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Ranking and Evaluation of Private Banks using Super-efficiency Model

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***Abstract*-** Private Sector banks played a vital role in catering the needs of common man as well as business community in early years and also in current time period. In this paper major private Sector banks are considered for evaluating their performance using Data Envelopment Analysis (DEA). Super-efficiency DEA model is also used to rank the private sector banks.

***Index Terms*-** Data Envelopment Analysis,Private Sector banks, Performance evaluation, Ranking, Super-efficiency.

I. INTRODUCTION

Banking system is a boon for any country's economy. Indian banking sector is a combination of public and private sector banks. Private sector bank is one in which majority of stakes are held by private shareholders. In early period of banking industry, private sector banks played a vital role in catering the needs of people as well as business community. But since 1969 the public sectorbanks dominated the private sector banks as a result of nationalization. Again in 1991, as a result of liberalization, ample scope had risen to play a prime role for private sector banks.

In the circumstances explained above it is needed to evaluate the performance of private sector banks and to know how private sector banks are influencing the common man and Indian economy. In current paper 13 major private sector banks were considered for performance evaluation. The secondary data pertaining to 13 private sector banks during the eleventh five year plan (2007-2012) has been obtained from the website of Indian Bank Association. Primarily we have evaluated the private sector banks using Data Envelopment Analysis (DEA) by calculating efficiencies of private sector banks with respect to Constant Return to Scale (CRS), Variable Return to Scale (VRS) and Scale efficiencies are also obtained. Further we have used super-efficiency model for ranking the private sector banks.

II. DEA MODEL

Several DEA models have been presented in the literature. The basic DEA model evaluates efficiency based on the productivity ratio which is the ratio of outputs to inputs. This study applied Charnes, Cooper and Rhode's (CCR) (1978) model and Banker, Charnes and Cooper (BCC) (1984) model. The production frontier has constant returns to scale in CCR model. The basic CCR model formulation (dual problem/ envelopment form) is given by :

A. The basic CCR model formulation (dual problem/ envelopment form)

$$Min\theta - \varepsilon\left(\sum_{i=1}^{m} s_i^- + \sum_{r=1}^{s} s_r^+\right)$$

Subject to:

$$\sum_{j=1}^{n} \lambda_j x_{ij} + s_i^- = \theta x_{i0} \quad (i=1,\ldots\ldots\ldots\ldots, m)$$

$$\sum_{j=1}^{n} \lambda_j y_{rj} - s_r^+ = y_{r0} \quad (r=1,\ldots\ldots\ldots\ldots, s)$$

$$\lambda_j \geq 0 \quad (j=1,\ldots\ldots\ldots\ldots,n)$$

Source :Zhu (2003, p.13)

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where, θ denotes the efficiency of DMU_j , while y_{rj} is the amount of r^{th} output produced by DMU_j using x_{ij} amount of i^{th} input. Both y_{rj} and x_{ij} are exogenous variables and λ_j represents the benchmarks for a specific DMU under evaluation (Zhu 2003). Slack variables are represented by s_i and s_r. According to Cooper, Seiford and Tone (2004) the constraints of this model are:

i the combination of the input of firm j is less than or equal to the linear combination of inputs for the firm on the frontier;
ii. the output of firm j is less than or equal to the linear combination of inputs for the firm on the frontier; and
iii. the main decision variable θ_j lies between one and zero.

Further, the model assumes that all DMUs are operating at an optimal scale. However, imperfect competition and constraints to finance may cause DMUs to operate at some level different to the optimal scale (Coelli, Rao & Battese 1998). Hence, the Banker, Charnes and Cooper (1984) BCC model is developed with a production frontier that has variable returns to scale. The BCC model forms a convex combination of DMUs (Coelli, Rao & Battese 1998). Then the constant returns to scale linear programming problem can be modified to one with variable returns to scale by adding the convexity constraint $\Sigma\lambda_j = 1$. The model given below illustrates the basic BCC formulation (dual problem/envelopment form):

B. The basic BCC model formulation (dual problem/envelopment form):

$$Min\theta - \varepsilon\left(\sum_{i=1}^{m} s_i^- + \sum_{r=1}^{s} s_r^+\right)$$

Subject to :

$$\sum_{j=1}^{n} \lambda_j x_{ij} + s_i^- = \theta x_{i0} \quad (i=1, \ldots\ldots\ldots\ldots, m)$$

$$\sum_{j=1}^{n} \lambda_j y_{rj} - s_r^+ = y_{r0} \quad (r=1, \ldots\ldots\ldots\ldots, s)$$

$$\lambda_j \geq 0 \quad (j=1, \ldots\ldots\ldots\ldots ,n)$$

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

Source: Zhu (2003, p.13)

