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Analyzing profit efficiency of banks in India with undesirable output — Nerlovian profit indicator approach

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Abstract The objective of this paper is to provide a holistic approach to measure the profit efficiency of banks, factoring desirable/undesirable outputs, using Nerlovian profit indicator approach. The profit inefficiency of banks has been decomposed into technical and allocation inefficiency using directional distance function. Results reveal that profit inefficiency of banks is primarily due to allocative inefficiency and the impact of technical inefficiency on profit inefficiency is minimal compared to allocative inefficiency, which indicates that banks need to focus on optimal utilization of input–output mix to enhance profit efficiency.

Introduction

The banking system in India has undergone a metamorphic change over the last two decades following the recommendations of the Narasimham Committee in 1991 and 1998. The Indian banking system consists of scheduled commercial banks (SCBs) and cooperative banks, of which SCBs account for around 95% of banking system assets. Scheduled commercial banks include: (1) public sector banks comprising State Bank of India and its associates, and nationalized banks, (2) private sector banks comprising old and new private sector banks, (3) regional rural banks, and (4) foreign banks. The measurement of banking efficiency helps banks to remain competitive, profitable, and viable, in an otherwise highly regulated banking industry in India. Das, Nag, and Ray (2005) opine that measurement of banking efficiency serves two important purposes: (1) it helps to benchmark the relative efficiency of an individual bank against the "best practice" bank(s), and (2) it helps to evaluate the impact of various policy measures on the efficiency and performance of these institutions.

The banking sector in India plays a vital role in economic growth and developmental activities in India, which had necessitated researchers to study the impact of the throughput on functional efficiency of banks in India. While there are a number of studies on technical/cost efficiency of financial institutions in the literature, there are very few

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empirical studies related to profit efficiency (Maudos & Pastor, 2003). Technical efficiency was originally developed for use in a nonmarket environment where prices are either not available or are not reliable even if they are available (Ray, 2004). In the input/output oriented technical efficiency approach, the objective of a firm is to contract all inputs/expand all outputs at the same rate to the extent possible without reducing any output/without increasing any input. Both the approaches measure technical efficiency without using the market prices of inputs and outputs. If market prices of inputs/outputs are available, then a firm would either try to minimize its cost or maximize its revenue/profit. In cost minimization process, a firm would seek to minimize the total input cost for a given level of output and in revenue maximization it would look for maximizing the output, thereby total revenue, for a given level of input.

In profit maximization, the objective of the firm would be to select such an input—output bundle that generates maximum revenue with minimum cost, for given input and output prices. Thus, maximizing revenue is as much a necessary condition as cost minimization for maximizing profit. Hence for a profit making firm, profit efficiency is a more important source of information than cost efficiency, which provides partial information (Ray & Das, 2010). In literature, there are numerous studies on measuring the efficiency of financial institutions. In the Indian context, Das et al. (2005) and Ray and Das (2010) studied the profit efficiency of banks using earning assets and excluding the non-performing element. Non-performing assets (NPAs) are the by-products of loans and advances and have a direct impact on performance of banks. Hence for meaningful evaluation, banks should be credited for performing assets (desirable outputs) and penalized for non-performing assets (undesirable output).

Construction of a measure of profit efficiency based on ratio is not viable when both maximal and observed profit may equal zero. In such cases, the ratio of maximal to observed profit may be infinite, which is not meaningful. This is resolved using the Nerlovian profit indicator, which is defined as the difference between price deflated maximal profit and price deflated observed profit.

Against this background, this paper seeks to analyze the profit inefficiency of banks in India with undesirable output using the Nerlovian approach, this being a novel attempt in the Indian context. Further, this paper seeks to analyze the effect of work force on the profit efficiency of banks as the staff expenses of public sector banks have gone up beyond that of the private sector banks during the last decade, though their staff strength declined sharply (Table 1; Chakrabarty, 2012).

The objectives of this paper are to: (1) measure the profit inefficiency of banks for the period 2005—2012, using Nerlovian profit indicator approach, (2) study the effect of work force on the profit inefficiency of banks, (3) analyze the profit inefficiency of banks, bank group-wise and asset size group-wise, (4) decompose Nerlovian profit inefficiency into technical inefficiency and allocative inefficiency and study the factors influencing the profit inefficiency of banks, and (5) provide an interval estimation for profit inefficiencies of banks.

Rest of the paper is as follows: The second section presents a brief review of the relevant literature and the third section provides an overview of the Indian banking system and its performance during the period of study. The fourth section describes the Nerlovian approach and directional distance function used in this paper. The empirical model, data sources along with identification of inputs and outputs are reported in the fifth section and the findings from the empirical analysis are discussed in the sixth section. The seventh section summarizes the findings and conclusions.

Review of literature

Farrell (1957) demonstrated the decomposition of cost inefficiency into technical inefficiency and allocative inefficiency using input distance function. Similarly, using the revenue function and its dual output distance function, Fare, Grosskopf, and Lovell (1994) decomposed revenue inefficiency into technical inefficiency and allocative inefficiency. The input/output distance function measures technical efficiency, either in the input direction or output direction. The directional distance function, on the other hand, simultaneously contracts the inputs and expands the outputs. It is shown that input and output distance functions are special cases of directional distance function (Fare & Grosskopf, 2000).

Table 1 Bank group-wise number of staff and cost per employee (Amount in rupees).

Bank group/Year	Public		Private		Foreign	
	No. of staff	Cost per employee	No. of staff	Cost per employee	No. of staff	Cost per employee
1999	883648	167940	60777	169307	15505	496539
2005	741480	339478	81040	363120	20002	682311
2006	744333	367821	110505	368977	22117	906618
2007	728878	381449	137284	383439	28426	1083927
2008	715408	400611	158823	447920	31301	1335477
2009	731524	472493	176339	483501	29582	1650978
2010	739646	555874	182520	516491	28012	1679855
2011	757535	715914	218679	563154	27969	1931768
2012	771388	744790	246042	599888	26472	2172241

Source: Database on Indian Economy, RBI Data warehouse.

The duality between this distance function and the profit function was exploited by Chambers, Chung, and Fare (1998) and Fare, Grosskopf, and Weber (2004) in the theoretical development and empirical application of profit efficiency defined by Nerlove (1965) and its decomposition into allocative and technical efficiency, respectively (Fare & Grosskopf, 2000).

Maudos and Pastor (2003), using Spanish banking sector data from 1985 to 1996, analyzed the cost and profit efficiencies of Spanish banks, applying Data Envelopment Analysis (DEA). They observed that there is a positive rank correlation coefficient between cost efficiency and profit efficiency of Spanish banks, and if banks are more cost efficient, they are also more profit efficient.

