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Trends of cost efficiency in response to financial deregulation: The case of Indian banks

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Abstract

Purpose – The purpose of this paper is to examine the trends of cost efficiency (CE) of Indian banks in response to financial deregulation programme launched in early 1990s. More specifically, the findings of this paper offer empirical testing of the basic underlined hypothesis that the CE of banks will rise in the more liberal and competitive environment.

Design/methodology/approach – The study employs input-oriented data envelopment analysis (DEA) models that incorporate the quasi-fixed inputs to compute the cost, technical, and allocative efficiency scores for individual banks. The unbalanced panel data spanning from the financial year 1992-1993 to 2007-2008 are used for obtaining efficiency measures. In addition, the panel data Tobit model has been applied to investigate the bank-specific factors explaining variations in the CE.

Findings – The empirical findings pertaining to the trends of efficiency measures suggest that: first, deregulation programme has had a positive impact on the CE of Indian banks, and the observed increase in CE is entirely due to improvements in technical efficiency (TE); second, the ranking of ownership groups provides that public sector banks are more cost efficient along with the foreign than private banks; and third, there is a strong presence of global advantage hypothesis in the Indian banking industry. The results of post-DEA analysis reveal that size and exposure to off-balance sheet activities are the key determinants of CE. The results also support the existence of bad luck or bad management hypothesis in Indian banking industry.

Practical implications – The practical implication of the research findings is that the financial deregulation programme seems to be successful in achieving the CE gains in the Indian banking industry. This explicitly signals that the cautious approach of banking reforms adopted by Indian policy makers has started bearing fruit in terms of the creation of an efficient banking system, which is immune to any sort of financial crisis, and resilient to both internal and external shocks.

Originality/value – The present study offers new evidence on the time-series properties of cost, allocative, and TEs of Indian banks. The DEA models used in this study explicitly incorporate the equity as a quasi-fixed input, which accounts for "risk" in the bank efficiency measurement.

Keywords Allocative efficiency, Data envelopment analysis, Cost efficiency, Indian banks, Panel data Tobit analysis, Quasi-fixed input

Paper type Research paper

1. Introduction

Prior to the launching of financial deregulation programme in the year 1992, all the signs of financial repression such as excessively high-reserve requirements, credit controls, interest rate controls, strict entry barriers, operational restrictions, pre-dominance of state-owned banks, etc., were present in the Indian banking system. The policy makers introduced an impressive array of reforms in the post-1992 period with the objectives to get rid of the regime of financial repression and to promote a diversified, efficient, and competitive banking system. Deregulatory measures like lowering of statutory pre-emption, easing of directed credit rules, interest rates

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deregulation, and lifting of entry barriers for *de novo* private and foreign banks (FBs), etc., were undertaken to induce efficiency and competition into the banking system. Prudential norms related to capital adequacy, asset classification, and income recognition in line with international norms were also brought in place. For infusing sufficient financial strength to public sector banks (PSBs), the government not only recapitalized these banks, but also brought diversification in the ownership of these banks by allowing equity participation by private investors up to a limit of 49 per cent. Further, to impart a greater operational flexibility, the government backed off to a significant extent from behest lending and lending decisions were largely left to banks.

Given the broad sketch of deregulation programme portrayed above, one may ask whether the efficiency performance of Indian banks since 1992 has improved or not. The present study explores this issue by providing a thorough investigation of inter-temporal behaviour of cost efficiency (CE) and its components in Indian banking industry during the post-deregulation period (1992-1993 to 2007-2008). This study is important for the policy makers and researchers alike for a number of reasons. First of all, India's approach to introduce the deregulation in the banking sector in a gradual manner offers a great scope for examining whether reforms should carry in a big bang fashion or sequenced at removing regulatory and operating constraints slowly over the years so as to augment the resource-use efficiency of the distressed banks. The empirical findings enable us to ascertain the efficacy of India's approach to financial deregulation and liberalization. Second, the deregulation of the banking sector led to the creation of a level playing field in which all banks, private or government controlled, domestic or foreign, have been subjected to the same prudential norms and standard regulations, and have been allowed significant liberty to design and price products on both sides of the balance sheet, to choose asset portfolios, and to enter into and exit from regional and local markets (Bhaumik and Dimova, 2004). Against this backdrop, it is pertinent to know how differently the banks with different ownership types reacted to the regulatory changes in terms of efficiency change. Third, Indian banking is a considerable component of Asian financial markets and it shares quite similar characteristics with the banking system of other Asian countries. Since most Asian countries have embarked on a deregulation path or are contemplating to do so, an empirical investigation of the effects of deregulation on the dynamics of efficiency in the Indian case could provide useful policy suggestions to those countries.

This study uses a non-parametric data envelopment analysis (DEA) approach to estimate the relative cost, technical, and allocative efficiency (AE) scores of Indian banks. DEA is a linear programming-based method first originated in the literature by Charnes *et al.* (1978) as a reformulation of the Farrell's (1957) single-output, single-input radial measure of technical efficiency (TE) to the multiple-output, multiple-input case. The subsequent developments in DEA are very extensive. Interested parties are directed to those provided by Seiford and Thrall (1990), Coelli *et al.* (2005), Zhu (2003), and Cooper *et al.* (2007). In recent years, there have been thousands of theoretical contributions and practical applications in various fields using DEA (Klimberg and Ratick, 2008). The bibliographies compiled by Tavares (2002) and Emrouznejad *et al.* (2008) highlight that over the years, DEA has been applied in many diverse areas to analyse efficiency performance differentials. Its first application in banking industry appeared with the work of Sherman and Gold (1985). Since then, DEA has emerged as a very potent technique to measure the relative efficiency of financial institutions, particularly of commercial banks (see survey articles of Berger and Humphrey, 1997; Ashton and Hardwick, 2000; Fethi and Pasiouras, 2010).

Our results indicate that the deregulation has had a positive impact on the CE of Indian banks, and the observed increase in CE (albeit modest) is entirely due to improvements in TE. PSBs outperformed the private banks (PBs), but shared the podium with FBs. The results of post-DEA analysis reveal that larger the bank, higher is the level of CE. Further, higher levels of efficiency are explained significantly by the greater exposure to off-balance sheet activities. Finally, there exists negative relationship between non-performing loans and bank efficiency, which supports the bad luck or bad management hypotheses instead of the skimping hypothesis in case of Indian banking industry.

The rest of the paper is structured as follows. The following section provides the relevant literature review and highlights the contribution of the present study. Section 3 briefs the structure and process of reforms in Indian banking industry. Section 4 outlines the non-parametric DEA methodology applied in this study. Specification of bank inputs and outputs, and database are presented in Section 5. Section 6 discusses the empirical findings. And, Section 7 concludes the paper and highlights the policy lessons learnt from this study.

2. Deregulation and CE: relevant literature review

There has been a vast empirical literature concerning with the effect of deregulatory measures upon the CE of the banking industry in developed economies (see Grabowski *et al.*, 1994; Zaim, 1995 for US banks; Sathye, 2001; Neal, 2004 for Australian banks; Tortosa-Ausina, 2002; Maudos and Pastor, 2003 for Spanish banks; Hasan and Marton, 2003 for Hungarian banks; Girardone *et al.*, 2004 for Italian banks; Gjirja, 2004 for Swedish banks; Christopoulos and Tsionas, 2001; Chortareas *et al.*, 2009 for Greek banks; for a selection of examples). Though this literature is growing for developing economies, but is still relatively miniscule in volume. Note here that the empirical results are not always affirmative with the theoretical proposition that deregulation boosts competition in the banking industry which in turn improves efficiency.

Table I summarizes the major findings of Indian studies. We note that the literature pertaining to the effect of deregulatory measures on CE of Indian banks is relatively scant, and offers mixed results. There exists substantial variations in the reported estimates of cost (in)efficiency for Indian banks. Further, there is no conclusive evidence on the dominant source of cost (in)efficiency in Indian banking industry. For example, Rezvanian *et al.* (2008) and Kumar (2013) found AE as a main driver of CE in Indian banking industry, while Reserve Bank of India (2008) found TE as a main source of CE. In addition, no consensus appears regarding the ranking of ownership groups. Our study differs from earlier studies because we have undertaken a comprehensive analysis of inter-temporal variations in CE across different ownership types using the data for larger time horizon spanning from 1992-1993 to 2007-2008 (i.e. 16 years). Earlier studies used relatively shorter time horizon. This can be confirmed from Table I. In addition, we have incorporated the risk element in the efficiency appraisal of the Indian banks. Following Berger and Mester (1997), this is accomplished by including "equity" as a quasi-fixed variable in the input vector used for computing CE and its component measures. All in all, the present study offers new evidence on the time-series properties of CE of Indian banks; as well as it provides deep insights on the CE of banks in diverse economic conditions.

