Journal of Economics and Business 61 (2009) 509–528

Contents lists available at ScienceDirect

Journal of Economics and Business

Financial deregulation and profit efficiency: A nonparametric analysis of Indian banks☆

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ARTICLE INFO

Article history:
Received 11 November 2008
Received in revised form 8 May 2009
Accepted 1 July 2009

JEL classification:
D61
G21
G34

Keywords:
Indian banks
Financial deregulation
Profit efficiency
DEA model

ABSTRACT

The paper examines the impact of financial deregulation on cost and profit efficiency of Indian commercial banks during the post-reform period 1992–2004 using the nonparametric data envelopment analysis (DEA). The results indicate high levels of cost efficiency and lower levels of profit efficiency, reflecting the importance of inefficiencies on the revenue side of banking activity. The decomposition of profit efficiency suggests that a large portion of outlay lost is due to allocative inefficiency. A multivariate regression of the proximate causes of profit efficiencies highlights the importance of bank size, ownership, product diversity and prudential indicators as important variables driving these efficiency differences.

1. Introduction

In recent years, a growing body of literature has analysed the efficiency of banks and financial institutions, mostly focused around costs and technical efficiency. On the cost side, differences in average costs have been examined by estimating economies of scale and, to a lesser extent, of scope economies. As against this, there is limited empirical evidence on profit efficiency of banks. However, the objective of profit maximization not only requires that goods and services be produced at a minimum cost, it also demands the maximization of revenues. Evidence from developed countries indicates that banks

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0148-6195/$ – see front matter
doi:10.1016/j.jeconbus.2009.07.003

which exhibit highest inefficiencies and incur the highest cost might be able to generate greater profits than more cost efficient banks (Berger & Humphrey, 1997; Berger & Mester, 2003). Computing profit efficiency, therefore, constitutes a more important source of information for bank management.

The paper addresses this issue in a developing country context, focusing on India as a case study. Among emerging markets, the study of banking in India is important for many reasons. First, over the 1990s, India has undergone significant financial deregulation with the objectives of enhancing efficiency, productivity and profitability of banks. Salient among the measures introduced include (a) lowering of statutory reserve requirements; (b) liberalizing the interest rate regime, allowing banks the freedom to determine their deposit and lending rates; (c) infusing competition by allowing more liberal entry of foreign banks and *de novo* Indian private banks; (d) introduction of micro-prudential measures such as capital adequacy requirements, income recognition, asset classification and provisioning norms for loan classification as also exposure norms and accounting standards; (e) diversifying the ownership base of state-owned banks by enabling them to raise up to 49% of their capital from the market and (f) mandating greater disclosures in the balance sheets to ensure greater transparency and market discipline. Second, India is one of the largest and fastest growing emerging economies with a gamut of banks across different ownership categories.[1] Therefore, it would be interesting to examine if the diversification of the ownership of state-owned banks and the penetration of private and foreign banks has had an impact on profit efficiency. Third, studies on efficiency in Indian banks have typically examined the cost and technical efficiency (Bhattacharyya, Lovell, & Sahay, 1997; Chatterjee, 2006; Das, 1997; Das & Ghosh, 2006; Das, Nag, & Ray, 2005; Sensarma, 2005; Shanmugam & Das, 2004).[2] Banking sector liberalization in its wake has lead to significant improvements in the quality of output (ATM, Internet banking, convenient banking hours, etc.). Such quality changes are, however, not captured in the conventional outputs typically used in empirical research, presumably due to data deficiencies, particularly for output quality. Examining whether and to what extent such quality changes are manifested in profit efficiency is a major concern of the paper. Fourth, the paper augments the extant literature by shedding light on the proximate determinants of profit efficiency for Indian banks. This assumes relevance, given the significant changes in terms of scope, opportunities and operational buoyancy of Indian banks and the increasing competitive pressures being faced by state-owned banks. Finally, the time period of the study coincides with the inception of economic reforms and therefore, offers an ideal vehicle to ascertain the impact of such reforms on the cost and profit efficiency of Indian banks. The findings so obtained may be representative of the impact of financial liberalization on profit efficiency of banks across different ownership groups in other emerging markets as well.

