An Efficiency Study of Indian Banks

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Abstract

Using DEA we measure the efficiencies of Indian Commercial banks comprising private sector, public sector and foreign banks. A set of 50 commercial banks for which data are available is included in our study. Normally, the number of Input/Output variables used in bank efficiency analysis is restricted to two/three in order to have an easy interpretation of a DEA output. In this paper, we have chosen seventeen variables as Input/Output to encompass a variety of factors like "Size and Strength", "Operations", "Earning Quality", "Productivity", "Capital Adequacy" and "Asset Quality" of a bank. We perform a discriminant analysis to identify the statistically significant variables that are very effective in discriminating the two groups, one consisting of efficient banks and the other composed of inefficient banks, generated by a DEA analysis. This gives an idea as to on which variables a bank should concentrate in order to achieve a full efficiency.

Key Words : *Data Envelopment Analysis, Efficiency scores, Indian Banks, Discriminant Analysis*

1. Introduction

Banking industry is a service-oriented industry whose performance is determined by how it implements its commercial objectives keeping an eye on their social implications. This makes it difficult to measure bank efficiency taking several multifarious services into account. DEA techniques have played a very important role and have found a tremendous success when applied to the problem of comparing efficiency of commercial banks.

While there are several studies on US banking efficiency (see Mester [Cooper & Seiford, 2006]), a good account on the use of DEA in European Banking efficiency is available in Molyneux et al. [Golany & Storbech, 1999]. In the literature, the work of Bhattacharyya et al. [Antreas Athanassopoulos & Giokas, 2000], Chatterjee [Charnes Cooper, Lewin & Seiford, 1994] and Saha et al. [IBA, 1999] show some related research on Indian bank efficiency. Sathye [Mester, 1997] considered models with two inputs/outputs for the study of efficiency of Indian Banks. Under model A, interest expenses and non-interest expenses were taken as inputs and net interest income and non-interest income as outputs, while under model B, deposits and staff members were inputs and net loans and non-interest income were outputs. Recently, Business Today (December 2002) published an extensive report on this issue of Bank Efficiency; but they did not measure the efficiency using DEA. They assigned some weights to the input/output variables to get the efficiency scores that are very much subjective in nature. In this study, the variables are not labeled as input/output rather the variables which influence the bank performance were considered. These variables were chosen to reflect the factors like "Size and Strength", "Operations", "Earning Quality", "Productivity", "Capital Adequacy" and "Asset Quality" of a bank. No rigorous empirical study is undertaken recently to measure the efficiency of Indian Banks.

The paper is structured as follows. In section 2, the Indian Banking system is described. Section 3 contains the Data Envelopment Analysis model used in our study. In section 4 the input and output variables are defined while section 5 presents the results and conclusions.

2. Indian Banking System

Important functions of a commercial bank consist of attracting deposits from public, making loans and advances and investing their funds in various securities. The Bank of Bengal, set up in 1806, was the first commercial bank in India, followed by Bank of Bombay in 1840 and Bank of Madras in 1843. These three banks were amalgamated in 1921 to form the Imperial Bank of India which ushered a new era in the Indian Banking industry. In 1949, the Reserve Bank of India, considered to be the bank of banks in India, was nationalized. The imperial Bank of India was nationalized in 1955 and renamed State Bank of India which started functioning from July 02, 1955. The SBI is the biggest commercial bank in India now. Nationalization of 14 major commercial banks in 1969 and 6 more in 1980 is regarded as an epoch making event in the history of Indian banking system. The major objectives laid down by the then Prime Minister Mrs Indira Gandhi were:

1. Decentralization of economic power
2. Avoiding subjective use of bank resources by its Directors
3. To provide agricultural credit
4. To encourage small entrepreneurs
5. Implementation of 5 year plans
   to mobilize the resources in the rural sectors through the expansions of bank branches.

After nationalization, banking system has revolutionized its services in the rural areas. The number of branches (with a deposits of Rs 306 crores) which was 1833 in 1969 has increases to 31, 641 (with a deposits of Rs 20, 977 crores) in 1996.

The banking system in India can be classified into specific categories like public sector, private sector and foreign banks. According to a study conducted by the Indian Bank's Association [Colwell & Davis, 1992] there are 27 public sector banks, 34 private sector banks and 42 foreign banks in India. In 1998, the deposits (advances) maintained by the public sector banks, the private sector banks and the foreign banks were respectively Rs 5317 billions (Rs 2599 billions), Rs 695 billions (Rs 354 billions) and Rs 429 billions (Rs 292 billions). The Indian Banking System provides customers all modern facilities including ATMs.