Fare et al. (2004) used Nerlovian measure to determine the effect of risk based capital requirements on the profit performance of US banks. They studied a random sample of US banks for three years 1990, 1992 and 1994 and observed that allocative inefficiency is a major contributor for profit loss rather than technical inefficiency. Also, they observed that risk based capital has a significant effect on a bank's allocative efficiency. Using Nerlovian measure, Resende and Silva (2007) studied the profit efficiency of Portuguese banks for 2000—2004 and observed that Portuguese banks need appropriate choices of input—output mix and a repositioning strategy. Mulwa and Emrouznejad (2011) illustrated the measurement of Nerlovian profit efficiency indicator and metafrontier using sugarcane production in three regions in Kenya.

In the Indian context, there are number of papers on technical/cost efficiency of banks in India (Das, 2002; Jayaraman & Srinivasan, 2009; Kumar & Gulati, 2008; Ram Mohan & Ray, 2004; Shanmugam & Das, 2004). Das et al. (2005) have analyzed the cost efficiency, revenue efficiency, and profit efficiency of Indian banks for 1997—2003 using DEA. They observed that results of input-oriented, output-oriented, and cost efficiency measures were more or less similar, but the results in respect of revenue and profit efficiencies differed sharply during this period. They found that bank size, ownership, and stock exchange listing had a positive impact on profit efficiency and to some extent, revenue efficiency.

Das and Ghosh (2006) investigated the performance of the Indian banking sector using three different approaches of DEA viz., (1) intermediation approach, (2) value added approach, and (3) operating approach. The findings suggest that medium-sized public sector banks performed reasonably well, and technically more efficient banks are those that have, on an average, fewer nonperforming loans. Das and Ghosh (2009) indicated that high levels of efficiency in costs and lower levels in profits reflect the importance of inefficiencies on the revenue side of banking activity. Further, the decomposition of profit efficiency shows that a large portion of outlay lost is due to allocative inefficiency of banks.

Ray and Das (2010) studied the cost and profit efficiency of Indian banks using DEA during the post reforms period and observed that public sector banks are more efficient compared to private sector banks, and small banks (with assets up to Rs.50 billion) are operating below the efficiency frontier. Also, there is a strong evidence of ownership explaining the efficiency differentials of banks. Using hedonic aggregator function, a similar study by Das and Kumbhakar (2012) on the productivity and efficiency of Indian banks observed that efficiency of public sector banks has surpassed the efficiency of private sector banks during the post reform period 1996—2005.

Overview of the Indian banking system

The banking system in India was mostly government owned till the early 1990s. The first phase of reforms in 1991 focussed on making the financial sector into an efficient, productive, and profitable financial service industry. Following are some of the major measures during the first phase of reforms: (a) reduction in reserves requirements, (b) capital adequacy norms, (c) introduction of prudential and uniform accounting practices aligning with international standards, (d) interest rate deregulation, (e) entry deregulation, (f) adoption of prudential norms, (g) shift of banking sector supervision, and (h) thrust on technological upgradation. These measures created a competitive environment in the banking system, which in turn facilitated lowering of interest rates and interest spread in line with international standards. During the second phase of reforms in 1998, the main emphasis was on structural measures, improvement in disclosure standards, and level of transparency with an aim to align Indian banking standards with internationally recognized best practices. The hallmark of the reform process has been "gradualism" (Mohan, 2005). The performance indicators of Indian banks are now approaching international standards and they are among the better performers in the emerging market group. A key achievement of banking sector reform isa sharp improvement in the financial health of banks, which is evident through strong balance sheet growth of the banks and improved asset quality (Das & Kumbhakar, 2012). Table 2 presents a few key performance indicators of SCBs for three years — 2005, 2008, and 2012.

The business and financial performance of SCBs during 2005 and 2006 was underpinned by a strong macroeconomic environment and supporting monetary and financial policies. Scheduled commercial banks exhibited robust growth in terms of aggregate deposits and gross bank credit during these two years with improved asset quality and profitability. The operation of SCBs in 2007 was marked by a large expansion of credit with some moderation. The continued high credit demand in 2007, caused an upward pressure on lending rates as well as deposits rates, which in turn caused increase in cost of borrowings and return on advances. In 2008, performance of SCBs was mainly shaped by macroeconomic performance. Though term loans and aggregate deposits declined during this year, investments recorded a very high growth compared to previous years. The net profits of SCBs registered a significant growth during this year despite a large increase in provisions and contingencies.

For the Indian banking industry, year 2009 was a testing period because of the global financial crisis and its repercussions. Counter-cyclical prudential regulations framework adopted during credit boom period as well as slowdown period, enabled the banking industry to withstand this test. However, it was not completely insulated from the effects of slowdown of economy which was

Table 2 Select performance indicators of scheduled commercial banks for 2005, 2008 & 2012 (Amount in Rs. billion).

Year/Bank group	2005			2008			2012		
	Pub.	Pvt.	For.	Pub.	Pvt.	For.	Pub.	Pvt.	For.
No. of banks	28	29	31	28	23	28	26	21	43
No. of branches	47320	6143	220	55124	8334	279	69498	13408	324
Deposits	14365	3146	864	24539	6750	1912	50020	11746	2774
Advances	8542	2213	753	17974	5184	1611	38783	9664	2301
Investments	6862	1407	429	7998	2786	989	15041	5260	2024
Profit/Loss	154	35	20	266	95	66	495	227	94
Net interest income	516	100	51	642	225	138	1562	472	211
Business per branch	0.48	0.87	7.35	0.77	1.43	12.63	1.28	1.60	15.66

Pub: public; Pvt: private; For: foreign.
Source: Database on Indian Economy, RBI Data warehouse.

evident from decelerated growth of aggregate deposits, loans and advances, and net profits, and a sharp increase in provisions and contingencies. In 2010, there were some concerns with respect to asset quality, deposits growth, and net profit of SCBs. The strong capital to risk-weighted assets ratio (CRAR) of the banks, above the Basel II requirements, provided cushion for the banks from the crisis.

The year 2011 was once again a testing period for the Indian banking sector because of a challenging operational environment characterized by high interest rates, tight liquidity conditions, and high inflation. The higher interest rate environment not only caused concern about slowdown in credit growth, but also about the possibility of deterioration in asset quality, as well as weakening of the repayment capacities of borrowers in general. Despite the widespread concern about slowdown, aggregate deposits, loans and advances, and net profits registered a higher growth rate during this year. In 2012, major profitability indicators i.e., return on assets and return on equity dipped marginally; however, cost to income ratio of banks improved during this year, reflecting marginal gains in efficiency. Banks' exposure to the stressed power and airline sectors particularly added to deterioration in their asset quality and there were concerns about the growing NPAs.