In the light of the aforesaid discussion, we estimate and examine the cost and profit efficiency of Indian commercial banks during the post-reform period, 1992–2004. Towards this end, we employ the nonparametric data envelopment analysis (DEA) methodology for obtaining the efficient benchmark profit frontier and optimal profit of individual bank.[3] In addition, the paper explores the proximate sources of (in)efficiency under a multivariate framework, and relates the findings to the spate of ongoing reforms. The findings reveal high levels of efficiency in costs and lower levels in profit efficiency, supporting the importance of inefficiencies on the revenue side of banking activity. More importantly, the variation of profit efficiency was observed to be greater than that of cost efficiency. The evidence also indicates that the efficiency gains wrought in by broad-basing the ownership of state-owned banks through reduction in government holding have, at best, been limited.

[1] The banking system in India comprises commercial and cooperative banks, of which the former accounts for around 95% of banking system assets. The commercial banking sector consists of state-owned (or public sector) banks, Indian private banks and foreign banks operating in India. State-owned banks cover nationalised banks (majority equity holding being with the Government), the State Bank of India (majority equity holding was with the Reserve Bank of India and has recently been transferred to the Government of India) and its associate banks (majority equity holding being with State Bank of India). Besides, there are the Regional Rural Banks, a category of commercial banks with equity participation from the Federal government, sub-national governments and sponsoring (state-owned) banks.

[2] Cost efficiency implies producing a given level of outputs using the mix of inputs at minimum possible cost. Technical efficiency (output oriented), on the other hand, is the ability producing maximum output with the available inputs.

[3] Nonparametric approaches put relatively little structure on the specification of the best-practice frontier. The parametric approach, on the other hand, specifies a functional form for the cost, profit or production relationship among inputs and outputs and allows for a random error.

The remainder of the paper is organised as follows. Section 2 presents a brief overview of efficiency studies on banking, with special emphasis on Indian banking. Section 3 provides a brief description of data and conceptual framework for measuring profit efficiency and its decomposition. The specifications of DEA models for estimating profit efficiency are also presented in this section. Section 4 discusses the empirical findings. In the concluding section, certain policy implications are highlighted.

2. Review of literature

Most of the studies on profit efficiency of banks are based on the experience of developed countries. The balance of evidence indicates that profit efficiency is lower than cost efficiency, the former reaching an average value of 64% for the US banking system (Berger & Humphrey, 1997). Contrary to expectations, their findings revealed that profit efficiency is not positively correlated with cost efficiency. Amel, Barnes, Panetta and Salleo (2004) provided a comparative international review of profit efficiency in the context of consolidation of the financial sector. They found an average level of profit efficiency of about 50% and cautioned that such estimates tend to be sensitive to model specification and estimation methods.

Studies on European nations also emphasized the role of relatively high profit inefficiency among banks. Lozano (1997) estimated profit efficiency of Spanish savings banks using the thick frontier approach during 1986–1991 coinciding with deregulation in their banking sector, based on both standard and alternative profit function specifications.[4] The result based on alternative profit function suggests that the profit inefficiency of Spanish savings banks, which averaged 28%, fell by 40% during 1986–1991. Evidence based on the German banking sector during 1989–1996 found little evidence that privately owned banks are more efficient than state-owned banks (Altunbas, Evans, & Molyneux, 2001). In a broader set-up, Maudos and Pastor (2003) analyzed the cost and profit efficiency of a sample of 14 countries of the European Union, as well as the Japan and the US. The evidence indicated that since 1990s, increasing competition has led to gains in profit efficiency in the US and Europe but not so in the Japanese banking system. More recently, Bonin, Hassan, and Wachtel (2005) examined both cost and profit efficiency for 11 transition countries during 1996–2000 based on stochastic frontier approach and concluded that privatization by itself is not sufficient to increase bank efficiency as government-owned banks are not appreciably less efficient than domestic private banks.