This approach forms a convex hull of intersecting planes (Coelli, Rao & Battese 1998). These planes envelop the data points more tightly than the constant returns to scale (CRS) conical hull. As a result, the variable returns to scale (VRS) approach provides technical efficiency (TE) scores that are greater than or equal to scores obtained from the CRS approach (Coelli, Rao & Battese 1998). Moreover, VRS specifications will permit the calculation of TE decomposed into two components: scale efficiency (SE) and pure technical efficiency (PTE). Hence, this study first uses the CCR model to assess TE then applies the BCC model to identify PTE and SE for each DMU. The relationship of these concepts is given below:

C. Relationship between TE, PTE and SE :

$TE_{CRS} = PTE_{VRS} * SE$

where TE_{CRS} = Technical efficiency of constant return to scale

PTE_{VRS} = Technical efficiency of variable return to scale

SE = Scale efficiency

Source : Coelli, et al., (1998).

The above relationship, which is unique, depicts the sources of inefficiency, i.e., whether it is caused by inefficient operation (PTE) or by disadvantageous conditions displayed by the scale efficiency (SE) or by both. If the scale efficiency is less than 1, the DMU will be operating either at decreasing return to scale (DRS) if a proportional increase of all input levels produces a less-than-proportional increase in output levels or increasing return to scale (IRS) at the converse case. This implies that resources may be transferred from DMUs operating at DRS to those operating at IRS to increase average productivity at both sets of DMUs (Boussofiane et al.,1992).

D. Super-efficiency DEA model:

The main purpose of super-efficiency is to provide tie-breaking procedure for ranking DMUs which are efficient in traditional DEA models. When a DMU under evaluation is not included in the reference set of the original DEA models, then these models are called super-efficiency DEA models. Then super-efficiency DEA models can be obtained in two categories namely CRS and VRS. The CCR super-efficiency DEA model was developed under CRS by Andersen and Petersen (1993) (Called AP model). Thrall (1996) pointed

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out that the AP model may result in infeasibility and instability when some inputs are close to zero. Similarly Zhu (2001) showed that super-efficiency DEA models with CRS could occur with infeasibility if and only if there is a zero in data.

The infeasibility of the related linear program is very likely to occur (see Banker et. al (1984) and Seiford and Zhu (1998)) when super-efficiency DEA model based on the BCC model (VRS super-efficiency model) is considered. Seiford and Zhu (1998) showed the necessary and sufficient conditions of infeasibility in VRS super-efficiency model. Yao (2003) stated that super-efficiency can be interpreted as input saving and output surplus achieved by an efficient DMU. By utilizing the Yao's interpretation, Said Ebadi (2012) proposed a VRS super-efficiency model which is known as input-output orientation super-efficiency model which is always feasible.

The super efficiency model with input-output orientation:
The model is as:

$$Min(1+\beta_0)$$

$$s.t \sum_{j=1,\, j\neq o}^{n} \lambda_j x_{ij} - (1+\beta_0)x_{io} \leq 0 \qquad i = 1, 2, \ldots, m$$

$$\sum_{j=1,\, j\neq o}^{n} \lambda_j y_{rj} - (1-\beta_0)y_{ro} \geq 0 \qquad r = 1, 2, \ldots, s$$

$$\sum_{j=1,\, j\neq o}^{n} \lambda_j = 1$$

$$\lambda_j \geq 0 \qquad j = 1, 2, \ldots, n,\ j \neq o$$

III. DATA AND VARIABLES FOR THE STUDY

The establishment of Private Sector banks at the National level was to serve as a substitute and to reduce the burden of Public sector banks. The primary duties of any bank are asset management and intermediation. But the primary duty of a Private Sector bank should be intermediation instead of asset management. 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. DEA is commonly used to evaluate the efficiency of a number of DMUs and it is a multi-factor productivity analysis model for measuring the relative efficiency of a homogeneous set of DMUs. For every inefficient DMU, DEA identifies a set of corresponding efficient DMU that can be utilized as benchmarks for improvement of performance and productivity. DEA is developed based on two scale of assumptions viz., Constant Return to Scale (CRS) model and Variable Return to Scale (VRS) model. CRS means that the producers are able to linearly scale the inputs and outputs without increasing or decreasing efficiency. This is a significant assumption. The assumption of CRS may be valid over limited ranges but its use must be justified. As an aside, CRS tends to lower the efficiency scores while VRS tends to raise efficiency scores.