Nerlovian profit indicator

The Nerlovian efficiency measure proposed by Nerlove (1965) decomposes the profit maximization into two stages: (1) Profit maximization of given production function and (2) maximum maximorum of profit is found by maximizing over all possible production functions (Mulwa & Emrouznejad, 2011). The overall efficiency of a decision making unit (DMU) is then obtained by comparing the maximum maximorum profit and observed profit. For a given production function, the difference between maximum maximorum profit and maximum profit of a DMU provides a measure of inefficiency which can be decomposed into technical inefficiency and allocative inefficiency using the directional distance function (Chambers et al., 1998).

Suppose there are K decision making units producing m outputs $\mathbf{y} = (y_1, \ldots, y_m) \in \mathbb{R}^{M+}$ from the given n inputs $\mathbf{x} = (x_1, \ldots, x_n) \in \mathbb{R}^{N+}$. Then the production possibility set (PPS) is defined as collection of all feasible input—output vectors and represented as: $T = \{(\mathbf{x}, \mathbf{y})$: $\mathbf{x}$ can produce $\mathbf{y}\}$. It is assumed that T is closed and convex with freely disposable inputs and outputs. Let $\mathbf{p}$ be the output prices of $\mathbf{y}$ denoted as $\mathbf{p} = (p_1, \ldots, p_m) \in \mathbb{R}^{M+}$ and $\mathbf{w}$ be the input prices of $\mathbf{x}$ denoted as $\mathbf{w} = (w_1, \ldots, w_n) \in \mathbb{R}^{N+}$. Using the input and output prices, the associated cost, revenue, and profit of a DMU is estimated as under:

$$\text{Cost}: \quad wx = \sum_{i=1}^{n} w_i x_i \tag{1}$$

$$\text{Revenue}: \quad py = \sum_{j=1}^{m} p_j y_j \tag{2}$$

$$\text{Profit}: \quad py - wx = \sum_{j=1}^{m} p_j y_j - \sum_{i=1}^{n} w_i x_i \tag{3}$$

The maximal profit denoted by π ($\mathbf{p}$, $\mathbf{w}$) is defined as:

$$\pi(\mathbf{p}, \mathbf{w}) = \text{Max}\{\mathbf{py} - \mathbf{wx}; (\mathbf{x}, \mathbf{y}) \in T\} = \mathbf{py}^* - \mathbf{wx}^* \tag{4}$$

where ($\mathbf{x}^*$, $\mathbf{y}^*$) are the input and output vectors associated with the maximum profit given the corresponding price vectors ($\mathbf{w}$, $\mathbf{p}$). For the k-th DMU, the maximum profit is obtained by solving the following linear programming problem:

$$\pi^k(\mathbf{p}, \mathbf{w}) = Max\left(\sum_{j=1}^{m} p_j^k y_j^{k^*} - \sum_{i=1}^{n} w_i^k x_i^{k^*}\right)$$

$$\begin{aligned} &\text{subject to} \\ &\sum_{k=1}^{K} \lambda^k y_j^k \geq y_j^{k^*} \quad j = 1, 2, \ldots, m \\ &\sum_{k=1}^{K} \lambda^k x_i^k \leq x_i^{k^*} \quad i = 1, 2, \ldots, n \\ &\sum_{k=1}^{K} \lambda^k = 1; \lambda^k \geq 0 \quad k = 1, 2, \ldots, K \end{aligned} \tag{5}$$

The Nerlovian profit inefficiency (NIE) for k-th DMU is defined as the difference between the maximal profit and the observed profit, normalized with value of direction vector (g_x, g_y) (Chambers et al., 1998) and provides unit-free measure of profit inefficiency (Fare & Grosskopf, 1997, 2004).

$$NIE = \frac{\pi^k(p,\ w) - \ (py^k - wx^k)}{pg_y + wg_x} \tag{6}$$

The Nerlovian profit inefficiency defined in Eqn. (6) can be decomposed into technical inefficiency and allocative inefficiency using the directional distance function (DDF). The DDF on the set T is defined as:

$$\overrightarrow{D_T}\left(x, y; g_x, g_y\right) = \max\left\{\beta : \left(y + \beta g_y, \times - \beta g_x\right) \in T\right\} \tag{7}$$

where (g_x, g_y) are the non-zero vectors in $R^{N+} x\, R^{M+}$, and determines the direction in which $\overrightarrow{D_T}(.)$ is defined. The positive vector for output $\boldsymbol{y}$ and negative for input $\boldsymbol{x}$ indicates simultaneous reduction of inputs and expansion of outputs. Under the free disposability of inputs and outputs and other assumptions on T, the directional distance function represents technology and provides a measure of technical efficiency. For *k-th* DMU, the technical efficiency under DDF can be measured by solving the following linear programming problem:

$$\overrightarrow{D_T^k}\left(x^k, y^k; g_x, g_y\right) = \max \beta$$

subject to

$$\sum_{k=1}^{K} \lambda^k y_j^k \geq y_j^{k^*} + \beta\, g_y \quad j = 1, 2, \ldots, m$$
$$\sum_{k=1}^{K} \lambda^k x_i^k \leq x_i^{k^*} - \beta\, g_x \quad i = 1, 2, \ldots, n \tag{8}$$
$$\sum_{k=1}^{K} \lambda^k = 1; \quad \lambda^k \geq 0 \quad k = 1, 2, \ldots, K$$

The dual relation between directional distance function and profit function provides the basis for decomposition of Nerlovian profit inefficiency into technical inefficiency and allocative inefficiency (Chambers et al., 1998). The link between profit function and directional distance function is established using the translated vector (Mulwa & Emrouznejad, 2011):

$$\left(y + \overrightarrow{D_T}\left(x, y; g_x, g_y\right) g_y, x - \overrightarrow{D_T}\left(x, y; g_x, g_y\right) g_x\right) \in T \tag{9}$$

implies that there exists a scalar β such that $(\,y + \ \beta\, g_y\ ,\ x - \ \beta\, g_x\,) \in T$. From the definition of profit efficiency.

$$\pi(\boldsymbol{p}, \boldsymbol{w}) = \text{Max}\left\{\boldsymbol{py} - \boldsymbol{wx}; (\boldsymbol{x}, \boldsymbol{y}) \in T\right\} \geq \boldsymbol{py} - \boldsymbol{wx} \tag{10}$$

