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Measuring the performance efficiency of banks in a developing economy The case study of Indian public

sector vs private sector

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Abstract

Purpose – The purpose of this paper is to measure and evaluate the performance efficiency of 44 Indian commercial banks, out of which 26 banks belong to the public sector, and 18 banks are from the private sector for the period of 2008-2013.

Design/methodology/approach – The two-stage network data envelopment analysis (DEA) approach (i.e. variable return to scale and constant return to scale) is used for the measurement of performance in the Indian banking sector. To verify the robustness of the proposed study, sensitivity analysis is also performed.

Findings – A comparative study between public sector banks (PSBs) and private sector banks (PVBs) showed that latter being more productive compared to the former. The investigation highlighted that two banks are most efficient among the PSBs, and eight banks from PVBs are found to be most effective. On the other side, the performance of State Bank of Bikaner & Jaipur and Lakshmi Vilas Bank is discovered to be less significant from PSB and PVB category, respectively.

Research limitations/implications – This study will guide the Indian banks to improve upon the factors in which they are lagging, for the improvement of their overall performance. The quality category parameters, i.e. quality of service, quality of equipment, are not considered due to unavailability of information in the output measures, and the methodology used for the study does not identify the causes or remedies for the inefficiency of the banks.

Originality/value – The developed DEA model would help the decision maker to take decisions on the issues related to the performance of the banks. This paper discusses very practical issues in an analytic manner.

Keywords Performance, Efficiency, DEA, Sensitivity analysis, Public sector banks

Paper type Research paper

1. Introduction

The most regulated domain in most of the countries in the banking sector and the crisis in this sector disrupt the payment system. In the developing economies, banking sector regulations are very rigid to balance the socioeconomic growth (Caprio *et al.*, 1994). Banking industry across the globe is facing the speediest dynamic environment where organisations have to be competitive and efficient for the survival (Devlin and Ennew, 1997). In India, banking services were mostly constricted to urban areas, before nationalisation. With the nationalisation of 14 large banks in 1970, banks of the public sector had 85 per cent of the total deposits, and the private and foreign banks contributed to 6 and 9 per cent, respectively (Bhattacharyya *et al.*, 1997). In the 1980s, it was found that the excessive regulation leads to the less efficient banking sector, which was unable to respond to the fast developing economy. This led to the Indian banking reforms in the 1990s, whose primary



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Received 15 October 2016 Revised 13 February 2017 Accepted 19 February 2017 objective was to improve the productivity, profitability, competitiveness, and performance of the Indian banks (Caprio et al., 1994; Das and Ghosh, 2009; Fujii et al., 2014). The banking sector gradually deregulated, and state-owned banks were partially privatised, consolidated, and interests on deposits and loans were efficiently controlled. To enhance the stability of the banking industry by modifying the regulations, to improve the performance, and to make the banks competitive, second-stage reforms were suggested by the Narasimhan Committee in 1998 (Fujii et al., 2014; Narasimham, 1991, 1998). The diversity of bank ownership in India makes it fascinating: it can be divided into three segments – public sector banks (PSBs), private sector banks (PVBs), and foreign-owned banks; all these groups function in the same markets, with a different bunch of regulations. In the continually changing and uneven regulatory environment, the operations of the bank's performance are expected to get affected (Bhattacharvya *et al.*, 1997). It may be noted that the Indian financial and banking sector is expanding at a rapid rate. The Indian banking sector is expected to undergo transformative changes shortly steered by fluctuating derivatives market, and IT-enabled business (Banerjee, 2015). Hence, there is a lot of research scope in the continuously changing scenario of the Indian banking sector.

1.1 Statistics of the Indian banking sector

The banking sector in India is broadly classified into scheduled banks and non-scheduled banks. All the banks that are included in the second schedule of the Reserve Bank of India (RBI) Act 1934 are considered to be as scheduled banks. These banks are further classified into scheduled commercial banks and scheduled co-operative banks. Scheduled co-operative banks constitute scheduled state co-operative banks and scheduled urban co-operative banks. Scheduled commercial banks are further categorised into five different groups, namely, State Bank of India and its associates; nationalised banks; PVBs; foreign banks; and regional rural banks. The Indian banking industry comprises of 26 banks in the public sector, 20 banks in the private sector, 56 regional, rural banks, 43 foreign-owned banks, 1.606 urban co-operative banks, and 93.550 rural co-operative banks, an extension to the co-operative credit institutions. Banks of the public sector dominate approximately 80 per cent of the business share, transmitting relatively small fragments to its private rivals (CAFRAL, 2014; RBI, 2008; RBI, 2013).

Table I represents the most significant banking indicators of commercial banks in India by the end of June 2013. Over the past five years, significant growth in deposits was shown by PVBs with 89.5 per cent, followed by PSBs with 84.5 per cent while foreign banks were the lowest at 34.5 per cent. Almost similar trends can be observed with growth in investments as well as advances. However, even after liberalisation and reforms, PSBs remain dominant in the Indian banking system.

Table II highlights the variation in the number of banks in each bank group over past five years. Significant growth can be seen only in case of foreign banks while the growth is

		Year	Number	Branches	Deposits (Rs. Billion)	Advances (Rs. Billion)	Investments (Rs. Billion)
	Public sector banks	2008-2009	27	57,979	31,127.4	22,592.1	10,126.6
		2012-2013	26	75,779	57,456.9	44,727.7	17,591.1
	Private sector banks	2008-2009	22	9,288	7,363.7	5,753.2	3,065.3
Table I		2012-2013	20	16,001	13,958.3	11,432.4	6,261.1
Banking data of	Foreign banks	2008-2009	31	295	2,140.7	1,653.8	1,303.5
commercial banks in		2012-2013	43	334	2,879.9	2,636.7	2,280.6
India as of 2013	Source: RBI (2013)						

BIJ 25.2 null or negative in the case of other banks, which represents the mergers & acquisitions happened during the considered period.

Table III provides the business dynamics of various banks which represents that PSBs were dominant as compared to PVBs in each of the attributes mentioned above. Surprisingly, business per employee was observed to be more in case of foreign-owned banks compared to the banks of the private sector, which represent a growing trend in the business of foreign banks.

Tables IV-VI represent the major indicators in the banking system, i.e. ROA, ROE, and CAR. It may be noted that the banks of the private sector are performing well in comparison with the banks of the public sector on the grounds mentioned above. Considering these

Bank groups	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013
State bank of India (SBI)& Associates Nationalised banks Public sector banks Old private sector banks New private sector banks Foreign banks	7 20 27 15 7 31	7 20 27 15 7 32	6 20 26 14 7 34	6 20 26 13 7 41	6 20 26 13 7 43
Source: RBI (2013)					

Particulars	SBI & Associates	Nationalised banks	Private sector banks	Foreign banks	
No. of offices No. of employees Business per employee (Rs. mn) Profit per employee(Rs. mn) Wages as % to total expenses	21,301 293,965 101.97 0.60 16.20	54,478 507,694 142.23 0.65 11.81	16,001 269,941 190.27 1.93 11.84	334 25,384 217.33 4.56 18.22	Table III. Group wise: comparative average
Source: RBI (2013)					(2012-2013)

Bank groups	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013	
SBI & Associates Nationalised banks Foreign banks New private sector banks Old private sector banks	17.74 18.05 13.75 10.69 14.69	15.92 18.30 7.34 11.87 12.29	14.11 18.19 10.28 13.62 14.11	16 15.05 10.79 15.27 15.18	15.29 12.34 11.52 16.51 16.22	Table IV. Group wise: return
Source: RBI (2013)						on equity (ROE)

Bank groups	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013	
SBI & Associates	1.02	0.91	0.79	0.89	0.88	
Nationalised banks	1.03	1.00	1.03	0.88	0.74	
Foreign banks	1.99	1.26	1.75	1.76	1.94	
New private sector banks	1.12	1.38	1.51	1.63	1.74	Table V
Old private sector banks	1.15	0.95	1.12	1.20	1.26	Group wise: retur
Source: RBI (2013)						on assets (ROA

Table II. Number of banks: group wise scenarios, there is an emerging need to measure the overall performance efficiency of PSBs and PVBs from investors to make decisions for the regulators as well.

As mentioned earlier, the business of PSBs is always dominating the PVBs in the past two decades. Conversely, the financial year 2015 has seen a different scenario altogether. The combined profits of 13 PVBs at Rs. 37, 361 Crore outstripped the total PSBs of Rs.36,349 Crore, for the first time in Indian banking history. Probably, regarding this scenario, the finance ministry requested RBI for a roadmap of PSBs' merger to enhance the overall efficiency of the banking sector (Ghosh, 2015). The present investigation intends to propose a framework which measures the performance of Indian banks using data obtained from the annual reports of various banks and to draw a comparison between the public and PVBs from the regulators, and investor's perspective. The present study is similar to the investigation conducted by Kao and Liu (2014b) and Wang, Huang, Wu and Liu (2014), but the input and output parameters considered for the present research are different. Also, the results obtained in the banking sector of any country cannot be made generic, as each country has its policies and regulations.

The rest of this investigation is structured as follows – Section 2 presents a literature review; Section 3 is the research methodology, and the case study part is covered in Section 4. Results and discussions are provided in Section 5, followed by the sensitivity analysis (Section 6). In Section 7, conclusion and limitations of the research are discussed. Lastly, managerial implications of the study are elaborated in Section 8.

2. Literature review

2.1 Banking sectors performance measurement using data envelopment analysis (DEA)

There is an increase in the research activities carried out in the area of performance measurement of the banking industry during the last two decades. In the domain of performance evaluation of banks using DEA, Saha and Ravisankar (2000) developed a framework using DEA for the measurement of the relative efficiency of Indian PSBs considering the point of view of the regulators and the investors. Bhattacharyya et al. (1997) examined the efficiency of Indian banks using DEA during the early phase of liberalisation, and to attribute the variance in the scores of efficiency, the stochastic frontier analysis was used. It was concluded that the PSBs were having more efficiency than the foreign-owned banks and PVBs. Sathye (2003) measured the productive efficiency of the Indian private sector, public sector, and foreign-owned banks using the DEA methodology. It was found that the efficiency of the PSBs and foreign-owned banks was higher than that of the PVBs. As of today, these studies are of less significance as the former research activity considered only the PSBs, and later two studies focussed on three segments of banks, but, during that period, the PVBs were in the emerging phase and were trying to mark their presence. Kao and Liu (2014a) measured the improvement of performance of commercial banks in Taiwan under the condition of uncertainty. The probabilistic analysis was used to account uncertainty related to some elements, and the Monte-Carlo simulation was carried out on the collected data. The results revealed that

Bank groups	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013
SBI & Associates	13.96	13.46	12.24	13.69	12.67
Nationalised banks	13.24	13.18	13.47	13.03	12.26
Foreign banks	14.19	17.26	16.97	16.75	17.88
New private sector banks	15.33	18.03	16.86	16.66	17.52
Old private sector banks	14.74	14.85	14.54	14.11	13.73
Source: RBI (2013)					

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Table VI. Group wise: capita adequacy ratio (CA there is an increase in the performance of the commercial banks. Kao and Liu (2014b) developed a relational network model to consider individual period's operations for the efficiency measurement. This model, along with two existing ones, was utilised to calculate the effectiveness of the commercial banks in Taiwan. It was concluded that the proposed model is more discriminating than the current models in ranking the performances, and results revealed that Taiwanese banks were improving their performance over the considered period. Kaur and Gupta (2015) measured the productive efficiency of the Indian banks using the DEA tool for the period 2009-2013. It was observed that the SBI and its groups were the most efficient. Luo *et al.* (2012) evaluated DEA efficiency evaluation for the selection of input/output indicators for the commercial banks of China. A new approach, namely, cash value added, was proposed for the selection of DEA variables, and it was found that statistic test and regression results were satisfactory.