Table I.
Review of literature on cost efficiency of Indian banks

Author (year)	Period of study	No. of banks in the sample	Methodology	Effect of deregulation	Dominant source of CE	Cost inefficiency (%)	Ranking of ownership groups
Kumbhakar and Sarkar (2005)	1986-2000	27 PSBs, 23 PBs	SFA	Negative	na	25-31	PBs > PSBs
Das *et al.* (2005)	1997-2003	71 banks in 1996-1997 and 68 banks in 2002-2003	DEA	Positive	na	2.9-9	FBs > PBs > PSBs
Sensarma (2005)	1986-2003	27 PSBs, 26 PBs, 25 FBs, 9 NPBs	SFA	Negative	na	PSBs: 6.3-10.7 PBs: 6.3-11.6 FB: 42.8-78.7 NPBs: 26.2-90.6	PSBs > PBs > FBs > NPBs
Rezvanian *et al.* (2008)	1998-2003	20 PSBs, 19 PBs, 16 FBs	DEA	Positive	AE	43.3-64.3	FBs > PBs > PSBs
Reserve Bank of India (2008)	1992-2007	All banks	DEA	Negative	TE	29-58	SBI > NPBs > NBs > FBs > OPBs
Das and Ghosh (2009)	1992-2004	64 banks in 1992 and 71 banks in 2004	DEA	Negative	na	12.6-23	PSBs > PBs > FBs
Ray and Das (2010)	1997-2003	71 banks in 1996-1997 and 68 banks in 2002-2003	DEA	Positive	Both AE and TE	6.3-10.2	SBI > FBs > NB > PBs
Tabak and Tecles (2010)	2000-2006	67 banks	Bayesian SFA	Positive	na	Model without OBS 12; Model with OBS 10	PSBs > PBs > FBs
Zhao *et al.* (2010)	1992-2004	27 PSBs, 20 PBs, 18 FBs	SFA	Positive	na	4.8-16.6	PBs > FBs > PSBs
Kumar (2013)	1993-2008	27 PSBs	DEA	Positive	AE	20.4	SBI > NB

Notes: DEA, Data envelopment analysis; SFA, stochastic frontier analysis; TE, technical efficiency; CE, cost efficiency; AE, allocative efficiency; PSBs, public sector banks; PBs, private banks; FBs, foreign banks; OPBs, old private banks; NPBs, new private banks; SBI, State Bank of India group; NB, nationalized bank group, respectively; na, not available

Source: Author's elaboration

3. Banking sector in India

3.1 Structure of Indian banking sector

The Reserve Bank of India (RBI) is the central bank of the country that regulates the operations of banks, manages the money supply, and discharges other myriad responsibilities that are usually associated with a central bank. The banking system in India comprises commercial and cooperative banks, of which the former accounts for more than 90 per cent of the assets of the banking system. Within the category of commercial banks, there are two types of the banks: first, scheduled commercial banks (i.e. which are listed in Schedule II of the Reserve Bank of India Act, 1934); and second, non-scheduled commercial banks. Depending upon the pattern of ownership, scheduled commercial banks can be classified as: PSBs which include State Bank of India (SBI) and its associate banks, nationalized banks, and other PSBs; PBs consist of private domestic banks (which can further be classified as old PBs that are in business prior to 1992, and *de novo* PBs that are established after 1992), and FBs; and others comprising Regional Rural Banks (RRBs) and local area banks.

Of these, PSBs have a countrywide network of branches and account for over 70 per cent of total banking business[1]. The contribution of PSBs in India's economic and social development is enormous and well documented. They have a strong presence in rural and semi-urban areas, and employ a large number of staff. On the other hand, *de novo* private domestic banks are less labour-intensive, have limited number of branches, have adopted modern technology, and are more profitable. Though FBs are more techno-savvy and have carved a niche in the market, but they confine their operations in major urban centres. The share of domestic banks (both public and private sector banks) is more than 90 per cent in all the business parameters of the Indian banking industry. As on end March 2009, about 85 per cent of branches of the commercial banks in India belong to PSBs. The PBs constitute about 13.7 per cent of commercial bank branch network. Further, the shares in total employment provided by the PSBs and PBs in India are about 78 and 18.7 per cent , respectively. However, FBs have a minuscule share (less than 9 per cent) in the all business parameters, and operate exclusively in urban and metropolitan areas. Moreover, PSBs sponsor the RRBs and their activities are localized. Further, RRBs serve the needs for rural credit and have a diminutive share (about 3 per cent) in the commercial banking industry of India.

3.2 Banking reforms in India

During the last 20 years, an extensive programme of banking reforms has been followed for strengthening of market institutions and allowing greater autonomy to the Indian banks. The details on various reform measures and their impact on the structure of Indian banking industry has been well documented. In this context, reference may be made to the works of Sen and Vaidya (1997), Hanson and Kathuria (1999), Arun and Turner (2002), Shirai (2002), Bhide *et al.* (2002), Yoo (2005), Hanson (2005), Reddy (2005), and Roland (2008). However, a brief discussion on the areas in which reforms have been introduced is presented here. First, for making available a greater quantum of resources for commercial purposes, the statutory pre-emption has gradually been lowered[2]. Second, the structure of administered interest rates has been almost totally dismantled in a phased manner[3]. Third, the burden of directed sector lending has been gradually reduced by expanding the definition of priority sector lending, and liberalizing lending rates on advances in excess of INR 0.2 million. Fourth, entry

regulations for domestic and FBs have been relaxed to infuse competition in the banking sector[4]. Fifth, the policy makers introduced improved prudential norms related to capital adequacy[5], asset classification[6], and income recognition in line with international norms, as well as increased disclosure level. Sixth, towards strengthening PSBs, the Government of India (GOI) recapitalized PSBs to avert any financial crisis and to build up their capital base for meeting minimum capital adequacy norms[7].

Since 1992, Indian banking system has undergone significant changes. A remarkable trend is the shift from traditional banking activities such as lending and deposits taking to a more universal banking character with financial market activities such as brokerage and portfolio management growing in importance. Thus, the traditional role of banks as mere financial intermediaries has since altered, and risk management has emerged as the defining attribute. While deregulation has opened up new vistas for banks to augment incomes, it has also entailed greater competition and consequently greater risks. Banks have been provided significant operational freedom in their resource allocation using their commercial judgements in a market-oriented environment. The banking system has also witnessed greater levels of transparency and standards of disclosure.

A positive externality of the banking reforms process has been the building up of the institutional architecture in terms of markets, and creation of enabling environment through technological and legal infrastructure and improving the managerial competence, etc. (Bhide *et al.*, 2002). The most notable achievement of banking industry is the significant improvement in capital adequacy and asset quality[8]. Further, the deregulation process has infused the competition in the banking sector by allowing the liberal entry of *de novo* private and FBs, and introduction of new products and technology[9]. Consequently, the market share of PSBs in terms of deposits, investments, advances, and total assets has declined constantly. In the post-1992 period, a wave of mergers and acquisitions swept through the industry as banks tried to cut cost and improved efficiency.

4. Methodological framework

As mentioned in the introductory section, this study uses DEA models to empirically estimate the cost, allocative, and TEs for individual banks. Using actual data for the banks under consideration, DEA employs linear programming technique to construct efficient or best-practice frontiers. In fact, a large number of linear programming DEA models (like CCR, BCC, slack-based measure models, etc.) have been proposed in the literature to compute efficiency of individual banks corresponding to different technical or behavioural goals (see e.g. Charnes *et al.*, 1994; Cooper *et al.*, 2007; Cook and Seiford, 2009). This study employs the input-oriented DEA models, which explicitly incorporate equity as quasi-fixed input, to compute cost, technical, and AE scores.

The computational procedure used in this study to implement the DEA approach for the measurement of CE and its components is outlined as follows. Let us suppose that there exist n banks ($j = 1, \ldots, n$) that produce a vector of s outputs $y = (y_1, \ldots, y_s) \in \Re_{s++}$ using a vector of m discretionary (or variable) inputs $x^D = (x_1^D, \ldots, x_m^D) \in \Re_{m++}$, for which they pay prices $p = (p_1, \ldots, p_m) \in \Re_{m++}$ and l quasi-fixed inputs $x^{QF} = (x_1^{QF}, \ldots, x_l^{QF}) \in \Re_{l++}$, which do not have any associated input price vector.

The TE for the case of bank "*o*" assuming constant returns-to-scale[10] (CRS) can be calculated by solving the following linear programming problem:

$$
\begin{aligned}
&TE_{o,CRS} = \min_{\theta,\lambda} \theta_o \\
&\text{subject to} \\
&\sum_{j=1}^{n} \lambda_j x_{ij}^{D} \leqslant \theta_o x_{io}^{D}, \quad i = 1, \ \ldots, \ m \\
&\sum_{j=1}^{n} \lambda_j x_{kj}^{QF} \leqslant x_{ko}^{QF}, \quad k = 1, \ \ldots, \ l \\
&\sum_{j=1}^{n} \lambda_j y_{rj} \geqslant y_{ro}, \quad r = 1, \ \ldots, \ s \\
&\lambda_j \geqslant 0, \quad j = 1, \ \ldots, \ n.
\end{aligned}
\tag{1}
$$

The optimal value θ_o^* reflects the TE score of bank "*o*". This efficiency score is within a range from zero to one, $0 < \theta_o^* \leqslant 1$, with a high score implying a higher efficiency. If $\theta_o^* = 1$ then the bank "*o*" is Pareto-efficient. Note that the model (1) measures the TE of single bank (i.e. bank "*o*"), it needs to be solved n times to obtain efficiency score of each bank in the sample.

Given the prices of inputs, the cost minimizing input quantities for bank "*o*" can be estimated by solving the following linear programming problem:

$$
\begin{aligned}
&\min \sum_{i=1}^{m} p_i^o x_{io}^{D} \\
&\text{subject to} \\
&\sum_{j=1}^{n} \lambda_j x_{ij}^{D} \leqslant x_{io}^{D}, \quad i = 1, \ \ldots, \ m \\
&\sum_{j=1}^{n} \lambda_j x_{kj}^{QF} \leqslant x_{ko}^{QF}, \quad k = 1, \ \ldots, \ l \\
&\sum_{j=1}^{n} \lambda_j y_{rj} \geqslant y_{ro}, \quad r = 1, \ \ldots, \ s \\
&\lambda_j \geqslant 0, \quad j = 1, \ \ldots, \ n
\end{aligned}
\tag{2}
$$

From the solution to model (2), we get minimum costs as $\sum_{i=1}^{m} p_i^o x_{io}^{D*}$, and the CE of bank "*o*" is then calculated as $CE_o = \text{minimum cost/actual cost} = \sum_{i=1}^{m} p_i^o x_{io}^{D*} / \sum_{i=1}^{m} p_i x_i^D$. Thus, the measure of AE for bank "*o*" is obtained as $AE_o = CE_o / TE_o$.