In contrast to the growing literature on efficiency for US and European banks, studies based on cost and profit efficiency of Asian banking system are limited. Early studies on technical efficiency and productivity include Leightner and Lovell (1998) for Thai banks, Gilbert and Wilson (1998) for Korean banks, and Shyu (1998) for Taiwan banks. Their evidence suggested that banks responded to deregulation by altering their mix of inputs and outputs, yielding increases in productivity. Kawn (2003) compared the operating performance of banks among the East Asian economies during 1992–1999. After controlling for loan quality, liquidity, capitalization, and output mix, the findings indicated that per unit bank operating costs vary significantly across Asian countries and over time. Operating efficiency was found to be unrelated to the degree of openness of the banking sector. Based on stochastic frontier approach on South-East Asian banks during 1990–2003, Williams and Nguyen (2005) observed that bank privatization is associated with superior profit efficiency performance as compared with other types of bank governance.

Among the earliest studies on the efficiency of Indian banking, Bhattacharyya et al. (1997) found that Indian public sector banks were the best performing and that they improved their efficiency in the deregulated environment. The study, however, essentially pertained to the pre-deregulation era. Since

[4] Standard and alternative profit maximization differs from one another only in terms of the specification of business conditions. Standard profit maximization is implemented using a profit function that specifies output prices in the business conditions vector in place of the output quantities specified in the cost function, but all other business conditions remain the same. Thus, firms are assumed to choose their outputs in response to relative output prices and other factors in the maximization process. Alternative profit maximization has the same objective as the standard profit maximization concept, but specifies the same set of business conditions as under cost minimization. The standard profit function is specified as a function of input and output prices, whereas the alternative profit function is specified as a function of input prices and output quantities (Berger & Mester, 2003).

the liberalization of the banking sector was initiated in 1991–1992, it is likely that its effect on efficiency would have manifested only at a later date. A more recent study addresses this lacuna by covering both the pre and post-liberalization era (Kumbhakar & Sarkar, 2003). Using the generalized shadow cost function, this study examined whether regulation engendered distortions in input choices by Indian public and private banks. The results indicate that total factor productivity growth has not been significant and importantly, there was no evidence of narrowing of performance differentials across ownership categories, following deregulation. Subsequently, Shanmugam and Das (2004) found that technical efficiency of raising interest margin of Indian commercial banks during 1992–1999 to be time invariant, while the efficiencies of raising other outputs, such as, non-interest income, investments and credits are time varying. Based on nonparametric approach, Rammohan and Ray (2004) and Das et al. (2005) compared various efficiency measures of Indian banks across different ownerships during post-liberalization period. The broad findings emanating from these studies were that state-owned banks performed significantly better than private sector banks on revenue maximization efficiency and the efficiency differential between state-owned and foreign banks was not significant. At the same time, Sensarma (2005) using parametric approach covering the period 1986–2003 found that state-owned banks exhibited higher cost efficiency than private banks. The balance of evidence appears to indicate that inefficiency is a major source of performance inadequacies of Indian banks and both size and increasing competitiveness in the Indian banking sector have favorably impacted on efficiency. Perhaps the medium size state-owned banks are more likely to be operating at higher levels of technical efficiency and have, on an average, less non-performing loans (Chatterjee, 2006; Das & Ghosh, 2006; Kumbhakar & Sarkar, 2005).

While these studies have enhanced the understanding of deregulation and efficiency change in Indian banking, there is admittedly limited evidence about the association between cost and profit efficiency and their proximate determinants. The significant deregulation of the Indian banking sector over the last decade-and-a-half has underscored the need of improved efficiency and productivity so that banks can withstand the risk of new challenges and competition ushered by deregulation. Against this background, this paper argues that cost efficiency is, by itself, not sufficient to achieve high profitability. In order to have a holistic view of the performance of banks, it is necessary to juxtapose both cost and profit efficiency.

3. Data and methodology

Efficiency is a relative concept since its measurement requires a standard of performance against which the success/failure of the firm is assessed. Broadly speaking, contemporary empirical studies employed parametric or nonparametric frontier techniques to measure the efficiency of firms relative to an estimated 'best-practice' frontier that represents the optimal utilization of resources. The parametric approach usually involves econometric estimation of a pre-specified stochastic production, cost or profit function. In contrast, nonparametric data envelopment analysis (DEA) approach does not require the specification of a particular functional form of the frontier. Instead, the frontier is constructed through a piecewise linear combination of the actual input–output correspondence set that envelops the data of all the firms in the sample. Hence, efficiency measurement is not contaminated by a possible misspecification of the functional form.