Wanke et al. (2016) proposed fuzzy DEA for the assessment of uncertainty and bootstrapped regressions for measuring the effect of each model on the scores of efficiency for Mozambican banks. Fuzziness was found to be more superior to randomness in the interpretation of results. The labour price, capital price, and market share were found to be the significant variables in measuring the efficiency of the banks. Soltanifar and Farhadi (2014) measured relative efficiency of Iranian banks using DEA; Andersen and Petersen's approach was utilised for the measurement of super efficiency for ranking efficient banks. Das and Ghosh (2009) investigated the post-reform period (1992-2004) performance of commercial banks in India, and the results highlighted that state-owned banks were more competitive. Also, their profit efficiency was greater than that of the private banks. San-Jose et al. (2014) measured efficiency considering overall, social, and economic dimensions of the banks and savings banks using DEA on stage I and bootstrapped regressions in stage II. It was concluded that savings banks were more socially efficient, economically less efficient, and, on overall efficiency dimension, they were more efficient. Ariff and Luc (2008) used the DEA tool for analysing the profit and cost efficiency of Chinese banks, and it was found that cost efficiency levels were well above the profit efficiency levels. Also, national and city-based banks were found to be more profit efficient and cost effective than the state-owned banks, and medium-sized banks were more efficient substantially than the big and small banks.

Řepková (2014) applied DEA window analysis for examining the efficiency of the Czech Republic banking sector. The most efficient and least efficient bank was identified, and it was also found that group of large banks was less effective, due to excess deposits and inappropriate size operations. Mukherjee *et al.* (2002) used DEA and concluded that the PSBs' efficiency is greater than that of the private and foreign-owned banks in India. Howland and Rowse (2006) assessed the major Canadian banks- (Canbank) efficiency using DEA. In the first stage of analysis, the US branch bank capabilities were utilised to construct a model considering the data of Canbank. The output of the model is compared with the results of the US study; then the model was revised considering the situation of the western, urban branches. The output differences in the initial and revised models were identified, and the modified model was then analysed. Asmild *et al.* (2013) developed a theoretical framework for measuring the rational inefficiency using DEA for the utilisation of staff in the branches of a large Canadian bank.

Avkiran and Morita (2010) captured synergy among the various viewpoints towards the performance measurement. DEA was used to take different inputs and outputs from the five-stake holders in the Chinese banking perspective. Das *et al.* (2009) used DEA for the measurement of labour use efficiency of various branches of a large Indian PSB. It was suggested that the procedures, incentives, policies could not nullify the effect of the local work atmosphere of different locations; downsizing the subordinate and clerical staff was

The performance efficiency of banks identified as the suitable option for reducing the cost of the labour. LaPlante and Paradi (2015) employed DEA for the assessment of growth potential of the Canadian individual bank branches. Five models examined three viewpoints of the branch growth potential and presented recommendations for the improvement. Ray (2016) evaluated the overall cost efficiency of an Indian sizeable PSB's network of offices within the Calcutta city, to identify the optimum number of branches with the least operating cost.

2.2 Banking sectors performance measurement using two-stage DEA

The standard DEA models do not consider internal banks' structure about their operations performed (Wang, Lu and Liu, 2014; Wanke and Barros, 2014). Hence, the two-stage approach was proposed for developing a better efficient model as compared to the conventional DEA. Wang, Huang, Wu and Liu (2014) used two-stage network DEA for measuring the efficiencies of Chinese banks during the third round of banking reforms. The main findings of the study were as follows – the two-stage DEA model was more efficient than the conventional DEA approach; state-owned banks' performance was found to be better than that of the joint stock commercial banks; and reforms have improved the efficiency of the banks. Wanke and Barros (2014) utilised two-stage DEA approach for measuring the efficiency of Brazilian banks. In the first stage, cost efficiency was measured using the number of branches and the number of employees, thereby administrative and personal expenses were accounted per year. Then, the second stage was performed to measure the productive efficiency with output variables as equity and permanent assets, while inputs being the costs obtained in the first stage. It was found that some of the country's banks were concentrating on the cost efficiency and others were focussing on the productive efficiency.

Ohsato and Takahashi (2015) measured the management ability of the regional banks of Japan using network DEA. The inputs considered for the research were interesting on deposits, branches, and employees while the outputs being fees and commissions, interest on loans and bills, interest and dividends on securities, and gains on the sale of bonds. The criteria for selecting the variables were wholly based on the relevancy of the study and were not quantified by any statistical results. Paradi *et al.* (2011) used the two-stage DEA methodology for measuring the operating performance of Canadian banks, and the modified Slacks-based measurement model was developed for generating an index of the performance of each unit. It was found that the small- and medium-sized branches were more efficient in the profits and production criteria. Ho and Zhu (2004) separated the operational efficiency and operational effectiveness using the two-stage DEA approach for the measurement of performance of banking sector in Taiwan. The results indicated that better efficient banks do not always mean that they have better effectiveness. Various inputs and outputs used for the evaluation of bank performance across different countries are summarised in Table VII.

2.3 Tools and techniques used in the performance measurement of banking sector

Among the various other tools/methodologies used for the performance measurement of banks, Athanassopoulos and Curram (1996) compared the results of DEA and artificial neural network tools for measuring the performance efficiency of banks, and it was concluded that both the methodologies gave a useful piece of information regarding the performance assessment. Taylor *et al.* (1997) used DEA and linked-cone assurance region approach for evaluating the profitability potential and efficiency of 13 Mexican banks. Rime and Stiroh (2003) examined the Swiss bank's performance based on relative cost estimation, economies of scale, profit efficiency, and economies of diversification using the parametric approach with translog function, and distribution-free approach. Ho (2006) measured the operational performance of Taiwan banks using grey relation analysis

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Sr. no.	Author(s)	Inputs	Outputs	Year	Country	The
1	Athanassopoulos and Curram	Number of counter transactions, number of automatic facilities, trained manpower to sell financial products, estimated market potential	Sale of loans, investment and insurance policies sold, liability sales	1996	England	efficiency of banks
2	Taylor et al.	Total deposits, total	Total income	1997	Mexico	581
3	Saha and Ravisankar	Establishment expenditure, branches, staff, non- establishment expenditure (excluding interest expenditure)	Total income, interest income, deposits, investments, advances, spread, non-interest income and working funds	2000	India	
4	Mukherjee et al.	Number of employees, net worth, borrowings, operating expenses number of branches	Interest spread, net profit, non-interest income, advances, deposit	2002	India	
5	Sathye	Interest expenses, non-interest expenses	Net interest income, non- interest income	2003	India	
6	Ho and Zhu	Assets, employees, branches, capital stocks	Sales, deposits	2004	Taiwan	
7	Howland and Rowse	Non sales FTE, sales FTE, size, city employment rate	Loans, deposits, average number of products/customer, customer lovalty	2006	Canada	
8	Wu et al.	Personal, other general	Deposits, revenues, loans	2006	Canada	
9	Ariff and Luc	Deposits and other funds, number of employees, physical capital	Loans, investments	2008	China	
10	Das and Ghosh	Deposits, labour (no. of employees), capital-fixed assets equity	Loans and advances, investments, other income	2009	India	
11	Mostafa	Assets, equity	Net profit, ROA, ROE	2009	Arab	
12	Olson and Zoubi	Deposits, labour, physical capital	Net loans, dollar value of securities and other earning assets	2011	MENA	
13	Paradi <i>et al</i> .	Employee expense, loan losses, sundry, cross charges, occupancy/computer expenses, other expenses	Commissions, consumer deposits, consumer lending, wealth management, home mortgages, commercial denosits, commercial	2011	Canada	
14	Kao and Liu	Labour, physical capital, purchased funds	Demand deposits, short-term loans, medium- and long-term loans	2014b	Taiwan	
15	Kao and Liu	Labour, physical capital, purchased funds	Demand deposits, short term loans, medium and long term loans	2014a	Taiwan	
16	Řepková	Labour, deposits	Loans, net interest income	2014	Czech Republic	
17	San-Jose et al.	Equity, total assets, deposits	Profit, loss, customer credit,	2014	Spain	
18	Soltanifar and Farhadi	Equipment, employee	Profit, resources absorbed	2014	Iran	
19	Wang et al.	Fixed assets, labour	Interest incomes (from loans), non-interest incomes	2014a (ce	China ontinued)	Table VII.Inputs and outputsused in performancemeasurement ofvarious banks

BIJ 25.2	Sr. no.	Author(s)	Inputs	Outputs	Year	Country
	20	Wang et al.	Total liability ratio, total equity ratio, unit employee cost	(commissions, fees, investment and other business income), Book to market equity (B/M Ratio), earnings to price (E/P Ratio)	2014b	USA
582	21	Wanke and Barros	Number of branches, number of employees	Equity, permanent assets	2014	Brazil
	22	Kaur and Gupta	Capital employed, number of branches, number of employees, average number of employees per branch, number of deposit accounts,	Number of loaned accounts, number of transactions, number of deposit accounts, number of branches,	2015	India
	23	Ohsato and Takahashi	Interest on deposits, branches, employees	Fees and commissions, interest on loans and bills discounted, interest and dividends on securities, gains on sales of bonds.	2015	Japan
Table VII.	24	Ray	Capital, labour	Deposits, credits, other non-interest income	2016	India

(GRA) approach. It was suggested that GRA could be utilised effectively for smaller samples and unknown distribution of data, and in the last phase, the results of GRA were compared with the output of financial statement analysis, and it was found that results of both the tools were same.

