



A COMPARATIVE ANALYSIS OF THE PERFORMANCE OF PUBLIC, PRIVATE AND FOREIGN BANKS IN POST REFORM ERA



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Abstract

The present paper investigates the performance of Indian banking industry across the different categories of banks during the post reform era using latest published data from RBI. The measurement of efficiency is done using non-parametric Data Envelopment Analysis (DEA). Three different approaches viz., production approach, intermediation approach and value added approach have been employed to differentiate how efficiency scores vary with changes in inputs and outputs. The findings suggest a positive impact of deregulation measures on the efficiency of Indian banking industry. All categories of banks are found highly efficient in the study period. Foreign banks and nationalized banks emerge 100 per cent efficient under the all three approaches during the entire study period. It is also observed that public sector banks are operating as efficiently as private and foreign banks.

Keywords: Bank efficiency, Data envelopment analysis and Indian banks.



1. INTRODUCTION

India is the largest country in South Asia with a huge financial system characterized by many and varied financial institutions and instruments. Indian banking sector was well developed even prior to its political independence in 1947. The system expanded rapidly after the nationalization of major commercial banks in 1969 and now ranks in the top quarter among developing countries. Scheduled Commercial Banks in India are categorised into five different groups

according to their ownership and / or nature of operation. These bank groups are: (i) State Bank of India and its Associates, (ii) Nationalised Banks, (iii) Regional Rural Banks, (iv) Foreign Banks and (v) Other Indian Scheduled Commercial Banks (in the private sector).

The financial development was given stimulus with the commencement of social control over banks in 1967 and subsequently nationalisation of 14 major scheduled banks in 1969. Since then the banking system has formed the core of the financial system in India. While nationalization accomplished the widening of the banking industry in the country, the task of deepening their services was still left unattended. Till 1990, the social banking goals set for the banking sector made

most of the public sector banks unprofitable. The consequential financial repression led to the deterioration in efficiency and productivity and erosion of profitability of the banking industry in general. Financial sector reforms were introduced in the country in 1992 in order to enhance the efficiency in the process of financial intermediation, improving the effectiveness in the conduct of monetary policy and creating favourable environment for the integration of domestic financial system with the global system. Significant changes have taken place in the banking environment since then. In the light of these comprehensive changes, it is quite appropriate to assess the impact of financial sector reforms on the efficiency, profitability and overall performance of Indian banks in the present era of globalization. This study is an attempt to measure the technical efficiency (or inefficiency) of the Indian banking industry in the post reform era using data envelopment analysis (DEA).

The rest of the paper is structured as follows. Section 2 presents a brief review of the recent studies on efficiency in the post reform era. Section 3 provides the conceptual framework for measuring efficiency using data envelopment analysis. Specification of bank inputs and outputs and data are presented in section 4. Section 5 presents the empirical findings. Section 6 concludes.

2. REVIEW OF LITERATURE

The literature on efficiency of financial institutions has expanded rapidly in recent times. Most bank efficiency studies based on DEA approach evaluated the performance of banking sector in developed countries. As far as developing countries are concerned, very few studies have evaluated the performance of banking sector in these countries. Here, a brief review is presented of the efficiency studies on Indian banking sector conducted in post-reform era.

Using Data Envelopment Analysis, Bhattacharyya et al (1997) assess the impact of the limited liberalization initiated before the deregulation of the 1990s on the performance of various categories of banks for the period 1986 to 1991. They find that public sector banks have the highest efficiency among the three categories, with foreign and private banks having much lower efficiencies. However, public sector banks exhibit a decline in efficiency after 1987, private banks show no change and foreign banks show a sharp rise in efficiency. Subsequently, Swamy (2001) analyse the comparative performance of different bank groups since 1995-96 to 1999-2000. By analysing the share of rural branches, average branch size, trends in bank's profitability, share of public sector assets, share of wages in expenditure, provision and contingencies, net non-performing assets in net advances, spread, he concludes that in many respects nationalized public sectors banks much better than private banks, even they are better than foreign banks. In an another study, Kumbhakar and Sarkar (2003) analyse the relationship between deregulation and productivity growth using data from the Indian banking industry for the period 1985-1996. The results show that a significant decline in regulatory distortions and the anticipated increases in TFP growth have not yet materialized in the Indian banking system following deregulation. While private sector banks have improved their performance mainly due to the freedom to expand output, public sector banks have not responded well to the deregulation measures. Using DEA Sathye (2003) measured the productive efficiency of Indian banks for the year 1997-1998. Two models have been constructed to show how efficiency scores vary with change in inputs and outputs. The study shows that as per Model A, the public sector banks have a higher mean efficiency score as compared to the private sector and foreign commercial banks in India. As per Model B, they have lower mean efficiency score than the foreign banks but still higher than private sector commercial banks. Most banks on the