For enabling the study of evaluation of Private Sector banks, we have the following resources (inputs) and productivity indicators or outputs:

Inputs: X_1 – Interest expenditure on deposits as % of deposits (Rs. in Lakhs)
X_2 - Deposits (accepted by banks) (Rs. in Lakhs)
X_3 – Total expenses (Rs. in Lakhs),
X_4 – Compensation to employees (Rs. in Lakhs)
X_5 – Financial charges (Rs. in Lakhs)
X_6- Non-cash charges (Rs. in Lakhs)
X_7-Total interest expenses (Rs. in Lakhs)
Outputs: Y_1 – Total assets (Rs. in Lakhs)
Y_2 – Net assets (Rs. in Lakhs)
Y_3- Total income (Rs. in Lakhs)
Y_4- Net worth (Rs. in Lakhs)
Y_5 -Interest income (Rs. in Lakhs)
Y_6- Profit before depreciation, interest, taxes and amortization (Rs. in Lakhs)
Y_7- Interest income on advances as % of loans and advances (Rs. in Lakhs)

The study involves the application DEA to assess the efficiency of 13 Private Sector banks in India during the years 2006-07, 2007-08, 2008-09, 2009-10, 2010-11 and 2011-12. The data used for assessment was obtained from the annual reports published by Indian

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Bank Association and from website <www.iba.org.in>. DEA model is executed separately for each year using input-orientation with radial distances to the efficient frontier. By running these programmes with the same data under CRS and VRS assumptions, measures of overall technical efficiency (TE) and 'pure' technical efficiency (PTE) are obtained.

IV. RESULTS AND DISCUSSION

The main theme of the present study is to assess the performance of 13 Private Sector banks in India. The study intends to assess the efficiency of Private Sector banks and thereby identifying the influence of them in improving the Indian economy.

The findings of DEA portrayed through Table 1 revealed the following salient information:

ii. Five banks among 13 Private Sector banks in in India are operated at Constant Return to Scale (CRS) in the entire period of study that is 2006-07 to 2011-12. This indicates that the banks are operated with stability, balancing the inputs (resources contained in them) to satisfy the outputs i.e. the purpose of Private Sector banks. They are :

Table 1: Private Sector banks with Constant Return to Scale(CRS) :

S.No.	Name of Private Sector Bank	Return to Scale					
		2007	2008	2009	2010	2011	2012
1	Axis Bank Ltd.	crs	crs	crs	crs	crs	crs
2	City Union Bank Ltd.	crs	crs	crs	crs	crs	crs
3	Development Credit Bank Ltd.	crs	crs	crs	crs	crs	crs
4	South Indian Bank Ltd.	crs	crs	crs	crs	crs	crs
5	Yes Bank Ltd.	crs	crs	crs	crs	crs	crs

iii. It is also noticed that some of the Private Sector banks have shown a shift in the return to scale pattern i.e., either from IRS to CRS or vice-versa implying that, there is increased resource use efficiency with reference to the exploitation of resources usage. Hence, these Private Sector banks have shown an increased pace of return to scale. Also it is observed that few banks have shown a shift in the return to scale pattern i.e., either from DRS to CRS or vice-versa implying that, there is decreased resource use efficiency with reference to the exploitation of resources usage. These Private Sector banks are :

Table 2: Private Sector banks with trend of Scale during 2007-2012

S.No.	Name of Private Sector Bank	Return to Scale					
		2007	2008	2009	2010	2011	2012
1	Catholic Syrian Bank Ltd.	crs	**irs**	crs	**DRS**	crs	crs
2	Dhanlaxmi Bank Ltd.	crs	crs	crs	**irs**	crs	crs
3	Federal Bank Ltd.	crs	crs	**DRS**	crs	crs	crs
4	Karnataka Bank Ltd.	crs	crs	crs	**DRS**	crs	**irs**
5	Karur Vysya Bank Ltd.	crs	crs	crs	**DRS**	crs	**DRS**
6	Lakshmi Vilas Bank Ltd.	crs	crs	crs	**irs**	crs	crs
7	Ratnakar Bank Ltd.	crs	crs	crs	crs	crs	**irs**
8	Tamilnad Mercantile Bank Ltd.	crs	**irs**	crs	crs	crs	crs

In this paper as a second step, we tried to rank the private sector banks under study, then it is observed that many there are some efficient DMUs which demanded for the rank to be shared among them. So for resolving the tie-breaking we preferred super-efficiency DEA model. For executing the super- efficiency DEA model we have considered different **efficient banks** in different study years. The particulars of **efficient banks** are as follows:

Table 3: Efficiencies of Banks based on complete technical efficiency with CRS

S.No.	Bank Name	2007	2008	2009	2010	2011	2012
1	Axis Bank Ltd.	1	1	1	1	1	1
2	Catholic Syrian Bank Ltd.	1	0.946	1	0.961	1	1
3	City Union Bank Ltd.	1	1	1	1	1	1
4	Development Credit Bank Ltd.	1	1	1	1	1	1
5	Dhanlaxmi Bank Ltd.	1	1	1	0.89	1	1
6	Federal Bank Ltd.	1	1	0.955	1	1	1
7	Karnataka Bank Ltd.	1	1	1	0.977	1	0.994
8	Karur Vysya Bank Ltd.	1	1	1	0.973	1	0.961
9	Lakshmi Vilas Bank Ltd.	1	1	1	0.968	1	1

