Efficiency of Private Sector Banks in India

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Abstract

This paper examined the relative efficiency of all the private sector banks in India from 2008 to 2013 using the data envelopment analysis (DEA) methodology. Axis Bank, Kotak Mahindra Bank, and ICICI Bank were relatively efficient in terms of technical efficiency, pure technical efficiency, and scale efficiency. The average (overall) technical inefficiency score during the study period was found to be 6%. In terms of pure technical efficiency, apart from the above three banks, HDFC Bank and Nainital Bank were also relatively efficient. The average (overall) pure technical inefficiency score during the study period was found to be 5%. Positive correlation ranging from 0.7 to 0.95 was observed between return on assets and different types of efficiencies during the study period (except for the year 2008-09). Negative correlation ranging from -0.3 to 0.5 was observed between non - performing assets ratio and different types of efficiencies during the study period (except for the year 2008-09).

Keywords: **data envelopment analysis, technical efficiency pure technical efficiency, scale efficiency, private sector banks**

JEL Classification: C61, C67, G21, P17

Paper Submission Date : June 17, 2014 ; Paper sent back for Revision : July 19, 2014 ; Paper Acceptance Date : August 2, 2014

The banking reforms introduced after 1990s had a great impact on the utilization of financial resources. Significant reforms, initiated in the form of technological improvement and operational flexibility, intensified competition among banks and hence changed the banking practices to improve productivity and efficiency. The Indian banking system started facing competition because of the entry of foreign banks and new private sector banks. With the advent of advances in information and communication technology, banks were able to introduce new products through faster channels of delivery. These changes made the banks to alter the combination of inputs to deliver better services. In this connection, the present paper assesses the efficiency of private sector banks using the data envelopment analysis methodology.

Review of Literature

The term data envelopment analysis (henceforth DEA), first introduced by Charnes, Cooper, and Rhodes (1978) developed a linear programming model to measure the efficiency of homogenous operating units . The model is used to construct an efficient frontier, and efficiency measures of decision making units (DMUs may be any type of organization) are estimated in comparison with this frontier. DMUs that lie on the efficient border are best practice units, which will have an efficiency value of one . All other DMUs which do not lie on the frontier are relatively inefficient and will have an efficiency value between zero and one. The objective of DEA is to identify best-practice units and inefficient units, and to benchmark to improve the performance of inefficient units. Banker, Charnes, and Cooper (1984) (BCC model) suggested an extension to account for the VRS (variable returns to

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scale) assumption. The use of VRS specification enables calculation of technical efficiency under the situation of imperfect competition.

Bhattacharyya, Lovell, and Sahay (1997) studied the efficiency of 70 Indian banks for a period from 1986 to 1991. They found that public Indian banks were most efficient, followed by foreign banks, and private sector banks. Most of the research studies in this area have concentrated on measuring performance inefficiency, efficiency changes between time periods, determinants of bank efficiency, ownership, external environmental conditions, and so forth.

Sufian (2007) studied the long-term trend while analyzing the efficiency of the Singapore banking sector. The DEA (data envelopment analysis) window analysis methodology was used, which allows to distinguish between three different types of efficiencies namely, technical, pure technical, and scale efficiencies. It was further examined whether the Singapore banking groups were drawn from the same environment during the two sub-periods by performing a series of parametric and non-parametric tests. Finally, the consistency of the estimated DEA efficiency scores - by examining their relationship with the traditional measures of banks' performance - was investigated. During the period of the study, the results suggested that the Singapore banking groups exhibited an overall mean or technical efficiency of 88.4% . It was found that the Singapore banking groups' overall efficiency experienced a declining trend during the earlier part of the study, before increasing dramatically during the later period.

Tahir, Bakar, and Haron (2009) used the DEA approach to estimate the overall, pure technical, and scale efficiencies for Malaysian commercial banks during the period from 2000-2006. The results suggested that domestic banks were relatively more efficient than foreign banks. The results also suggested that domestic banks' inefficiency was attributed to pure technical inefficiency rather than scale inefficiency. In contrast, foreign banks inefficiency was attributed to scale inefficiency rather than to pure technical inefficiency. Kumar, Malathy, and Ganesh (2010) used the DEA method to assess the efficiency of the entire banking sector and the bank groups. The purpose was to investigate total factor productivity (TFP) change and its components' (obtained using the Malmquist index) influence on the growth in the banking sector as well as in the four bank groups. In doing so, for each bank group, the levels of technical efficiency, technical efficiency change, efficiency change, and TFP change had been estimated. Further investigation was done to determine if significant differences in these existed between the different bank groups in terms of size, time period, and ownership. The determinants of productivity were also assessed. The TFP growth over the entire period (1995-2006) was driven by technical change as compared to efficiency change, showing that technology and innovation had a greater impact on banking efficiency than efficiency change.

Kumar and Gulati (2010) appraised the efficiency, effectiveness, and performance of 27 public sector banks (PSBs) operating in India by using a two-stage performance evaluation model. Cross-sectional data for the financial year 2006/2007 was used. The DEA technique has been used for computing the efficiency and effectiveness scores for individual PSBs. The overall performance scores were derived by taking the product of efficiency and effectiveness scores. The empirical results revealed that high efficiency did not stand for high effectiveness in the Indian PSB industry. A positive and strong correlation between effectiveness and performance measures was noted. Furthermore, on the efficiency front, State Bank of Travancore appeared as an ideal benchmark, while State Bank of Bikaner and Jaipur, and State Bank of Mysore emerged as ideal benchmarks on the effectiveness front.

Sufian (2011) examined the sources of inefficiency in the Korean banking sector by focusing on three different approaches: intermediation approach, value-added approach, and operating approach, to differentiate how efficiency scores varied with changes in inputs and outputs. The non-parametric data envelopment analysis methodology was used to measure the efficiency of banks operating in the Korean banking sector. The method allows for the decomposition of technical efficiency (TE) into its mutually exhaustive components of pure technical and scale efficiencies. The empirical findings suggested that estimates of TE are consistently higher under an operating approach vis- a - vis the intermediation and value-added approaches. On the other hand, banks are characterized by a relatively low level of TE under the intermediation approach.