frontier are foreign owned. Mohan and Ray (2004) attempt a comparison of performance based on revenue maximization efficiency among three categories of banks - public, private and foreign – using Data Envelopment Analysis for the period 1992 to 2000. They find that public sector banks performed significantly better than private sector banks but no significant difference is found between the public sector banks and foreign banks on this measure. The superior performance of public sector banks is to be ascribed to higher technical efficiency rather than higher allocative efficiency.

Kumar (2004) attempts to empirically investigate the ownership-liberalization-efficiency issue of the Indian banking industry using a panel data set for the period 1985 to 1996. It tries to estimate time-invariant and time-variant technical efficiency of the banks in the Indian banking industry using stochastic frontier production function incorporating the Cobb-Douglas technology with four inputs and two alternative measures of output. The results show that the efficiency of the banking industry has not improved after liberalization and the foreign-owned banks as a group has the highest efficiency regardless of the choice of the output measure. Between public sector banks and domestic private banks the results are sensitive to the output measure. The results also show that for more than 70 per cent of the banks the hypothesis of time-invariant technical efficiency holds. In a study on Indian banking covering period 1995-2001, Bhaumik and Dimova (2004) has examined the impact of ownership and competition on bank performance. Using regression framework, the authors have examined the relationship between ownership and performance. The results suggest that, although domestic private and foreign banks performed better than public-sector banks at the onset of financial liberalization, the degree of divergence between the privately owned and public-sector banks narrows significantly over time. Hence, public-sector banks have responded better to competitive forces than their private sector counterparts. Using Stochastic Frontier Analysis for the panel data of 94 banks belonging to different ownership groups, Shanmugam and Das (2004) have analysed the efficiency of banks in India during 1992–1999. The results in general indicate that the state bank group and private-foreign group banks perform better than their counter parts. In a study, Das and Ghosh (2006) investigate the performance of Indian commercial banks during the post reform period 1992–2002, using Data Envelopment Analysis (DEA) under three different approaches viz., intermediation approach, value-added approach and operating approach have been employed to differentiate how efficiency scores vary with changes in inputs and outputs. The study finds that medium-sized public sector banks performed reasonably well and are more likely to operate at higher levels of technical efficiency and observes a close relationship is between efficiency and soundness as determined by bank's capital adequacy ratio. The study suggests that banks having less non-performing loans are technically more efficient. Using stochastic frontier analysis, Sensarma (2006) tries to compare the performance of foreign banks operating in India with the domestic banks for the period 1986 to 2000. The results indicate that foreign banks have been the worst performers throughout the period as compared with state owned and private domestic banks. No significant difference is found in the performance of public sector banks and domestic private sector banks.

Rao (2007) assesses the impact of reform measures on the efficiency, profitability and overall performance of banks vis-à-vis bank groups in public and private sector during the period 1992-93 to 2002-03. The results indicate that in terms of profitability new private sector banks have fared better than public sector banks and old private sector banks. While the level of Non-Performing Assets of public sector banks remained high. In terms of quality of services, capital adequacy and asset quality almost all banks have made significant improvement during the study period. Vedpal and Malik (2007) using multinomial regression analysis examine the difference in financial characteristics of public, private and foreign sector banks based on factors such as profitability, liquidity, risk and efficiency for the period 2000-2005. Results reveal that foreign banks are proved to