The CE, AE, and TE measures always range between zero and one. Corresponding to these efficiency measures, the measures of inefficiency can be obtained as (1-CE_o) (1-AE_o), and (1-TE_o), respectively.

5. Data and measurement of input and output variables

In computing the efficiency scores, the most challenging task that an analyst always encounters is to select the relevant inputs and outputs for modelling banks' behaviour. In the literature on bank efficiency, there is no consensus on what constitute the inputs and outputs of a bank and how to measure them (Casu and Girardone, 2002; Sathye, 2003). There are mainly two approaches for selecting the inputs and outputs for a bank: first, the production approach as pioneered by Benston (1965); and second, the intermediation approach as proposed by Sealey and Lindley (1977). 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 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.

The intermediation approach treats banks as financial intermediaries channeling 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. Berger and Humphrey (1997) pointed out that neither of these two approaches is perfect because they cannot fully capture the dual role of banks as providers of transactions/document processing services and being financial intermediaries. Nevertheless, they suggested that the intermediation approach is best suited for analysing bank-level efficiency, whereas the production approach is well suited for measuring branch-level efficiency. This is because, at the bank level, management will aim to reduce total costs and not just non-interest expenses, while at the branch level a large number of customer services processing take place and bank funding and investment decisions are mostly not under the control of branches. Also, in practice, the availability of flow data required by the production approach is usually exceptional rather than in common.

Consistent with most of the recent literature on bank efficiency, this study uses a modified version of intermediation approach for selecting input and output variables. The input variables used for computing efficiency measures are physical capital, labour, loanable funds, and equity (as a quasi-fixed), which are proxied by fixed assets, number of employees, deposits plus borrowings, and capital plus reserves and surpluses, respectively. Correspondingly, the prices of these inputs are worked out as per unit price of physical capital, per employee wage bill, and cost of loanable funds (see Table II for details). It is worth mentioning here that we have considered the input variable "equity" as a quasi-fixed variable without any associated price to account for both risk-based capital requirements and the risk-return trade-off that bank owners face. This adds a new dimension to the specification of input variables used for measuring the CE of Indian banks. The output vector contains three output variables: advances, investments, and non-interest income. The output variable "non-interest income" accounts for income from fee generating off-balance sheet items such as commission, exchange, and brokerage, etc. The inclusion of "non-interest income" enables us to capture the recent changes in the production of services as Indian banks are increasingly engaging in non-traditional banking activities. As pointed out by Gulati and Kumar (2011), the failure to incorporate these types of activities may seriously understate bank's output, and thus, it is likely to have statistical and economic effects on estimated efficiency.

Variables	Description in the balance sheet	Unit of measurement
Input variables		
(1) Physical capital	Fixed assets	Lakh
(2) Labour	Staff (number of employees)	Number
(3) Loanable funds	Deposits+borrowings	Lakh
(4) Equity (quasi-fixed)	Capital+reserve and surpluses	Lakh
Output variables		
(1) Advances	Advances in India (= term loans+cash credits, overdrafts+bills purchased and discounted, etc.)+advances outside India	Lakh
(2) Investments	Investments in India (= investment in government securities +other approved securities+shares, debentures and bonds, etc.) +investments outside India	Lakh
(3) Non-interest income	Other income (= commission, exchange, brokerage, etc.+net profit (loss) on sales of investments+net profit(loss) on revaluation of investments+net profit(loss) on sale of land and other assets+net profit(loss) on exchange transactions+miscellaneous receipts)	Lakh
Input prices		
(1) Price of physical capital	(Rent, taxes and lighting+printing and stationary+depreciation on bank's property+repairs and maintenance+insurance)/physical capital	
(2) Price of labour	(Payment to and provisions for employees)/labour	
(3) Price of loanable funds	(Interest paid on deposits+interest paid on borrowings from RBI and other agencies)/loanable funds	

Notes: 1 lakh = 100 thousands; 10 lakh = 1 million
Source: Author's elaboration

Table II.
Description of input and output variables

The present study is based on unbalanced data covering a 16-year period spanning from the financial year 1992-1993 to 2007-2008. The input and output data were collected from the various issues of "Statistical Tables Relating to Banks in India", an annual publication of RBI, and "Performance Highlights of Public Sector Banks", "Performance Highlights of Private Banks", and "Performance Highlights of Foreign Banks", annual publications of Indian Banks' Association. All data (except labour) were deflated using the GDP deflator using 1999-2000 as base year. Only banks with minimum of two branches were included in the sample. To reduce the effects of random noise due to measurement error in the inputs and outputs, we followed Denizer *et al.* (2007) and Kumar and Gulati (2009b), and normalized all the input and output variables by number of branches.

6. Empirical results

6.1 Trends in CE of Indian banking industry

To compute efficiency scores, we construct separate efficiency frontiers for all the years rather than constructing a single multi-year frontier[11]. We begin by examining the trends in CE and its components in Indian banking industry during the post-reforms years. Table III provides the relevant results. We note that the mean CE scores ranged from a minimum of 0.773 in 1995-1996 to a maximum of 0.872 in 1997-1998, with the grand mean of 0.822. Accordingly, the Indian banking system exhibited significant cost

Year↓	CE	AE	TE
1992-1993	0.841	0.902	0.929
1993-1994	0.811	0.891	0.906
1994-1995	0.788	0.872	0.902
1995-1996	0.773	0.859	0.895
1996-1997	0.830	0.903	0.915
1997-1998	0.872	0.927	0.940
1998-1999	0.817	0.895	0.910
1999-2000	0.817	0.904	0.900
2000-2001	0.813	0.896	0.905
2001-2002	0.805	0.896	0.895
2002-2003	0.856	0.919	0.928
2003-2004	0.853	0.905	0.941
2004-2005	0.828	0.877	0.942
2005-2006	0.792	0.866	0.909
2006-2007	0.829	0.885	0.934
2007-2008	0.833	0.889	0.933
Grand mean	0.822	0.893	0.918
Average annual growth rates (%)	0.127	−0.034	0.161
Acceleration (+)/deceleration (−)	(−)	(−)	(+)

Source: Author's calculations

Table III.
Year-wise mean cost, allocative, and technical efficiency scores for Indian banking industry

inefficiency[12] ranging between a minimum of 12.8 per cent and a maximum of 22.7 per cent during the 16-year period of evaluation. We further note from the figure of grand mean of CE scores that the average level of CE (inefficiency) in Indian banking industry was 82.2 per cent (17.8 per cent). This figure of CE implies that the typical bank in the sample could have produced the same level of outputs using only 82.2 per cent of the cost actually incurred, if it was producing on the cost frontier rather than at its current location. On the other hand, in each year of the study period, the typical bank needed 17.8 per cent more resources, and thus, incurred more cost to produce the same output relative to the best-practice bank. This divulges that Indian banks, in general, have not been successful in employing best-practice production methods and achieving the maximum outputs from the minimum cost of inputs.

The apparent policy implication that can be derived from aforementioned analysis is that there is substantial room for significant cost savings if Indian banks use and allocate their productive inputs more efficiently. Interestingly, our estimates of average cost inefficiency in Indian banking is relatively low when compared to the inefficiencies in the banking systems of developing and emerging economies. For instance, the estimated inefficiencies are 28 per cent for the Turkish banks (Isik and Hassan, 2002), 25.5 per cent for the Pakistani banks (Burki and Niazi, 2010), 32.8 per cent for the Taiwanese banks (Chen, 2004), 48 per cent for Kuwaiti banks (Darrat *et al.*, 2002), 48-59 per cent for Chinese banks (Fu and Heffernan, 2007). Further, our estimate of cost inefficiency is lower than the world mean inefficiency of 27 per cent (Berger and Humphrey, 1997) and mean inefficiency of 35 per cent for developing economies (Fu, 2004).

As noted in methodology section, the literature spells out two mutually exclusive components of CE, i.e. TE and AE. Thus, cost inefficiency incorporates both allocative inefficiency from failing to react optimally to relative prices of inputs, and technical inefficiency from employing too much of the inputs to produce a certain

output bundle (Gjirja, 2004). The year-wise mean AE and TE scores for Indian banks are reported in the Table III. We note that over the sampled years, the average AE is 89.3 per cent, indicating that average bank incurred about 10.7 per cent more production cost by choosing the incorrect input combination given input prices. The observed level of average TE is 91.8 per cent , indicating that an average bank wasted about 8.2 per cent of factor inputs in the production process by operating off the efficient production frontier. For determining the dominant source of cost inefficiency, we make a comparison of the relative sizes of technical and allocative inefficiency levels. We note that, except 1999-2000 and 2001-2002, mean TE scores were consistently higher than mean AE scores, suggesting that allocative inefficiency had greater significance than technical inefficiency as a source of cost inefficiency within all inefficient banks. This is also evident from the fact that of 17.8 per cent of average cost inefficiency, 10.7 per cent was caused by inappropriate selection of the optimal combinations of inputs given their prices and technology. Thus, the observed cost inefficiency in Indian banking industry originated primarily due to regulatory environment in which banks were operating rather than managerial problems in using the resources. This finding suggests that the managers of Indian banks on average were doing better job in utilizing all factor inputs rather than choosing the proper input-mix given the prices.

