Estimation of Commercial Bank's efficiency through Data Envelopment Analysis

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Introduction

Economic status of a country fully depends on its financial system. Banking sector is predominate and plays a key role in the financial system of modern economy. Growth of banks accelerates financial system positively and contributes more in development of a nation. Liberalization, privatization and globalization policy integrated Indian economy with the global economy, which brought many structural changes in major sectors (primary, secondary and tertiary). Indian banking system also changed with technological innovations like internet banking, mobile banking, Automated teller machine (ATM), tele-banking and anywhere and anytime banking. These technical changes made Indian banks to cut their business boundaries and to penetrate into foreign markets.

Now there is fierce competition among scheduled commercial banks which is good for our economy. Data Envelopment Analysis (DEA) has been used to compare the efficiency of banks and to find out which bank is utilizing its deposits in best possible way.

Objective of Study

The main objective of the present study was to compare the efficiency of top 21 scheduled commercial banks operating in India in terms of utilizing their deposits.

Introduction to DEA

Data Envelopment Analysis (DEA) is an increasingly popular management tool. DEA is commonly used to evaluate the efficiency of a number of decision making units (DMU). DEA compares each DMU with best DMU.

In DEA, there are a number of DMUs. The production process for each DMU is to take a set of inputs and produce a set of outputs. Each DMU has a varying level of inputs and gives a varying level of outputs. For instance, consider a set of banks. Each bank will receive certain amount of deposits and with that they will utilize it in advances, investments etc. DEA attempts to determine which of the banks are most efficient, and to point out specific inefficiencies of other banks.

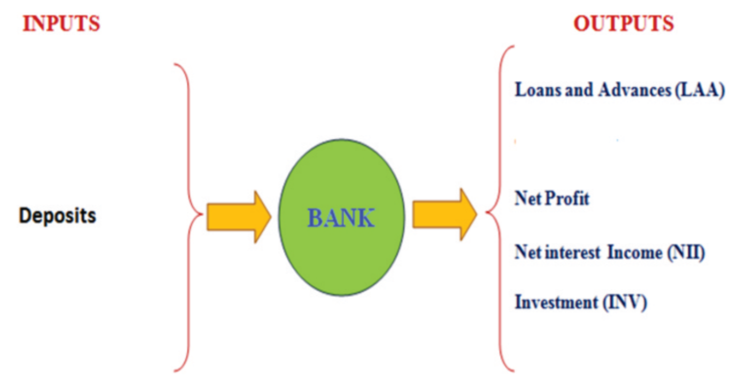
A fundamental assumption behind this method is that if a given producer, A, is capable of producing Y(A) units of output with X(A) inputs, then other producers should also be able to do the same if they were to operate efficiently. Similarly, if producer B is capable of producing Y(B) units of output with X(B) inputs, then other producers should also be capable of the same production schedule. Producers A, B, and others can then be combined to form a composite producer with composite inputs and composite outputs. Since this composite producer does not necessarily exist, it is typically called a virtual producer.

The heart of the analysis lies in finding the "best" virtual producer for each real producer.

If the virtual producer is better than the original producer by either making more output with the same input or making the same output with less input then the original producer is inefficient.

Selection of variables and Banks

We have selected top 21 scheduled commercial banks operating in India. We have tried to compare them on how efficient they are in utilizing their deposits such as in investments and advances and also in generating profit.



As there is an intense competition among banks to increase their profits, so utilizing the deposits in efficient way forms a crucial part for the bank. DEA analysis on the above parameters will help us in finding the efficient banks and we can also find out by how much a bank can increase their output with the given input.

Methodology

DEA using linear programming

Data Envelopment Analysis, is a linear programming procedure for a frontier analysis of inputs and outputs. DEA assigns a score of 1 to a unit only when comparisons with other relevant units do not provide evidence of inefficiency in the use of any input or output. DEA assigns an efficiency score less than one to (relatively) inefficient units. A score less than one means that a linear combination of other units from the sample could produce the same vector of outputs using a smaller vector of inputs. The score reflects the radial distance from the estimated production frontier to the DMU under consideration.

Let Xi be the vector of inputs into DMU i. Let Yi be the corresponding vector of outputs. Let X0 be the inputs into a DMU for which we want to determine its efficiency and Y0 be the outputs. So the X's and the Y's are the data. The measure of efficiency for DMU 0 is given by the following linear program:

$$\text{Min } \theta$$

$$\text{Subject to: } \sum \lambda i \, Xi \leq \theta \, Xo$$

$$\sum \lambda i \, Yi \geq Yo$$

$$\lambda \geq 0$$

Whereλi is the weight given to DMU i in its efforts to dominate DMU 0 and is the efficiency of DMU 0. So the λ's and are the variables. Since DMU 0 appears on the left hand side of the equations as well, the optimal cannot possibly be more than 1. When we solve this linear program, we get a number of things:

1. The efficiency of DMU 0 ( ), with = 1 meaning that the unit is efficient.
2. The unit's "comparable" (those DMU with nonzero λ).
3. The "goal" inputs
4. Alternatively, we can keep inputs fixed and get goal outputs.