be high performer in generating business with a given level of resources and they are better equipped with managerial practices and in terms of skills and technology. Foreign banks are more consistent with market system as reflected in terms of net interest margin. The public banks emerge as the next best performer after foreign banks. The private sector banks emerged with a better utilization of resources as compared to PSB's. Kumar and Gulati (2008) analyse and examine the trends of cost efficiency and the issue of convergence in cost, technical and allocative efficiencies levels across Indian public sector banks for the period 1992-93 to 2007-08. They find that deregulation has had a positive impact on the cost efficiency levels of Indian public sector banks. Technical efficiency of Indian public sector banks followed an upward trend, while allocative efficiency followed a path of deceleration. It is also found that the cost inefficiency is mainly driven by technical inefficiency rather than allocative inefficiency. The convergence analysis reveals that the inefficient public sector banks are not only catching-up but also moving ahead than the efficient ones in the post reform period. Dwivedi and Charyulu (2011) seek to determine the impact of various market and regulatory initiatives on efficiency improvements of Indian banks using data envelopment analysis under the CRS assumption. The study covers the period from 2005-06 to 2009-10. It was found from the results that nationalized banks, new private banks and foreign banks have showed high efficiency over a period time than remaining banks. Using Stochastic Frontier Analysis, Rajan et al (2011) attempt to examine technical efficiency and productivity performance of Indian scheduled commercial banks, for the period 1979-2008. They model a multiple output/multiple input technology production frontier using semi-parametric estimation methods. The results show that the banking system has gone through two major policy upheavals: nationalization in 1969 and deregulation and other reforms in mid-nineties. Both of these have had a significant impact on the efficiency and productivity in the banking industry. Significant changes in the policy environment have clearly enabled banks to expand their operations efficiently under the new liberalized atmosphere. It turns out that the public sector banks (PSBs) are more efficient compared to domestic private banks and foreign banks. Foreign banks are considerably less efficient than PSBs possibly because of their relatively smaller scale. However, the foreign banks have higher efficiency compared to the domestic private banks, due to their specialized activities.

Majority of the studies discussed above seem to suggest a positive impact of deregulation and other reforms started in mid-nineties on the efficiency and productivity of Indian banks across the different ownership groups.

3. DATA ENVELOPEMENT ANALYSIS

It is usual to measure the performance of banks using financial ratios. The major drawback of this approach is its dependence on benchmark ratios. These benchmarks could be arbitrary and may mislead an analyst. In addition, financial ratios do not capture the long-term performance, and aggregate many aspects of performance such as operations, marketing and financing. In recent years, there is a trend towards measuring bank performance using one of the frontier analysis methods. In frontier analysis, the institutions that perform better relative to a particular standard are separated from those that perform poorly. Such separation is done either by applying a non-parametric or parametric frontier analysis to firms within the financial services industry. The parametric approach includes stochastic frontier analysis, the free disposal hull, thick frontier and the distribution free approaches, while the non-parametric approach is data envelopment analysis (DEA). These methodologies differ due to the assumptions imposed on the data in terms of (i) the functional form of the frontier function (Berger and Mester, 1997), (ii) more restrictive parametric form versus less restrictive non-parametric form (Giokas, 1991), (iii) whether or not account is taken of random error, and (iv) if there is random error, the probability distributions assumed for the one-sided inefficiency

term (half normal, truncated normal, exponential and gamma) used to disentangle the inefficiency term from the random error. An excellent review on these approaches is available in Berger and Humphrey (1997), Greene (1993), Bauer (1990) and Kalirajan and Shand (1994). The present study employs the nonparametric frontier approach to estimate the input-oriented technical efficiency of commercial banks in India. The technical efficiency of a decision-making unit (DMU) refers to its success or failure in transforming inputs into outputs. It is a relative concept since its measurement requires a standard of performance against which the success/failure of the firm is assessed.

DEA is a linear programming technique initially developed by Charnes, Cooper and Rhodes (CCR) (1978) and further generalised by Banker, Charnes and Cooper (BCC) (1984) to evaluate the efficiency of public sector non-profit organisations. DEA calculates the relative efficiency scores of various decision making units (DMUs) in the particular sample. The DMUs could be bank or branches of banks. The DEA measure compares each of DMUs in that sample with the best practice in the sample. It tells the user which of the DMUs in the sample are efficient and which are not. The ability of the DEA to identify possible peers or role models as well as simple efficiency scores gives it an edge over other methods. As an efficient frontier technique, DEA identifies the inefficiency in a particular DMU by comparing it to similar DMUs regarded as efficient, rather than trying to associate a DMUs performance with statistical averages that may not be applicable to that DMU.