Arjonmandi (2011) empirically investigated financial institutions in Iran during 2003 to 2008 to assess their technical efficiency and productivity using DEA. Furthermore, he also used the Malmquist index technique under the variable returns to scale and Hicks-Moorsteen approach to analyze productivity and efficiency change. The results showed that the industry efficiency level improved over the period from 2003-2006, but declined considerably after 2006. The industry showed a negative change in productivity over the period from 2007-2008. The study revealed that poor overall productivity of Iran's financial sector after 2007 has constrained the growth and development of its overall economy.

Ab-Rahim, Md-Nor, Ramlee, & Ubaidillah (2012) estimated the cost efficiency and its decomposition of Malaysian banks over the period from 1995 to 2010 by utilizing the data envelopment analysis (DEA) method. This study contributes to the existing literature by integrating determinants of banking efficiency into the areas of DEA methodology in the context of the Malaysian banking system across individual domestic banks. Tobit regression analysis was used to identify the determinants of various measures of banking efficiency. The results indicated that government ownership, population density, demand density, and market concentration were positively associated with several measures of efficiency, while the year in which merger takes place, macroeconomic condition, capitalization, credit risk, asset quality, and management quality had a negative relationship with various measures of efficiency. However, the size of banks was found to have a mixed relationship - it had a positive coefficient with technical and pure technical efficiency, while a negative relationship was observed in case of scale efficiency, cost, and allocative efficiency.

Mariappan and Sreeaarthi (2013) evaluated the performance of seven scheduled commercial banks of India. For this study, the researchers collected the data from 2008 to 2012 and evaluated the same using the DEA methodology. The authors observed that Punjab National Bank and Andhra Bank were relatively efficient based on the output oriented technical efficiency. Punjab National Bank, UCO Bank, and Dena Bank were relatively efficient based on the input oriented technical efficiency. With the exception of Indian banks, all the other banks were relatively efficient based on the output oriented technical efficiency. Boitumelo (2008) studied the efficiency and productivity of Botswana's financial institutions using DEA and Malmquist indices. The empirical results indicated that foreign institutions were, overall, relatively more efficient than their public counterparts (after analysis was conducted using different approaches of data envelopment analysis).

Jagwani (2012) studied the efficiency of 42 sample banks in India using the data envelopment analysis. The study found that public sector banks were relatively more efficient than private-domestic and foreign banks. The study also found that the overall technical inefficiency in banks was primarily due to the underperformance of the management, rather than due to scale inefficiency. Also, the differences between captured efficiency scores of public, private-domestic, and foreign banks were found to be statistically significant. Chandrasekhar and Sonar (2008) examined the impact of information technology investments and related assets on the efficiency and total factor productivity of Indian banks. For this study, panel data of 29 banks (public and private banks) were considered for a period from 2001 to 2006. The results indicated that private sector banks had a slight edge in terms of efficiency over their counterparts.

Marcochi (2006) studied the efficiency of the Brazilian banking industry using the DEA analysis based on constant returns to scale. IT expenses were used as an input variable and deposits were used as the single output variable. Malmquist index was used for measuring productivity for the above combination of inputs and output. The results revealed that the public institutions were more efficient than the private institutions. Ketkar, Noulas, Athanasios, and Agarwal (2003) studied the efficiency of all categories of Indian banks from 1990 to 1995 using the DEA methodology. The results indicated that the foreign banks were more efficient than the other categories of banks. Sharma and Kumar (2013) studied the impact of the banking sector reforms on the performance of commercial banks in India. The performance of these banks was measured using profitability indicators. The results revealed that the reforms had a significant impact on total income, especially in the post-reform period for all bank groups.

Makkar and Singh (2013) studied the financial performance of 37 Indian commercial banks (22 public sector banks and 15 private sector banks) for the period from 2006-07 to 2010-11. CAMELS rating methodology was used for the study. The results indicated that capital adequacy, asset quality, and earning capacity of public and

private sector banks in India had statistical significant differences, while there were no significant differences in the management, liquidity position, and sensitivity to market risk of the two different banks groups.

Objectives of the Study

(1) To study the technical efficiency, pure technical efficiency, and scale efficiency of private sector banks using the data envelopment analysis methodology.

(2) To study the association between return on assets and efficiency.

(3) To study the association between non-performing assets (NPA ratio) and efficiency.

Methodology and Data Sources

In this study, the DEA technique was used for the assessing the technical efficiency of the private sector banks. DEA is a non-parametric method which does not require any assumption of the distribution of the data being used. This technique uses multiple inputs and outputs to measure the efficiency of the decision making units which may be hospitals, banks, government enterprises, and educational institutions. DEA measures relative efficiency of inefficient units with best performing units and sets targets for the inefficient units to improve the usage of inputs to achieve the best output.

Concepts Related to DEA

(1) Returns to Scale measures the relationship between output and inputs. Returns can be constant, increasing, or decreasing depending on whether output increases in proportion to, more than, or less than inputs, respectively. In the case of multiple inputs and outputs, this means how outputs change when there is an equi-proportionate change in all inputs.

(2) Technical Efficiency (Constant Returns to Scale Efficiency) is determined by the difference between the observed ratio of combined quantities of an entity's output to input and the ratio achieved by the best practice. It can be expressed as the potential to increase quantities of outputs from given quantities of inputs, or the potential to reduce the quantities of inputs used in producing given quantities of outputs.

(3) Pure Technical Efficiency (Variable Returns to Scale Efficiency) is the efficiency measure corresponding to VRS assumption that represents pure technical efficiency (PTE) which measures efficiency due to managerial performance.