DEA assumes that the inputs and outputs have been correctly identified. Usually, as the number of inputs and outputs increase, more DMUs tend to get an efficiency rating of 1 as they become too specialized to be evaluated with respect to other units. On the other hand, if there are too few inputs and outputs, more DMUs tend to be comparable. In any study, it is important to focus on correctly specifying inputs and outputs.

Results of DEA Analysis

Data for the recent concluded financial year 2013-14 have been taken for analysis purpose. Following table represents the collected data:

Table 1 Data for the Year 2013-14

	All Figures are in Rs Crores					
		Input	Output			
Sr. No.	Banks(DMU)	Deposits	Advances	Net Profit	Net Interest Income	Investment
1	HDFC	367337.4777	303000.2712	3478.38	18482.63	120951.0703
2	ICICI	331913.66	338702.65	9810.48	16475.56	177021.82
3	Axis	280944.56	230066.76	6217.67	11951.64	113548.43
4	SBI	1394403.51	1209328.72	10891.17	49282.17	398308.19
5	Bank of India	476974.05	370733.54	2729.27	33618.26	114152.44
6	Bank of Baroda	568894.39	397005.81	4541.08	11965.35	116112.66
7	PNB	451395.75	349269.13	3342.58	16145.97	143785.5
8	Kotak Mahindra	59072.33	53027.63	1502.52	3720.05	25434.55
9	Central Bank of India	240063.99	177315.17	-1262.84	6494.39	86135.14
10	Canara Bank	420722.82	301067.48	2438.19	8944.44	126828.26
11	Yes Bank	74192.02	55532.96	1617.78	2716.26	40950.36
12	Syndicate Bank	212343.3	173912.41	1711.46	5539.83	55539.38
13	Union Bank of India	297675.64	229104.43	1696.2	7879.32	93723.18
14	Uco Bank	199533.55	149584.21	1510.54	6059.09	67451.69
15	Allahabad Bank	190842.81	138006.57	1172.02	5311.32	63950.53
16	Oriental Bank	193483.96	139079.84	1139.41	5127.1	61472.23
17	Indian Bank	162274.82	122208.99	1158.95	4360.42	46910.42
18	Dena Bank	110027.69	77553.77	551.66	2505.08	36612.07
19	United Bank	111509.71	65767.51	-1213.44	2562.82	44876.34
20	Federal Bank	59731.28	43436.1	838.89	2228.61	24117.85
21	Indusland Bank	60502.29	55101.84	1408.02	2890.71	21552.95

Source: http://www.moneycontrol.com/india/stockpricequote/banksprivatesector/

Variables:
Input: Deposits
Output: Advances, Net Profit, Net Interest Income, Investment
By looking at the above table it is very difficult to identify which bank is most efficient and in this regard DEA helps us to identify the same.

Steps for analysis

1. Assign weights $\lambda 1, \lambda 2$ .....to all commercial which acts as variables for our solver.
2. Write the linear programing equation for all the inputs and outputs as mentioned in linear programing approach.
3. Number of equations will be equal to number of input and outputs.
4. Our objective function is to minimize .
5. Use the solver and put objective function as well as all the required constraints.
6. For finding out the exact input required and for a given input, output obtained we have converted objective function as