3. Data Envelopment Analysis

Data Envelopment Analysis (DEA) techniques are used extensively in the study of evaluating, improving and benchmarking performances of organizations such as hospitals, educational institutions and banks (see [Business Today, 2002]). DEA was first applied to banking system by Sherman and Gold [Molyneux, Altumbas & Gardner, 1996].

DEA is an important tool in measuring the relative efficiencies of a homogeneous set of decision-making units (DMUs) in presence of multiple inputs and outputs. The efficiency score in such situations is defined as

$$\textbf{Efficiency} = \frac{\textit{weighted sum of outputs}}{\textit{weighted sum of inputs}} \quad (3.1)$$

which is of the form

$$\frac{\textit{virtual output}}{\textit{virtual input}} \quad (3.2)$$

(see [Chatterjee, 1997]). Let there are n DMUs: $DMU_1, \ldots, DMU_n$ which uses m input items and s output items. Let x_{ij} denote the amount of input j utilized by DMU_i, and, let y_{kj} denote the amount of output k produced by DMU_i. Then, the basic CCR model (see [Chatterjee, 1997]) can be written as (where DMU_0 denotes the DMU being evaluated) :

$$\max \quad \theta = \frac{\sum_{k=1}^{s} u_k y_{k0}}{\sum_{j=1}^{m} v_j x_{j0}} \quad (3.3)$$

$$\text{s.t.} \quad \frac{u_1 y_{1i} + \cdots + u_s y_{si}}{v_1 x_{1i} + \cdots + v_m x_{mi}} \le 1 \quad (3.4)$$

(i=1,…,n),

$$v_1, \ldots, v_m \ge 0 \quad (3.5)$$

$$u_1, \ldots, u_s \ge 0, \quad (3.6)$$

where $v_j (u_k)$ is the weight given to input j (output k).

The above fractional program can be replaced by the linear program:

$$\textbf{Max} \quad \theta = \sum_{k=1}^{s} u_k y_{k0} \tag{3.7}$$

$$\textbf{s.t.} \quad \sum_{i=1}^{m} v_i x_{i0} = 1 \tag{3.8}$$

$$\frac{u_1 y_{1l} + \dots + u_s y_{sl}}{v_1 x_{1l} + \dots + v_m x_{ml}} \leq 1 \tag{3.9}$$

$$v_1, \dots, v_m \geq 0 \tag{3.10}$$

$$u_1, \dots, u_s \geq 0. \tag{3.11}$$

Thus, one has to run n times the above LP to get the relative efficiency scores of all n DMUs. The constraint (3.9) tells that the efficiency score of a bank could be at most one. The inputs/outputs values are assumed to be non-negative, which implies that a bank with a negative net profit is discarded from our study. The meaning of an optimal solution to this LP is that through a proper selection of the weights, the efficiency score is maximized for a bank that utilizes a given set of inputs and outputs. A bank can be declared to be efficient based on DEA analysis if its efficiency score is 1; otherwise, we call it inefficient. Note that the efficiency score lies between 0 and 1. For every inefficient DMU, DEA identifies a set of corresponding efficient DMUs that can be used as benchmarks for improvements.

The dual of the LP in (3.7) to (3.11) yields benchmarks; the dual with variables λ_i can be written as:

$$\text{Min} \quad \theta \tag{3.12}$$

s.t.

$$\sum_{l=1}^{n} \lambda_l x_{il} - \theta x_{i0} \leq 0 \quad j=1,\dots,m \tag{3.13}$$

$$\sum_{l=1}^{n} \lambda_l y_{kl} - y_{k0} \geq 0, \quad k=1,\dots,s, \tag{3.14}$$

$$\lambda_i \geq 0, \quad i=1,\dots,n. \tag{3.15}$$

This dual is the basis for the DEA analysis. A test DMU is compared with a hypothetical DMU (which does not exist in reality) that uses less input than the test DMU but at the same time yields output being greater than or equal to that of the test DMU. As a result, the composite DMU is more efficient than the test DMU.

Since the composite DMU so constructed is based on the all DMUs in the group under consideration, the test DMU can be identified as relatively inefficient compared to the remaining DMUs in the group. This is basically an Input Oriented CCR model, known as CCR-I (see [Chatterjee, 1997]), whose objective is to minimize input levels while producing at least the given output levels. We used DEA-Solver to solve the CCR-I model in this paper.

4. Input and Output Variables

In applying DEA to banks, researchers have identified banks as intermediaries of financial services. As financial intermediaries, bank's primary function is to borrow funds from interested party and lend these funds to others for profit (Colwell and Davis (1992)). We have chosen the input factors to reflect the resources and the output factors represented measures of results that are expected out of a commercial bank (Golony et al 1999). The input and output variables are constructed in such a way that they manifest the objective of saving / minimizing input resources and expanding output parameters (Athanassopoulos et al 2000).