Substituting the translated vector Eqn. (9) in Eqn. (10), the profit efficiency of *k-th* DMU is defined as:

$$\pi^k(\boldsymbol{p}, \boldsymbol{w}) \geq p\left(y^k + \overrightarrow{D_T^k}\left(x^k, y^k; g_x, g_y\right) g_y\right) - w\left(x^k - \overrightarrow{D_T^k}\left(x^k, y^k; g_x, g_y\right) g_x\right) \geq \left(py^k - wx^k\right) + \overrightarrow{D_T^k}\left(x^k, y^k; g_x, g_y\right)\left(pg_y + wg_x\right) \tag{11}$$

By rearranging Eqn. (11), we get.

$$\frac{\pi^k(p,\ w) - \left(py^k - wx^k\right)}{\left(pg_y + wg_x\right)} \geq \overrightarrow{D_T^k}\left(x^k, y^k; g_x, g_y\right) \tag{12}$$

where left hand side of Eqn. (12) represents the Nerlovian profit inefficiency of *k-th* DMU, which is, difference between the maximal profit $\pi^{\,k}(p,\ w)$ and the actual profit $(py^k - wx^k)$, normalized with value of direction vector $(pg_y +\ w\, g_x)$. On the other hand, the directional distance function on the right hand side of Eqn. (12) provides the technical inefficiency of *k-th* DMU. The difference between the Nerlovian profit inefficiency and technical inefficiency provides a measure for allocative inefficiency of *k-th* DMU (Chambers et al., 1998; Fare & Grosskopf, 1997). The technical inefficiency indicates performance of DMU below the frontier and allocative inefficiency refers to profit losses of DMU due to incorrect choice of input—output mix given the relative prices of inputs and outputs. The Nerlovian profit inefficiency decomposed into technical inefficiency and allocative inefficiency (AIE) is given below:

$$\frac{\pi^k(p, w) - \left(py^k - wx^k\right)}{\left(pg_y + wg_x\right)} = \overrightarrow{D_T^k}\left(x^k, y^k; g_x, g_y\right) + \text{AIE} \tag{13}$$

All the measures in Eqn. (13) are necessarily non-negative, which implies that if a DMU is Nerlovian profit efficient, then it must be both technical and allocative efficient.

Basis of selection of inputs and outputs, and empirical models

In the highly regulated Indian banking industry, which has multiple stakeholders such as the government, the Reserve Bank of India as regulator, the general public, investors, borrowers, and others., the margin and options available to banks to improve their profits is very limited. Banks follow multiple approaches to expand their business operations and profits such as expansion of bank branches, improving customer services, technology adoption, deployment of funds in aggressive/moderate/low risk appetites, sector focussed business strategies, and so on. All of these either individually or collectively lead to profit efficiency or inefficiency for each of the constituent banks.

Subbarao (2011) opined that Indian banks should make efforts to reduce the operating costs through productivity improvement and skill enhancement and by leveraging of technology. This is achieved through nurturing asset quality, diligent loan restructuring of viable assets, and reducing non-performing loans through recovery or upgradation. In this context, the selection of input—output variables plays an important role in measuring the efficiency of banks. Because of interconnectedness of various products and services, selection of input—output variables for banks has not been straightforward. In general, there is no consensus in literature about selection of input—output variables for bank studies and the selection is left to the choice of researchers. Production approach and intermediation approach are the two most widely used approaches in banking studies. While the former uses deposits and advances as outputs, and capital and labor as inputs, the latter uses deposits, investments and advances as outputs, and operational and interest expenses as inputs. The appropriateness of each approach depends on the issues and problems addressed in a research study. In general, production approach is suitable for branch level studies, while intermediation approach is suitable for bank level studies (Berger & Humphrey, 1997).

Borrowed funds (deposits and borrowing), advances, and investments along with associated prices viz., cost of funds, return on advances, and return on investments are the commonly used variables to measure the efficiency of a bank (Das et al., 2005; Fare et al., 2004; Ray & Das, 2010; Resende & Silva, 2007). In this study, we have used borrowed funds and deployed funds (advances and investments) and a few other variables to measure the profit efficiency of the banks. The deployed funds used in this paper include only performing loans and advances (not gross loans and advances) as they contribute to the revenue of a bank (Das et al., 2005). Since non-performing loans have a direct impact on provisions and contingences as well as on net profits of banks, as a novel attempt, in this paper we have included non-performing assets as undesirable output in this study. Of late, there is an emphasis on including non-traditional activities of banks while studying efficiency of banks. Considering the increased importance of non-traditional activities of banks, non-interest income from fee, commission, brokerage etc. has been included as one of the output variables. Bank branch networks which contribute to the business performance of the banks have been included as one of the input variables.

The present study uses four inputs, two outputs, and one undesirable output to measure and analyze the profit efficiency of banks. The two output variables are: (1) deployed funds comprising performing loans and investments and (2) non-interest income from fee, commission, brokerage etc. The associated output price for deployed funds is ratio of interest income from performing loans and investments to total deployed funds, and for non-interest income, it is unity (Das et al., 2005). Gross NPA is the undesirable output and its associated price is the ratio of provision for NPA to gross NPA. The four input variables are: (1) equity (capital plus reserves and surplus), (2) borrowed funds comprising deposits and borrowings, (3) work force i.e., number of employees, and (4) total number of bank branches. Equity is treated as fixed inputs with no associated cost and the associated cost for borrowed funds is the ratio of interest expenses on deposits and borrowings to total borrowed funds. The associated cost for work force is the ratio of payments to and provisions for employees to total staff strength and the associated cost for total number of bank branches is the ratio of operating expenses excluding payments to and provisions for employees to total number of bank branches. Summary statistics of selected variables are given in Table 3.