$$Z = \min -S1-s2-S3-S4-S5$$

$$\text{Subject to: } \sum \lambda i\, Xi + S^* = Xo$$

$$\sum \lambda i\, Yi - S^* = Yo$$

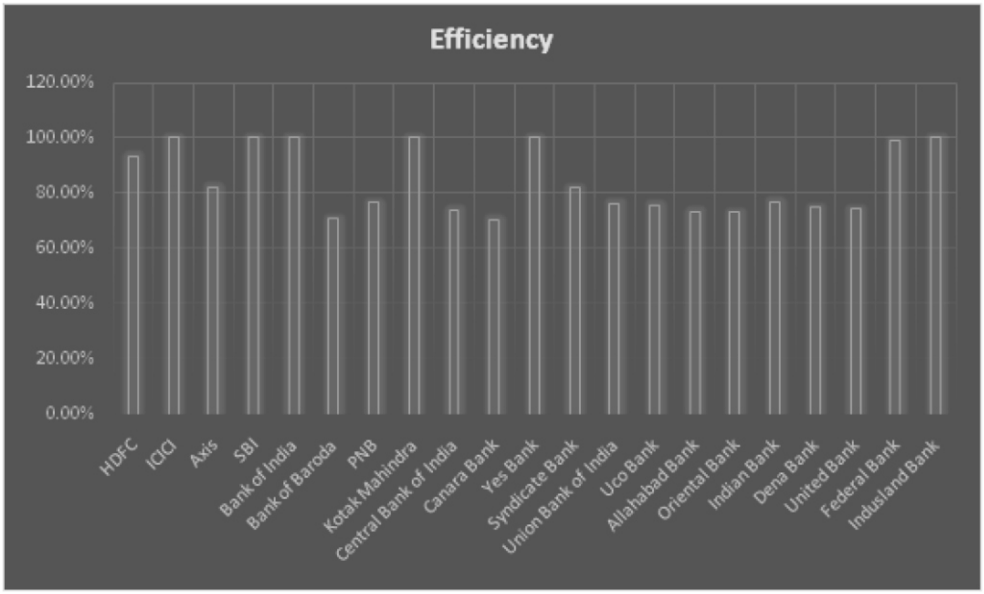
$$\lambda \geq 0$$

7. The corresponding values of S1, S2, S3, S4, S5 gives by how much input and output should be changed if the corresponding bank has to perform efficiently.

Table 2 Efficiency table for banks using DEA analysis:

Banks(DMU)	Efficiency
HDFC	93.32%
ICICI	100.00%
Axis	82.06%
SBI	100.00%
Bank of India	100.00%
Bank of Baroda	70.84%
PNB	76.39%
Kotak Mahindra	100.00%
Central Bank of India	73.92%
Canara Bank	70.33%
Yes Bank	100.00%
Syndicate Bank	82.04%
Union Bank of India	76.27%
Uco Bank	75.64%
Allahabad Bank	73.28%
Oriental Bank	72.81%
Indian Bank	76.86%
Dena Bank	74.79%
United Bank	74.05%
Federal Bank	98.90%
Indusland Bank	100.00%

Figure 1 Efficiency of Banks using DEA analysis



From our analysis we found that out of 21 banks which we considered 6 banks have efficiency of 100% in terms of deposit utilization and they can be taken as benchmark by other banks and by looking at their value they can optimize their use of deposits.

For example if we consider Axis bank which has an efficiency of 82.06 % let us see the values of input and outputs using DEA.

0.596597 $\lambda 2$ + 0.020794 $\lambda 5$ + 0.382609 $\lambda 8$ will combine to give better efficiency than axis bank.

Required inputs and outputs for Axis Bank to be efficient:

	Original	Changed
Advances	230066.76	230066.76
Net Profit	6217.67	6484.53384
Net Interest Income	11951.64	11951.64
Investment	113548.43	117734.973
Deposits	280944.56	230538.34

Limitations of the Study

- Since DEA is an extreme point technique, noise (even symmetrical noise with zero mean) such as measurement error can cause significant problems.
- DEA is good at estimating "relative" efficiency of a DMU but it converges very slowly to "absolute" efficiency.
- Since DEA is a nonparametric technique, statistical hypothesis tests are difficult.
- Since a standard formulation of DEA creates a separate linear program for each DMU, large problems can be computationally intensive.

Concluding observations:

- DEA can handle multiple input and multiple output models.
- It doesn't require an assumption of a functional form relating inputs to outputs.
- DMUs are directly compared against a peer or combination of peers.
- Inputs and outputs can have very different units. For example, X1 could be in units of lives saved and X2 could be in units of dollars without requiring an a priori tradeoff between the two.

References:

· Andersen, Per, and Niels Christian Petersen. "A procedure for ranking efficient units in data envelopment analysis." Management science 39.10 (1993): 1261-1264.

· Coelli, Timothy J., et al. "Data Envelopment Analysis." An Introduction to Efficiency and Productivity Analysis (2005): 161-181.

· Wei, Quanling. "Data envelopment analysis." Chinese Science Bulletin 46.16 (2001): 1321-1332.

· Banker, Rajiv D., Abraham Charnes, and William Wager Cooper. "Some models for estimating technical and scale inefficiencies in data envelopment analysis."Management science 30.9 (1984): 1078-1092.

· Cooper, William W., Lawrence M. Seiford, and Kaoru Tone. Data envelopment analysis: a comprehensive text with models, applications, references and DEA-solver software. Springer Science & Business Media, 2007.