The present study employs the nonparametric DEA approach to estimate the cost and profit efficiency of commercial banks in India. The DEA method introduced by Charnes, Cooper, and Rhodes (1978) and further extended to non-constant returns technologies by Banker, Charnes, and Cooper (1984) provides a way to construct the production possibility set from an observed data set of input–output bundles. It assumes that the production possibility set is convex and both inputs and outputs are freely disposable. In practice, it characterizes the so-called efficient frontier (surface) based on the available set of decision making units (DMUs) and project all DMUs onto this frontier. If a DMU lies on the frontier, it is referred to as an efficient unit, otherwise it is labelled as inefficient. The data are enveloped in such a way that radial distances to the frontier are minimised and efficiency scores are calculated by solving a linear programming problem. Before explaining the empirical DEA models for estimating cost and profit efficiency, we discuss the data and selection of inputs and outputs in the subsequent section.

Table 1
Summary statistics of inputs, outputs and prices.

Year/variables	1992		1998		2004	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
No. of observations	64		74		71	
Inputs						
x_d: deposits (Rs. billion)	40.81	84.64	86.17	171.38	220.02	414.70
x_l: labour—no. of employees	14,486	30,768	12,982	30,571	11,929	26,526
x_k: capital—fixed assets (Rs. billion)	0.30	0.58	1.68	2.43	2.95	5.84
x_q: equity, quasi-fixed (Rs. billion)	1.38	2.40	7.01	12.70	15.99	27.50
Input prices						
w_d: price of deposits (%)	0.0645	0.0089	0.0775	0.0134	0.0508	0.0141
w_l: price of labour (%)	0.0082	0.0051	0.0214	0.0157	0.0438	0.0343
w_k: price of capital (%)	0.0071	0.0034	0.0035	0.0022	0.0055	0.0057
Outputs						
Y_1: loans and advances (Rs. billion)	24.68	59.48	43.27	93.40	120.90	216.01
Y_2: Investments (Rs. billion)	15.16	31.95	36.30	71.37	111.99	234.26
Y_3: Other income (Rs. billion)	0.72	1.81	1.61	3.43	5.53	10.11
Output prices						
P_1: price of loans and advances (%)	0.1456	0.0413	0.1312	0.0181	0.0894	0.0389
P_2: price of investments (%)	0.0903	0.0121	0.1097	0.0141	0.0817	0.0158

3.1. Choice of inputs and outputs, and data sample

For selecting inputs and outputs of banks, we have adopted *intermediation approach*.[5] Four inputs are considered – deposits, number of employees, fixed assets and equity. Compared with the other three inputs, the level of equity is difficult to alter – especially in the short run. For this reason, we treat equity as quasi-fixed in our measurement of cost and profit efficiency without any associated price. The prices of the first three inputs are respectively—cost of deposits, measured by average interest paid per rupee of deposits, average staff cost per employee and cost per unit fixed assets as measured by non-labour operational cost per rupee amount of fixed asset. On the output side, we use three variables—investments, loans and advances and other non-interest fee based incomes. While the first two are fairly standard in the literature, the third follows from Rogers (1998). The choice of this variable is dictated by the fact that, in recent years, an increasing portion of bank income has been generated through fee-based activities. Illustratively, the fee income of Indian banks as a percentage of their total income has doubled from around 10% in 1992 to nearly 20% in 2004. The associated price indicator for the first two output measures are average interest earned per rupee of investment and average interest earned per rupee of loan and advances, respectively. For non-interest income, the total amount itself is taken as an output in value term. Non-interest income emanates from fee, commission, brokerage, etc., and has fairly standardised pricing mechanism. Therefore, it is assumed that price of non-interest income is unity throughout the years for all banks. Summary statistics of selected variables are presented in Table 1.