(4) Scale Efficiency measures the extent to which an organization can take advantage of returns to scale by altering its size towards an optimal scale (which is defined as the region in which there are constant returns to scale in the relationship between outputs and inputs). The scale efficiency can be measured as given below :

$$\text{Scale Efficiency} = \frac{\text{Technical Efficiency (TE or CRS Efficiency)}}{\text{Pure Technical Efficiency (PTE or VRS Efficiency)}} \quad \text{..... (1)}$$

Indian private sector banks (old and new private sector banks) were considered for the present study. The secondary data for all the private sector banks were collected from RBI's website for the period from 2008 to 2013.

Approaches Used in DEA and Sample Size Selection : From the literature, it was found that there are basically three approaches that are used for selecting inputs and outputs :

Table 1. Description of Notations

Symbol	Meaning
DEA	Data Envelopment Analysis
DMU	Decision Making Units
CRS	Constant Returns to Scale
VRS	Variable Returns to Scale
TE (also known as CRS as explained previously)	Technical Efficiency
PTE(also known as VRS as explained previously)	Pure Technical Efficiency
CV (%)	Coefficient of Variation
NPA Ratio	Non-performing asset ratio
CCR Model	Charnes, Cooper, and Rhodes Model
BCC Model	Banker,Charnes, and Cooper Model
ROA	Return on Assets
CSB	Catholic Syrian Bank
CUB	City Union Bank
DB	Dhanlaxmi Bank
FB	Federal Bank
IVB	ING Vysya Bank
JKB	Jammu & Kashmir Bank
KB	Karnataka Bank
KVB	Karur Vysya Bank
LVB	Lakshmi Vilas Bank
NB	Nainital Bank
RB	Ratnakar Bank
SIB	South Indian Bank
TMB	Tamilnad Mercantile Bank
AB	Axis Bank
DCB	Development Credit Bank
HDFC	HDFC Bank
ICICI	ICICI Bank
IB	IndusInd Bank
KMB	Kotak Mahindra Bank
YB	Yes Bank

(1) Under the production approach (Benston, 1965), banks are defined as the producer of deposit accounts and loan services; the number of accounts services/transactions processed are measures of output. Capital and labor are considered as inputs. This approach is suitable for measuring branch efficiency studies.

(2) Under the intermediation approach (Sealey Jr. & Lindley, 1977), banks are viewed as intermediaries who are involved in collecting huge deposits and funds purchased from other financial institutions into loans and financial investments. Total loans and securities are considered as outputs, whereas deposits along with labour and physical capital are considered as inputs.

(3) Under the operating approach (Leightner & Lovell, 1998), banks are considered as business units with an objective of generating revenue from the total cost incurred for running the business. Total revenue (interest and

non-interest income) is defined as output, and total expenses are defined as inputs. From the existing literatures of Berger and Humphrey (1991), Bhattacharyya et al. (1997), Shanmugam and Das (2004) and so on, different combination of variables were used for selection of outputs and inputs.

In this study, variables such as total income, net interest margin are used as outputs, and interest expense, operating expense, no. of employees, and deposits are used as inputs. The sample size was decided based on the thumb rule found in the DEA literature. Cooper, Seiford, and Tone (2007) provided the thumb rule, which is as follows :

$$N = \text{Max}\ \{(O \text{ x } 1{,}3\ (O+1)\} \quad \ldots\ldots\ldots\ldots\ldots (2)$$

where,

N = number of decision making units (banks),

O = number of outputs,

I = Number of inputs.

In this study, the number of input variables is 4 and number of output variables is 2.Also, the number of banks considered for the study is 20. $N(20) = \text{Max}\ (8, 18)$. Hence, the thumb rule is satisfied.

Different Models of DEA

Input oriented, CRS/CCR Model	**Input oriented, CRS/CCR Model**
Minimise E_n Subject to $\sum_{j=1}^{N} W_j Y_{ij} - Y_{in} = 0, \quad i = 1, 2, \ldots \ldots, I$ $\sum_{j=1}^{N} W_j X_{kj} - E_n X_{kn} = 0, \quad k = 1,, 2, \ldots \ldots, K$ $W_j = 0, \quad j = 1, 2, \ldots \ldots N$	**Minimise F_n** Subject to $\sum_{j=1}^{N} W_j Y_{ij} - F_n Y_{in} = 0, \quad i = 1, 2, \ldots \ldots, I$ $\sum_{j=1}^{N} W_j X_{kj} - X_{kn} = 0, \quad k = 1,, 2, \ldots \ldots, K$ $W_j = 0, \quad j = 1, 2, \ldots \ldots N$
Input oriented VRS/BCC Model	**Output oriented VRS/BCC Model**
Minimise S_n Subject to $\sum_{j=1}^{N} W_j Y_{ij} - Y_{in} = 0, \quad i = 1, 2, \ldots \ldots, I$ $\sum_{j=1}^{N} W_j X_{kj} - S_n X_{kn} = 0, \quad k = 1,, 2, \ldots \ldots, K$ $\sum_{j=1}^{N} W_j = 1$ $W_j = 0, \quad j = 1, 2, \ldots \ldots N$	**Minimise T_n** Subject to $\sum_{j=1}^{N} W_j Y_{ij} - T_n Y_{in} = 0, \quad i = 1, 2, \ldots \ldots, I$ $\sum_{j=1}^{N} W_j X_{kj} - X_{kn} = 0, \quad k = 1, 2, \ldots \ldots, K$ $\sum_{j=1}^{N} W_j = 1$ $W_j = 0, \quad j = 1, 2 \ldots \ldots N$

where,

N = number of decision making units/service units being compared in the DEA analysis,

E_n , F_n , T_n , S_n = Efficiency rating of the decision making unit/service unit being evaluated by DEA under respective models of DEA,

Y_{ij} = amount of output i used by decision making unit/service unit j,

X_{kj} = amount of input k used by decision making unit/service unit j,

Table 2. Descriptive Statistics of Data (All Private Sector Banks)