Wu *et al.* (2006) used DEA for examining the relative efficiency of a big Canadian bank branch, and a neural network methodology was employed for the prediction of short-term efficiency. Mostafa (2009) investigated the efficiency of Arab banks using DEA and probabilistic neural network approach. It was found that neural network models were best suited for the relative efficiency classification of banks. Secme *et al.* (2009) evaluated the performance of the banks of Turkey using the analytic hierarchy process (AHP) and technique for order preference by similarity to ideal solution (TOPSIS). The results indicated that in the competitive environment, financial and non-financial performance should be taken into consideration. Olson and Zoubi (2011) used a distribution-free method for estimating profit and cost efficiencies of the Middle East and North African (MENA) countries and compared the same with the output of ROA and ROE. It was found that the efficiency of cost had the least effect on profit efficiency, and the MENA countries banks were less profitable as compared to European banks, and similar to the developing countries.

Barros *et al.* (2012) analysed the technical efficiency of the banks of Japan using Russell directional distance function. The non-performing loans were found to be the considerable burden on the performance of the banks, and it was concluded that the inputs of the banks need to be explored efficiently, especially premises and labour. Yang and Morita (2013) employed DEA and Nash bargaining game theory to improve inefficient Japanese banks' efficiency from multiple perspectives. Fujii *et al.* (2014) used a disaggregated approach for measuring the bank efficiencies and growth of productivity of Indian banks using weighted Russell directional distance model. After analysing the data, it was found that foreign-owned banks had a strong market position, and it was also found that state public banks and domestic private banks were least efficient. Mandic *et al.* (2014) analysed Serbian banks' financial parameters using fuzzy AHP for determining the weights of the criteria, and the TOPSIS approach was used to rank the banks. Wang, Lu and Liu (2014) investigated the linkage between the performance of bank holding companies and their

intellectual capital using a two-stage DEA approach along with fuzzy multiple objective programming methodologies for finding the magnitude of efficiency. The truncated regression theory was also utilised for establishing the interrelationship, and the obtained results revealed that there is a positive relation between the two. Wanke *et al.* (2015) used TOPSIS in the first stage for assessing the relative efficiency of Angolan banks, and in the second phase, a performance model of the banks was developed using neural network approach along with TOPSIS. The results of the study highlighted that variables linked to cost structure had a considerable adverse effect on the performance, and the competition among the institutions would improve th formance of the banking sector. Other tools/ techniques used for the measurement of s' performance are tabulated in Table VIII.

area of bank performance measurement are The country-wise papers published in shown in Figures 1 (bar chart) and 2 (pie t). It may be inferred from the numbers that a significant amount of work has been ca l out in India, Canada, China, and Taiwan. Though 14 papers out of 44 collected t rs (32 per cent) are from India. it is worth mentioning that the past research activity were conducted during the phase when the PSBs were profoundly dominating the Indian markets, and private banks were in the emerging phase. Figure 3 shows the number of papers published in the area of bank performance measurement from the year 1997 to 2016, and Figure 4 shows the year-wise

S.N.	Author(s)	Methodology/approach	Year	Country
1	Athanassopoulos and	DEA and artificial neural network	1996	England
2	Tavlor <i>et al.</i>	DEA and linked-cone assurance region approach	1997	Mexico
3	Rime and Stiroh	Parametric approach with translog function, distribution-free approach	2003	Switzerland
4	Но	Grey relation analysis	2006	Taiwan
5	Wu et al.	DEA and neural networks	2006	Canada
6	Mostafa	DEA and neural networks	2009	Arab
7	Seçme et al.	Fuzzy AHP and TOPSIS	2009	Turkey
8	Olson and Zoubi	Distribution free approach	2011	MENA
9	Barros et al.	Russell directional distance function	2012	Japan
10	Yang and Morita	DEA and Nash bargaining game theory	2013	Japan
11	Fujji et al.	Russell directional distance function	2014	India
12	Mandic et al.	Fuzzy AHP and TOPSIS	2014	Serbia
13	Wang et al.	Two-stage DEA, MOP, truncated regression theory	2014b	USA
14	Wanke et al.	TOPSIS and neural networks	2015	Angola



Figure 1. Number of countrywise published papers in the bank performance measurement area

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percentage of papers published in the same period. It is very much apparent from the numbers that in the year 2014, maximum number of papers got published (10 out of 44) which accounts for 23 per cent, and the graph also shows that there is an increasing trend in research during the considered period.

Part of the literature that has been done so far focusses on the performance of the banks regarding technical efficiency while the other on productivity. Efficiency is concerned with the utilisation of available inputs to achieve an optimum mix of outputs within the boundaries of the feasibility of operations, while productivity is concerned about the capacity use and quality of outputs obtained. In a service industry like banking, efficiency is of great significance as it is a good measure of success or failure of a bank. Second, it helps in identifying the areas of inefficiency so as to formulate suitable strategies to improve its relative position in the market. Third, it can help the regulators to take appropriate decisions and prevent the system failures.



The performance efficiency of banks



Figure 4. Year-wise frequency

percentage in the

bank performance

3. Research methodology

DEA is chosen for this study to measure the performance of the Indian banks. It is a non-parametric technique with a broad range of applications, and in previous literature, it has been predominantly used for measuring the efficiency of performance of banks. DEA estimates the effectiveness of a bank in transforming inputs into outputs about its peer group. Charnes et al. (1978) developed the DEA approach on the concept of technical efficiency. It is done by relating the mix and volume of providing services by each bank, and the resources used are compared with all other banks. Each bank is evaluated against a hypothetical bank with an identical output mix that is modelled from a combination of various efficient banks. DEA identifies the most active banks in a population and provides a measure of inefficiency for all others. The efficiency score of the most valuable bank will have unity value while that of the lower efficient bank will have scores ranging from 0 to 1. Although DEA does not give a measure of optimal efficiency, it however differentiates the least profitable banks from the set of all banks based on the scores obtained. Consequently, the active organisations assessed using DEA set the best practice frontier (Siems, 1992). CRS is considered for this study, as it is more widely applicable and practiced. The DEA model for a particular bank can be formulated as a linear fractional programming problem, which can be solved if it is transformed into an equivalent linear form in which the bank's input and output weights are treated as the decision variables (Saha and Ravisankar, 2000). To calculate the efficiency of each of the N decision-making units (DMUs) through DEA,

each comprising of *I* inputs and *J* outputs, a linear programme is to be solved for each DMU, and the linear programme is given by Charnes *et al.* (1978) as:

Maximize
$$e^0 = \frac{\sum_{j=1}^{J} u_j^0 y_j^0}{\sum_{i=1}^{I} v_i^0 x_i^0}$$

Subject to:

$$\frac{\sum_{j=1}^{J} u_j^0 y_j^n}{\sum_{i=1}^{I} v_i^0 x_i^0} \leq 1, \ n = 1, 2, \dots, N, \ v_i^0, u_j^0 \geq 0; \ i = 1, \ 2, \dots, I; \ j = 1, 2, \dots, J.$$

where y_j^n , x_i^n are the outputs and inputs of *n*th DMU, and v_i^0 , u_j^0 are the variable weights to be determined by solving the problem. The DMU that is being measured is indicated by the index 0, which is the base DMU. The maximum of the objective function e^0 given by the above problem is the DEA efficiency score assigned to DMU⁰. Since every DMU can be DMU⁰, this optimisation problem is well defined for every DMU. If the efficiency score $e^0 = 1$, DMU⁰, satisfies the necessary condition to be DEA efficient, otherwise it is DEA inefficient.

Since the above problem is non-linear and is difficult to solve, Charnes *et al.* (1978) transformed the above problem into linear problem and is given as follows:

Maximize
$$h^0 = \sum_{j=1}^J u_j^0 y_j^0$$

Subject to:

$$\sum_{i=1}^{I} v_i^0 x_i^0 = 1, \quad \sum_{j=1}^{J} u_j^0 y_j^n - \sum_{i=1}^{I} v_i^0 x_i^n \le 0; \quad n = 1, 2, \dots, N, \quad v_i^0 \ge \varepsilon, \quad u_j^0 \ge \varepsilon, \quad i = 1, 2, \dots, I, \quad j = 1, 2, \dots, J.$$

The variables referred in the new problem are same to the earlier problem, and a small positive number ε is introduced to ensure that all the inputs and outputs have positive weight values. The condition $h^0 = 1$ ensures that the base DMU⁰ is DEA efficient, otherwise it is DEA inefficient with respect to all other DMUs in the test. A complete DEA model involves the solution of *N* such problems, each for a base DMU, yielding *N* different (v_i^n, u_j^n) weight sets. In each programme, the constraints are held constant while ratio to be maximised is changed. Finally, these DEA problems were solved using the www.DEA.OS software.

The significant advantages of DEA are as follows: no need to develop a mathematical function for the model explicitly; ability to handle multiple inputs and outputs; proven to be useful in discovering the hidden relationships, among other methodologies; capable of being used with any input-output measurement; and ability to quantify efficiency or inefficiency for every evaluated unit. However, just like any other method, DEA to has some limitations and they are as follows: sensitive to the selection of inputs and outputs; and number of efficient DMU's tends to increase with some inputs and output variables.

The crucial part of the DEA analysis is to select the inputs and outputs for the results to be appropriate. For this reason, research done in the banking sector by the DEA method has been studied, and various inputs and outputs considered in the past have been collated in Table VII. Further, considering the relevance of different factors to the Indian banking

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sector, limitations in performing DEA and on the availability of data ROA, ROE, and investments have been considered as outputs, whereas branches, number of employees, deposits, operating expenses, interest expenses, wages as per cent of total costs have been considered as inputs for this study.

4. Case study

Nationalisation of banks started in 1969 in India with an objective to remove the controlling power among a few. With the government forcing these newly nationalised banks to open their branches in the remote places, investment rate and savings rose steeply by 10 per cent of the gross domestic product. In 1993, RBI enabled the banking sector for private participation for the first time to create market competition, thereby improving efficiency and productivity. Recently, the government proposed to privatise IDBI bank, which is the fifth biggest PSB regarding market capitalisation as the return on equity to the government's investment has fallen drastically over the years. It is not able to generate the 4 per cent interest than any other bank provides for a savings account. On the contrary, new banks like Kotak Mahindra Bank and Yes Bank were able to generate much higher income besides carrying lower assets. As the PVBs were performing well, the government is proposing to privatise IDBI bank on a similar model of Axis bank to improve productivity. Currently, under the global Basel III standard, PSBs are in need of large capital to meet the newly proposed capital adequacy norms. To cater to these future needs, the government proposed to merge the 26 PSBs into six large institutions as part of its roadmap to be more competitive and productive globally. Valuable information that is to be considered at this stage is that India's largest bank, SBI, is not on the list of top 50 banks across the world. Considering this scenario, measuring the performance of banks in India and a comparison of the public sector and PVBs will provide leads on the government's plan to merge all PSBs. It is also proposed that the banks be merged based on the credit risk and non-performing asset (NPA) to be within threshold limits as per the Basel III standards to benefit the shareholders as well as the customers. The above problem is considered in the form of case studies, and a comparative study between public and PVBs is presented below.