Our sample covers all commercial banks in India and span over 13-year period beginning with the financial year 1992–2004. The sample includes those banks which had at least three branches during the entire study period. This was done to remove small and outlier foreign banks, which were operating mainly to service their clients of their parent banks abroad and may be choosing their input and output mix on considerations totally different from other banks having significant retail presence in the country. We also excluded the Regional Rural Banks, given their differential business philosophy and ownership structure as compared to other commercial banks. Based on these criteria, we have 64 banks in the year 1991–1992 and 71 banks in the terminal year of the study. These banks accounted for,

[5] State-owned banks in India service a large number of small sized deposit accounts. Therefore, ideally one should use valued-added approach for selecting inputs and outputs. However, in such case, it is difficult to define prices of inputs and outputs which are essential for profit efficiency estimation.

on average, over 90% of total bank assets in India. The data for inputs, outputs and prices are culled out from various issues of *Statistical Tables Relating to Banks in India*, an annual publication of the Reserve Bank of India, and *IBA Bulletin* of the Indian Banks Association.

3.2. Cost and profit efficiency using nonparametric DEA methodology

Consider an industry producing m outputs from n inputs. An input–output bundle (x, y) is considered feasible when the output bundle y can be produced from the input bundle x. The technology faced by the firms in the industry can be described by the production possibility set

$$T = \{(x, y) : y \text{ can be produced from } x\} \tag{1}$$

Suppose that (x^j, y^j) is the input–output bundle observed for firm j ($j = 1, 2, \ldots, N$). Clearly, these input–output bundles are all feasible. Then the smallest production possibility set satisfying the assumptions of convexity and free disposability that includes these observed bundles is

$$S = \{(x, y) : x \geq \sum_{j=1}^{N} \lambda_j x^j;\ y \leq \sum_{j=1}^{N} \lambda_j y^j;\ \sum_{j=1}^{N} \lambda_j = 1;\ \lambda_j \geq 0;\ (j = 1, 2, \ldots, N)\}. \tag{2}$$

The set S is also known as the free disposal convex hull of the observed input–output bundles. One can obtain various measures of efficiency of a firm using the set S as the reference technology.

3.2.1. Cost, profit efficiency and quasi-fixed inputs

Suppose that the input price vector faced by the firm with input–output bundle (x^0, y^0) is w. Then its actual cost is $C^0 = w'x^0$. The minimum cost of producing the target output is

$$C(w, y^0) = \min\ w'x : (x, y^0) \in T.$$

With reference to the estimated production possibility set S, the minimum cost is obtained as $C^* = \min\ w'x$ s.t.

$$\sum_{j=1}^{N} \lambda_j y^j \geq y^0;\ \sum_{j=1}^{N} \lambda_j x^j \leq x;\ \sum_{j=1}^{N} \lambda_j = 1;\ \lambda_j \geq 0;\ (j = 1, 2, \ldots, N). \tag{3}$$

The cost efficiency of the firm is then measured as $\gamma = C^*/C^0 \leq 1$.

For estimating cost efficiency, outputs were treated as exogenously given. However, for firms like commercial banks, both inputs and outputs are choice variables and the only constraint would be the feasibility of the input–output bundle chosen. For such case, the suitable criterion of efficiency is profit maximization. Under the DEA model, the maximum profit may be obtained as

$$\begin{aligned} &\Pi^* = \max\ p'y - w'x \text{ s.t.} \\ &\sum_{j=1}^{N} \lambda_j y^j \geq y;\ \sum_{j=1}^{N} \lambda_j x^j \leq x;\ \sum_{j=1}^{N} \lambda_j = 1;\ \lambda_j \geq 0;\ (j = 1, 2, \ldots, N). \end{aligned} \tag{4}$$

The profit efficiency of the firm is measured as $\delta = \Pi^0/\Pi^*$. This measure is also bounded between 0 and 1 except in the case where the actual profit is negative and the maximum profit is positive. In that case δ is less than 0. If the maximum profit is negative as well, δ exceeds unity.