Year	Variables	Average	Standard Deviation	CV (%)	MinimumMaximum
2008-09	No. of employees	9470.95	15271.10	161.24	566.0052687.00
	Deposits	360301.17	566147.06	157.13	13070.482183478.25
	Interest income	41820.73	74565.45	178.30	1378.72310925.48
	Other income	8862.87	18167.62	204.99	103.7976037.27
	Interest expended	27961.45	52067.42	186.21	744.38227259.34
	Operating expenses	10727.39	19048.10	177.57	332.5370451.14
	Net Interest Margin	3.02	0.92	30.41	1.805.33
2009-10	No. of employees	9213.90	13637.79	148.01	692.0051888.00
	Deposits	403623.43	578085.66	143.22	15850.372020165.97
	Interest income	40703.37	64583.50	158.67	1441.66257069.33
	Other income	10143.61	19053.65	187.84	132.2074776.50
	Interest expended	25074.21	40726.48	162.42	852.47175925.70
	Operating expenses	11174.08	18165.51	162.57	387.0459398.00
	Net Interest Margin	2.83	0.93	32.82	1.085.62
2010-11	No. of employees	10894.05	16481.04	151.28	816.0056969.00
	Deposits	501122.79	695459.33	138.78	20421.572256021.08
	Interest income	48338.38	70381.77	145.60	1891.88259740.53
	Other income	10434.01	18541.55	177.70	113.4166478.93
	Interest expended	28561.51	41474.03	145.21	940.32169571.52
	Operating expenses	13798.02	21409.15	155.16	559.1971529.14
	Net Interest Margin	3.17	0.66	20.70	2.094.75
2011-12	No. of employees	12414.20	18316.78	147.55	851.0066076.00
	Deposits	587293.70	802070.86	136.57	34775.292554999.56
	Interest income	67277.75	94653.61	140.69	3418.77335426.52
	Other income	12524.04	21977.87	175.49	223.6975027.60
	Interest expended	43392.16	59194.22	136.42	2010.83228084.96
	Operating expenses	17015.10	26799.15	157.50	722.6892776.00
	Net Interest Margin	3.05	0.67	21.86	1.714.31
2012-13	No. of employees	13497.05	19583.73	145.10	830.0069401.00
	Deposits	697917.75	932451.06	133.60	37236.002962470.00
	Interest income	83243.25	115649.77	138.93	3927.00400756.00
	Other income	14896.30	25323.06	170.00	303.0083457.00
	Interest expended	53566.65	70862.85	132.29	2461.00262092.00
	Operating expenses	20242.45	31579.19	156.00	801.00112361.00
	Net Interest Margin	3.03	0.63	20.90	1.944.29

The money value of the variables is given in million rupees.

i = number of inputs used by the decision making unit/service unit,
k = number of outputs generated by the decision making unit/service unit,
I = Number of output variables,
K = Number of input variables,
W_j are weights applied across the N organizations.

Table 3. Output Oriented Technical Efficiency Score (CRS) of Private Sector Banks

Private Sector Banks	2008-09	2009-10	2010-11	2011-12	2012-13	Average	Standard Deviation	Coefficient of Variation
CSB	1.0000	0.7045	0.7483	0.8068	0.7938	0.8107	0.1133	13.97
CUB	0.9183	1.0000	1.0000	0.9881	0.9702	0.9753	0.0341	3.50
DB	1.0000	0.7313	0.7433	0.7518	0.8119	0.8077	0.1119	13.86
FB	0.8531	1.0000	1.0000	0.9988	0.9334	0.9571	0.0648	6.77
IVB	1.0000	0.8678	0.8697	0.8887	0.8870	0.9026	0.0553	6.12
JKB	1.0000	0.9673	0.9651	1.0000	1.0000	0.9865	0.0185	1.88
KB	0.9937	0.9437	0.8407	0.8925	0.8989	0.9139	0.0577	6.31
KVB	0.9372	0.9243	0.9504	0.9541	0.9190	0.9370	0.0155	1.65
LVB	1.0000	0.8984	0.9419	0.8879	0.8858	0.9228	0.0487	5.28
NB	0.9642	1.0000	1.0000	1.0000	1.0000	0.9928	0.0160	1.61
RB	0.9036	1.0000	1.0000	0.9796	0.8761	0.9519	0.0580	6.10
SIB	0.9985	0.9142	0.9075	0.9116	0.9101	0.9284	0.0393	4.23
TMB	0.8892	0.9411	1.0000	1.0000	1.0000	0.9660	0.0500	5.17
AB	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.00
DCB	1.0000	0.8083	0.8422	0.8671	0.8603	0.8756	0.0732	8.36
HDFC	1.0000	0.9772	1.0000	1.0000	1.0000	0.9954	0.0102	1.03
ICICI	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.00
IB	1.0000	0.8842	0.9723	0.9625	0.9509	0.9540	0.0430	4.51
KMB	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.00
YB	0.9147	1.0000	1.0000	1.0000	1.0000	0.9829	0.0382	3.88

In this study, output oriented DEA model was used to measure the technical efficiency of the selected private sector banks.

Results and Discussion

The Table 2 shows the descriptive statistics of the variables considered for the study (based on the data (in million rupees) obtained for all the private sector banks). Average of the net interest margin (NIM) is higher than 3 for all the 4 years except for the year 2009-10. Kotak Mahindra Bank recorded the highest net interest margin for all the years. The minimum value of NIM is found to be 1.80. The CV% is found to be the highest in the year 2009-10. This shows that the NIM variation is wider among the banks in that year.

The average interest income is found to be the highest in the year 2012-13. The mean value of interest income is found to be gradually increasing from the year 2009-10 onwards. The CV% of the interest income is found to be gradually decreasing from 178.30% (from the year 2008-09) to 138.93% (in the year 2012-13).This means that the banks had consistent interest income because of improved credit policies. The mean value of operating expense is found to be gradually increasing from the year 2008-09 onwards. The reason might be the improvement in the banking infrastructure that ultimately led banks to increasing their spending on overheads. The CV% of operating expense is found to reduce gradually from 2008-09 onwards. This shows that banks were consistently increasing their operating expenses every year. The same trend is observed for the variable - Deposits. The average number of employees is found to be gradually increasing from 2008-09 onwards. CV% of number of employees is found to be almost stable. This shows that there is a need to increase the number of employees every year because of expansion of banking services.