A total of 44 banks is deemed to explore the performance of Indian banks of which 20 banks are PSBs, and 18 banks are PVBs. Secondary data have been collected on the factors (inputs and outputs) for each of the banks for a five-year period from 2008 to 2013 to perform DEA. To make a level ground, all the data points have been normalised before feeding it to the model. The collected secondary data are shown in Tables AI-AV. These data are supplied to the DEA model, and the efficiency scores of all the 44 banks are calculated. Table IX shows the efficiency scores of all the considered banks along with their ranks in the hierarchy. The descriptive statics of efficiency scores of all the 44 banks are tabulated in Table X.

5. Results and discussion

The published secondary data from the period 2008-2013 of 44 Indian banks of both public and private sector is given as input to the non-parametric technique of the DEA model, and the obtained results are tabulated in Tables IX and X. This section is divided into three parts – top efficient banks, active intermediate banks, and least efficient banks. The results indicated that ten banks are found to hold the first rank out of 44 banks, and these ten banks fell into the category of top performing banks. Out of top ten banks, only two are from the PSBs (State Bank of India, and IDBI Bank) and rest of eight banks (ING Vysya Bank, Karnataka Bank, Nainital Bank, Ratnakar Bank, Axis Bank, HDFC Bank, Kotak Mahindra Bank, and Yes Bank) are from the private sector.

In the central, efficient bank's segment, there are 19 banks whose efficiency score is ranging from 0.998 to 0.807, and the ranking order of the same is dropping from the

The performance efficiency of banks

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BIJ 25.2	S. N.	Bank code	Bank name	Efficiency score	Rank
20,2	1	SBI	State Bank of India	1	1
	2	IDBI	IDBI Bank	1	1
	3	IVB	ING Vysva Bank	1	1
	4	KB	Karnataka Bank	1	1
-00	5	NB	Nainital Bank	1	1
588	6	RB	Ratnakar Bank	1	1
	7	AXB	Axis Bank	1	1
	8	HDFC	HDFC Bank	1	1
	9	KMB	Kotak Mahindra Bank	1	1
	10	YB	Yes Bank	1	1
	11	ICICI	ICICI Bank	0.998	2
	12	FB	Federal Bank	0.963	3
	13	BOM	Bank of Maharashtra	0.954	4
	14	COB	Corporation Bank	0.954	5
	15	ALB	Allahabad Bank	0.908	6
	16	UNBI	United Bank of India	0.899	7
	17	PSB	Punjab and Sind bank	0.893	. 8
	18	IKB	I&K Bank	0.89	9
	19	CSB	Catholic Syrian Bank	0.872	10
	20	CBI	Central Bank of India	0.865	11
	21	UBI	Union Bank of India	0.848	12
	22	INB	Indian Bank	0.839	13
	23	SBH	State Bank of Hyderabad	0.837	14
	20	SIB	South Indian Bank	0.835	15
	25	DB	Dena Bank	0.826	16
	26	BOB	Bank of Baroda	0.82	10
	20 27	TMB	Tamilnad Mercantile Bank	0.819	18
	28	IIB	IndusInd Bank	0.816	10
	20	PNB	Punjah National Bank	0.807	20
	30	CB	Capara Bank	0.778	20 21
	31	BOI	Bank of India	0.77	21
	30	SBM	State Bank of Mysore	0.769	22
	32	KVB	KarurVyeya Bank	0.705	20
	34	SBT	State Bank of Travancore	0.753	24 25
	35	LICO	LICO Bank	0.755	20
	26	CLIB	City Union Bank	0.75	20 27
	27	OBC	Oriental Bank of Commorce	0.749	21 99
	20	IOR	Indian Oversees Bank	0.740	20
	20	VB	Vijeva Bank	0.732	29
	40		Andhro Donk	0.716	00 91
Table IX.	40 41	AND	Allulla Dalik Syndicate Bank	0.710	31 90
Efficiency scores and	41 49	SD	Synucate Dank State Reply of Deticle	0.701	3∠ 22
ranks of the of the	42 42	SDF	State Bank of Pilonen & Join	0.001	00 94
nulan private and	40 44	SDDJ LVD	Jalpur Labrahmi Vilaa Dari-	0.040	34 25
public sector ballks	44	LVD	Lakshini viias dank	0.019	30

Table X.		п	Mean	SD	Min.	Max.	Max. count	Max. count %
Descriptive statistics of bank efficiency scores	Public sector Private sector	26 18	0.816 0.907	0.096 0.114	0.646 0.619	1 1	2 8	7.7 44.44

2nd rank to the 20th rank. These 19th banks in the decreasing order of their efficiency score are ICICI Bank (2nd position), Federal Bank (3rd rank), Bank of Maharashtra (4th rank), Corporation Bank (5th rank), Allahabad Bank (6th rank), United Bank of India (7th rank), Punjab and Sind Bank (8th rank), J&K Bank (9th rank), Catholic Syrian Bank (10th rank), Central Bank of India (11th rank), Union Bank of India (12th rank), Indian Bank (13th rank), State Bank of Hyderabad (14th rank), South Indian Bank (15th rank), Dena Bank (16th rank), Bank of Baroda (17th rank), Tamilnad Mercantile Bank (18th rank), IndusInd Bank (19th rank), Punjab National Bank (20th rank).

The 15 least efficient Indian banks, arranged in the decreasing order of their efficiency score and ranking hierarchy of the same, are as follows – Canara Bank (21st rank), Bank of India (22nd rank), State Bank of Mysore (23rd rank), KarurVysya Bank (24th rank), State Bank of Travancore (25th rank), UCO Bank (26th rank), City Union Bank (27th rank), Oriental Bank of Commerce (28th rank), Indian Overseas Bank (29th rank), Vijaya Bank (30th rank), Andhra Bank (31st rank), Syndicate Bank (32nd rank), State Bank of Patiala (33rd rank), State Bank of Bikaner & Jaipur (34th rank), Lakshmi Vilas Bank (35th rank). It can be deduced from the outcomes that the banks of the private sector have performed better than the banks of public sector during 2008-2013. Although the range of the efficiency scores of both the banks seems similar, PVBs show wide variation in performance compared to PSBs as eight banks out of 18 PVBs (44.44 per cent) were efficient while only two banks out of 26 PSBs (7.7 per cent) were found to be useful in the developed model.

As per the results observed, PVBs have a higher mean efficiency score as compared to the PSBs in India. However, considering mean efficiency scores, some efficient banks of both the sectors seems to be in fierce competition, and few PSBs were outperforming to be competitive with their counterparts.

6. Sensitivity analysis

It is the analysis of how uncertainty in model prognostications is circumscribed by uncertainty in model inputs. It takes into consideration the potential effects of simultaneous changes in model inputs over their uncertainty range. The inputs given to the model are subject to many origins of uncertainty like measurement errors, lack of information, scaling errors, out of date information, sampling design, etc. Sensitivity analysis increases the confidence in the developed mental model and its forecasts, by rendering a clear understanding of how the model response factors react to the variation in the input variables (Burrough *et al.*, 2015; Lilburne and Tarantola, 2009).

The results of the sensitivity analysis are shown in Table AVI, and the interpretation of the same is mentioned below. Although the DEA model is sensitive to input and output factor selection, it may vary with the considered data set. Hence, an attempt is made to alter the input and output factors to see the variation. The factor "Deposits" was selected for this purpose because of its extensive use as input and output in the past research studies. Table XI shows the efficiency scores of the public and PVBs, considering the alteration in the inputs and outputs, i.e. accounting deposits in the outputs and exchanging inputs with outputs. Tables XII and XIII indicate efficiency scores of the public and PVBs, respectively, taking into consideration the input and output alteration.

Figure 5 shows the efficiency score when deposits factor is varied between input and output. Although the variation of efficiency scores in Figure 5 is not too much, few banks got the same efficiency score while few others showed a more considerable difference, projecting that the DEA model with the considered data set is somewhat sensitive to input-output selection.

Taking this one step further, the inputs and outputs are interchanged to observe the changing patterns inefficiency score. Figure 6 depicts the scenario of efficiency ratios of banks with input and output interchanged.

The performance efficiency of banks

DII						
BIJ 25,2	Output	S		Return on assets (ROA)	Return on assets (ROA)	No. of offices
				Return on equity (ROE)	Return on equity (ROE)	No. of employees
				Investments	Investments Deposits	Interest expended Operating expenses
590	Inputs			No. of offices	No. of offices	Return on assets (ROA)
				No. of employees	No. of employees	Return on equity (ROE)
				Deposits Interest expended	Interest expended Operating expenses	Investments Deposits
				Operating expenses	-	
	Sr. no.	Bank code SBI	Bank name State Bank of India	Efficiency score	All banks together Efficiency score	Efficiency score
	2	SDDJ	Jaipur	0.040	0.009	1
	3	SBH	State Bank of Hyderabad	0.837	0.931	0.858
	4	SBM	State Bank of Mysore	0.769	0.804	0.953
	5	SBP	State Bank of Patiala	0.681	0.983	1
	07		Allehebed Perly	0.755	0.800	0.905
	0	ALD	Andhro Bonk	0.908	0.900	0.957
	9	ROR	Rank of Baroda	0.713	0.00	0.978
	10	BOI	Bank of India	0.02	0.981	0.956
	10	BOM	Bank of Maharashtra	0.954	0.997	0.949
	12	CB	Canara Bank	0.778	0.905	1
	13	CBI	Central Bank of India	0.865	0.985	1
	14	COB	Corporation Bank	0.954	1	0.741
	15	DB	Dena Bank	0.826	0.974	0.918
	16	IDBI	IDBI Bank	1	1	0.917
	17	INB	Indian Bank	0.839	0.934	0.961
	18	IOB	Indian Overseas Bank	0.732	0.83	0.991
	19	OBC	Oriental Bank of Commerce	0.746	0.982	1
	20	PSB	Punjab and Sind bank	0.893	0.924	0.86
	21	PNB	Punjab National Bank	0.807	0.923	1
	22	SB	Syndicate Bank	0.701	0.963	1
	23		UCO Bank	0.75	0.957	1
	24 25	UDI	United Bank of India	0.848	0.975	0.873
	25 26	VB	Vijava Bank	0.099	0.801	1
	20 27	CSB	Catholic Syrian Bank	0.872	0.025	1
	28	CUB	City Union Bank	0.749	0.88	0.923
	29	FB	Federal Bank	0.963	0.992	0.798
	30	IVB	ING Vysya Bank	1	1	0.832
	31	JKB	J&K Bank	0.89	0.995	0.789
Table XI.	32	KB	Karnataka Bank	1	1	0.816
Efficiency scores of	33	KVB	KarurVysya Bank	0.756	0.857	0.876
the public and private	34	LVB	Lakshmi Vilas Bank	0.619	0.807	1
considering the	35	NB	Namtal Bank	1	1	0.959
inputs and outputs						(continued)