There are several different ways to present the linear programming problem for DEA. The simplest general presentation of DEA where assumptions include constant returns to scale(CRS), and an objective of minimising inputs for a given level of output (an input-orientated version of DEA), proceeds by solving a sequence of linear programming problems:

(1) Minimise E_n with respect to $w_1, w_2, \dots, w_N, E_n$

Subject to:

$$\sum_{j=1}^N w_j y_{ij} - y_{in} \geq 0 \quad i = 1, \dots, I$$

$$\sum_{j=1}^N w_j x_{kj} - E_n x_{kn} \leq 0 \quad k = 1, \dots, K$$

$$w_j \geq 0 \quad j = 1, \dots, N$$

where there are N organisations in the sample producing I different outputs (y_{in} denotes the observed amount of output i for organisation n) and using K different inputs (x_{kn} denotes the observed amount of input k for organisation n). The w_j are weights applied across the N organisations. When the n th linear program is solved, these weights allow the most efficient method of producing organisation n 's outputs to be determined. The efficiency score for the n th organisation, E_n^* , is the smallest number E_n which satisfies the three sets of constraints listed above. For a full set of efficiency scores, this problem has to be solved N times — once for each organisation in the sample.

The above formula is saying that the efficiency score for the n th organisation should be minimised subject to a number of constraints. The factors that can be varied to do this are the weights w_j and the score E_n itself. The weights are used to form the hypothetical organisation lying on the frontier. The constraints are that the weighted average of the other organisations must produce at least as much of each output, as does organisation n (the first set of constraints above), while not using any more of any input than does organisation n (the second set of constraints above). The third set of constraints simply limits the weights to being either zero or positive. The efficiency score is being minimised because it represents the smallest proportion of existing inputs that organisation n can use and still produce its existing output if it was using the best practice observed in the sample.

One simple addition to the DEA formulae above enables the change to variable returns scale (VRS). This change relaxes the simplistic assumption that inputs normally will move in exact proportions to the scale of operations: it allows for the existence of economies and diseconomies of scale. The additional constraint is that the weights in the DEA formula must sum to one. The variable returns to scale DEA linear program is given by:

(2) Minimise S_n with respect to w_1, \dots, w_N, S_n

Subject to:

$$\sum_{j=1}^N w_j y_{ij} - y_{in} \geq 0 \quad i = 1, \dots, I$$

$$\sum_{j=1}^N w_j x_{kj} - S_n x_{kn} \leq 0 \quad k = 1, \dots, K$$

$$\sum_{j=1}^N w_j = 1$$

$$w_j \geq 0 \quad j = 1, \dots, N$$

The estimation of technical efficiency with CRS and VRS assumptions allows the overall technical efficiency (TE) to be decomposed into two collectively exhaustive components: pure technical efficiency (PTE) and scale efficiency (SE) i.e., $OTE = PT \times SE$. The former relates to the capability of managers to utilize firms' given resources, whereas the latter refers to exploiting scale economies by operating at a point where the production frontier exhibits constant returns to scale. DEA assigns values between 0 and 1 to each efficiency measure. A DMU receiving score 1, is regarded as 100 per cent efficient.

4. DATA AND INPUT OUTPUT SPECIFICATION

The selection of variables to represent inputs and outputs is crucial to the validity of the analysis, and is particularly difficult for financial services firms (as opposed to manufacturing firms that use physical natural resources to produce physical completed products as outputs). Generally speaking, the inputs represent resources that a DMU employs in order to conduct its operations. The

outputs reflect the results that are desired from the inputs utilized. It is worth noting here that there is no consensus on what constitute the inputs and outputs of a bank (Casu and Girardone 2002, Sathye 2003). In the literature on banking efficiency, mainly two approaches dominate for selecting the inputs and outputs for a bank. One is called *production approach*, while the other is known as *intermediation approach*. Both these approaches apply the traditional microeconomic theory of the firm to banking and differ only in the specification of banking activities. The *production approach* as pioneered by Benston (1965) treats banks as the providers of services to customers. The output under this approach represents the services provided to the customers and is best measured by the number and type of transactions, documents processed or specialized services provided over a given time period. However, in case of non-availability of detailed transaction flow data, they are substituted by the data on the number of deposits and loan accounts, as a proxy for the level of services provided. In this approach, input includes physical variables (like labour, material, space or information systems) or their associated cost. This approach focuses only on operating cost and completely ignores interest expenses. The *intermediation approach* as introduced by Sealey and Lindley (1977) treats banks as financial intermediaries channelling funds between depositors and creditors. In this approach, banks produce intermediation services through the collection of deposits and other liabilities and their application in interest-earning assets, such as loans, securities, and other investments. This approach is distinguished from production approach by adding deposits to inputs, with consideration of both operating cost and interest cost.