To ascertain a more concrete picture about the trends of efficiency measures, we estimated average annual growth rates of efficiency scores. For computing the average annual growth rate of efficiency scores, we estimated a log-linear trend equation: $\ln E_t = \alpha + \beta t + \varepsilon_t$, where E_t is mean efficiency score in the year t ($t = 1, 2, \ldots, T$) and ε_t denotes stochastic error term. Further, a temporal pattern of growth may have a tendency to either accelerate or decelerate. To explore such possibilities, we estimated the log quadratic equation: $\ln E_t = a + bt + ct^2 + u_t$. A significantly positive value of c indicates acceleration in the growth rate of efficiency; a significantly negative value indicates a deceleration. The inclusion of time squares on the right-hand-side of aforementioned equation introduces a multicollinearity problem. This is solved by normalizing time in mean deviation form. That is, it is set to zero on the mid-point of the time-series. For more detailed discussion, interested parties can refer Majumdar (1998).

Table III also provides the growth rate estimates of CE and its components. We note that CE of Indian banking industry grew at a diminutive rate of 0.127 per cent per annum over the study period. This miniscule growth in CE is entirely contributed by the growth in TE at the rate of 0.161 per cent per annum, whereas AE component has shown a negative growth of (–)0.034 per cent . Thus, the components of CE moved in opposite directions, and they are counterbalancing in nature. Overall, CE of Indian banks propagated at a very modest rate during the post-deregulation years. Further, TE followed an uptrend, while AE followed a path of deceleration. It is interesting to note that CE and AE measures had a tendency to decelerate, whilst TE measure had a tendency to accelerate over time.

In all, it seems that reforms process did have a positive impact in improving the CE levels of the Indian banking sector. However, the observed declining trend in AE is a serious concern. One of the most plausible reasons for increasing allocative inefficiency might be high fluctuations and instability in factor prices due to chronic inflation in the country in the recent years. If bank managers are uncertain about prices, they are likely to make inefficient decisions (Isik and Hassan, 2002). Another reason could be the idle capacity and staff redundancies of some state-owned banks. Even when the management recognizes the need to choose a different mix of inputs in light of given prices, it might feel constrained from doing so due to, for example,

political and social resistance to lay off staff (Havrylchyk, 2006). Deterioration in AE may also be occurred due to an introduction of stringent regulatory restrictions primarily in the area of maintaining capital adequacy ratio as per Basel norms during the post-reforms years. From no norm of capital adequacy in the pre-reforms period, Indian banking system has implemented Basel I and II norms in a phased manner during the reforms period. Further, in more recent years, domestic banks have increasingly used equity market to raise funds. This exposed banks to the consequences of the imperfections inherent in this market. This may have led to distortions in the process of allocating resources in Indian banks. Overall, the analysis manifests that the declining trend in the AE offsetted the uptrend in the TE, and thus, found to be responsible for the modest growth of CE in Indian banking industry.

6.2 Comparison of efficiency across distinct ownership groups

Any analysis of bank efficiency seems incomplete if no attempt is made to examine the performance differential across entire spectrum of ownership groups in the banking system. This study tries to explore the efficiency differences across public, private, and FB groups' operating in India. Although these groups of banks operate in the same market, each group faces a different set of regulations and have different business strategies. In the light of this, we expect to find variations in the performance, both across ownership groups and over time. Here, we try to quantify and explain the anticipated variations in their performance. This task would also enable us to verify the issue of economic linkage of ownership *vis-à-vis* efficiency performance in the light of property right hypothesis, principal agent framework (Alchian, 1965; De Alessi, 1980), and public choice theory (Niskanen, 1975; Levy, 1987). As per property right hypothesis, PBs should perform more efficiently than public counterparts, because of strong linkage between markets for corporate control and efficiency of PBs.

The relevant results are reported in Panel A of Table IV. We note that: first, on average, there appeared CE differences across ownership groups, but these differences were not fairly large; second, PBs were underperformer relative to public and FBs; and third, on year-to-year basis, FBs outperformed the peers by a good margin. Our results suggest that PSBs performed better than PBs, but not strikingly different from FBs. Thus, the ranking of ownership groups in Indian banking industry is PSBs = FBs > PBs. The similar ordering of the banks' groups also holds broadly for the allocative and TE components of CE. Our finding pertaining to the ordering of ownership groups seems completely in consonance with Ram Mohan and Ray (2004) and in line with Tabak and Tecles (2010) who reported the better performance of PSBs relative to their counterparts in terms of CE. It has been argued by Tabak and Tecles (2010) that PSBs benefitted from the increased competition in the country enhancing their CE, while private and FBs were concerned in service quality improvements which involve huge costs. This is evident from the fact that, in 2006-2007, the estimated ratio of operating cost to total assets is lower for PSBs (1.77) relative to private (2.06) and foreign (2.78) banks (Reserve Bank of India, 2008). In fact, PSBs had managed their operating expenses in more aggressive manner than their counterparts during the last couple of years, and thus, experienced substantial CE gains.

We feel that some discussion on what derived the better efficiency performance of PSBs is warranted here. The most significant factor is the heightened competition in the Indian banking sector during the post-reforms period due to relaxed entry norms for *de novo* private domestic and FBs. To keep their survival intact in the highly competitive environment, the PSBs, especially the weak ones, started allocating

Table IV.
Mean cost, allocative, and technical efficiency scores of banks across ownership groups

Panel A: Year-wise mean efficiency scores

	Bank group								
	Public sector banks			Private banks			Foreign banks		
Year↓	CE	AE	TE	CE	AE	TE	CE	AE	TE
1992-1993	0.838	0.890	0.941	0.742	0.847	0.874	0.943	0.971	0.970
1993-1994	0.760	0.846	0.894	0.763	0.882	0.865	0.927	0.959	0.965
1994-1995	0.740	0.838	0.879	0.770	0.900	0.857	0.855	0.884	0.968
1995-1996	0.778	0.839	0.923	0.763	0.871	0.874	0.779	0.863	0.891
1996-1997	0.867	0.918	0.944	0.835	0.922	0.905	0.798	0.876	0.903
1997-1998	0.861	0.904	0.949	0.874	0.947	0.922	0.878	0.924	0.949
1998-1999	0.799	0.890	0.897	0.814	0.913	0.891	0.830	0.885	0.933
1999-2000	0.835	0.918	0.905	0.826	0.918	0.898	0.798	0.885	0.897
2000-2001	0.786	0.874	0.896	0.798	0.908	0.876	0.845	0.902	0.933
2001-2002	0.798	0.883	0.901	0.809	0.912	0.884	0.807	0.891	0.899
2002-2003	0.896	0.949	0.941	0.857	0.933	0.915	0.821	0.879	0.930
2003-2004	0.877	0.936	0.935	0.818	0.892	0.915	0.868	0.890	0.973
2004-2005	0.870	0.911	0.954	0.773	0.851	0.906	0.844	0.870	0.967
2005-2006	0.841	0.904	0.928	0.762	0.851	0.893	0.773	0.846	0.906
2006-2007	0.888	0.926	0.958	0.806	0.880	0.914	0.790	0.848	0.927
2007-2008	0.897	0.941	0.953	0.783	0.874	0.895	0.808	0.847	0.947
Grand mean	0.833	0.898	0.925	0.800	0.894	0.893	0.835	0.889	0.935
Average annual growth rates (%)	0.833	0.572	0.276	0.228	−0.007	0.270	−0.765	−0.613	−0.168
Acceleration (+)/deceleration (−)	(+)	(−)	(+)	(−)	(−)	(−)	(+)	(+)	(+)

Panel B: Hypothesis testing- differences in annual mean efficiency across pair-wise ownership groups

Ownership categories	Public vs private			Private vs foreign			Public vs foreign		
ANOVA test	4.619**	0.127	15.755***	5.284**	0.814	23.112***	0.014	0.532	1.061
	(0.040)	(0.724)	(0.000)	(0.029)	(0.671)	(< 0.0001)	(0.908)	(0.472)	(0.311)
Mann-Whitney test	1.960**	0.396	3.148***	−2.017**	0.773	−3.582***	0.113	0.999	−1.018
	(0.050)	(0.692)	(0.002)	(0.044)	(0.440)	(0.000)	(0.910)	(0.318)	(0.309)
Kruskal-Wallis test	3.843**	0.157	9.911***	4.070**	0.597	12.831***	0.013	0.999	1.036
	(0.050)	(0.692)	(0.002)	(0.044)	(0.440)	(0.000)	(0.910)	(0.318)	(0.309)
Kolmogorov-Simrnov test	0.438*	0.188	0.625***	0.313	0.313	0.688***	0.188	0.375	0.313
	(0.065)	(0.912)	(0.002)	(0.347)	(0.347)	(0.000)	(0.912)	(0.347)	(0.347)

Notes: The figures in parentheses are the *p*-values. *,**,***Statistical significant at 10, 5 and 1 per cent levels, respectively
Source: Author's calculations

resources efficiently, and changed their behavioural attitude and business strategies. Primarily, PSBs concentrated on the rationalization of the labour force and branching, and reduction in the cost of financial transactions. For making optimal use of labour force, these banks evolved policies aimed at "rightsizing" and "redeployment" of the surplus staff either by way of retraining them and giving them appropriate alternate employment or by introducing a "voluntary retirement scheme" with appropriate incentives. Consequently, the labour cost per unit of earning assets fell from 2.44 per cent in 1992-1993 to 0.95 per cent in 2007-2008. With the objectives of cutting the cost of day-to-day banking operations in the long run, and retaining their existing customers and attracting new ones by providing new technology-based delivery channels (like internet banking, mobile banking, and card-based funds transactions), PSBs made a heavy investment in information technology during the post-reforms years[13].