Table 4. Year Wise Descriptive Statistics of Technical Efficiency (CRS) Score

Particulars	2008-09	2009-10	2010-11	2011-12	2012-13
Average Technical Efficiency Score	0.9686	0.9281	0.9391	0.9445	0.9349
Standard Deviation	0.0473	0.0904	0.0854	0.0737	0.0674
Coefficient of Variation	4.8926	9.7462	9.0958	7.8091	7.2113
Minimum	0.8531	0.7045	0.7433	0.7518	0.7938
Maximum	1.0000	1.0000	1.0000	1.0000	1.0000
Number of efficient banks	11(55%)	8(40%)	10(50%)	8(40%)	8(40%)
Number of inefficient banks	9(45%)	12(60%)	10(50%)	12(60%)	12(60%)

Table 5.Output Oriented Pure Technical Efficiency Score (VRS) of Private Sector Banks

Private Sector Banks	2008-09	2009-10	2010-11	2011-12	2012-13	Average	Standard Deviation	Coefficient of Variation
CSB	1.0000	0.7090	0.7485	0.8074	0.7945	0.8119	0.1122	13.82
CUB	0.9256	1.0000	1.0000	0.9908	0.9724	0.9778	0.0313	3.20
DB	1.0000	0.7346	0.7451	0.7898	0.8346	0.8208	0.1077	13.13
FB	0.8803	1.0000	1.0000	1.0000	0.9343	0.9629	0.0542	5.63
IVB	1.0000	0.8691	0.8710	0.8890	0.8871	0.9032	0.0548	6.07
JKB	1.0000	0.9680	0.9652	1.0000	1.0000	0.9867	0.0183	1.86
KB	0.9973	0.9662	0.8408	0.8926	0.9014	0.9197	0.0622	6.76
KVB	0.9504	0.9245	0.9504	0.9550	0.9200	0.9401	0.0164	1.75
LVB	1.0000	0.9003	0.9431	0.8900	0.8967	0.9260	0.0463	5.00
NB	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.00
RB	1.0000	1.0000	1.0000	0.9897	0.8801	0.9740	0.0527	5.41
SIB	1.0000	0.9255	0.9077	0.9119	0.9108	0.9312	0.0391	4.20
TMB	0.9055	0.9419	1.0000	1.0000	1.0000	0.9695	0.0437	4.51
AB	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.00
DCB	1.0000	0.8288	0.8476	0.8903	0.8638	0.8861	0.0675	7.62
HDFC	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.00
ICICI	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.00
IB	1.0000	0.8845	0.9731	0.9631	0.9509	0.9543	0.0430	4.51
KMB	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.00
YB	0.9154	1.0000	1.0000	1.0000	1.0000	0.9831	0.0379	3.85

Table 6. Year Wise Descriptive Statistics of Pure Technical Efficiency (VRS) Score

Particulars	2008-09	2009-10	2010-11	2011-12	2012-13
Average Pure Technical Efficiency Score	0.9787	0.9326	0.9396	0.9485	0.9373
Standard Deviation	0.0393	0.0891	0.0848	0.0678	0.0644
Coefficient of Variation	4.0175	9.5537	9.0274	7.1560	6.8772
Minimum	0.8803	0.7090	0.7451	0.7898	0.7945
Maximum	1.0000	1.0000	1.0000	1.0000	1.0000
Number of efficient banks	13(65%)	9(45%)	10(50%)	9(45%)	8(40%)
Number of inefficient banks	7(35%)	11(55%)	10(50%)	11(55%)	12(60%)

Table 7. Scale Efficiency Scores of Private Sector Banks

Private Sector Banks	2008-09	2009-10	2010-11	2011-12	2012-13	Average	Standard Deviation	Coefficient of Variation
CSB	1.0000	0.9937	0.9998	0.9992	0.9992	0.9984	0.0026	0.26
CUB	0.9921	1.0000	1.0000	0.9972	0.9978	0.9974	0.0032	0.32
DB	1.0000	0.9955	0.9976	0.9519	0.9727	0.9835	0.0208	2.12
FB	0.9691	1.0000	1.0000	0.9988	0.9990	0.9934	0.0136	1.37
IVB	1.0000	0.9984	0.9986	0.9996	0.9999	0.9993	0.0008	0.08
JKB	1.0000	0.9993	0.9998	1.0000	1.0000	0.9998	0.0003	0.03
KB	0.9964	0.9767	0.9999	0.9998	0.9972	0.9940	0.0098	0.98
KVB	0.9861	0.9998	0.9999	0.9990	0.9988	0.9967	0.0059	0.60
LVB	1.0000	0.9979	0.9987	0.9977	0.9878	0.9964	0.0049	0.49
NB	0.9642	1.0000	1.0000	1.0000	1.0000	0.9928	0.0160	1.61
RB	0.9036	1.0000	1.0000	0.9898	0.9955	0.9778	0.0417	4.26
SIB	0.9985	0.9878	0.9997	0.9997	0.9992	0.9970	0.0051	0.51
TMB	0.9820	0.9991	1.0000	1.0000	1.0000	0.9962	0.0079	0.80
AB	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.00
DCB	1.0000	0.9752	0.9936	0.9739	0.9959	0.9877	0.0122	1.24
HDFC	1.0000	0.9772	1.0000	1.0000	1.0000	0.9954	0.0102	1.03
ICICI	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.00
IB	1.0000	0.9996	0.9992	0.9993	1.0000	0.9996	0.0004	0.04
KMB	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.00
YB	0.9993	1.0000	1.0000	1.0000	1.0000	0.9999	0.0003	0.03