The available literature on the identification of banking output led to the establishment of the *asset, user cost and value-added approaches*, which can be viewed as variants of the *intermediation approach*. All the three approaches focus on the intermediation activity of banks and mainly use financial data. Under the *asset approach*, banks are considered only as financial intermediaries between liability holders and those who receive bank funds. Loans and other assets are considered to be bank outputs, whereas deposits and other liabilities, together with real resources (labour and capital) are defined as inputs to the intermediation process (Sealey and Lindley 1977). The *user cost approach* determines whether a financial product is an input or an output on the basis of its net contribution to bank revenue. If the financial returns on an asset exceed the opportunity cost of funds or if the financial costs of a liability are less than the opportunity cost, then the instrument is considered to be a financial output. Otherwise, it is considered to be a financial input (Hancock 1985). Finally, *value added* approach identifies the categories of bank balance sheet (assets and liabilities) as outputs by their contribution to the value or because they are associated with the consumption of real resources (Berger et al., 1987). Considering that banks provide two main categories of financial services: intermediation and credit services on one hand, and care, payment and cash on the other hand, in the value added approach, deposits are considered as input and output at the same time. Thus, under this approach, the major categories of deposit products (demand, savings and term deposits) and credits are considered as outputs because they are responsible for a significant proportion of the value added (Karray and Chichti 2005).

The appropriateness of each approach varies according to the circumstances. Following Das and Ghosh (2006) and Forughi and De Zoysa (2012), the present study applies the three major approaches for the identification of the inputs and outputs of banks in the Indian context: (a) production approach, (b) intermediation approach and (c) value added approach. The specified inputs and outputs under every approach are summarized in Table 1.

The present study uses the latest available published data for the period 2005-06 to 2012-13 compiled by Reserve Bank of India. As per this database, Indian banking industry is categorised into

five groups: (1) State Bank of India and its Associates, (2) Nationalised Banks, (3) Old Private sector banks Banks,(4) New private sector banks and (5) Foreign Banks.

Table 1: Specification of Inputs and Outputs

Approaches	Inputs	Outputs
Production approach	Interest expenses Operating expenses Number of employees	Interest income Non-interest income
Intermediation approach	Deposits Operating expenses Number of employees	Loans Investments
Value added approach	Interest expenses Operating expenses Number of employees	Deposits Loans Investments

5. RESULTS

Table 2 to table 4 present the overall, pure and scale technical efficiency scores of five categories of banks calculated by input-oriented DEA under the three different approaches of inputs and outputs specification of banks. The technical efficiency calculated under constant returns to scale assumption is called overall technical efficiency (OTE) which refers to the success/failure of a decision making unit (DMU) in transforming inputs into outputs. The overall technical efficiency is further decomposed into pure technical efficiency (PTE) (the technical efficiency calculated under variable returns to scale assumption) and scale efficiency ((SE).

Table 2: Technical efficiency scores under production approach

BANKS		05-06	06-07	07-08	08-09	09-10	10-11	11-12	12-13
SBI GROUP BANKS	OTE	1	0.9563	0.9778	0.9756	0.9290	0.9734	1	0.9718
	PTE	1	0.9585	0.9870	0.9782	0.9484	0.9890	1	1
	SE	1	0.9977	0.9907	0.9973	0.9795	0.9843	1	0.9718
NATIONLISED BANKS	OTE	1	1	1	1	1	1	1	1
	PTE	1	1	1	1	1	1	1	1
	SE	1	1	1	1	1	1	1	1
OLD PRIVATE SECTOR BANKS	OTE	1	0.9979	1	1	0.9623	0.9686	0.9656	0.9763
	PTE	1	1	1	1	1	1	1	1
	SE	1	0.9979	1	1	0.9623	0.9686	0.9656	0.9763
NEW PRIVATE SECTOR BANKS	OTE	1	1	1	1	1	1	1	1
	PTE	1	1	1	1	1	1	1	1
	SE	1	1	1	1	1	1	1	1
FOREIGN BANKS	OTE	1	1	1	1	1	1	1	1
	PTE	1	1	1	1	1	1	1	1
	SE	1	1	1	1	1	1	1	1

Note: OTE = overall technical efficiency, PTE = pure technical efficiency and SE = scale efficiency.

Source: Authors’ DEA calculation.