Another major influential factor that contributed to high levels of CE is that due to profound changes in the regulatory and legal frameworks, there has been a better recovery of non-performing loans which led to an improvement in the assets quality of the PSBs[14]. Due to this, the share of net-interest income in total income of PSBs has increased significantly. Further, the government ownership facilitated recapitalization of PSBs at the onset of reforms, and this provided the depositors the implicit guarantee of "too-big-to-fail" (Das and Ghosh, 2006). Due to customers' perception that in troubled times, PSBs act as safe havens, these banks attracted large volume of funds by paying lower rates of interest than PBs. This in turn saved the considerable sums of money of PSBs, and as a consequence improved their CE. Moreover, the loan approvals and extensions of PSBs are generally less prudential because of government intervention. This loose lending policy boosted loan production and other bank outputs per unit of input in the PSBs. All in all, higher CE stemmed not only due to cost-curtailing measures adopted by PSBs, but also occurred due to measures aiming at augmenting income-generating capacity of banks.

Regarding the sources of cost inefficiency across ownership groups, we broadly found that there existed a trade-off between one source of inefficiency against another. Table IV reports the relevant results for distinct ownership groups. We note that, in PSBs and FBs, allocative inefficiency contributed more in raising a bank's cost, while a rise in private bank's cost is both due to allocative and technical inefficiencies. This is evident from the figures of grand means of AE (TE) at the level of 0.898 (0.925) and 0.889 (0.935) for PSBs and FBs, respectively. The observed level of grand means of technical and AEs for PBs has been noted to be 0.893 and 0.894, respectively. The growth rates of efficiency measures for distinct ownership groups are also reported in the Table IV. From the growth rates of efficiency measures, we note that the CE, TE, and AE of PSBs followed an uptrend during the post-reforms period. On the other hand, the CE of PBs also grew, and both TE and AE of PBs moved in the opposite direction. In particular, TE grew and AE declined. Further, the CE of FBs dropped off significantly over the study period because of the declining trend in both the components. This finding suggests that allocative inefficiency is the main culprit to cause cost inefficiency among the distinct ownership groups of Indian banking industry. Moreover, the CE of public and FBs showed a tendency to accelerate in the long run, and that of PBs had a tendency to decelerate.

To answer the question: "does ownership matter in Indian banking industry?", we made use of a battery of tests to find out the statistical significance of observed efficiency differentials across ownership categories. The results are reported in Panel B of Table IV. We note that: first, no significant difference between efficiency measures

of public and FBs appeared in Indian banking industry; second, the difference between CE and TE of public and PBs was observed to be statistically significant; and third, the CE and TE differences between private and FBs was also found to be statistically significant. Thus, the findings suggest that there exist significant efficiency differentials across public and PBs, and private and FBs, but not in public and FBs' groups. In sum, there are significant differences in the efficiency performance of banks belonging to distinct ownership groups. We can thus safely conclude that ownership matters in case of Indian banking industry[15].

An efficiency analysis in Indian banking industry seems inadequate if the records of efficiency performance of *de novo* PBs are not detailed. This is because the entry of these banks completely changed the landscape of Indian banking industry by infusing greater price and non-price competition, a thing which was completely missing in the pre-reforms years. The results are reported in Table V. We note that the *de novo* PBs were more cost efficient than old PBs. The grand means of CE for old and *de novo* PBs has been noted to be 0.783 and 0.830, respectively. The growth rate analysis reveals that the CE has declined at the rate of (−)0.081 per cent per annum for *de novo* PBs, and recorded a decent growth rate of 0.115 per cent per annum for old PBs. Further, the main source of cost inefficiency in old PBs was technical inefficiency, and in *de novo* PBs, it was driven by allocative inefficiency. The most plausible reason for the better performance of *de novo* PBs is that due to their late entry into the industry, they had the advantage of not carrying any baggage from the past, as was the case with the other groups operating in Indian banking industry. Therefore, new PBs have successfully managed their business at lower operating costs than the other groups (Sensarma, 2006). Further, this is not surprising because employees and managers of *de novo* PBs are more trained and qualified than those of old PBs.

Table V.
Mean cost, allocative, and technical efficiency scores for old and new private banks

	Bank groups					
	Old private banks			New private banks		
Year↓	CE	AE	TE	CE	AE	TE
1992-1993	0.742	0.847	0.874	–	–	–
1993-1994	0.763	0.882	0.865	–	–	–
1994-1995	0.770	0.900	0.857	–	–	–
1995-1996	0.783	0.870	0.897	0.711	0.874	0.814
1996-1997	0.828	0.920	0.899	0.856	0.926	0.924
1997-1998	0.857	0.940	0.912	0.919	0.965	0.949
1998-1999	0.799	0.919	0.867	0.855	0.896	0.954
1999-2000	0.806	0.915	0.880	0.886	0.929	0.953
2000-2001	0.789	0.911	0.862	0.825	0.899	0.915
2001-2002	0.808	0.924	0.870	0.811	0.878	0.920
2002-2003	0.845	0.935	0.900	0.884	0.929	0.950
2003-2004	0.819	0.914	0.894	0.814	0.840	0.965
2004-2005	0.792	0.884	0.892	0.722	0.762	0.942
2005-2006	0.746	0.858	0.865	0.813	0.830	0.976
2006-2007	0.780	0.876	0.888	0.875	0.889	0.982
2007-2008	0.767	0.881	0.869	0.818	0.859	0.954
Grand mean	0.793	0.899	0.881	0.830	0.883	0.938
Average annual growth rates (%)	0.115	0.109	0.028	−0.081	−0.860	0.766
Acceleration (+)/deceleration (−)	(−)	(−)	(−)	(−)	(−)	(−)

Source: Author's calculations

In addition, *de novo* PBs evolved a rewarding incentive schemes for their employees and managers to put their best foot forward. This is what missing in old PBs.

Our analysis thus facilitates that the ranking of ownership groups in Indian banking industry is sensitive to the level of aggregation at which the researcher is explaining the outcomes of his empirical investigation. In particular, if the level of aggregation is high and only three ownership groups are being considered then the ranking in terms of CE is PSBs = FBs > PBs. However, when the ownership groups are further disaggregated then the ranking turns out be different and holds as: CE improvements in PSBs were the fastest along with FBs, followed by *de novo* private and old PBs.

To explore which bank group dominates in the formation of cost efficient frontier for the Indian banking industry, we constructed the frequency distribution of CE scores for each bank group in all the sample years, and reported the results in Table VI. For the analytical purpose, we categorized the number of banks in five distinct categories: $0 \leqslant CE < 0.45$, $0.45 \leqslant CE < 0.60$, $0.60 \leqslant CE < 0.75$, $0.75 \leqslant CE < 0.90$, and $0.90 \leqslant CE \leqslant 1$. We note that leaving aside a few exceptions, majority of public, private, and FBs had CE score above 60 per cent in each year of the study period. Further, in each year, a greater proportion of public and PBs fell in the class interval $0.75 \leqslant CE < 0.90$ relative to FBs, and thus, had CE level between 75 and 90 per cent . In contrast, majority of the FBs had CE level greater than 90 per cent . This finding clearly indicates that there is a large scope for public and PBs to curtail their cost of operations while still maintaining the same level of output.

Looking at the number of cost efficient banks in each ownership type, we note that the percentage of banks lying on the cost efficient frontier was far more in FBs' group than the public and PBs' groups in each sample year. For instance, of 18 banks that together constructed the best-practice frontier of Indian banking industry in the year 1992-1993, the number of public, private, and FBs were two, one, and 15, respectively. The figures in table for the remaining years also confirmed the dominance of FBs in constructing the efficient frontier of Indian banking industry. In all, the results of this study contradict the property rights hypothesis and public choice theory since PSBs shared the place on the podium along with FBs and were more efficient than PBs. Further, while FBs were mostly defining the grand technological frontier of the Indian banking system, PSBs closely pursued the frontier to stay competitive.

Next, we move to empirically investigate the impact of foreign ownership on bank performance in India. In particular, we intend to test the validity of either the home field advantage hypothesis or the global advantage hypothesis in the Indian banking industry. Both the hypotheses are developed by Berger *et al.* (2000). The former hypothesis argues that FBs may have lower efficiency than domestic banks due to the cross-border disadvantages. This might be due to the liability of foreignness[16] which imposes costs on FBs such that the domestic banks are more efficient than FBs (Sturm and Williams, 2004). On the other hand, the global advantage hypothesis suggests that some FBs overcome the diseconomies of cross-border operations and have higher efficiencies than domestic banks (Ersoy, 2009). Table VII provides the relevant results. We note that,on average, FBs performed better in terms of CE and TE than domestic banks in India. Thus, empirical evidences are in favour of the global advantage hypothesis in Indian banking industry. The better efficiency performance of FBs in India mightbe because of their superior investment strategies, managerial services, and provision of better quality services to their customers. Moreover, market conditions in India may have offered opportunities for FBs to exploit their comparative advantages, resulting in higher efficiencies. But, domestic banks are found to be more

Table VI.
Frequency distribution of cost efficiency scores for public, private, and foreign banks