36	RB	Ratnakar Bank	1	1	1	- The performance efficiency of
37	SIB	South Indian Bank	0.835	0.902	0.873	
38	TMB	Tamilnad Mercantile	0.819	0.858	0.846	
39 40	AXB HDEC	Bank Axis Bank HDEC Bank	1	1	0.756 1	banks
40 41 42	ICICI IIB	ICICI Bank IndusInd Bank	0.998 0.816	0.876 0.836	1 0.964	591
43	KMB	Kotak Mahindra Bank	1	0.909	1	Table XI.
44	YB	Yes Bank	1	1	0.926	

			(ROA)	(ROA)		
			Return on equity (ROE)	Return on equity (ROE)	No. of employees	
			Investments	Investments	Interest expended	
_				Deposits	Operating expenses	
Inputs			No. of offices	No. of offices	Return on assets (ROA)	
			No. of employees	No. of employees	Return on equity (ROE)	
			Deposits	Interest expended	Investments	
			Interest expended	Operating expenses	Deposits	
			Operating expenses	1 0 1	1	
Sr. no.	Bank code	Bank name	Efficiency score	Efficiency score	Efficiency score	
1	SBI	State Bank of India	1	1	1	
2	SBBI	State Bank of Bikaner &	0.828	0.882	1	
	5	Jaipur				
3	SBH	State Bank of Hyderabad	0.952	0.981	0.89	
4	SBM	State Bank of Mysore	0.966	0.906	1	
5	SBP	State Bank of Patiala	0.877	1	1	
6	SBT	State Bank of Travancore	1	1	0.948	
7	ALB	Allahabad Bank	0.975	0.97	1	
8	ANB	Andhra Bank	0.785	0.891	1	
9	BOB	Bank of Baroda	0.877	1	1	
10	BOI	Bank of India	0.812	0.981	0.965	
11	BOM	Bank of Maharashtra	1	1	1	
12	CB	Canara Bank	0.82	0.912	1	
13	CBI	Central Bank of India	0.936	0.985	1	
14	COB	Corporation Bank	1	1	0.794	
15	DB	Dena Bank	0.953	1	1	
16	IDBI	IDBI Bank	1	1	1	
17	INB	Indian Bank	0.922	0.988	1	
18	IOB	Indian Overseas Bank	0.812	0.832	1	
19	OBC	Oriental Bank of Commerce	0.773	0.982	1	
20	PSB	Punjab and Sind bank	1	1	1	
21	PNB	Punjab National Bank	0.828	0.923	1	Table XII.
22	SB	Syndicate Bank	0.757	0.963	1	Efficiency scores of
23	UCO	UCO Bank	0.814	0.957	1	the public sector
24	UBI	Union Bank of India	0.902	0.975	0.873	banks, considering the
25	UNBI	United Bank of India	0.932	0.981	1	alteration in the
26	VB	Vijaya Bank	0.79	0.823	1	inputs and outputs

лп						
БIJ 25,2	Ou	tputs		Return on assets (ROA)	Return on assets (ROA)	No. of offices
				Return on equity (ROE)	Return on equity (ROE)	No. of employees
				Investments	Investments Deposits	Interest expended Operating expenses
592	Inp	outs		No. of offices	No. of offices	Return on assets (ROA)
				No. of employees	No. of employees	Return on equity (ROE)
				Deposits	Interest expended	Investments
				Interest expended	Operating expenses	Deposits
				Operating expenses		
	1	CSB	Catholic Syrian Bank	0.872	0.925	1
	2	CUB	City Union Bank	0.785	0.89	0.923
	3	FB	Federal Bank	0.963	1	1
	4	IVB	ING Vysya Bank	1	1	0.913
	5	JKB	J&K Bank	0.934	1	0.907
	6	KB	Karnataka Bank	1	1	0.816
	7	KVB	KarurVysya Bank	0.769	0.897	0.88
	8	LVB	Lakshmi Vilas Bank	0.619	0.833	1
	9	NB	Nainital Bank	1	1	0.959
	10	RB	Ratnakar Bank	1	1	1
	11	SIB	South Indian Bank	0.835	0.931	0.946
	12	TMB	Tamilnad Mercantile Bank	0.82	0.899	0.846
Table XIII	13	AXB	Axis Bank	1	1	0.771
Ffficiency scores of	14	HDFC	HDFC Bank	1	1	1
the private sector	15	ICICI	ICICI Bank	1	1	1
banks, considering the	16	IIB	IndusInd Bank	0.848	0.944	1
alteration in the	17	KMB	Kotak Mahindra Bank	1	0.909	1
inputs and outputs	18	YB	Yes Bank	1	1	0.934



From Figure 6, it is clear that the variation again is not too much, and it can be considered almost consistent except for a few outliers. Likewise, another attempt is made to perform DEA analysis to compare the efficiency scores of banks when all the banks were considered together with that of public and PVBs held separately. Figure 7 depicts the mentioned scenario.

From Figure 7, it is clear that the efficiency scores of banks were consistent except for a few outliers when the public and PVBs were considered together and separately. Hence, the model is not sensitive to this scenario, and it is worth mentioning that the sensitivity analysis has improved the confidence of the developed model.

Figure 5. Efficiency scores when a factor "Deposits" is varied

output

between input and

7. Conclusion and limitations of the study

In the past, the banking sector's performance measurement has been carried out by many researchers using DEA in many countries. It may be noted that the present study cannot be compared with the global research as each country has its regulations, parameters, and the result vary significantly from place to place. It may be noted that in India, very few research activities (Saha and Ravisankar, 2000; Ray, 2016; Bhattacharyya *et al.*, 1997; Mukherjee *et al.*, 2002; Das and Ghosh, 2009; Tabak and Tecles, 2010; Sathye, 2003) related to performance measurement of the banking industry have been carried out in the past. As of today, these eight studies are of less significance as the first two research activities were carried out in the PSBs domain and, later ,six were studied during the period when the PSBs were dominating, and the PVBs were in the emerging phase and were trying to mark their presence.

Kaur and Gupta (2015) did not consider the number of offices, the number of employees in the inputs which are very important in evaluating the performance of banks. In outputs, the returns on equity and return on assets have not been considered. The consideration of all these factors may influence the results of the model, as they are having considerable weight, and are found significant in the present research work. It may be noted that the past research results mentioned so far in this section are contradictory to the findings of the present study, which highlighted that the private sectors banks are more efficient than the banks of the public sector in India. The present investigation results are very much in parallel with the findings of Kumbhakar and Sarkar (2003), Denizer (1999), and Sanyal and Shankar (2011).

The DEA has been extensively used by the researchers all over the world from the past two decades in the management and economics research domain. The present study analysed the current changes in the bank sectors' efficiency measurement and developed a model, based on the network DEA (VRS and CRS) approach, to measure the overall efficiency of a set of DMUs for the period from 2008 to 2013, taking into account the operations in each period. This study extended the literature review on banking efficiency evaluation and inefficiency identification. In this research, the overall efficiency is calculated



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Figure 7. Comparison of efficiency scores of banks when public and private banks were held together and separately

BIJ 25,2	and compared with public vs PVBs based on three significant indicators, i.e. return on assets, return on equity, and investment. Like any other research, this study also has limitations, which are listed as follows:
	• The quality category parameters, i.e. quality of service, quality of equipment, were not considered due to unavailability of information in the output measures.
594	• The methodology used for the study does not identify the causes or remedies for the inefficiency of the banks. Reviews or internal audits are required for defining the various changes in the operations for improving the performance.
	• It is worth mentioning that some of the DEA targets may not be possible for achieving in practice, as inputs may not be under the total control of management. The results of the DEA are obtained from the mathematical algorithm, which does not consider the particular constraint or hindrance of the bank; here, the role of a manager is significant, as he/she has to use these results adroitly for the useful decision-making purpose.
	• The overall business performance of the banks is measured not the marketing performance.
	• The selected parameters for the evaluation purpose may not be exhaustive, and the set of data is small.
	• Only local banks were considered for the evaluation purpose.
	In the present investigation, performance evaluation of 44 banks (public sector and private sector) has been carried out using DEA approach. A total of ten banks are found to be the most efficient, out of which two are from the public sector, namely, State Bank of India and IDBI Bank. The remaining eight banks are from the private sector, namely, ING Vysya Bank, Karnataka Bank, Nainital Bank, Ratnakar Bank, Axis Bank, HDFC Bank, Kotak Mahindra Bank, and Yes Bank

In future, the authors would like to take a larger sample size and data with different input and output sets for testing the robustness of the outcome. Also, the use of neural networks for the analysis is suggested.

8. Managerial implications

Indian banks of the public and private sector are under immense competitive atmosphere for improving their efficiencies. For evaluating the performance efficiency of the 44 banks, and to compare the PSBs and PVBs from the investors and regulators perspective, the required data are obtained from the annual reports of the identified banks. The research has some implications for the banks and the government. For the government, this investigation highlights that the reforms are effective in the improvising performance of the banks.

The present study contributes credible and up-to-date erudition on the performance of the Indian banking sector and guides the decision makers about their bank's position among the various banks considered in the study. It helps in knowing how to enhance bank performance and offers valuable information for making policies and implementation of the same in the future growth of the sector.

This research guides the decision makers and regulators to focus on the existing systems, to address and reduce the non-performing loans, for quick decision making, for overstaffing reduction, for analysing high age issues of staff, for effective risk management provisions, to optimise number branches required, for imparting sufficient training to the manpower, to analyse the methodologies for increasing deposits, loan accounts, reducing NPAs, revenue generation, etc. (Fujii *et al.*, 2014; Mukherjee *et al.*, 2002). To enhance competitiveness, the banking sector needs to improve their technologies, explore effective

business practices, innovations, improvised and useful operating procedures, winning strategic planning, increasing productivity, enhancing quality, and expanding the options to multiply the financial activities for maximising the profits (Chang and Lo, 2005; Das and Ghosh, 2009; Mostafa, 2009).