Table 4.1
Input/output variables used in our study.

Variable	Name	Name/Abbreviation used in SPSS
Input(1)	Deposits	DEPOSITS
Input(2)	Average working fund (AWF)	AVEWORKF
Input(3)	Cost of average Interest bearing fund	COSTINTB
Input(4)	Incremental low-cost deposits/incremental deposits	INCREMEN
Input(5)	Cost to income ratio	CIR
Input(6)	NPA/net advances	NPA_ADVA
Input(7)	NPA growth rate	NPAGROTH
Output(1)	Net profit	NETPROFI
Output(2)	Net interest income/AWF	NETININ
Output(3)	Fee income/total income	FEEINCOM
Output(4)	Interest spread/AWF	INTSPREA
Output(5)	Operating profit/AWF	OPPROFIT
Output(6)	Return on average assets	RETURN
Output(7)	Business/branch	BUS_BRAN
Output(8)	Operating profit/employee	OPROF_EM
Output(9)	Operating profit/branch	OPROF_BR
Output(10)	Capital adequacy ratio	CAR

For a detailed description of the input/output variables see [Bhattacharya, Lovell & Sahay, 1997].

5. Results and Conclusions

Table 5.1 shows the efficiency scores of all the 50 banks considered for the present study. 27 banks are found to be on the frontier with the efficiency score =1. Out of these 27 banks, all 5 foreign banks are fully efficient; the inefficiency lies mostly in public sector banks. The fact that only 5 out of 21 are inefficient implies that the private sector banks are doing very well. This conclusion is summarized in Table 5.2.

DEA manufactures two groups of banks--- one is efficient and the other is inefficient. So, the natural question is what are the inputs and outputs that are responsible for the creation of these two distinct groups. In other words, on which variables (input/output) the banks have to focus their attention in order to improve their efficiency. This question could be answered quantitatively by performing discriminant analysis (we employ SPSS) on the two groups generated by the DEA.

A p-value of 0 in the Wilk's lamda table, Table 5.3, shows that the two groups defined above are statistically significantly different. From the "Classification Results" table, Table 5.4, we see that the Fisher's linear discriminant function (LDF) has done an excellent job in classifying the banks into two categories defined according to their efficiencies based on 17 variables. The group-wise descriptive statistics are given in Table 5.5 where the "Total" means the combined group of 50 banks under study. The most important and interesting component of the SPSS output is the Table 5.6, which identifies the variables with high discriminating power, in the sense that these variables are very effective in discriminating between efficient and inefficient banks. These variables (for which p-values are < 0.05) are listed below, see Table 5.7. So the inefficient banks should concentrate mainly on these variables to reach the efficient frontier.

Table 5.1
Ranks of the banks and their efficiency scores

In Rank order		Score			
1	The United Western Bank	1	29	IDBI BANK	0 95
1	ABN Amro Bank NV	1	30	The Federal Bank	0 95
1	HDFC	1	31	Bank of Baroda	0 94
1	Standard Chartered	1	32	State Bank of Saurashtra	0 93
1	Citibank	1	33	Vijaya Bank	0 92
1	The Jammu & Kashmir Bank	1	34	Indian Overseas Bank	0 92
1	Corporation Bank	1	35	State Bank of Bikanir & Jaipur	0 92
1	Standard Chartered Grindlays	1	36	The South Indian Bank	0 91
1	State Bank of Hyderabad	1	37	Punjab National Bank	0 88
1	The Karur Vsys Bank	1	38	State Bank of Travancore	0 87
1	State Bank of india	1	39	Bank of India	0 85
1	The Catholic Syrian Bank	1	40	Bank of Maharastra	0 84
1	HSBC	1	41	Union Bank of India	0 84
1	State Bank of Indore	1	42	Development Credit bank	0 78
1	Canara bank	1	43	Central Bank of India	0 78
1	Oriental Bank of Commerce	1	44	Allahabad Bank	0 76
1	Global trust bank	1	45	State Bank of Mysore	0 76
1	The Laksmi Vilas Bank	1	46	UCO Bank	0 74
1	The Vysya Bank	1	47	United Bank of India	0 69
1	ICICI	1	48	The Bank of Rajastha	0 67
1	Tamilnad Marcantile Bank	1	49	Andra Bank	0 67
1	Lord Krishna	1	50	Panjab & Sind Bank	0 58
1	Bharat Overseas	1			
1	City Union Bank	1			
1	Nainital Bank	1			
1	UTI	1			
1	Karnataka Bank	1			
28	Syndicate Bank	0 97			