The empirical model used in this paper is as follows: Assume there are $k = 1, \ldots, K$ banks using 'n' inputs and $(n+1)$ fixed input and produce 'm' outputs and 'q' undesirable outputs denoted by $\boldsymbol{x} = (x_1, \ldots, x_n) \in \mathbb{R}^{N+}$, $\boldsymbol{y} = (y_1, \ldots, y_m) \in \mathbb{R}^{M+}$ and $\boldsymbol{u} = (u_1, \ldots, u_q) \in \mathbb{R}^{Q+}$. Let $\boldsymbol{r}$ be the price of undesirable output u denoted as $\boldsymbol{r} = (r_1, \ldots, r_q) \in \mathbb{R}^{Q+}$. The production possibility set T is defined as:

$$T = \Big\{ (x,y) : \sum_{k=1}^{K} \lambda^k y_j^k \geq y_j, j = 1,2,\ldots,m; \sum_{k=1}^{K} \lambda^k u_l^k = u_l, l = 1,2,\ldots,q; \sum_{k=1}^{K} \lambda^k x_i^k \leq x_i, i = 1,..,n; \sum_{k=1}^{K} \lambda^k x_{n+1}^k \leq x_{n+1}; \sum_{k=1}^{K} \lambda^k = 1; \lambda^k \geq 0; k = 1,2,\ldots,K \Big\} \tag{14}$$

The maximum profit for *k-th* bank is obtained by solving Eqn. (15) and its technical inefficiency is obtained by solving the directional distance function eqn. given in Eqn. (16) (Ke, Li, & Chiu, 2011).

$$\pi^k(\boldsymbol{p}, \boldsymbol{r}, \boldsymbol{w}) = Max \left(\sum_{j=1}^{m} p_j^k y_j^{k^*} - \sum_{l=1}^{q} r_l^k u_l^{k^*} - \sum_{i=1}^{n} w_i^k x_i^{k^*} \right)$$

subject to

$$\begin{aligned} &\sum_{k=1}^{K} \lambda^k y_j^k \geq y_j^{k^*} \quad j = 1,2,\ldots,m \\ &\sum_{k=1}^{K} \lambda^k u_l^k = u_l^{k^*} \quad l = 1,2,\ldots,q \\ &\sum_{k=1}^{K} \lambda^k x_i^k \leq x_i^{k^*} \quad i = 1,2,\ldots,n \\ &\sum_{k=1}^{K} \lambda^k x_{n+1}^k \leq x_{n+1}^k \\ &\sum_{k=1}^{K} \lambda^k = 1; \quad \lambda^k \geq 0 \quad k = 1,2,\ldots,K \end{aligned} \tag{15}$$

$$\overrightarrow{D_T^k}\left(x^k, y^k, u^k; g_x, g_y, g_u\right) = max\beta$$

subject to

$$\begin{aligned} &\sum_{k=1}^{K} \lambda^k y_j^k \geq y_j^{k^*} + \beta g_y \quad j = 1,2,\ldots,m \\ &\sum_{k=1}^{K} \lambda^k u_l^k = u_l^{k^*} - \beta g_u \quad l = 1,2,\ldots,q \\ &\sum_{k=1}^{K} \lambda^k x_i^k \geq x_i^{k^*} - \beta g_x \quad i = 1,2,\ldots,n \\ &\sum_{k=1}^{K} \lambda^k x_{n+1}^k \leq x_{n+1}^k \\ &\sum_{k=1}^{K} \lambda^k = 1; \quad \lambda^k \geq 0 \quad k = 1,2,\ldots,K \end{aligned} \tag{16}$$

The choice of directional vector $g = (g_x, g_y, g_u)$ in Eqn. (16) depends on the optimal values of inputs and outputs obtained from Eqn. (15). If the optimal values of inputs and outputs are the same for all the banks, then the directional vector is the same as that of optimal values i.e. $g = (x*, y*, u*)$. If the optimal values of inputs and outputs are varying, then the directional vector is $g = (-1, 1, -1)$ or $g = (\overline{x}, \overline{y}, \overline{u})$ (Mulwa & Emrouznejad, 2011). In this study, we have used $g = (\overline{x}, \overline{y}, \overline{u})$ as the directional vector because of varying optimal values. The Nerlovian profit inefficiency and the allocative inefficiency of *k-th* bank is obtained by substituting Eqn. (15) and Eqn. (16) in Eqn. (17) using $(p\overline{y} + r\overline{u} + w\,\overline{x})$ as denominator.

$$\frac{\pi^k(p,r,w) - \left(py^k - ru^k - wx^k\right)}{\left(pg_y + rg_u + w\,g_x\right)} \geq \overrightarrow{D_T^k}\left(x^k, y^k, u^k; g_x, g_y, g_u\right) \tag{17}$$

Table 3 Summary statistics of selected variables — mean & standard deviation (Amount in Rs. billion).

Year	2005	2006	2007	2008
Input variables and their cost				
Equity (x_1)	26.48	33.13	37.97	47.94
	(36.83)	(46.57)	(55.17)	(76.45)
Borrowed funds (x_2)	394.10	469.88	545.46	648.41
	(566.13)	(647.28)	(743.67)	(884.66)
No. of branches (x_3)	1206	1245	1255	1294
	(1529)	(1536)	(1532)	(1639)
No. of staff (x_4)	19175	19526	19091	18851
	(31974)	(30939)	(28505)	(27312)
Cost of borrowed funds (w_2)	0.05	0.05	0.05	0.06
	(0.01)	(0.01)	(0.01)	(0.01)
Per branch cost (w_3) (Rs. lakhs)	61.77	70.63	69.67	71.64
	(96.66)	(121.49)	(117.97)	(95.17)
Staff cost (w_4) (Rs. lakhs)	3.28	3.64	3.67	3.91
	(0.54)	(0.70)	(0.64)	(0.80)
Output variables and their price				
Deployed funds (y_1)	382.71	461.84	536.74	639.72
	(565.60)	(652.68)	(747.15)	(890.93)
Non-interest income (y_2)	2.89	3.62	4.52	5.40
	(5.93)	(7.36)	(9.33)	(11.62)
Gross NPA (y_3)	13.36	12.06	10.61	10.77
	(20.42)	(17.68)	(15.68)	(18.53)
Return on deployed funds (p_1)	0.08	0.08	0.09	0.09
	(0.01)	(0.01)	(0.01)	(0.01)
Return on non interest income (p_2)	1.00	1.00	1.00	1.00
	(0.00)	(0.00)	(0.00)	(0.00)
NPA provision (p_3)	0.62	0.62	0.61	0.60
	(0.19)	(0.18)	(0.21)	(0.19)
Year	2009	2010	2011	2012
Input variables and their cost				
Equity (x_1)	63.24	72.57	89.18	104.77
	(103.95)	(115.54)	(125.96)	(141.59)
Borrowed funds (x_2)	840.11	1001.58	1236.18	1427.54
	(1148.62)	(1378.11)	(1599.88)	(1829.71)
No. of branches (x_3)	1429	1508	1691	1799
	(1833)	(1974)	(2149)	(2236)
No. of staff (x_4)	20115	20015	21990	22591
	(31438)	(30456)	(34242)	(33527)
Cost of borrowed funds (w_2)	0.07	0.06	0.05	0.07
	(0.01)	(0.01)	(0.01)	(0.01)
Per branch cost (w_3) (Rs. lakhs)	68.91	66.19	67.87	71.68
	(78.90)	(65.20)	(59.26)	(59.41)
Staff cost (w_4) (Rs. lakhs)	4.71	5.26	6.85	6.90
	(1.03)	(1.28)	(1.61)	(1.70)
Output variables and their price				
Deployed funds (y_1)	819.76	968.46	1197.32	1388.88
	(1136.73)	(1353.48)	(1567.01)	(1776.72)
Non interest income (y_2)	6.74	7.56	9.42	10.09
	(14.07)	(16.05)	(19.53)	(20.52)
Gross NPA (y_3)	12.71	15.15	19.27	25.43
	(24.03)	(28.76)	(35.96)	(49.84)
Return on deployed funds (p_1)	0.10	0.09	0.09	0.10
	(0.01)	(0.01)	(0.01)	(0.01)
Return on non interest income (p_2)	1.00	1.00	1.00	1.00
	(0.00)	(0.00)	(0.00)	(0.00)
NPA provision (p_3)	0.59	0.57	0.58	0.56
	(0.18)	(0.16)	(0.16)	(0.16)