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Glossary	
DEA	Data envelopment analysis
PSB	Public sector hank
PVB	Private sector bank
RBI	Reserve Bank of India
ROF	Reserve Dank of India Return on equity
POA	Peturn on equity
CAD	Conital adaguage matic
CDA	Cross relation analysis
GKA	Grey relation analysis
AHP	Analytic hierarchy process
TOPSIS	Technique for order preference by similarity to ideal solution
MENA	Middle East and North African countries
MOP	Multiple objective programming
CRS	Constant return to scale
VRS	Variable return to scale
DMU	Decision-making unit
NPA	Non-performing asset
SBI	State Bank of India
IDBI	IDBI Bank
IVB	ING Vysya Bank
KB	Karnataka Bank
NB	Nainital Bank
RB	Ratnakar Bank
AXB	Axis Bank
HDFC	HDFC Bank
KMB	Kotak Mahindra Bank
YB	Yes Bank
ICICI	ICICI Bank
FB	Federal Bank
BOM	Bank of Maharashtra
COB	Corporation Bank
ALB	Allahabad Bank
UNBI	United Bank of India
PSB	Punjab and Sind bank
IKB	I unjab and only bank
CSB	Catholic Svrian Bank
CBI	Control Bonk of India
	Union Pank of India
	Indian Dank Of India
CDU	State Dank of Hyderabad
SDIT	State Dalik Of Hyderabad
SID	South Indian Bank
	Denia Dank Denia of Dena de
BUB	Balik OI Baroda
IMB	Laminad Mercantile Bank
IIB	Indusind Bank
PNB	Punjab National Bank

СВ	Canara Bank
BOI	Bank of India
SBM	State Bank of Mysore
KVB	KarurVysya Bank
SBT	State Bank of Travancore
UCO	UCO Bank
CUB	City Union Bank
OBC	Oriental Bank of Commerce
IOB	Indian Overseas Bank
VB	Vijaya Bank
ANB	Andhra Bank
SB	Syndicate Bank
SBP	State Bank of Patiala
SBBJ	State Bank of Bikaner & Jaipur
LVB	Lakshmi Vilas Bank

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(The Appendix follows overleaf.)

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Appendix 1. Secondary Data collected

The following tables show the secondary data collected for each of the banks for various factors across years from 2008 to 2013 for a five-year period:

Wages as % Return Return 600 Bank No. of No. of Interest Operating to total on on code offices employees Deposits expended expenses expenses equity assets Investments SBI 12.070 205,896 7.420.731 429.153 156,487 16.64 17.05 1.04 2.759.540 109,988 SBBJ 928 11,439 392,244 27,071 7,874 13.19 21.46 0.92 SBH 1,062 624,489 42,427 9,331 0.91 209,817 12,577 10.67 20.87 SBM 720 329,158 24,090 9,671 6,651 12.51 18.47 0.91 113,780 SBP 895 11,365 600,062 46,763 7,939 18.2 170,292 8.12 0.83 SBT 756 11,365 420,411 28,406 7,994 13.40 30.64 1.30 132,317 ALB 2,340 20,457 849,718 52,061 13,994 13.23 13.88 0.90 296,510 ANB 1,471 14,255 593,900 37,477 11,043 12.86 18.94 1.09 169,111 BOB 99,682 3,006 36,440 1,923,970 35,761 17.34 18.62 1.09 524,459 BOI 3,118 40,155 1,897,085 108,485 30,940 13.90 24.97 1.49 526,072 BOM 1,463 13,631 522,549 30,350 9,630 14.50 17.46 0.72183,821 1,868,925 CB 2,850 44,090 124,012 30,652 12.14 18.25 1.06 577,769 CBI 3.644 32,804 82,267 9.25 430,607 1,312,718 18,617 12.61 0.45COB 1,079 12,465 739,839 43,764 10,466 19.57 1.24 249,378 9.46 DB 1,125 9,883 430,506 23,831 7,682 14.85 21.29 1.02124,731 IDBI 515 10,201 1,124,010 103,057 13,379 4.89 9.41 0.62 500,476 1,680 228,006 INB 19,993 725,818 42,218 15,881 19.84 20.26 1.622,012 67,718 19,417 22.07 IOB 25,512 1.001.159 14.60 1.17312,154 OBC 1,472 68.600 13,978 9.34 13.51 284,890 14,656 983.688 0.88 PSB 930 8,700 22.353 6,978 17.91 20.37 1.24126,274 346.757 PNB 4,536 54,780 2,097,605 122,953 42,062 17.72 22.92 1.39 633,852 2,343 69,776 17,910 12.77 19.63 SB 25,068 1,158,851 0.81 305,372 UCO 2,113 64,767 12.56 23,736 1,002,216 14,630 16.20.59 293,848 UBI 2,684 1,387,028 80,758 22,141 11.19 21.46 1.27429,970 29,014 15.94 UNBI 1,485 15,111 545,359 31,504 9,751 0.34 179,242 6.44 9,247 VB 1,175 11,975 545,354 41,130 11.86 9.36 0.59 173,877 CSB 377 2,676 63,328 3,909 1,865 20.65 10.72 0.57 21,840 CUB 2102,424 82,066 5,618 1,395 9.26 19.9 1.50 23,975 FB 639 7,570 321,982 19,999 5,715 12.35 12.13 1.48 121,190 IVB 15,903 474 6,086 248,895 7,725 16.60 11.66 0.70 104,955 **JKB** 19,879 4,709 552 7,627 330,041 11.34 16.72 1.09 107,363 KB 4,947 14,438 3,465 10.64 1.25 469 203,333 18.1 89,615 KVB 343 3,941 10,357 2,576 9.50 18.57 1.49 151,014 47,160 LVB 265 2,433 73,609 5,041 1,517 11.96 11.54 0.71 18,631 NB 94 650 21,372 1,164 390 16.70 22.45 1.68 5,606 RB 87 566 13,070 744 333 19.04 9.19 1.96 4,045 SIB 541 4,523 180,923 11,640 3,285 14.35 15.8 1.09 60,752 TMB 230 2,337 95,660 6,434 2,043 14.67 16.27 1.51 32,072 AXB 831 20,624 1,173,741 71,493 28,582 9.97 19.12 1.44 463,304 55,328 HDFC 1,422 52,687 1,428,116 89,111 15.50 17.17 1.28 588,175 1,030,583 ICICI 1,434 51,835 2,183,478 227,259 70,451 6.62 7.8 0.98 Table AI. 4,251 80,834 IIB 196 221,103 18,504 5,470 7.81 9.84 0.58 Secondary data 225 8,227 KMB 15,466 11,964 21.28 7.36 1.03 91,102 during 2008-2009 156,440 YB 118 2,671 161,694 14,921 4,185 11.41 1.59 71,170 (in millions) 20.65

										T 1
						Wages as %	Return	Return		The
Bank	No. of	No. of		Interest	Operating	to total	on	on		performance
code	offices	employees	Deposits	expended	expenses	expenses	equity	assets	Investments	efficiency of
	40.050					10.00				hanks
SBI	13,252	200,299	8,041,162	473,225	203,187	18.86	14.8	0.88	2,957,852	banko
SBBJ	953	11,629	460,588	27,657	8,905	13.73	20.39	0.93	136,005	
SBH	1,215	13,597	729,707	44,709	9,838	11.05	22.02	1.03	240,085	601
SBM	736	10,111	388,800	23,224	7,249	13.73	18.06	1.06	114,944	601
SBP	943	12,409	645,519	44,410	9,009	9.37	16.01	0.79	181,651	
SBT	781	12,192	508,834	29,779	9,559	15.64	26.88	1.26	158,444	
ALB	2,367	20,959	1,060,558	57,187	16,178	13.79	19.14	1.16	384,286	
ANB	1,601	14,292	776,882	41,781	13,495	14.91	25.96	1.39	208,810	
BOB	3,182	38,152	2,412,619	107,589	38,106	16.14	21.86	1.21	611,824	
BOI	3,304	39,676	2,297,619	121,220	36,678	14.54	12.56	0.70	670,802	
BOM	1,496	13,673	633,041	34,393	10,729	14.53	16.35	0.70	213,239	
CB	3,155	43,380	2,346,514	130,714	34,776	13.26	22.48	1.30	696,770	
CBI	3,704	34,826	1,621,075	95,190	22,220	13.15	15.01	0.66	505,629	
COB	1,180	13,143	927,337	50,843	12,600	9.96	21.93	1.28	345,226	
DB	1,165	10,525	513,443	29,103	8,481	13.61	21.43	1.01	156,942	
IDBI	713	12,220	1,676,671	130,052	18,314	5.10	10.53	0.53	733,455	
INB	1,792	19,641	882,277	45,532	17,302	19.30	20.18	1.67	282,683	
IOB	2,099	26,732	1,107,947	70,779	24,665	18.18	9.63	0.53	376,506	
OBC	1,580	15,358	1,202,576	73,497	16,860	10.75	14.51	0.91	357,853	
PSB	936	8,259	491,551	27,502	7,182	15.27	21.4	1.05	178,868	
PNB	5,056	57,103	2,493,298	129,440	47,619	17.63	24.12	1.44	777,245	
SB	2,429	25,569	1,170,258	73,074	20,336	14.32	15.29	0.62	330,109	
UCO	2,195	23,264	1,224,156	72,022	15,844	12.04	22.08	0.87	435,214	
UBI	2,941	29,419	1,700,397	91,103	25,078	11.66	21.65	1.25	544,035	
UNBI	1,564	15,285	681,803	38,577	10,741	13.43	9.24	0.45	260,677	
VB	1,231	11,565	619,317	37,516	10,716	14.63	15.32	0.76	211,074	
CSB	378	2,696	69,784	4,552	1,891	18.11	0.43	0.02	22,894	
CUB	225	2,628	102,846	6,785	1,659	9.49	20.55	1.52	32,104	
FB	700	7,896	360,580	22,624	6,769	12.45	10.3	1.15	130,546	
IVB	497	6,113	258,653	14,031	8,081	19.39	12.01	0.80	104,729	
IKB	553	7,790	372,372	19,375	5,774	14.57	18.19	1.20	139,562	
КВ	486	5,244	237,306	17,078	3,860	9.88	9.83	0.67	99,920	
KVB	369	4,175	192,719	11,930	3,487	10.59	22.63	1.76	66,022	
LVB	285	2.655	90,754	6.602	1.865	10.92	5.14	0.33	29.832	
NB	103	692	25.075	1.306	448	15.77	20.9	1.72	7.067	
RB	90	707	15.850	852	387	18.47	5.5	1.05	5.072	
SIB	591	4.860	230.115	13.674	3.662	13.06	16.76	1.07	71.556	
TMB	233	2.267	116.393	7,439	2.314	14.76	17.27	1.54	34,992	
AXB	1 035	21640	1 413 002	66,335	37 097	1214	1915	1.67	559748	
HDFC	1 736	51,888	1 674 044	77 863	59,398	16.68	16.3	1.53	586.076	
ICICI	1 721	41,068	2 0 2 0 1 6 6	175,926	58 598	8.21	7.96	1 13	1 208 928	Table AII
IIB	233	5 383	267 102	18 206	7 360	11.37	17.25	1 14	104 018	Secondary data
KMB	257	8 804	238 865	13,975	11 894	22.56	13 29	1 72	125 127	during 2000-2010
YB	151	2,906	267,986	15,818	5,002	12.34	20.27	1.79	102,099	(in millions)