Table2 shows that the technical efficiency scores computed under the production approach. As per this approach nationalized banks, new private sector banks and foreign banks exhibit 100 per cent overall technical efficiency(OTE) during the sample period, while the SBI group banks appear 100 percent efficient only in 2005-06 and 2011-12 and the old private sector banks are reported 100 percent efficient only in 2005-06, 2006-07 and 2008-09. In the remaining years, these two categories of banks are reported with the presence of some inefficiency as indicated by comparatively their low OTE score in these years. In case of SBI group banks, this part of inefficiency is mainly attributed by scale and non-scale factors as indicated by their SE and PTE scores. On the other hand, in case of old private sector banks, the presence of inefficiency is purely due to scale factors. In utilizing the inputs old private sector banks appear 100 per cent efficient, as indicated by its PTE score, during the entire study period.

Table 3: Technical efficiency score under intermediation approach

BANKS		05-06	06-07	07-08	08-09	09-10	10-11	11-12	12-13
SBI GROUP BANKS	OTE	0.9364	1	0.9875	1	1	1	1	1
	PTE	1	1	0.9898	1	1	1	1	1
	SE	0.9364	1	0.9976	1	1	1	1	1
NATIONLISED BANKS	OTE	1	1	1	1	1	1	1	1
	PTE	1	1	1	1	1	1	1	1
	SE	1	1	1	1	1	1	1	1
OLD PRIVATE SECTOR BANKS	OTE	0.9508	0.9359	1	1	1	1	0.9521	0.9395
	PTE	1	1	1	1	1	1	1	1
	SE	0.9508	0.9359	1	1	1	1	0.9521	0.9395
NEW PRIVATE SECTOR BANKS	OTE	1	1	1	1	1	1	1	0.9918
	PTE	1	1	1	1	1	1	1	1
	SE	1	1	1	1	1	1	1	0.9918
FOREIGN BANKS	OTE	1	1	1	1	1	1	1	1
	PTE	1	1	1	1	1	1	1	1
	SE	1	1	1	1	1	1	1	1

Note: OTE = overall technical efficiency, PTE = pure technical efficiency and SE = scale efficiency.

Source: Authors’ DEA calculation.

As per intermediation approach as indicated by table3, nationalized banks and foreign banks again emerge as 100 per cent technically efficient in all respects. The new private sector banks also exhibit 100 per cent overall technical efficiency during the entire study period, except the year 2012-13. In this year the OTE score of this group of banks is 0.9918, hence shows the presence some inefficiency, though insignificant, due to some scale factors. As far as PTE is concerned, this group of banks get score 1 during the entire study period, which means that it is 100 per cent efficient in utilizing inputs. In 2005-06, SBI group banks exhibit 6.26 per cent inefficiency which is purely due to scale factors. On the front of input utilization, this group is 100 per cent efficient in this year. In the subsequent years it make improvement in its OTE score by minimising these scale inefficiencies and attains 100 per cent OTE score except the year 2007-08. In this year it shows 1.25 per cent

inefficiency which is very low. As far as old private sector banks are concerned, in the initial two years, this group of banks exhibits 5 and 6.5 percent inefficiency respectively due to scale factors and therefore, indicate that this group of banks is not operating at the optimal scale.

Table 4: Technical efficiency scores under value added approach

BANKS		05-06	06-07	07-08	08-09	09-10	10-11	11-12	12-13
SBI GROUP BANKS	OTE	0.9574	1	1	1	1	1	1	1
	PTE	0.9782	1	1	1	1	1	1	1
	SE	0.9787	1	1	1	1	1	1	1
NATIONLISED BANKS	OTE	1	1	1	1	1	1	1	1
	PTE	1	1	1	1	1	1	1	1
	SE	1	1	1	1	1	1	1	1
OLD PRIVATE SECTOR BANKS	OTE	1	0.9983	0.9966	1	1	0.9838	0.9299	0.9185
	PTE	1	1	1	1	1	1	1	1
	SE	1	0.9983	0.9966	1	1	0.9838	0.9299	0.9185
NEW PRIVATE SECTOR BANKS	OTE	1	1	1	0.9575	1	0.9739	0.9384	0.8992
	PTE	1	1	1	0.9577	1	1	1	1
	SE	1	1	1	0.9998	1	0.9739	0.9384	0.8992
FOREIGN BANKS	OTE	1	1	1	1	1	1	1	1
	PTE	1	1	1	1	1	1	1	1
	SE	1	1	1	1	1	1	1	1
<i>Note:</i> OTE = overall technical efficiency, PTE = pure technical efficiency and SE = scale efficiency.									