In this paper, profit inefficiency of banks in India has been analyzed for the period 2005—2012 in two phases, to study the effect of work force on the profit inefficiency of banks. In the first phase, i.e., model 1, profit inefficiency of banks has been calculated by keeping work force as one of the input variables and in second phase, i.e., model 2, profit inefficiency of banks has been calculated excluding work force as input variable. Inefficiency scores from these two models have been used to study the impact of work force on the profit inefficiency of the banks. To make it comparable, only banks with more than Rupees fifty billion assets have been included in this study. Further, since the operational aspects of foreign banks are different from public and private sector banks, they have been excluded from the study. Data for this study has been collected from Reserve Bank of India's data warehouse, Database on Indian Economy, various issues of *Statistical Tables Relating to Banks in India* and *Trend and Progress of Banking in India*. The nominal variables are not adjusted for inflation, since efficiency is measured against a contemporaneous frontier, (Ray & Das, 2010). We have used MS-Excel Solver to measure the Nerlovian profit inefficiency and directional distance function scores (Zhu, 2009).

Empirical results

Following the models specified in the previous section, we have measured Nerlovain profit inefficiency, technical inefficiency, and allocative inefficiency of each bank for each year, by solving the linear programming problem of profit maximization and the directional distance function given in Eqn. (15) and Eqn. (16) respectively. Table 4 presents year-wise profit inefficiency of the banks obtained from the two models viz., with work force (WWF) and without work force (WOWF).

Under model 1, the Nerlovian profit inefficiency of banks ranges between 2.3% and 7.1% and, under model 2 it ranges between 2.2% and 7.1% during the period of study. Steady decline in profit inefficiency in the scores of public sector and private sector banks during 2005—2012 under both models implies better performance of these banks, despite economic slowdown. The increase in number of banks operating on the efficient frontier during the post financial crisis period (2009—2012) compared to the pre-crisis period (2005—2007) also supports the above fact. The higher profit inefficiency score observed during 2005—2007 is mainly due to high branch operating cost and, to some extent, due to low non-interest income and gross NPAs of banks.

During 2005—2012, both public sector banks and private sector banks witnessed a significant increase in staff expenses and a marginal increase in work force (Table 1). Using *t*-test, we have examined the effect of work force on the profit inefficiency of the banks by comparing the scores from model 1 and model 2 (Table 4). Though profit inefficiency scores of banks under model 2 are less than model 1 for a few years during 2005—2012, t-values indicate that the difference is not significant, except for two years, 2010 and 2011. During 2009—2011, both public sector banks and private sector banks went for mass recruitment. Public sector banks recruited around 26,000 employees and private sector banks recruited around 42,000 employees during this period. Also, public sector banks had a wage settlement in 2010, which resulted in a sharp increase in staff cost during this period. Otherwise, profit inefficiency score from both models is almost the same, which implies that the effect of work force on profit inefficiency of banks is not significant at an overall level and if it exists, it may be bank specific. Bank group-wise analysis (Table 5) also supports the above finding, which is evident from significant t-values for public sector banks in 2010 and 2011, private sector banks in 2011 and 2012 (Table 1). During the entire period of study, the profit inefficiency of private sector banks is close to 2.0%, whereas the profit inefficiency of public sector banks gradually declined to 3.0%. It is interesting to note from Table 6 that compared to model 2, the number of banks operating on the efficient frontier under model 1 in both bank groups reinforces the fact that work force does play a major role in the productivity of the banks.

To study the relation between profit inefficiency and asset size, we have grouped banks into four groups based on their asset size. The four groups are: (1) less than Rs. 100 billion (small), (2) Rs. 100—500 billion (medium), (3) Rs. 500—1000 billion (big), and (4) above Rs. 1000 billion (large). Tables 7 and 8 present the year-wise and asset size-wise distribution of profit inefficiency scores of banks obtained from model 1 and model 2.

Though profit inefficiency is high, ranging between 11.0% and 20.0% during 2005—2007 for big and large size banks, it declined sharply from 2008 onwards (ranging between 2.0%

Table 4 Year-wise Nerlovian profit inefficiency.

Year	No. of banks	NIE (WWF)			NIE (WOWF)			*t*-value
		Eff. banks	Mean	Std. dev.	Eff. banks	Mean	Std. dev.	
2005	43	18	0.0711	0.1059	17	0.0707	0.0993	0.107
2006	43	19	0.0767	0.1162	19	0.0729	0.1095	1.423
2007	45	18	0.0785	0.1102	17	0.0747	0.0965	0.735
2008	47	25	0.0398	0.0593	21	0.0397	0.0546	0.064
2009	45	24	0.0268	0.0360	22	0.0249	0.0318	1.182
2010	46	24	0.0318	0.0571	24	0.0260	0.0463	3.174[a]
2011	44	24	0.0345	0.0565	23	0.0272	0.0436	3.159[a]
2012	45	22	0.0227	0.0302	22	0.0223	0.0294	0.280

[a] *Significant at 5% level*; NIE (WWF): Nerlovian profit inefficiency (with work force); NIE (WOWF): Nerlovian profit inefficiency (without work force); Eff. Bank: efficient bank.

Table 5 Bank group-wise comparison.