The Table 3 shows the output oriented technical efficiency score (CRS) of private sector banks for the period from 2008 to 2013. A score of 1 for the banks indicates that the banks were 100% efficient and the banks with a score of less than 1 indicates that they were relatively inefficient than the banks with a score of 1. 'Relatively inefficient' means that the banks have the scope to improve their output further. It is observed that CV% of technical efficiency is 13.97 % (highest among all the banks) for Catholic Syrian Bank (CSB). This means that CSB did not have consistent efficiency during the study period. Similarly, the banks denoted as DCB and DB are inconsistent in terms of technical efficiency scores. The banks - CSB, DCB, and DB have average technical efficiency score of 81.07%, 87.56%, and 80.77% respectively when compared to all other banks which have efficiency. These banks have the scope to improve the output by 8.93%, 2.44%, and 19.23% respectively (without altering the given inputs) when compared to all other banks which have a technical efficiency score of more than 90%. The banks - Axis Bank, Kotak Mahindra Bank, and ICICI Bank had a technical efficiency of 100% throughout the study period (2008 to 2013). This means that these banks are completely technically efficient. The banks which have a technical efficiency score of less than 100% can benchmark with these banks to improve their efficiency.

The Table 4 shows the year wise descriptive statistics of technical efficiency (CRS) score of private sector banks. The Table depicts that in the year 2008-09, 55% of the banks had an efficiency of 100%. Also, the bank denoted as FB is the least efficient and CV% of technical efficiency is least in the same year when compared to all other years of the study period. In the year 2009-10, 40% of the banks were efficient and the bank denoted by CSB is the least efficient. In the same year, the variability (CV %) in the technical efficiency is the highest as compared to the remaining years under study. This means that there was a wide variation in efficiency among the banks. In the year 2010-11, 50% of the banks were efficient. The bank denoted as DB was least efficient in the years 2010-11, 2011-12, and 2012-13. The CV% of average technical efficiency of banks gradually reduces from 2009-10 onwards ; 40% of the banks were found to be efficient in both the years 2011-12 and 2012-13. The average efficiency score ranges from 92.81% to 96.86% during the study period. This implies that banks can improve their

Table 8. Year Wise Descriptive Statistics of Scale Efficiency Score

Particulars	2008-09	2009-10	2010-11	2011-12	2012-13
Average Scale Efficiency Score	0.9896	0.9950	0.9993	0.9953	0.9972
Standard Deviation	0.022881	0.008575	0.001495	0.011861	0.006428
Coefficient of Variation	2.312191	0.861781	0.149638	1.191735	0.644672
Minimum	0.9036	0.9752	0.9936	0.9519	0.9727
Maximum	1.0000	1.0000	1.0000	1.0000	1.0000
Number of efficient banks	11(55%)	8(40%)	10(50%)	9(45%)	9(45%)
Number of inefficient banks	9(45%)	12(60%)	10(50%)	11(55%)	11(55%)

Table 9 . Correlation Between Return on Assets (ROA) and Types of Technical Efficiencies

TYPE OF EFFICIENCY	2008-09(ROA)	2009-10(ROA)	2010-11(ROA)	2011-12(ROA)	2012-13(ROA)
Technical Efficiency	-0.51104	0.73067	0.83725	0.95695	0.90572
Pure Technical Efficiency	-0.35481	0.70043	0.83505	0.93966	0.88646

Table 10. Correlation Between NPA Ratio and Types of Technical Efficiencies

TYPE OF EFFICIENCY	2008-09(NPA Ratio)	2009-10(NPA Ratio)	2010-11(NPA Ratio)	2011-12(NPA Ratio)	2012-13(NPA Ratio)
Technical Efficiency	0.50209	-0.32992	-0.51272	-0.46169	-0.57782
Pure Technical Efficiency	0.41532	-0.31702	-0.51381	-0.49621	-0.53063

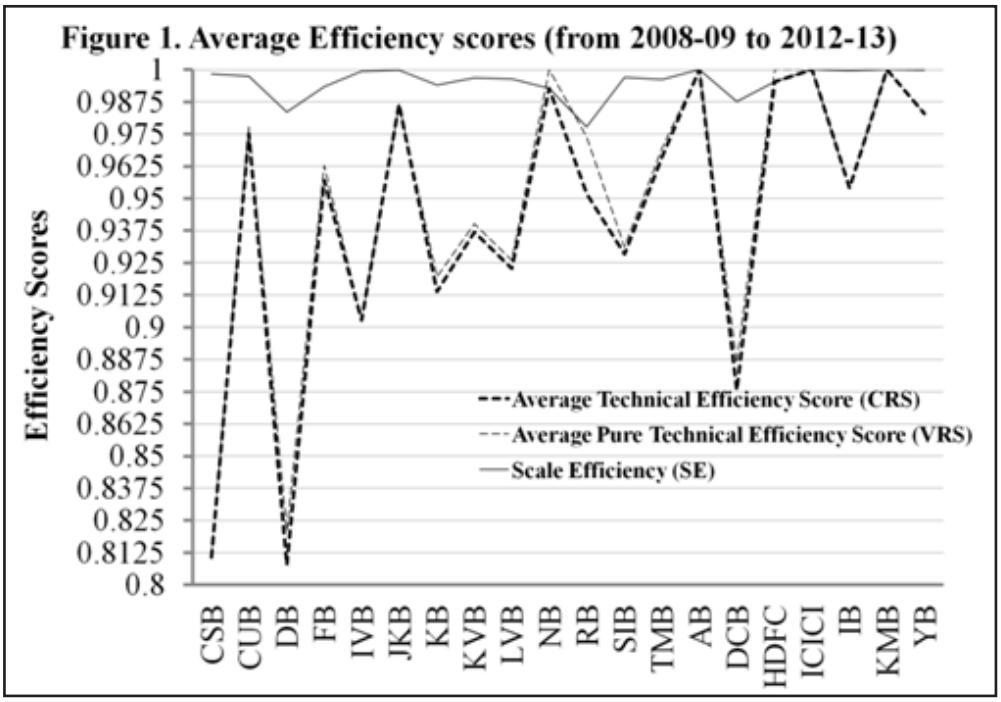
efficiency - from 3.14% to 7.19% without altering the inputs.