In standard DEA applications where inputs are treated as choice variables, we implicitly assume that the firm can vary all the inputs to achieve efficiency. This clearly corresponds to a long run analysis. It is possible, however, that one or more input is quasi-fixed and only the other inputs are subject to variation at the discretion of the firm. Suppose that the input vector $\mathbf{x}$ can be partitioned as $\mathbf{x} = \{\mathbf{v}, \mathbf{K}\}$, where $\mathbf{v}$ is an n_1 element vector of variable inputs, while $\mathbf{K}$ is an n_2 element vector of quasi-fixed

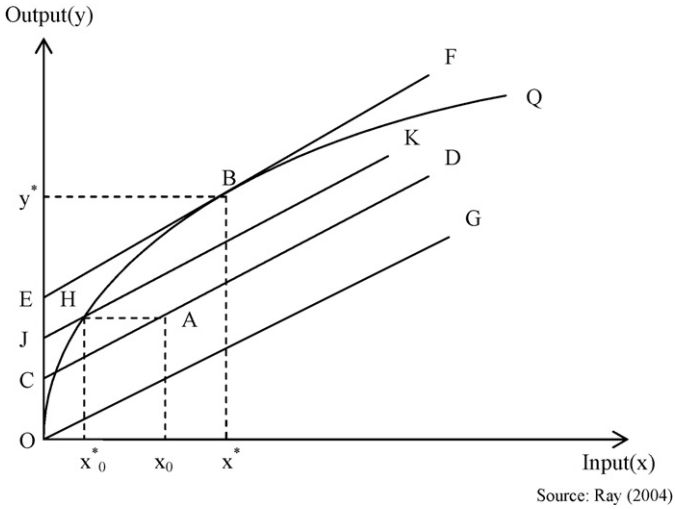

Fig. 1. Profit efficiency and its decomposition.

inputs. Now, the revised DEA problem to be solved for variable cost minimization is $VC^* = \min q'v$ s.t.

$$\sum_{j=1}^{N}\lambda_j y^j \geq y^0;\ \sum_{j=1}^{N}\lambda_j v^j \leq v;\ \sum_{j=1}^{N}\lambda_j K^j \leq K^0;\ \sum_{j=1}^{N}\lambda_j = 1;\ \lambda_j \geq 0;\ (j = 1, 2, \ldots, N). \tag{5}$$

The variable cost efficiency of the firm is $\gamma_v = VC^*/VC^0$.

Similarly, the revised DEA problem for variable profit maximization is:

$$\begin{aligned} &\Pi_v^* = \max\ p'y - q'v\, s.t. \\ &\sum_{j=1}^{N}\lambda_j y^j \geq y;\ \sum_{j=1}^{N}\lambda_j v^j \leq v;\ \sum_{j=1}^{N}\lambda_j K^j \leq K^0;\ \sum_{j=1}^{N}\lambda_j = 1;\ \lambda_j \geq 0;\ (j = 1, 2, \ldots, N). \end{aligned} \tag{6}$$

The variable profit efficiency of the firm is $\delta_v = \Pi_v^0/\Pi_v^*$.

3.3. Decomposition of profit efficiency

The standard profit-maximization problem of a competitive firm is

$$Max.\Pi = p'y - w'x \text{ subject to} (x, y) \in T,$$

where $p = (p_1, p_2, \ldots, p_m)$ is the vector of output prices and $w = (w_1, w_2, \ldots\ldots, w_n)$ is the vector of input prices.

For single-input (x), single-output (y) case, one can conceptualize the production function as

$$y^* = f(x) = \max\ y : (x, y) \in T.$$

In Fig. 1, suppose the actual input–output combination of the firm (x_0, y_0) is shown by the point A and OQ represents the production function. The profit earned by the firm is $\Pi = py_0 - wx_0$ with normalized profit $\pi_0 = \Pi/p$ and normalized input price $\omega = w/p$. The set of all (x, y) through A which yield normalized profit π_0 is shown by the line CD. The objective of the firm is to reach the highest isoprofit line parallel to CD that can be attained at any point on or below OQ. The point B represents such a point on OQ where the line EF through B is parallel to CD. Let the optimal input–output bundle at B be (x^*, y^*). The line OG is a ray through O parallel to CD and represents the zero profit line. At