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25,2 No. of No. of Bank Interest Operating to total on on code offices employees Deposits expended expenses expenses equity assets Investments 9,339,328 SBI 14,350 222,933 488,680 230,154 21.16 12.62 0.71 2,956,006 SBBJ 997 11,444 538,523 30,268 12,692 19.25 20.91 0.96 135,207 SBH 1,339 14,778 886,279 50,028 15,128 15.95 24.35 1.22284,467 602 SBM 755 9,926 432,255 24,431 9,174 16.32 15.77 1.03 129,271 SBP 1,071 12,559 680,661 41,446 13,298 16.09 16.65 0.88 172,746 SBT 35,327 11,013 826 11,735 581,579 15.11 23.09 1.12 179,270 ALB 2,504 21,227 69,922 23,383 18.65 1,318,872 16.69 1.11 432,471 ANB 14,098 921,563 50,703 17,049 16.30 23.24 242,040 1,678 1.36 39,385 BOB 3,054,395 130,837 46,298 16.47 23.47 713,966 3,447 1.33 BOI 3,586 39,788 2,988,858 139,410 50,682 18.28 15.79 0.82858,724 BOM 1,577 13,861 668,447 35,947 16,442 22.09 9.68 0.47224,911 CB 3,365 43,397 2,934,366 152,407 44,193 15.03 23.2 1.42836,360 CBI 3,871 34,015 1,793,560 98,952 39,990 21.33 13.49 0.70 545,045 1,370 61,955 11.42 COB 13,861 1,167,475 16,417 21.89 1.21434,527 1,233 DB 9,953 642,096 32,702 10,734 15.84 19.55 1.00187,689 IDBI 821 1,804,858 142,719 22,547 6.21 13.35 13,598 0.73 682,692 INB 1,899 19,311 53.249 19,263 18.38 19.27 347,838 1.058.042 1.53 2,281 78,934 25,725 12.73 IOB 25,626 1,452,288 16.64 0.71486,105 OBC 1,693 79,103 15.55 16,964 1,390,543 18,925 10.70 1.03495,454 33,721 PSB 983 8,107 597,232 9,840 17.35 16.39 0.90 186,437 PNB 5,256 151,791 3,128,987 63,642 20.71 22.6 1.34 53,114 951,623 2,623 25,481 18.44 SB 28,509 1,355,961 70,681 16.53 0.76 350,676 UCO 2,248 23,026 1,452,776 75,259 20,754 15.42 14.36 429,273 0.66 102.364 UBI 3,150 27,746 2,024,613 39,500 18.33 17.96 1.05 583.991 41,721 UNBI 12,994 1,601 15,062 778,448 14.88 11.74 0.66 262,589 38,973 14,333 12.63 VB 1,276 11,079 732,483 18.96 0.72 251,386 CSB 2,820 87,257 5,140 2,890 26.43 26,903 377 2.6 0.14 CUB 249 2,840 129,143 7,984 2,164 10.01 23.47 1.6736,162 FB 8,270 430,148 23,054 8,361 15.29 11.98 1.34 145,377 771 IVB 527 6,909 301,942 16,875 10,260 22.32 12.86 0.89 110,583 **JKB** 572 7,938 446,759 21,695 7,589 17.88 18.96 1.22196,958 KB 501 5,795 273,364 17,584 5,490 14.96 9.6 0.72 115,063 KVB 404 4,572 247,219 14,508 4,306 12.20 22.26 1.71 77,318 LVB 289 2,626 111,495 6,998 2,281 12.53 12.4 0.91 35,189 NB 103 816 28,249 1,407 559 17.77 16.24 1.56 7,907 RB 102 907 20,422 940 945 38.34 1.71 0.53 8,925 SIB 653 5,619 297,211 16,549 4,625 13.69 17.56 1.05 89,238 TMB 2502,531 137,933 8,272 2,980 17.33 19.96 1.74 37,671 47,794 26,341 85,918 AXB 1,466 1,892,378 12.07 19.34 1.68 719,916 2,085,864 93,851 71,529 17.15 709,294 HDFC 1,999 55,752 16.74 1.58 2,565 56,969 2,256,021 169,572 66,172 1,346,860 ICICI 11.95 9.65 1.35 Table AIII. IIB 323 7,008 343,654 22,129 10,085 11.88 17.91 135,508 1.46 Secondary data KMB 329 10,400 292,610 20,922 15,533 21.50 14.39 1.77 171,214 during 2010-2011 2153,929 459,389 27,948 188,288 (in millions) YB 6,798 10.43 21.13 1.58

Wages as %

Return

Return

										(T)
						Wages as %	Return	Return		The
Bank	No. of	No. of		Interest	Operating	to total	on	on		performance
code	offices	employees	Deposits	expended	expenses	expenses	equity	assets	Investments	efficiency of
										hanks
SBI	14,902	215,481	10,436,474	632,304	260,690	19.01	15.72	0.88	3,121,976	banno
SBBJ	1,036	12,866	615,721	40,700	13,308	15.18	18.59	0.99	166,695	
SBH	1,499	15,043	987,319	72,822	17,358	12.77	21.98	1.15	292,418	602
SBM	788	10,249	501,863	34,941	10,411	13.68	9.62	0.67	147,327	603
SBP	1,121	13,573	794,166	57,859	13,234	11.74	17.95	0.93	220,429	
SBT	910	12,597	714,698	49,984	12,299	12.65	13.93	0.65	224,376	
ALB	2,594	22,334	1,595,931	103,606	26,914	14.06	19.64	1.02	542,832	
ANB	1,757	15,099	1,058,512	75,794	18,042	12.25	19.25	1.19	296,289	
BOB	3,993	41,447	3,848,711	193,567	51,587	12.18	20.64	1.24	832,094	
BOI	4,088	41,537	3,182,160	201,672	49,407	12.22	14	0.72	867,536	
BOM	1,632	13,803	765,287	46,969	16,425	17.56	9.91	0.55	260,314	
CB	3,707	42,272	3,270,537	231,613	46,737	10.68	15.36	0.95	1,020,574	
CBI	4,151	35,901	1,961,733	139,809	37,490	14.14	4.57	0.26	592,433	
COB	1,512	13,813	1,361,422	98,709	17,836	7.84	19.54	1.06	474,746	
DB	1,286	10,202	771,668	46,931	11,547	12.22	19.75	1.08	230,276	
IDBI	979	15,435	2,104,926	188,251	26,075	5.41	11.95	0.83	831,754	
INB	1,994	18,710	1,208,038	78,133	21,870	14.84	17.19	1.31	379,760	
IOB	2,733	27,201	1,784,342	128,729	31,631	12.99	9.88	0.52	555,659	
OBC	1,821	18,371	1,559,649	115,991	23,155	9.75	9.91	0.67	521,013	
PSB	1,045	8,041	631,240	49,734	11,585	13.58	11.21	0.65	200,641	
PNB	5,777	62,127	3,795,885	230,617	70,028	15.71	19.8	1.19	1,227,030	
SB	2,828	26,904	1,579,411	101,833	28,141	14.55	16.32	0.81	408,151	
UCO	2,436	23,147	1,540,035	107,303	20,562	10.82	13.83	0.69	457,715	
UBI	3,344	30,838	2,228,689	142,354	39,875	13.61	13.05	0.79	623,636	
UNBI	1,659	15,500	891,163	54,819	13,833	12.98	11.93	0.70	290,588	
VB	1,377	11,838	830,555	60,846	12,014	10.16	11.54	0.66	286,438	
CSB	385	2,651	106,049	7,686	2,988	19.89	4.66	0.24	31,451	
CUB	303	3,347	163,408	11,970	2,798	8.28	24.91	1.71	45,862	
FB	978	8,745	489,371	36,050	9,793	11.86	14.37	1.41	174,025	
IVB	547	9,642	351,954	26,485	11,102	17.32	13.82	1.09	127,155	
IKB	626	9,258	533,469	29,972	8,022	13.72	21.22	1.56	216,243	
КВ	527	6,087	316,083	23,689	5,682	11.06	9.79	0.73	128,412	
KVB	487	5,673	321,116	23,532	5,416	9.13	20.81	1.56	105,061	
LVB	310	3,054	141,141	11,480	2,937	9.80	11.56	0.73	43,951	
NB	104	851	34,775	2.011	723	18.03	17.74	1.75	11.331	
RB	103	1.328	47.393	2,783	1.391	20.16	5.9	1.38	23,338	
SIB	713	5.630	365.005	25.617	6,173	11.77	19.99	1.12	93,999	
TMB	296	2.855	171.104	12.320	3,490	13.47	20.89	1.75	48,903	
AXB	1.701	31,738	2.201.043	139,769	60.071	10.41	20.29	1.68	931.921	
HDFC	2,553	66,076	2,467,064	149 896	92,776	14.01	18.69	177	974 829	
ICICI	2,786	58 276	2,555,000	228 085	78 504	11 47	11 2	1.50	1.595 600	Table AW
IIB	423	9,370	423 615	36 549	13 430	971	18.26	1.57	145 719	Secondary data
KMB	363	12,540	385,365	36 677	18,348	16 40	14.65	1.83	215,668	during 2011-2012
YB	357	5,642	491,517	46,917	9,325	8.45	23.07	1.57	277,573	(in millions)