Year↓	Categories I $0 \leqslant CE < 0.45$	II $0.45 \leqslant CE < 0.60$	III $0.60 \leqslant CE < 0.75$	IV $0.75 \leqslant CE < 0.90$	V $0.90 \leqslant CE \leqslant 1$	No. of cost efficient banks
Panel A: public sector banks						
1992-1993 ($n = 27$)	0 (0%)	0 (0%)	4 (14.8%)	17 (63.0%)	6 (22.2%)	2 (7.4%)
1993-1994 ($n = 27$)	0 (0%)	1 (3.7%)	14 (51.9%)	7 (25.9%)	5 (18.5%)	3 (11.1%)
1994-1995 ($n = 27$)	0 (0%)	4 (14.8%)	11 (40.7%)	8 (29.6%)	4 (14.8%)	3 (11.1%)
1995-1996 ($n = 27$)	0 (0%)	1 (3.7%)	13 (48.1%)	6 (22.2%)	7 (25.9%)	4 (14.8%)
1996-1997 ($n = 27$)	0 (0%)	0 (0%)	3 (11.1%)	15 (55.6%)	9 (33.3%)	3 (11.1%)
1997-1998 ($n = 27$)	0 (0%)	0 (0%)	5 (18.5%)	11 (40.7%)	11 (40.7%)	1 (3.7%)
1998-1999 ($n = 27$)	0 (0%)	0 (0%)	8 (29.6%)	15 (55.6%)	4 (14.8%)	1 (3.7%)
1999-2000 ($n = 27$)	0 (0%)	1 (3.7%)	6 (22.2%)	12 (44.4%)	8 (29.6%)	6 (22.2%)
2000-2001 ($n = 27$)	0 (0%)	0 (0%)	12 (44.4%)	10 (37%)	5 (18.5%)	2 (7.4%)
2001-2002 ($n = 27$)	0 (0%)	0 (0%)	7 (25.9%)	16 (59.3%)	4 (14.8%)	2 (7.4%)
2002-2003 ($n = 27$)	0 (0%)	0 (0%)	2 (7.4%)	13 (48.1%)	12 (44.4%)	7 (25.9%)
2003-2004 ($n = 27$)	0 (0%)	0 (0%)	1 (3.7%)	16 (59.3%)	10 (37%)	3 (11.1%)
2004-2005 ($n = 27$)	0 (0%)	0 (0%)	1 (3.7%)	17 (63%)	9 (33.3%)	3 (11.1%)
2005-2006 ($n = 27$)	0 (0%)	0 (0%)	7 (25.9%)	13 (48.1%)	7 (25.9%)	3 (11.1%)
2006-2007 ($n = 28$)	0 (0%)	0 (0%)	1 (3.6%)	14 (50%)	13 (33.3%)	3 (10.7%)
2007-2008 ($n = 28$)	0 (0%)	0 (0%)	0 (0%)	15 (53.6%)	13 (46.4%)	4 (14.3%)
Panel B: private banks						
1992-1993 ($n = 23$)	0 (0%)	1 (4.3%)	11(47.8%)	9 (39.1%)	2 (8.7%)	1 (4.3%)
1993-1994 ($n = 23$)	0 (0%)	3 (13%)	6 (26.1%)	12 (52.2%)	2 (8.7%)	1 (4.3%)
1994-1995 ($n = 23$)	0 (0%)	0 (0%)	8 (34.8%)	15 (65.2%)	0 (0%)	0 (0%)
1995-1996 ($n = 33$)	0 (0%)	4 (12.1%)	12 (36.4%)	11 (33.3%)	6 (18.2%)	2 (6.1%)
1996-1997 ($n = 33$)	0 (0%)	0 (0%)	6 (18.2%)	20 (60.6%)	7 (21.2%)	3 (9.1%)
1997-1998 ($n = 34$)	0 (0%)	0 (0%)	3 (8.8%)	19 (55.9%)	12 (35.3%)	6 (17.6%)
1998-1999 ($n = 33$)	0 (0%)	0 (0%)	10 (30.3%)	16 (48.5%)	7 (21.2%)	4 (12.1%)
1999-2000 ($n = 32$)	0 (0%)	0 (0%)	8 (25%)	15 (46.9%)	9 (28.1%)	3 (9.4%)
2000-2001 ($n = 31$)	0 (0%)	2 (6.5%)	9 (29%)	14 (45.2%)	6 (19.4%)	3 (9.7%)
2001-2002 ($n = 30$)	0 (0%)	2 (6.7%)	7 (23.3%)	14 (46.7%)	7 (23.3%)	4 (13.3%)

(*continued*)

Table VI.

Year↓	Categories I $0 \leqslant CE < 0.45$	II $0.45 \leqslant CE < 0.60$	III $0.60 \leqslant CE < 0.75$	IV $0.75 \leqslant CE < 0.90$	V $0.90 \leqslant CE \leqslant 1$	No. of cost efficient banks
2002-2003 ($n = 30$)	0 (0%)	2 (6.7%)	3 (10%)	12 (40%)	13 (43.3%)	6 (20%)
2003-2004 ($n = 30$)	0 (0%)	1 (3.3%)	7 (23.3%)	14 (46.7%)	8 (26.7%)	4 (13.3%)
2004-2005 ($n = 29$)	0 (0%)	3 (10.3%)	9 (31%)	12 (41.4%)	5 (17.2%)	2 (6.9%)
2005-2006 ($n = 28$)	0 (0%)	3 (10.7%)	9 (32%)	13 (46.4%)	3 (10.7%)	3 (10.7%)
2006-2007 ($n = 25$)	0 (0%)	3 (12%)	3 (12%)	15 (60%)	4 (16%)	2 (8%)
2007-2008 ($n = 23$)	0 (0%)	1 (4.3%)	6 (26.1%)	16 (69.6%)	0 (0%)	0 (0%)
Panel C: foreign banks						
1992-1993 ($n = 23$)	0 (0%)	0 (0%)	2 (8.7%)	4 (17.4%)	17 (73.9%)	15 (65.2%)
1993-1994 ($n = 21$)	0 (0%)	0 (0%)	2 (9.5%)	4 (19%)	15 (71.4%)	10 (47.6%)
1994-1995 ($n = 25$)	2 (8%)	0 (0%)	3 (12%)	5 (20%)	15 (60%)	9 (36.0%)
1995-1996 ($n = 30$)	4 (13.3%)	2 (6.7%)	3 (10%)	9 (30%)	12 (40%)	8 (26.7%)
1996-1997 ($n = 37$)	3 (8.1%)	3 (8.1%)	6 (16.2%)	11 (29.7%)	14 (37.8%)	9 (24.3%)
1997-1998 ($n = 37$)	1 (2.7%)	1 (2.7%)	6 (16.2%)	10 (27%)	19 (51.4%)	12 (32.4%)
1998-1999 ($n = 41$)	2 (4.9%)	3 (7.3%)	5 (12.2%)	14 (34.1%)	17 (41.5%)	11 (26.8%)
1999-2000 ($n = 41$)	3 (7.3%)	2 (4.9%)	9 (22%)	15 (36.6%)	12 (29.3%)	10 (24.4%)
2000-2001 ($n = 39$)	1 (2.6%)	3 (7.7%)	4 (10.3%)	13 (33.3%)	18 (46.2%)	11 (28.2%)
2001-2002 ($n = 35$)	2 (5.7%)	5 (14.3%)	4 (11.4%)	10 (28.6%)	14 (40%)	11 (31.4%)
2002-2003 ($n = 31$)	2 (6.5%)	1 (14.3%)	4 (12.9%)	12 (38.7%)	12 (38.7%)	9 (29.0%)
2003-2004 ($n = 29$)	2 (6.9%)	1 (3.4%)	3 (10.3%)	3 (10.3%)	20 (69%)	9 (31.0%)
2004-2005 ($n = 28$)	3 (10.7%)	0 (0%)	4 (14.3%)	6 (21.4%)	15 (53.6%)	12 (42.9%)
2005-2006 ($n = 28$)	3 (10.7%)	3 (10.7%)	7 (25%)	3 (10.7%)	12 (42.9%)	12 (42.9%)
2006-2007 ($n = 27$)	0 (0%)	8 (29.6%)	2 (7.4%)	6 (22.2%)	11 (40.7%)	10 (37.0%)
2007-2008 ($n = 26$)	2 (7.7%)	2 (7.7%)	6 (23.1%)	5 (19.2%)	11 (42.3%)	8 (30.8%)

Note: Figures in parentheses are the percentages
Source: Author's calculations

Panel A: Year-wise mean efficiency measures

	Bank groups					
	Domestic banks			Foreign banks		
Year↓	CE	AE	TE	CE	AE	TE
1992-1993	0.794	0.870	0.911	0.943	0.971	0.970
1993-1994	0.762	0.862	0.881	0.927	0.959	0.965
1994-1995	0.754	0.866	0.869	0.855	0.884	0.968
1995-1996	0.770	0.856	0.896	0.779	0.863	0.891
1996-1997	0.849	0.920	0.922	0.798	0.876	0.903
1997-1998	0.868	0.928	0.934	0.878	0.924	0.949
1998-1999	0.808	0.903	0.894	0.830	0.885	0.933
1999-2000	0.830	0.918	0.902	0.798	0.885	0.897
2000-2001	0.792	0.892	0.885	0.845	0.902	0.933
2001-2002	0.803	0.898	0.892	0.807	0.891	0.899
2002-2003	0.875	0.941	0.927	0.821	0.879	0.930
2003-2004	0.846	0.913	0.925	0.868	0.890	0.973
2004-2005	0.820	0.880	0.929	0.844	0.870	0.967
2005-2006	0.801	0.877	0.910	0.773	0.846	0.906
2006-2007	0.850	0.904	0.938	0.790	0.848	0.927
2007-2008	0.845	0.911	0.927	0.808	0.847	0.947
Grand mean	0.817	0.896	0.909	0.835	0.889	0.935
Average annual growth rate (%)	0.520	0.245	0.275	−0.765	−0.613	−0.168

Panel B: Hypothesis testing-differences in annual mean efficiency scores

Individual tests	Domestic vs foreign banks		
Efficiency measure→	CE	AE	TE
ANOVA test	1.428	0.452	8.408***
	(0.241)	(0.507)	(0.007)
Mann-Whitney test	−0.792	1.112	−2.526**
	(0.428)	(0.266)	(0.012)
Kruskal-Wallis test	0.627	1.237	6.382**
	(0.428)	(0.266)	(0.012)
Kolmogorov-Simrnov test	0.188	0.375	0.500**
	(0.912)	(0.162)	(0.023)

Notes: The figures in parentheses are the *p*-values; *,**,***Significant at 10, 5 and 1 per cent levels, respectively

Source: Author's calculations

Table VII.
Mean cost, allocative, and technical efficiencies of domestic and foreign banks

allocatively efficient. This might be due to the fact that domestic banks face less expensive input prices, particularly in labour. The aforementioned findings are further supported by the rejection of the null hypothesis of no difference in efficiency levels across domestic and FBs in majority of the sample years under consideration[17].