The Table 5 exhibits the output oriented pure technical efficiency score (VRS) of private sector banks. This Table shows the efficiency due to managerial performance. The banks denoted as KMB, AB, ICICI, HDFC, NB had 100% pure technical efficiency throughout the study period. This implies that managerial resources were being efficiently utilized in these banks. The banks denoted as DCB, DB, and CSB have an average managerial efficiency between 81% and 88%, which is less as compared to all other banks.

The Table 6 depicts the year wise descriptive statistics of pure technical efficiency (VRS) score. The average pure technical efficiency (97.87%) score was found to be high for the year 2008-09.Thereafter, efficiency ranges from 93.26% to 94.85%. This indicates that there is a scope for all the banks to increase the overall pure technical efficiency from 5.15% to 6.74%. The CV% of average pure technical efficiency (when compared to technical efficiency) shows a similar trend. The variability is found to be the highest in the year 2008-09, which means there was a wider difference in managerial performance among the banks ; 65%(maximum year wise) of the banks were found to be managerially efficient in the year 2008-09 ; 40%(minimum year wise) of the banks were found to be managerially efficient in the both the years 2009-10 and 2012-13.

The Table 7 exhibits the scale efficiency scores of the sample private sector banks. The scale efficiency is measured as a ratio of technical efficiency to pure technical efficiency. The banks with technical efficiency and pure technical efficiency, each having a score of 1, are both scale efficient and managerially efficient. The banks denoted as AB ,ICICI, and KMB are both scale efficient and managerially efficient, whereas other banks are either scale efficient or managerially efficient or are inefficient in both terms. The other banks have an average scale efficiency score ranging from 97.78% to 99.99%. This means that these banks have to either improve their managerial efficiency or the outputs with the same level of inputs being used depending on the nature of VRS efficiency or CRS efficiency.

The Table 8 exhibits the year wise descriptive statistics of scale efficiency score. Average scale efficiency is found to be high (99.93%) in the year 2010-11 and low (98.96%) in the year 2008-09. The CV% (2.31%) of scale



efficiency is high in the year 2008-09. This shows that there is a wider variability in scale efficiency among banks. The CV% is minimum in the year 2010-11. This means that there was a consistent performance in terms of scale efficiency among the banks in this time period. During the study period, only 40-55% of the banks were found to be scale efficient. The remaining banks which are inefficient have a better scope to improve their scale efficiency.

The Table 9 exhibits the correlation between return on assets (ROA) and types of technical efficiencies. It can be seen that there is a positive correlation (ranging from 0.70043 to 0.95695) between ROA and efficiencies (both technical and pure technical efficiency) except for the year 2008-09. There is a moderate negative correlation (-0.51104) between TE and ROA in the year 2008-09. The reason for this negative correlation is that external operating environment variables are not included in the study. The correlation (0.95695 between TE and ROA, 0.93966 between PTE and ROA) is found to be highest in the year 2010-11, and lowest positive correlation (0.73067 between TE and ROA, 0.70043 between PTE and ROA) is observed in the year 2009-10. This correlation might have improved further if external environmental variables were included in the study.

The Table 10 exhibits correlation between NPA ratio and types of technical efficiencies. It can be seen that there is a negative correlation (ranging from -0.31702 to -0.57782) between NPA ratio and efficiencies (both technical and pure technical efficiency) except for the year 2008-09. There is moderate positive correlation (0.50209) between TE and NPA ratio in the year 2008-09. The reason for positive correlation is that external operating environment variables are not included in the study. The most negative correlation (-0.57782 between TE and NPA ratio, -0.53063 between PTE and NPA ratio) is found in the year 2012-13 and the least negative correlation (-0.32992 between TE and NPA ratio, -0.31702 between PTE and NPA Ratio) is observed in the year 2009-10. This correlation might have improved further if external environmental variables were included in the study.

The Figure 1 shows the trend in average efficiency scores of each bank for the study period. It can be observed from the Figure that the banks denoted as AB, ICICI ,and KMB are 100% efficient and can be benchmarked by other banks to improve their efficiency.

Summary and Conclusion

The objective of the study was to estimate various types of efficiencies of private sector banks using output oriented data envelopment analysis. Three banks (AB, ICICI, and KMB) were found to be relatively technically

efficient (average score for 5 years is equal to 1) throughout the study period (from 2008 to 2013). Also, three banks (CSB, DB, and DCB) were found to be relatively the most inefficient because of the low scores of average technical efficiency of less than 0.85. This implies that these banks can focus on better input usage by benchmarking with relatively efficient banks.

In terms of pure technical efficiency (PTE), five banks (NB, AB, HDFC, ICICI, and KMB) were found to be managerially efficient, whereas three banks (CSB, DB and DCB) were found to be relatively the most inefficient because of their low scores of average pure technical efficiency between 0.81 and 0.88. Three banks (AB, ICICI and KMB) were found to be both scale efficient and managerially efficient, whereas other banks were either scale efficient or managerially efficient or inefficient in terms of the same. The other banks (except AB, ICICI and KMB) had an average scale efficiency score between 97.78% to 99.99%. Positive correlation (year wise) was observed between different types of efficiencies and return on assets (ROA) for all the years except 2008-09. Negative correlation (year wise) was observed between different types of efficiencies and non performing assets ratio (NPA Ratio) for all the years except 2008-09.

Implications

The study used data envelopment analysis methodology to measure banking efficiency .This methodology helps banks to benchmark efficiency with best performing units (banks) and accordingly alters the usage of inputs to achieve a better performance. Instead of using several ratios for performance measurement, a single efficiency measure would help banks to assess their overall performance, provided the selection of input and output variables is significant and matches with each other. The study also revealed that there is a correlation among important ratios and efficiencies obtained using the DEA methodology.