Year	Public sector banks			Private sector banks		
	NIE (WWF)	NIE (WOWF)	*t*-value	NIE (WWF)	NIE (WOWF)	*t*-value
2005	0.1008	0.1001	0.11	0.0157	0.0158	−0.18
2006	0.1101	0.1027	1.96	0.0144	0.0174	−1.55
2007	0.1143	0.1080	0.77	0.0194	0.0200	−1.39
2008	0.0567	0.0563	0.15	0.0148	0.0152	−0.72
2009	0.0380	0.0350	1.14	0.0100	0.0098	0.40
2010	0.0473	0.0379	3.22[a]	0.0099	0.0092	1.28
2011	0.0499	0.0385	3.08[a]	0.0123	0.0109	2.13[a]
2012	0.0299	0.0307	0.82	0.0129	0.0110	2.52[a]

[a] *Significance at 5% level*; NIE (WWF): Nerlovian profit inefficiency (with work force); NIE (WOWF): Nerlovian profit inefficiency (without work force).

and 7.0%) under model 1. Table 8 shows a similar trend for big and large size banks under model 2. For medium size banks, the profit inefficiency is below 6.0% under model 1 and under model 2, and is around 2.0% from 2009 onwards. For small size banks, the profit inefficiency is almost zero for the entire period of study under both models which implies their better performance during 2005—2012. Again, the high profit inefficiency scores during 2005—2007 and during 2011—2012 is due to high branch operational cost, gross NPA and low non-interest income. Although there is a yearly variation in the distribution of profit inefficiency scores under both model 1 and model 2, in general, it cannot be considered very significant. For the marginal increase in profit inefficiencies of banks with asset size above Rs. 1000 billion during 2010 and 2011, we refer to our explanation provided in this paper earlier. Again, profit inefficiency of banks across various asset sizes was high during pre financial crisis period compared to post financial crisis period.

We now move our focus from examining the effect of work force on the profit inefficiency, to decomposition of Nerlovian profit inefficiency of banks into technical

Table 6 Bank group-wise number of efficient banks.

Year	Public sector banks			Private sector banks		
	Total	NIE (WWF)	NIE (WOWF)	Total	NIE (WWF)	NIE (WOWF)
2005	28	9	8	15	9	9
2006	28	9	9	15	10	10
2007	28	8	7	17	10	10
2008	28	13	10	19	12	11
2009	27	12	10	18	12	12
2010	27	13	13	19	11	11
2011	26	13	13	18	11	10
2012	26	12	12	19	10	10

NIE (WWF): Nerlovian profit inefficiency (with work force).
NIE (WOWF): Nerlovian profit inefficiency (without work force).

Table 7 Nerlovian profit inefficiency (WWF) — asset size.

Year	Small	Medium	Big	Large
2005	0.0091	0.0591	0.1967	0.1386
2006	0.0026	0.0610	0.1166	0.1488
2007	0.0041	0.0553	0.1135	0.1563
2008	0.0000	0.0278	0.0569	0.0661
2009	0.0000	0.0139	0.0401	0.0405
2010	0.0001	0.0141	0.0221	0.0631
2011	0.0000	0.0189	0.0339	0.0509
2012	0.0000	0.0103	0.0342	0.0254

WWF: with work force.

Table 8 Nerlovian profit inefficiency (WOWF) — asset size.

Year	Small	Medium	Big	Large
2005	0.0093	0.0546	0.2343	0.1266
2006	0.0072	0.0565	0.1157	0.1348
2007	0.0047	0.0516	0.1214	0.1286
2008	0.0007	0.0289	0.0583	0.0612
2009	0.0000	0.0135	0.0395	0.0357
2010	0.0004	0.0126	0.0192	0.0497
2011	0.0000	0.0163	0.0276	0.0385
2012	0.0000	0.0081	0.0304	0.0254

WOWF: without work force.

inefficiency and allocative inefficiency. While technical inefficiency represents the managerial underperformance of the banks, allocative inefficiency refers to bank's inability to achieve the optimal input—output mix for given input—output prices. Since profit inefficiency scores of model 1 and model 2 could not be differentiated during 2005—2012 except in a few cases, the subsequent discussions are based on model 1.

Fig. 1 clearly indicates that Nerlovian profit inefficiency of banks is due to allocative inefficiencies of the banks rather than technical inefficiencies. The average technical

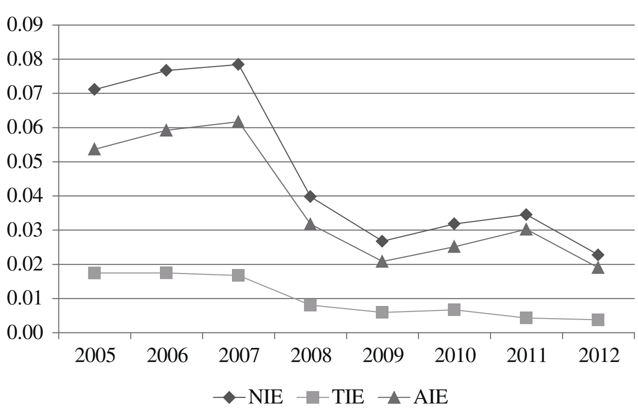

Figure 1 Movement of Nerlovian profit inefficiency (NIE), technical inefficiency (TIE) and allocative inefficiency (AIE) under WWF (with work force).

inefficiency scores below 1.0% during 2008—2012 indicates there is a little scope for improving the technical efficiency from the technical component side of the bank activity. However, the average allocative inefficiency suggests that there is scope for improving the allocative efficiency.

Table 9 presents year-wise and bank group-wise decomposition of Nerlovian profit inefficiency into technical inefficiency and allocative inefficiency. The technical inefficiency of private sector bank group close to zero indicates their better managerial performance during the entire period of study and allocative inefficiency close to 1.0% indicates that a small improvement in utilization of input—output mix would make the bank group efficient. In case of the public sector bank group, high allocative inefficiency is mainly due to high branch operational cost and gross NPA, and low non-interest income, and they need to focus on optimal utilization of input—output mix to move towards the efficient frontier.

In general, banks need to focus on branch operational cost, non-performing assets and non-interest income to enhance profit efficiency. The impact of technical inefficiency is minimal in comparison to allocative inefficiency which indicates better managerial performance of banks during 2005—2012.

Table 10 provides year-wise confidence interval for profit inefficiency of banks along with percentage of banks in confidence interval. Being a relative measure, confidence intervals for profit efficiency are not strictly comparable across the years. However, the closer intervals and percentage of banks in the confidence interval from 2007

Table 9 Bank group-wise Nerlovian profit inefficiency (WWF).