It is interesting to note that the domestic and FB groups have shown reversal in their performance in the most recent years. Domestic banks' outperformed FBs in India during the later years of reforms after 1999-2000. This is mainly due to the efforts of the GOI and RBI which restructured the domestic banking industry, and overcome the setbacks being faced by these banks before 1990s. Moreover, domestic banks have also invested heavily in technological upgradation which boosted up their performance. Thus, efficiency gaps between foreign and domestic banks narrowed down with the increase in the pace of reforms. We can thus conclude that though a strong presence of global advantage hypothesis has been observed in Indian banking industry during the early years of reforms, but this presence lost its sheen, and was appearing in

somewhat weak form during the most recent years. All in all, the results favour the existing policy of opening-up the Indian banking sector, with liberalization of foreign-entry by way of setting up a wholly owned banking subsidiary (WOS) or conversion of the existing branches into a WOS. We expect that the liberal entry of FBs not only brings in more competition, but will also really push the domestic banks closer to global best-practices, and would improve their performance and service quality.

6.3 Post-DEA analysis

To investigate the factors explaining inter-bank variations in efficiency measures, we performed a post-DEA analysis using panel data Tobit model. Note here that panel data Tobit model is an appropriate method since the dependent variable, the calculated efficiency measure, falls between the interval 0 and 1, and thus, censored at one. Some of the notable studies that applied the panel data Tobit analysis in banking sector include Pasiouras (2008) for Greek banks, Awdeh and El Moussawi (2009) for Lebanese banks, Tochkov and Nenovsky (2009) for Bulgarian banks, Sufian (2009) for Malaysian banks, Staub *et al.* (2010) for Brazilian banks, Burki and Niazi (2010) for Pakistani banks, among others.

In the post-DEA regression analysis, the choice of the explanatory variables is always problematic. In fact, the issue of what independent variables to be included in the model is complicated due to the fact that theory does not offer such guidance (Ariff and Can, 2008). In the absence of a theoretical rationale for determinants of efficiency of banks, we, therefore, used previous research in this area as a yardstick. In particular, we estimated the following regression models for distinct efficiency measures:

$$Model\ 1: \ Efficiency = f(\text{SIZE, ROA, OFF\_BALANCE, NPA})$$

$$Model\ 2: \ Efficiency = f(\text{SIZE, ROA, OFF\_BALANCE, NPA, D\_PUBLIC, D\_PRIVATE})$$

The first regressor included in our second-stage DEA analysis is *SIZE*, which is measured by the logarithm of total assets. The literature spells an ambiguity in the relationship between bank size and efficiency. The positive and significant coefficient of *SIZE* may be considered as an indication of significant economies of scale in the production process. It is contended that large banks may be able to hire a better management team, utilize better technology, be located in larger, more diversified loan portfolios, and thus, succeed in their attempts to establish scale economies (Kyj and Isik, 2008). The studies of Berger *et al.* (1993), Miller and Noulas (1996), Yildirim (2002), Ray and Das (2010), and Burki and Niazi (2010) found a significant positive relationship between bank size and efficiency. On the other hand, Hermalin and Wallace (1994), Kaparakis *et al.* (1994), DeYoung and Nolle (1996), Ataullah *et al.* (2004), Girardone *et al.* (2004), Kumar and Gulati (2008) reported a significant negative relationship. However, there are also a few studies that reported no significant relationship between bank size and efficiency (see, for instance, Aly *et al.*, 1990; Mester, 1993, 1996; Berger and Hannan 1998; Berger and Mester 1997; Chang *et al.*, 1998; Havrylchyk, 2006). Since previous empirical work does not provide any clear evidence, no a priori expectation is formed regarding the sign of relationship between bank size and efficiency.

The second predictor used in the analysis is *ROA*, which is an indicator of profitability of banks. It is hypothesized that more profitable banks are also more efficient. Therefore, we expect a positive relationship between *ROA* and efficiency measures. Earlier studies that reported a positive relationship between profitability

and bank efficiency include Jackson and Fethi (2000), Pasiouras (2008), Havrylchyk (2006), Sufian and Majid (2007), and Sufian(2009). In recent years, banks have made larger exposure to off-balance sheet activities with the objective to generate more non-interest revenues. The effect of this exposure is expected to be translated positively in their operating efficiency to generate incomes. Thus, we expect a positive relationship between the predictor *OFF_BALANCE* and efficiency measure. *OFF_BALANCE* is measured as a ratio of non-interest income to total assets. Sufian (2009) and Kumar and Gulati (2009a) confirmed a positive relationship between the exposure to off-balance sheet activities and bank efficiency in their empirical works.

The ratio of non-performing loans to total advances (*NPAs*) is a good indicator of asset quality of banks. The conventional wisdom favours a strict negative relationship between *NPAs* and efficiency measure since the lower of this ratio would facilitate higher efficiency in the banking operations. Thus, we expect a negative and significant coefficient of the predictor *NPA* in our post-DEA analysis, which would confirm the presence of bad management and bad luck hypotheses proposed by Berger and DeYoung (1997) in the Indian banking industry. The bad management hypothesis posits that *NPA*s are generally caused by controllable (i.e. endogenous) factors such as poor bank management. Banks with poor managers do not adequately monitor and control operational expenses and problem loans which lead to cost inefficiency. Postulating the other side, the bad luck hypothesis asserts that problem loans are generally caused by uncontrollable (i.e. exogenous) factors such as adverse weather conditions for a bank operating in a rustic area. Thus, the measured CE of banks might be fallaciously low because low CE may reflect the high-operating cost of managing problem loans (additional management effort, loan workout arrangements, etc.). Finally, to control for the effects of ownership status of banks, we introduced two dummy variables, namely, *D_PUBLIC and D_PRIVATE* for public and PBs, respectively, and use FBs as base category in our regression models. It is worth noting here that we expect no a priori relationship between ownership dummies and efficiency measures.

Table VIII report the post-DEA results. We note that in both the model specifications i.e., Model 1 (without ownership dummies) and Model 2 (with ownership dummies), except *ROA*, all the regressors bear the sign consistent with a priori expectations. The explanatory variable *OFF_BALANCE* has had a significant positive impact on efficiency measures, indicating that larger the exposure of banks to off-balance sheet activities, higher is the level of efficiency. With respect to asset quality of banks, we note that there exists a significant negative relationship between *NPAs* and cost and AEs, i.e., lower the ratio of *NPAs*, higher is the efficiency of banks in reducing costs of banking operations and choosing the optimal mix of inputs. Additionally, it bears the sign according to a priori expectation with TE, but the coefficient is not statistically significant. The observed negative relationship between asset quality and efficiency may be an indication of poor management (bad management) or a direct consequence of adverse factors outside the management control (bad luck). Whether exogenously or endogenously determined, this negative relationship reflects the high-operating cost of managing *NPAs*. Thus, it is not clear whether the results support bad luck or bad management hypotheses, but do not support the skimping hypothesis[18] in case of Indian banking industry. Our results are in line with those of Isik and Hassan (2003) for Turkish banks.

The predictor *SIZE* seems to have a positive and statistically significant relation with CE and AE measures. The possible explanation of this finding is that larger banks

Model specifications	Model 1 (without ownership dummies)			Model 2 (with ownership dummies)		
Panel A: Independent variables						
	CE	AE	TE	CE	AE	TE
Constant	0.4981***	0.6510***	0.8369***	0.4911***	0.6483***	0.8255***
	(10.65)	(17.79)	(21.98)	(8.84)	(14.83)	(0.000)
ROA	−0.0162**	−0.0147***	−0.0017	−0.0185***	−0.0152***	−0.0053
	(−2.40)	(−2.82)	(−0.31)	(−2.73)	(−2.89)	(−0.93)
OFF_BALANCE	0.0635***	0.0421***	0.0483***	0.0622***	0.0418***	0.0471***
	(10.79)	(9.40)	(8.36)	(10.34)	(0.000)	(7.82)
SIZE	0.0191***	0.0151***	0.0024	0.0219***	0.0159***	0.0064*
	(6.09)	(6.19)	(0.96)	(4.89)	(4.52)	(1.73)
NPA	−0.0025***	−0.0022***	−0.0004	−0.0026***	−0.0022***	−0.0005
	(−2.98)	(−3.23)	(−0.64)	(−3.07)	(−3.26)	(−0.84)
D_PUBLIC				−0.0227	−0.0059	−0.0348*
				(−1.01)	(−0.34)	(−1.91)
D_PRIVATE				−0.0502***	−0.0117	−0.0694***
				(−2.96)	(−0.88)	(−5.20)
Panel B: Test statistics						
No. of observations	687	687	687	687	687	687
Log likelihood	121.73	269.43	142.99	126.84	269.87	158.67
Wald χ^2	176.85***	149.16***	82.48***	186.71***	149.62***	108.38***
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

Notes: In panel A, the figures in parentheses are the *t*-values; in panel B, the figures in parentheses are the *p*-values. *,**,***Significant at 10, 5 and 1 per cent levels, respectively
Source: Author's calculations

Table VIII.
Results of post-DEA analysis

tend to be more efficient indicating that there are significant economies of scale. Thus, the larger is the size of the bank, the more is the possibility of managing its input costs efficiently. We further note that *ROA* as an indicator of profitability has a significant negative coefficient in both the models. Most probably this is the outcome of the problem of multicollinearity. However, we have a valid and logical explanation for the observed opposing results regarding the relationship between profitability and CE. The negative effect of profitability on CE and its components may be stemmed from the fact that most of cost efficient banks have invested heavily on IT in their drive to provide better customer services at low transaction cost which inversely affected their margins. On the other hand, the cost inefficient banks enjoy higher profitability due to high margins charged by those banks. This is a pointer towards the prevalence of "quite life" hypothesis in the Indian banking industry. According to Berger and Hannan (1998), in more concentrated markets, efficiency of banks worsen because the absence of competitive pressures results in lessened effort by managers to minimize costs. Managers can simply have a "quiet life", translating higher inefficiencies in higher prices. Our results are line with those observed by Awdeh and El Moussawi (2009) for Lebanese banks and Turati (2001) for European banks.