Table 5.2
Sector wise study of bank efficiency

Efficient	Inefficient
Public: 6	Public: 17
Private: 16	Private: 5
Foreign: 5	Foreign: 0
Total: 27	Total: 23

Table 5.3
Statistical evidence of two distinct groups of banks
Wilks' Lambda

Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1	.275	51.051	17	.000

Table 5.4
Classification Results

			Predicted Group Membership		
		GROUP	1.00	2.00	Total
Original	Count	1.00	24	2	26
		2.00	0	24	24
	%	1.00	92.3	7.7	100.0
		2.00	.0	100.0	100.0

a 96.0% of original grouped cases correctly classified.

Table 5.5
Group Statistics; group 1 denotes the efficient banks and group 2 inefficient banks.

GROUP		Mean	Std Deviation	Group		Mean	Std Deviation
1.00	DEPOSITS	21967.2404	52418.21069	2.00	DEPOSITS	22515.7000	19014.29204
	AVEWORKF	24887.1573	60969.91158		AVEWORKF	23651.3442	19642 26818
	COSTINTB	7.5962	.94084		COSTINTB	7.5917	.61071
	INCREMEN	30.7308	25.47562		INCREMEN	47.0500	46.13423
	CIR	45.2077	8.17440		CIR	56.5708	10.19111
	NPA_ADVA	4.4231	3.07041		NPA_ADVA	6.6708	2.30056
	NPAGROTH	4.5115	2.84188		NPAGROTH	4.0833	1.18603
	NETPROFI	264.3500	471.18639		NETPROFI	173 4583	159.70946
	NETINTIN	2.9308	.91248		NETINTIN	2.9583	.43028
	FEEINCOM	10.2500	4.15772		FEEINCOM	8.0000	1.94780
	INTSPREA	2.7731	.93960		INTSPREA	2.5333	.43606
	OPPROFIT	2.9500	.63765		OPPROFIT	2 1167	.57458
	RETURN	1.3231	.46244		RETURN	.7417	.23759
	BUS_BRAN	220.3265	417.00075		BUS_BRAN	33.4212	23.21027
	OPROF_EM	.1173	.13144		OPROF_EM	.0413	.04523
	OPROF_BR	7.3996	16.14944		OPROF_BR	5250	.41011
	CAR	13.1615	2.43032		CAR	11 2917	1.09343
Total	DEPOSITS	22230.5010	39644.07214				
	AVEWORKF	24293.9670	45586.01265				
	COSTINTB	7.5940	.79164				
	INCREMEN	38.5640	37.38963				
	CIR	50.6620	10.75772				
	NPA_ADVA	5.5020	2.92934				
	NPAGROTH	4.3060	2.19716				
	NETPROFI	220.7220	356.86217				
	NETINTIN	2.9440	.71547				
	FEEINCOM	9.1700	3.44817				
	INTSPREA	2.6580	.74453				
	OPPROFIT	2.5500	.73436				
	RETURN	1.0440	.47085				
	BUS_BRAN	130.6120	312.84091				
	OPROF_EM	.0808	.10606				
	OPROF_BR	4.0998	12.04904				
	CAR	12.2640	2.11310				

Table 5.6
Tests of Equality of Group Means (Univariate ANOVA)

	Wilks' Lambda	F	df1	df2	Sig.
DEPOSITS	1.000	.002	1	48	.962
AVEWORKF	1.000	.009	1	48	.925
COSTINTB	1.000	.000	1	48	.984
INCREMEN	.951	2.448	1	48	.124
CIR	.716	19.055	1	48	.000
NPA_ADVA	.850	8.468	1	48	.005
NPAGROTH	.990	.469	1	48	.497
NETPROFI	.983	.806	1	48	.374
NETINTIN	1.000	.018	1	48	.893
FEEINCOM	.892	5.838	1	48	.020
INTSPREA	.974	1.302	1	48	.260
OPPROFIT	.672	23.426	1	48	.000
RETURN	.612	30.476	1	48	.000
BUS_BRAN	.909	4.800	1	48	.033
OPROF_EM	.869	7.235	1	48	.010
OPROF_BR	.917	4.340	1	48	.043
CAR	.801	11.958	1	48	.001

Table 5.7
Variables with high discriminating power

INPUT VARIABLES	OUTPUT VARIABLES
Cost to income ratio	Operating profit/AWF
NPA/Advances	Return on average assets
	Business/branch
	Operating profit/employee
	Operating profit/branch
	Capital adequacy ratio

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