiency of the inefficient banks was calculated and presented in Table 3.

Table 3: Technical Inefficiency of Inefficient Dmus

DMU	Technical Inefficiency
State Bank of Mysore	0.02
State Bank of Patiala	0.01
State Bank of Travancore	0.03
Allahabad Bank	0.03
Bank of Baroda	0.06
Canara Bank	0.10
Central Bank of India	0.11
Corporation Bank	0.02
Dena Bank	0.11
Indian Bank	0.04
Indian Overseas Bank	0.12
Oriental Bank of Commerce	0.04
Punjab And Sind Bank	0.03
Punjab National Bank	0.04
Uco Bank	0.11
Vijaya Bank	0.10

From the above table, technical inefficiency of Indian Overseas Bank has 0.12.. Therefore, 12 percent of input, namely total assets are turned out be unproductive. To make Indian Overseas Bank becomes efficient, it should either utilize its total assets completely or it should reduce this unproductive part. Similarly, one can analyze technical inefficiency of other commercial banks.

Table 4: Super Efficiency Score of Efficient Banks

DMU	Score	Ranks
Idbi Bank Limited	222.30%	1
United Bank of India	119.78%	2
State Bank of India	102.86%	3
Bank of India	102.18%	4
State Bank of Bikaner & Jaipur	101.22%	5
Union Bank of India	101.08%	6
State Bank of Hyderabad	100.49%	7
Syndicate Bank	100.11%	8
Bank of Maharashtra	100.07%	9
Andhra Bank	100.04%	10

Form table 4, IDBI Bank Limited stands in the first position, United Bank of India, State Bank of India and Bank of India are in second, third and fourth ranks, respectively. The last two ranks are bagged by Bank of Maharashtra and Andhra Bank, respectively.

5. RESULTS AND CONCLUSIONS

DEA is a mathematical and non- parametric technique, used to measure relative efficiency, which can handle multiple inputs and multiple outputs with ease of use. In the present study, we used Number of Employees, Total assets as inputs and Advances, Non-interest income as outputs in order to calculate global technical efficiency, local pure technical efficiency and scale efficiencies. Among 26 public sector banks, 10 banks are emerging to be global technical efficient, on the other hand, 13 banks are local pure technically efficient. That means State Bank of Mysore, Bank of Baroda and Punjab and Sindh banks are global technical inefficient, but they are local pure technical efficient, because of inefficiency in scale size i.e., due to disadvantageous conditions. 10 banks are scaling efficient, meaning that, these banks need not change their input mix as well their operating scale size. It is difficult to rank among these 10 scale efficient banks, and to break ties among 10 efficient banks, one can use super efficiency model. Using this model, IDBI Bank limited falls in top position and Andhra Bank in the last position, with respect to their efficiency scores.

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