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Table 3: Efficiencies of Banks based on complete technical efficiency with CRS							
S.No.	Bank Name	2007	2008	2009	2010	2011	2012
10	Ratnakar Bank Ltd.	1	1	1	1	1	1
11	South Indian Bank Ltd.	1	1	1	1	1	1
12	Tamilnad Mercantile Bank Ltd.	1	0.94	1	1	1	1
13	Yes Bank Ltd.	1	1	1	1	1	1

Based on the super-efficiencies, we have compared the ranks obtained through technical efficiencies and they are tabulated in the tables 4 and 5.

V. CONCLUSIONS

Under technical efficiency, nearly 38 percent of private sector banks exhibited constant performance throughout the study period. Some of the banks showed mixed performance even though they exhibited constant performance in some years. Super-efficiency DEA model resolved tie-breaking of efficient banks under technical efficiency. South Indian Bank Ltd. attained first rank in the years 2007 and 2010. Development Credit Bank Ltd., City Union Bank Ltd., Tamilnadu Mercantile Bank Ltd. and Dhanalakshmi Bank Ltd. have stood first in rank in the years 2008, 2009, 2011 and 2012 respectively.

Table 4: Comparison of the Ranks through Technical Efficiencies(TE) and Super-efficiencies(SE)													
S No.	Name of the Bank	2007				2008				2009			
		TE	Rank	SE	Rank	TE	Rank	SE	Rank	TE	Rank	SE	Rank
1	Axis Bank	1	1	1.8788	5	1	1	1.8389	6	1	1	1.8522	11
2	Catholic Syrian Bank	1	1	1.907	3	0.946	12	0.946	12	1	1	1.4835	12
3	City Union Bank	1	1	1	13	1	1	1.8128	10	1	1	1.969	1
4	Development Credit Bank	1	1	1.7602	11	1	1	1.9724	1	1	1	1.9052	4
5	Dhanlaxmi Bank	1	1	1.7313	12	1	1	1.8288	8	1	1	1.9162	3
6	Federal Bank	1	1	1.8853	4	1	1	1.9106	2	0.955	13	0.955	13
7	Karnataka Bank	1	1	1.8648	9	1	1	1.8322	7	1	1	1.8837	8
8	Karur Vysya Bank	1	1	1.8725	7	1	1	1.8474	5	1	1	1.9018	5
9	Lakshmi Vilas Bank	1	1	1.8679	8	1	1	1.8749	3	1	1	1.8874	7
10	Ratnakar Bank	1	1	1.9396	2	1	1	1.793	11	1	1	1.8634	10
11	South Indian Bank	1	1	1.9711	1	1	1	1.8552	4	1	1	1.925	2
12	Tamilnad Mercantile Bank	1	1	1.8197	10	0.94	13	0.94	13	1	1	1.8745	9
13	Yes Bank	1	1	1.8759	6	1	1	1.8143	9	1	1	1.8898	6

Table 5: Comparison of the Ranks through Technical Efficiencies(TE) and Super-efficiencies(SE)													
S. No.	Name of the Bank	2010				2011				2012			
		TE	Rank	SE	Rank	TE	Rank	SE	Rank	TE	Rank	SE	Rank
1	Axis Bank	1	1	1.9463	3	1	1	1	13	1	1	1.8845	7
2	Catholic Syrian Bank	0.961	12	0.961	12	1	1	1.9151	3	1	1	1.875	11
3	City Union Bank	1	1	1.1786	8	1	1	1.9214	2	1	1	1.8753	10
4	Development Credit Bank	1	1	1.7792	6	1	1	1.9042	4	1	1	1.8846	6
5	Dhanlaxmi Bank	0.89	13	0.89	13	1	1	1.8495	12	1	1	1.9445	1
6	Federal Bank	1	1	1.9627	2	1	1	1.8981	7	1	1	1.8823	8
7	Karnataka Bank	0.977	9	0.977	9	1	1	1.8766	8	0.994	12	0.994	12
8	Karur Vysya Bank	0.973	10	0.973	10	1	1	1.9009	6	0.961	13	0.961	13
9	Lakshmi Vilas Bank	0.968	11	0.968	11	1	1	1.8706	9	1	1	1.8887	4
10	Ratnakar Bank	1	1	1.5187	7	1	1	1.8677	10	1	1	1.877	9
11	South Indian Bank	1	1	1.968	1	1	1	1.8636	11	1	1	1.8942	3
12	Tamilnad Mercantile Bank	1	1	1.825	4	1	1	1.9967	1	1	1	1.8884	5
13	Yes Bank	1	1	1.805	5	1	1	1.9033	5	1	1	1.9167	2

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