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BII										
25,2	Bank	No. of	No. of	Donosita	Interest	Operating	Wages as % to total	Return on	Return on	Introctmente
	code	offices	employees	Deposits	expended	expenses	expenses	equity	assets	Investments
	SBI	15,564	228,296	12,027,396	753,258	292,844	17.57	15.43	0.91	3,509,273
	SBBJ	1,120	12,831	721,162	49,324	15,792	15.17	16.36	0.96	201,459
CO 4	SBH	1,576	15,090	1,133,243	85,299	21,051	13.31	17.70	0.99	339,680
604	SBM	829	10,784	569,690	41,253	11,048	12.24	10.00	0.66	167,746
	SBP	1,184	14,439	886,721	71,134	15,903	11.02	13.17	0.68	239,567
	SBT	1,028	12,525	846,237	65,066	14,302	11.15	14.94	0.66	272,255
	ALB	2,794	22,557	1,787,416	125,693	29,581	12.79	10.84	0.64	583,059
	ANB	1,910	16,523	1,237,956	91,527	20,372	11.50	16.19	0.99	376,324
	BOB	4,377	43,108	4,738,833	238,814	59,467	11.57	15.07	0.90	1,213,937
	BOI	4,373	42,348	3,818,396	228,849	53,315	11.09	12.25	0.65	946,134
	BOM	1,771	13,593	943,369	65,801	17,966	14.18	13.66	0.74	314,303
	CB	3,837	42,693	3,558,560	261,989	51,420	10.38	12.08	0.77	1,211,328
	CBI	4,429	37,113	2,260,383	161,231	42,323	14.21	7.31	0.44	726,038
	COB	1,716	14,819	1,660,055	119,082	19,968	7.12	16.08	0.88	581,645
	DB	1,411	11,093	972,072	65,163	12,997	10.13	15.83	0.86	343,431
	IDBI	1,085	15,465	2,271,165	196,912	31,344	6.74	9.26	0.72	988,009
	INB	2,128	18,793	1,419,802	93,684	27,509	16.29	13.89	1.02	418,050
	IOB	3,042	28,280	2,021,353	154,248	34,078	11.94	4.47	0.24	614,173
	OBC	2,005	18,891	1,758,975	130,036	26,652	10.06	10.74	0.71	585,547
	PSB	1,138	8,533	706,415	56,991	11,193	11.34	7.66	0.44	225,425
	PNB	5,977	63,292	3,915,601	270,368	81,651	16.12	15.70	1.00	1,298,962
	SB	3,041	26,606	1,853,559	116,666	31,788	14.68	20.47	1.07	456,477
	UCO	2,646	24,109	1,734,310	121,702	21,766	9.71	6.76	0.33	522,449
	UBI	3,660	31,798	2,637,616	175,819	45,122	12.47	13.52	0.79	808,304
	UNBI	1,706	15,479	1,006,515	67,642	15,039	11.28	6.84	0.38	334,634
	VB	1,432	12,601	970,172	71,739	13,630	9.94	10.83	0.59	312,850
	CSB	403	2,817	123,416	9,816	3,318	17.81	4.94	0.25	33,011
	CUB	377	3,785	203,048	15,647	3,742	7.78	22.33	1.58	52,668
	FB	1,128	10,059	576,149	41,929	11,795	11.66	13.89	1.35	211,546
	IVB	562	9,381	413,340	33,230	12,728	16.33	14.24	1.26	182,782
	JKB	704	9,400	642,206	38,208	9,890	13.56	23.56	1.70	257,411
	KB	574	6,339	360,562	28,606	6,660	10.64	12.76	0.89	134,325
	KVB	592	6,730	386,530	30,840	7,622	8.93	19.00	1.35	138,373
	LVB	311	3,149	156,190	13,685	3,379	9.24	9.28	0.54	43,245
	NB	110	830	37,236	2,461	801	16.49	13.31	1.30	10,356
	RB	126	1,859	83,405	6,218	2,273	14.73	6.73	1.06	55,714
	SIB	762	6,087	442,623	31,535	7,672	12.05	19.41	1.17	125,235
	TMB	340	3,171	202,238	16,108	4,185	11.94	24.08	2.00	53,483
	AXB	2,019	37,901	2,526,136	175,163	69,142	9.73	18.53	1.70	1,137,375
	HDFC	3,046	69,401	2,962,470	192,538	112,361	13.01	20.34	1.90	1,116,136
Table AV.	ICICI	3,134	62,065	2,926,136	262,092	90,129	11.05	13.10	1.70	1,713,936
Secondary data	IIB	521	11,502	541,167	47,504	17,564	10.17	17.15	1.63	196,542
during 2012-2013	KMB	446	13,620	510,288	48,368	22,097	15.26	15.60	1.81	288,734
(in millions)	YB	428	7,024	669,556	60,752	13,345	8.85	24.81	1.57	429,760

Appendix 2	n assets on equity ents s <u>i</u> y cy score SD	0.000 0.133	89 0.056	0.093 0.128 948 0.095	0.030 0.114 0.078 965 0.094 0.025	The performance of ficiency of bank
n on assets No. of of n on equity No. of er n in on equity No. of er n interest expende expende expende expende	e offices Return c (ROA) e employees Return c (ROE) st Investm ded ded Deposits ses e banks held separate iency score Efficien	1 1 0.882 1	0.981 0.8	0.906 1 1 1 2.0 1 0.0	0.97 1 0.891 1 1 1 0.981 0.9 1 1	
etum on assets Retur (AA) (ROA) etum on equity Retur (ROE) (ROE) (ROE) nvestments Invest Depos	 o. of offices No. of o. of employees No. of eposits Intere expentation perating Public and private officiency score Effici 	1 0.828	0.952	0.966 0.877 1	$\begin{array}{c} 0.975\\ 0.785\\ 0.877\\ 0.812\\ 1\end{array}$	
No. of offices R (R No. of employees R Interest In expended Operating expenses	Return on assets N (ROA) Return on equity N (ROE) Investments D Deposits In Deposits e e e e e e e e e e e e e e e e e e e	1	0.858	0.953 1 0.905	0.957 1 0.978 0.956 0.949	
Return on assets (ROA) Return on equity (ROE) Investments Deposits	No. of offices No. of employees Interest expended Operating expenses All banks together Efficiency score	$\begin{array}{c}1\\0.809\end{array}$	0.931	0.804 0.983 0.856	0.966 0.88 1 0.981 0.997	
Return on assets (ROA) Return on equity (ROE) Investments	No. of offices No. of employees Deposits Interest expended Operating expenses Efficiency score	$\frac{1}{0.646}$	0.837	$\begin{array}{c} 0.769\\ 0.681\\ 0.753\end{array}$	0.908 0.715 0.82 0.77 0.954	
	Bank name	State Bank of India State Bank of Bikaner & Tainur	State Bank of Hvderahad	State Bank of Mysore State Bank of Patiala State Bank of	Allahabad Andhra Bank Andhra Bank Bank of Baroda Bank of India Bank of Maharashtra	
Outputs	Inputs Sr. Bank	no. code 1 SBI 2 SBBJ	3 SBH	4 SBM 5 SBP 6 SBT	7 ALB 8 ANB 9 BOB 10 BOI 11 BOM	Table AV Comparison of bar efficiency score pub vs private bar

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BIJ 25.2			
20,2	0.091 0.053 0.117 0.117 0.066 0.066 0.034 0.034 0.038 0.058 0.107 0.120	0.062 0.082 0.133 0.105 0.055 0.055 0.055 0.078 0.075 0.078 0.075 0.077 0.075 0.077 0.077 0.077 0.077 0.077 0.077 0.077	$\begin{array}{c} 0.122 \\ 0.000 \\ 0.050 \\ 0.077 \\ 0.047 \\ 0.036 \end{array}$
606	1 0.794 1 1 1 1 1	$\begin{array}{c}1\\1\\0.873\\0.907\\0.913\\0.913\\0.913\\0.913\\0.913\\0.916\\0.816\\0.913\\0.946\\0.946\\0.946\\0.846\end{array}$	0.771 1 1 1 1 0.934
	0.912 0.985 1 1 1 0.988 0.982 0.982	1 0.923 0.963 0.967 0.967 0.981 0.881 0.823 0.925 0.823 0.925 0.823 0.823 0.823 0.823 0.833 0.897 0.833 0.831 0.831	1 1 0.944 0.909 1
	0.82 0.936 1 0.953 0.953 0.953 0.953 0.812 0.812 0.773	$\begin{array}{c} 1\\ 0.828\\ 0.757\\ 0.814\\ 0.902\\ 0.932\\ 0.799\\ 0.769\\ 0.768\\ 0.769\\ 0.769\\ 0.769\\ 0.769\\ 0.769\\ 0.769\\ 0.769\\ 0.769\\ 0.835\\ 0.835\\ 0.835\\ 0.835\\ 0.82\end{array}$	1 1 0.848 1
	$\begin{array}{c} 1\\ 1\\ 0.741\\ 0.918\\ 0.917\\ 0.917\\ 0.961\\ 0.991\\ 1\end{array}$	$\begin{array}{c} 0.86\\ 1\\ 1\\ 1\\ 0.873\\ 0.873\\ 0.789\\ 0.789\\ 0.876\\ 0.876\\ 0.876\\ 0.876\\ 0.873\\ 0.876\\ 0.873\\ 0.876\\ 0.873\\ 0.876\\ 0.873\\ 0.876\\ 0.866\\ 0$	$\begin{array}{c} 0.756\\ 1\\ 1\\ 0.964\\ 1\\ 0.926\end{array}$
	$\begin{array}{c} 0.905\\ 0.985\\ 0.985\\ 1\\ 0.974\\ 1\\ 0.934\\ 0.83\\ 0.83\\ 0.982\end{array}$	$\begin{array}{c} 0.924\\ 0.923\\ 0.963\\ 0.967\\ 0.981\\ 0.981\\ 0.981\\ 0.88\\ 0.91\\ 0.88\\ 0.88\\ 0.995\\ 0.88\\ 0.992\\ 0.867\\ 0.992\\ 0.992\\ 0.992\\ 0.992\\ 0.992\\ 0.995\\ 0.992\\ 0.992\\ 0.992\\ 0.995\\ 0.995\\ 0.992\\ 0.995\\ $	$1 \\ 1 \\ 0.876 \\ 0.836 \\ 0.909 \\ 1$
	0.778 0.865 0.954 0.826 0.826 1 0.839 0.732 0.732	$\begin{array}{c} 0.893\\ 0.807\\ 0.701\\ 0.75\\ 0.718\\ 0.848\\ 0.718\\ 0.872\\ 0.718\\ 0.718\\ 0.718\\ 0.718\\ 0.718\\ 0.718\\ 0.718\\ 0.718\\ 0.718\\ 0.718\\ 0.718\\ 0.718\\ 0.718\\ 0.718\\ 0.835\\ 0.835\\ 0.819\\ 0.818\\ 0.819\\ 0.8$	$\begin{array}{c} 1\\ 1\\ 0.998\\ 0.816\\ 1\\ 1\end{array}$
	Canara Bank Central Bank of India Corporation Bank Dena Bank IDBI Bank Indian Bank Indian Overseas Bank Oriental Bank of	Punjab and Sind bank Punjab National Bank Syndicate Bank Urion Bank of India Union Bank of India Vijaya Bank City Union Bank Federal Bank Rarur Vysya Bank Karur Vysya Bank Karur Vysya Bank Karur Vysya Bank Ratmatat Bank Ratmatar Bank Ratmatar Bank Ratmatar Bank Ratmatar Bank Ratmatar Bank Bank South Indian Bank	Axis Bank HDFC Bank ICICI Bank ICICI Bank Kotak Mahindra Bank Yes Bank
Table AVI.	12 CB 13 CB 14 CB 15 DB 16 DB 17 NB 18 CB 17 NB 19 OB 17 NB 19 OB 10 DB 10 DB	TMB MB MB MB MB MB MB MB MB MB	39 AXB 40 HDFC 42 IIB 43 KMB 44 YB YB