Source: Authors’ DEA calculation

Table 4 shows that as per value added approach nationalized banks and foreign banks show 100 per cent OTE score during the sample period. It is quite interesting that under the intermediation and value added approach SBI group banks make significant improvement in their OTE score compared to production approach and appear 100 per cent efficient except the year 2005-06. This could be due the fact that DEA scores are very sensitive to the changes in inputs and outputs. As we change inputs and outputs DEA scores vary significantly. Under the production approach, we take interest and non-interest income as output, while under the intermediation and value added approach loans, investments and deposits are taken as outputs. In maximising loans, investments and deposits, this group of banks is reported highly efficient, whereas in maximising income some inefficiency exists. If banks are unable to enhance their income based efficiency even when they are able to improve their loan based efficiency, this could be due to the presence of non-performing loans (NPLs) in their portfolios. Another possible explanation for this gap between the efficiency scores obtained under the production and intermediation approach could be that this group of banks transferred the benefits of improvement in their efficiency to their customers because though banks produced more loans, advances and investments (i.e. intermediated more funds) with given inputs, they did not extract more income from this intermediation process. On the other hand, new private sector banks lose their status of being 100 percent efficient under the value added approach. Till 2008-09 (the year of global financial crisis), both old and new sector banks have 100 percent or approximately 100 percent OTE score, but after that year a significant decline is observed in their OTE scores. This is due the fact that in value added approach we treat deposits as output rather than input. The decline in the OTE score of these banks particularly after 2008-09, indicates their failure

in augmenting their deposit base (output) in the post crisis period. The reason may be assigned to the losing faith of depositors in the private sector banks due to the global financial crisis.

Table 5: Comparison of Banks on Overall Technical Efficiency

Approaches	Banks	Mean	t-statistic (public & private)	t-statistic (public & foreign)	t-statistic (private & foreign)
Production approach	Public	0.9865	-1.072 (0.303)	-3.321 (0.013)*	-2.656 (0.33)
	Private	0.9919			
	Foreign	1			
Intermediation Approach	Public	0.9952	1.409 (0.183)	-1.209 (0.266)	-2.582 (0.036)*
	Private	0.9856			
	Foreign	1			
Value added Approach	Public	0.9973	1.797 (0.112)	-1.00 (0.351)	-2.056 (0.79)
	Private	0.9748			
	Foreign	1			

Note: (1) Means are for the period 2005-06 to 2012-13.

(2) Figures in parentheses indicate p-values.

The present paper compares the mean levels of overall technical efficiency across the different bank categories using t- test. The table 5 present the results of these comparisons. Under the all three approaches there is no significance difference between the public and private sector banks. Foreign banks are performing better than public sector banks under the production approach. However, no significant difference is found in their performance under the remaining two approaches. Similarly, foreign banks are found significantly better performer than the private sector banks only under the intermediation approach. As per the production and value added approach there is no significance difference between their performances.

6. CONCLUSION

Using latest published data, this paper compares the performance of public, private and foreign banks in India in the post reform era by computing overall, pure and scale efficiency under the three different approaches (production, intermediation and value added) of inputs and outputs specification of banks using Data Envelopment Analysis. The results indicate that nationalized banks and foreign banks show 100 percent technical efficiency under the CRS and VRS assumption regardless of the choice the input and output measures. New private sector banks show 100 percent overall technical efficiency under the production and intermediation approach, while under the value added approach they show the presence of some inefficiency partly due to the scale factors and partly due to their failure in augmenting their deposit base in the post crisis period. Old private sector banks receive 100 per cent PTE score under the all three approaches during the entire study period, but their OTE scores are below 100 per cent. The difference in OTE and PTE scores clearly demonstrate the existence of scale inefficiency among the old private sector banks. SBI group banks appear 100 per cent efficient under the inter mediation and value added approach. However, some inefficiency is observed under the production approach partly due to scale factors and partly due to their inability to enhance their income based efficiency. It is also found that there is no significance difference between performance of public and private sector banks. Foreign banks are significantly better than public sector banks under the production approach, but as per intermediation and value added approach no significance difference is found. Foreign banks are performing significantly better than

the domestic private sector banks only under the intermediation approach. Under the remaining two approaches no significance is found. The results indicate a positive impact of the financial sector reforms on the efficiency of Indian banking industry. All categories of banks are operating with 97 per cent efficiency on average during the entire study period. In the present era of globalization public sector banks are working as efficiently as the domestic private banks and foreign banks.

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