Year	Public sector banks			Private sector banks		
	NIE	TIE	AIE	NIE	TIE	AIE
2005	0.1008	0.0243	0.0766	0.0157	0.0048	0.0109
2006	0.1101	0.0247	0.0854	0.0144	0.0040	0.0104
2007	0.1143	0.0245	0.0898	0.0194	0.0040	0.0154
2008	0.0567	0.0117	0.0451	0.0148	0.0027	0.0121
2009	0.0380	0.0084	0.0296	0.0100	0.0023	0.0077
2010	0.0473	0.0103	0.0370	0.0099	0.0016	0.0083
2011	0.0499	0.0063	0.0436	0.0123	0.0014	0.0109
2012	0.0299	0.0049	0.0250	0.0129	0.0021	0.0108

Nerlovian profit ineffícnecy (NIE), technical inefficiency (TIE) and allocative inefficiency (AIE) under WWF (with work force).

Table 10 Confidence interval for profit inefficiency (WWF).

Year	Total no. of banks	No. of efficient banks	Avg. Profit efficiency (M)	Std. dev. (σ)	Max.	Interval I = (M − σ, M + σ)	% of banks in I
2005	43	18	0.0711	0.1059	0.4207	(0, 0.1770)	88.37
2006	43	19	0.0767	0.1162	0.4720	(0, 0.1929)	88.37
2007	45	18	0.0785	0.1102	0.5145	(0, 0.1887)	88.89
2008	47	25	0.0398	0.0593	0.2284	(0, 0.0991)	85.11
2009	45	24	0.0268	0.0360	0.1394	(0, 0.0628)	80.00
2010	46	24	0.0318	0.0571	0.2315	(0, 0.0889)	89.13
2011	44	24	0.0345	0.0565	0.2225	(0, 0.0910)	88.64
2012	45	22	0.0227	0.0302	0.1163	(0, 0.0529)	75.56

onwards suggest improved performance of banks. Confidence interval for the year 2012 implies around 75.5% of banks' profit inefficiency is close to 5.3%. Bank-wise average Nerlovian profit inefficiency, technical inefficiency, and allocative inefficiency scores are given in Appendix 1.

Summary of findings and conclusion

In this paper, Nerlovian profit indicator approach has been used to analyze the profit inefficiency of banks in India during 2005—2012. The following are the observations based on the empirical results: (1) The steady decline in profit inefficiency of banks as well as increase in the number of efficient banks during 2008—2012 as compared to 2005—2007 implies improved performance of banks. (2) The least impact of work force on the profit inefficiency of banks during 2005—2012 suggests that work force had played an important role in the productivity of banks, which is contrary to the general belief that it contributes to inefficiency. (3) During the entire period of study, the profit inefficiency of private sector bank group is close to 2.0%, whereas the profit inefficiency of public sector bank group gradually declined to 3.0%. (4) Compared to small and medium size banks, profit inefficiency is higher for big and large size banks. (5) Decomposition of the Nerlovian profit inefficiency into technical inefficiency and allocative inefficiency clearly points out that profit inefficiency of banks could be primarily attributed to allocative inefficiency. Results suggest that banks need to focus on branch operational costs, non-performing assets, and non-interest income to enhance profit efficiency. The impact of technical inefficiency on profit inefficiency is minimal in comparison to allocative inefficiency which indicates better managerial performance of banks during the period of study. The use of non-performing assets has made this study holistic. Further, an assessment adopting the Nerlovian profit indicator approach may help banks to move towards the efficient frontier.

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Appendix 1

Bank-wise average inefficiency scores (2005—2012).

Banks	NIE	TIE	AIE
Public Sector Bank			
State Bank of Bikaner and Jaipur	0.0068	0.0006	0.0062
State Bank of Hyderabad	0.0124	0.0012	0.0112
State Bank of India	0.0000	0.0000	0.0000
State Bank of Indore	0.0087	0.0037	0.0050
State Bank of Mysore	0.0166	0.0024	0.0142
State Bank of Patiala	0.0402	0.0128	0.0275
State Bank of Saurashtra	0.0152	0.0028	0.0123
State Bank of Travancore	0.0000	0.0000	0.0000
Allahabad Bank	0.1173	0.0228	0.0945
Andhra Bank	0.0741	0.0164	0.0577
Bank of Baroda	0.1889	0.0458	0.1431
Bank of India	0.0661	0.0137	0.0524
Bank of Maharashtra	0.0654	0.0190	0.0464
Canara Bank	0.0196	0.0039	0.0157
Central Bank Of India	0.1660	0.0369	0.1291
Corporation Bank	0.0787	0.0170	0.0617
Dena Bank	0.0619	0.0177	0.0442
IDBI Bank Limited	0.0000	0.0000	0.0000
Indian Bank	0.1056	0.0183	0.0873
Indian Overseas Bank	0.1037	0.0208	0.0829
Oriental Bank of Commerce	0.1773	0.0391	0.1382
Punjab and Sind Bank	0.0388	0.0091	0.0297
Punjab National Bank	0.2129	0.0404	0.1726
Syndicate Bank	0.0361	0.0087	0.0275
UCO Bank	0.0000	0.0000	0.0000
Union Bank of India	0.1340	0.0137	0.1203
United Bank of India	0.1047	0.0212	0.0836
Vijaya Bank	0.0497	0.0119	0.0378
Private Sector Banks			
Bank of Rajasthan	0.0076	0.0017	0.0060
Catholic Syrian Bank	0.0000	0.0000	0.0000
City Union Bank Limited	0.0008	0.0002	0.0006
Federal Bank	0.0555	0.0089	0.0466
ING Vysya Bank	0.0093	0.0016	0.0077
Jammu & Kashmir Bank	0.0665	0.0188	0.0477

(*continued*)

Banks	NIE	TIE	AIE
Karnataka Bank	0.0427	0.0073	0.0355
Karur Vysya Bank	0.0211	0.0030	0.0180
Lakshmi Vilas Bank	0.0010	0.0003	0.0008
Ratnakar Bank	0.0000	0.0000	0.0000
South Indian Bank	0.0201	0.0043	0.0158
Tamilnad Mercantile Bank	0.0045	0.0002	0.0044
The Dhanalakshmi Bank	0.0000	0.0000	0.0000
United Western Bank	0.0000	0.0000	0.0000
Axis Bank Limited	0.0000	0.0000	0.0000
Centurion Bank of Punjab	0.0000	0.0000	0.0000
Development Credit Bank	0.0000	0.0000	0.0000
HDFC Bank Ltd.	0.0000	0.0000	0.0000
ICICI Bank Limited	0.0000	0.0000	0.0000
IndusInd Bank Ltd	0.0104	0.0028	0.0076
Kotak Mahindra Bank	0.0000	0.0000	0.0000
Yes Bank Ltd.	0.0000	0.0000	0.0000

Nerlovian profit ineffícnecy (NIE), technical inefficiency (TIE) and allocative inefficiency (AIE).

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