Limitations of the Study and Scope for Further Research

The study measured only the efficiency of private sector banks in India. Other categories of banks were not included in the study. Also, only a few important variables such as total income, net interest margin, interest expense, operating expense, no. of employees, and deposits were considered for the study. Efficiency measures obtained using the DEA methodology were correlated with NPA ratio and return on assets ratio only. The study only used secondary data obtained from the financial statements for the period from 2008-2013.

The study can be extended in the future to compare the efficiency among different categories of banks. The efficiency can also be compared with traditional performance indicators such as ratios in predicting stock market returns.

References

Ab-Rahim, R., Md-Nor,N.G., Ramlee, S., & Ubaidillah, N. Z. (2012). Determinants of cost efficiency in Malaysian banking. *International Journal of Business and Society, 13* (3), 355 - 374.

Arjonmandi, A. (2011). *Efficiency and productivity in Iran's financial institutions (Ph.D thesis)*. School of Economics, Faculty of Commerce, University of Wollongong. Retrieved from http://ro.uow.edu.au/theses/3386

Banker, R. D., Charnes, A., & Cooper,W. W.(1984). Some models for estimating technical and scale inefficiencies in data envelopment analysis. *Management Science, 30*(9), 1078-1092. DOI :http://dx.doi.org/10.1287/mnsc.30.9.1078

Benston, G.J. (1965). Branch banking and economies of scale. *The Journal of Finance, 20* (2), 312-331. DOI: 10.1111/j.1540-6261.1965.tb00212.x

Berger, A. N., & Humphrey, D. B. (1997). Efficiency of financial institutions: International survey and directions for future research. *European Journal of Operational Research, 98* (2), 175 - 212. DOI: 10.1016/S0377-2217(96)00342-6

Bhattacharyya, A., Lovell, C. A. K., & Sahay, P. (1997).The impact of liberalization on the productive efficiency of Indian commercial banks. *European Journal of Operational Research, 98* (2), 332-345. DOI: 10.1016/S0377-2217(96)00351-7

Boitumelo, D. M. (2008). *Efficiency and productivity in Botswana's financial institutions (Ph.D thesis)*. School of Economics, Faculty of Commerce, University of Wollongong. Retrieved from http://ro.uow.edu.au/theses/728

Chandrasekhar, M., & Sonar, R. (2008). Impact of information technology on the efficiency and total factor productivity of Indian banks. *South Asian Journal of Management, 15* (3), 74 -91.

Charnes, A., Cooper, W.W., & Rhodes, E. (1978). Measuring the efficiency of decision-making units. *European Journal of Operational Research, 2* (6), 429 - 444.

Cooper, W.W., Seiford, L. M., & Tone, K. (Eds.) (2007). *Data envelopment analysis: A comprehensive text with models, applications, references and DEA-solver software*. Boston, MA : Springer Science.

Jagwani, B. (2012). Efficiency measurement in the Indian banking industry: An application of data envelopment analysis. *Vision: The Journal of Business Perspective, 16* (4), 315-331. DOI: 10.1177/0972262912460191

Ketkar, K., Noulas, W., Athanasios, G., & Agarwal, M. M. (2003). An analysis of efficiency and productivity growth of the Indian banking sector. *Finance India, 17* (2), 511-521.

Kumar, L., Malathy, D., & Ganesh, L. S. (2010). Productivity growth and efficiency change in Indian banking: Technology effect vs catch - up effect. *Journal of Advances in Management Research, 7* (2), 194 - 218. DOI: 10.1108/09727981011084995

Kumar, S., & Gulati, R. (2010). Measuring efficiency, effectiveness and performance of Indian public sector banks. *International Journal of Productivity and Performance Management, 59* (1), 51-74. DOI: 10.1108/17410401011006112

Leightner, J.E., & Lovell, C. A. K. (1998). The impact of financial liberalization on the performances of Thai banks. *Journal of Economics & Business, 50*, 115 - 131.

Makkar, A., & Singh, S. (2013). Analysis of the financial performance of Indian commercial banks: A comparative study. *Indian Journal of Finance, 7* (5), 41 - 49.

Marcochi, D. C. (2006). *Efficiency in the Brazilian banking industry: A data envelopment analysis approach (Doctor of Philosophy thesis)*.Webster University, Missouri, United States.

Mariappan, P., & Sreeaarthi, G. (2013). Application of data envelopment analysis [DEA] to study the performance efficiency of the scheduled commercial banks of India. *International Journal of Marketing and Technology, 3* (8), 52-70.

Sealey Jr., C.W. & Lindley, J.T. (1977). Inputs, outputs, and a theory of production and cost at depository financial institutions. *The Journal of Finance, 32* (4), 1251-1266. DOI: 10.1111/j.1540-6261.1977.tb03324.x

Shanmugam, K.R., & Das, A. (2004). Efficiency of Indian commercial banks during the reform period. *Applied Financial Economics, 14* (9), 681-686. DOI:10.1080/0960310042000233458

Sharma, V. K., & Kumar, A. (2013). Assessment of performance of commercial banks in India. *Indian Journal of Finance, 7* (12), 47 - 54.

Sufian, F. (2007). Trends in the efficiency of Singapore's commercial banking groups : A non stochastic frontier DEA window analysis approach. *International Journal of Productivity and Performance Management, 56* (2), 99-136. DOI: 10.1108/17410400710722626

Sufian, F. (2011). Benchmarking the efficiency of the Korean banking sector: A DEA approach. *Benchmarking: An International Journal, 18* (1), 107-127. DOI: 10.1108/14635771111109841

Tahir, I. M., Bakar, N. M. A., & Haron, S. (2009). Evaluating efficiency of Malaysian banks using data envelopment analysis. *International Journal of Business and Management, 8* (4), 96-106. DOI: 10.5539/ijbm.v4n8p96