Finally, the banks with private ownership are underperforming relative to public and FBs in terms of CE. This is evidenced by the negative and significant coefficient of the dummy variable *D_PRIVATE*. The negative and statistically significant coefficients of ownership dummy variables in case of TE measures suggest that on average, FBs are more technically efficient than private and public banks. Thus, we can

infer that PBs are less cost efficient than their foreign and public counterparts. The regression results reiterate our earlier finding that public and FBs share the same place on the podium and are definitely more cost efficient than PBs. It has also been observed that the ownership does not have a strong link with the AE of Indian banks. All in all, the regression results suggest that ownership effects are significant in explaining cost variations in Indian banking industry.

7. Conclusions

The Indian banking industry has been substantially deregulated over the last two decades, with entry restrictions for *de novo* private and FBs greatly relaxed, and the industry has followed interest rates deregulation, lowering of statutory pre-emption, easing of directed credit rules, diversification in the ownership of PSBs. By employing input-oriented DEA models that incorporate the quasi-fixed inputs, this study examines how the CE performance of the banking industry has been affected by these deregulatory changes. In particular, we empirically tested the basic underlined hypothesis that the CE of Indian banks will rise in the more liberal and competitive environment. The main finding of the study is that typical bank in the Indian banking industry wastes about 17.8 per cent of its costs relative to the best-practice bank. Interestingly, our estimate of 17.8 per cent average cost inefficiency is considerably lower than that of world's average of 27 per cent cited in the extensive survey of Berger and Humphrey (1997).

The empirical results indicate that the financial deregulation process initialized in early 1990s has had a positive impact on the CE of Indian banks, and the observed increase in CE (albeit modest) is entirely due to improvements in TE. It seems that allocative inefficiency is the main culprit behind cost inefficiency in the Indian banking sector. Our most striking result is that AE in the banking industry worsened during the post-reforms period. This might be due to high fluctuations and instability in factor prices due to chronic inflation in the country in the recent years constrained the bank managers to take rational decision regarding input-mix. Another finding of our study is that PSBs that pursue not only profit maximization objective, but are also concerned with social justice in the allocation of credit, are the more efficient along with the FBs than PBs. In particular, we get the ranking of ownership groups in Indian banking industry as PSBs = FBs > PBs.

Our results also show that the magnitude of the deregulation impact varies among the different forms of ownership. The CE of public and PBs grew, but the same followed a path of deceleration for FBs during the post-reforms years. Further, in a majority of years, FBs were dominating in defining the production frontier of the Indian banking system. This indicates that FBs in India have succeeded in using their superior technology and managerial expertise and experience, and this in turn has offsetted potential cross-border disadvantages, e.g., lack of knowledge about the local market, barriers of culture, and regulations, etc. Thus, the empirical evidence is in favour of the prevalence of the global advantage hypothesis in Indian banking industry. The results of post-DEA analysis reveals that: first, PBs are less cost efficient than public and FBs; second, the negative relationship between *NPA* and efficiency measures supports the bad luck or bad management hypotheses instead of the skimping hypothesis in case of Indian banking industry; third, larger banks are more cost efficient, indicating the existence of significant economies of scale in Indian banking industry; and fourth, higher levels of efficiency are explained significantly by the greater exposure to off-balance sheet activities.

The aforementioned findings help us to draw a broad conclusion that to a large extent, the deregulation programme seems to be successful in achieving the CE gains in the Indian banking industry, and PSBs tend to have benefited most from deregulation. The results explicitly signals that the approach of cautious and gradual banking reforms adopted by Indian policy makers has started bearing fruit in terms of the creation of an efficient banking system, which is immune to any sort of financial crisis and resilient to both internal and external shocks. The Indian banks have not experienced the kinds of losses and write-downs that even venerable banks and financial institutions in the western world have faced after the global financial meltdown of 2008. Indian banks have shown resilience, as they have a buffer well over the required capital adequacy ratio of 9 per cent. The cautious approach of RBI in the early 2000s advising banks to go slow on their exposure to sensitive sectors like real estate and capital market has also helped the banking system to get insulated from the worst of effects of recent global crisis. All this is a pointer towards the overall effectiveness of banking reforms process in India. In the light of this, we suggest that the future reforms in the Indian banking sector should be directed towards strengthening competitive and market-oriented policies.

Notes

1. This is evident from the fact that the share of public sector banks in deposits, advances, and total assets of Indian banking industry was 76.6, 75.3, and 71.9 per cent during the financial year 2008-2009, respectively.
2. The combined pre-emption under Cash Reserve Ratio (CRR) and Statutory Liquidity Ratio (SLR), amounting to 63.5 per cent of net demand and time liabilities in 1991 (of which CRR was 25 per cent) has since been reduced and presently, the combined ratio stands below 35 per cent (of which, the SLR is at 25 per cent).
3. Prior to 25 October 2011, except saving deposit account, non-resident Indian deposits, small loans up to INR 0.2 million, and export credit, all the interest rates were fully deregulated. Recently, RBI also deregulated the savings bank deposit interest rate.
4. In 1993, the RBI issued guidelines concerning the establishment of *de novo* private banks. Nine new banks have entered the market since then. In addition, over 20 foreign banks have started their operations since 1994.
5. India adopted the Basel Accord Capital Standards in April 1992. An 8 per cent capital adequacy ratio was introduced in phases between 1993 and 1996, according to banks' ownership and scope of their operations. The regulatory minimum capital adequacy ratio was later raised to 10 per cent in the phased manner.
6. The time for classification of assets as non-performing has been tightened over the years, with a view to move towards the international best-practice norm of 90 days as on year end 2004.
7. The GOI has injected about 0.1 per cent of GDP annually into weak public sector banks.
8. The capital adequacy ratio has increased to 13 per cent for scheduled commercial banks as on end March 2008, which is much above the international norm. The net NPAs declined to 1 per cent of net advances during 2007-2008 from 8.91 per cent in 1995-1996.
9. The heightened competition is evident from the fact that the top three- and five-bank advances-based concentration ratios have declined from 42.16 and 52.4 per cent in 1991-1992 to 30.76 and 39.67 per cent in 2007-2008.

10. Even though the true technology could be different from CRS, but we adopt the CRS specification of technology on account of the following two reasons: first, given the small sample size like ours, one may get a distribution with many observations having efficiency score equal to 1 using variable returns-to-scale (VRS) specification. This implies that one may not get better discrimination of sampled units under VRS specification of technology in case of small sample size. Second, regarding the use of VRS specification of technology, Noulas (1997) stated that the assumption of CRS allows the comparison between small and large banks. In a sample where a few large banks are present, the use of VRS framework raises the possibility that these large banks will appear as being efficient for the simple reason that there are no truly efficient banks.
11. Isik and Hassan (2002) pointed out that: first, it is more flexible, and thus, more appropriate than estimating a single multi-year frontier for the banks in the sample, and second, it alleviates, at least to some extent, the problems related to the lack of random error in DEA by allowing an efficient bank in one year to be inefficient in another under the assumption that the errors owing to luck or data problems are not consistent over time.
12. Cost inefficiency = (1−cost efficiency) × 100.
13. Between September 1999 and March 2008, PSBs incurred an expenditure of INR 150 billion on computerization and development of communication networks (Reserve Bank of India, 2006). About 93.7 per cent branches of PSBs were fully computerized, and the number of both on- and off-site ATMs by PSBs also increased from 3,473 in 2003 to 34,789 in 2008.
14. This is evident from the fact that in PSBs, the quantum of net NPAs as a percentage of net advances declined from 10.7 per cent in 1994-1995 to 0.99 per cent in 2005-2006.
15. This result is complemented by the rejection of null hypothesis of no difference in efficiency score across distinct ownership groups in majority of the sample years under consideration, particularly in the most recent years. The detailed results are available upon request to the authors.
16. The liability of foreignness are the costs borne by banks operating away from their home market, such costs include monitoring, staff turnover, diseconomies of scale for retail operations, and factors such as culture, language and market structure acting as barriers to entry (Miller and Parkhe, 2002).
17. The detailed results are available upon request to the authors.
18. The skimping hypothesis maintains that the high volume of problem loans may be a conscious decision of a bank because its management might be trading off between short-term operating costs and long-run profitability. Management might rationally decide to reduce short-term expenses by skimping on resources allocated to loan origination and monitoring, at the expense of greater problem loans and costs in the future.

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