any input level x, the vertical distance between the production function and the point on OG shows the normalized profit earned if the firm produced the maximum output from the given input. Clearly at A, the firm exhibits considerable technical inefficiency. The efficient input-oriented projection of A onto OQ is H. The same output y_0 at H could have been produced using input x_0^* ($<x_0$). The normalized profit through this technically efficient point H is $\pi_T = y_0 - \omega x_0^* = y_0 - \beta(\omega x_0)$, where $\beta = x_0^*/x_0$ is the measure of input oriented technical efficiency of the firm. Again, given the normalized input price ω, the firm can increase its profit by moving from the point H to the point B along OQ. This increase in profit is due to the improvement in allocative efficiency of the firm. Thus the firm maximizes profit by moving from point A to point B in two stages. In the first stage, normalized profit increases from π_0 to π_T due to improvement in technical efficiency. As allocative efficiency improves, normalized profit further increases from π_T to π^* in the second stage.

Like cost efficiency, a multiplicative decomposition of profit efficiency into technical and allocative components is not yet established in the theory. However, Färe, Grosskopf, and Weber (2004) and Ray (2004) provided an alternative additive decomposition of profit efficiency. For multiple-input, multiple-output case, define:

$$\Delta = \Pi^* - \Pi_0 = (\Pi_T - \Pi_0) + (\Pi^* - \Pi_T) \Rightarrow \delta = \frac{\Delta}{C_0} = \frac{(\Pi_T - \Pi_0)}{C_0} + \frac{(\Pi^* - \Pi_T)}{C_0},$$

where, C_0 is the actual cost of the firm with input–output bundle (x^0, y^0). Here δ represents the lost or unrealized part of the maximum return on outlay. The first component of δ is $\delta_T = [(p'y^0 - \beta w'x^0) - (p'y^0 - w'x^0)]/w'x^0 = (1-\beta)$ = input oriented technical inefficiency of the bank. The other component $\delta_A = [p'(y^* - y^0) - w'(x^* - \beta x^0)]/w'x^0$ denotes the return on outlay lost due to allocative inefficiency. As β lies between 0 and 1, δ_T also lies between 0 and 1. But δ_A (≥ 0) can actually exceed 1 and thus normalized difference measure of profit inefficiency can also exceed 1.

3.4. Determinants of inefficiency of banks

The empirical methodology adopted here is based on both univariate and two-stage multivariate approaches. Univariate cross-tabulation approach basically delineate the empirical correlates of cost and profit (in)efficiency across ownership and size classes. This approach, however, does not satisfactorily address the interrelationship among various efficiency measures and bank financial parameters, since most bank characteristics are likely to be correlated with each other. To address this aspect, and to examine the sources of efficiency differential, efficiency estimates derived in the first stage DEA models are regressed on bank attributes in a multivariate framework. The second-stage analysis therefore examines various hypotheses on efficiency by linking them to the factors deemed to be relevant in explaining efficiency. Several hypotheses are postulated in the literature, mostly dealing with ownership, size, corporate governance, market power, balance sheet composition, etc. (Table 2).

3.4.1. Multivariate approach

A commonly held view in the efficiency literature is that the use of Tobit model can handle the characteristics of the distribution of efficiency measures and thus can provide important policy guidelines (Das & Ghosh, 2006; DeYoung & Hasan, 1998). As the estimated value of profit efficiency score (dependent variable) is bounded between 0 and 1, an appropriate theoretical specification is a Tobit model with two-side censoring. However, banks with efficiency score of zero will never be observed in practice. Therefore, the results of the empirical analysis will not be different if one specifies a one or a two-sided Tobit model. Accordingly, the DEA profit efficiency scores obtained in the first stage are used as the dependent variables in the second stage one-side censored Tobit model in order to allow for the restricted (0, 1] range of efficiency values.[6] The standard Tobit model can be defined as follows:

$$\begin{aligned} y_0^* &= \beta x_0 + \varepsilon_0 \\ y_0 &= y_0^* \text{ if } y_0^* > 0, \text{ and } 0, \text{ otherwise} \end{aligned} \tag{7}$$

[6] Profit efficiency, by definition, can be negative. However, our empirical estimates of profit efficiency of individual banks consistently fell within (0, 1] throughout 1992–2004.

Table 2
Potential correlates of bank efficiency—alternative hypotheses.

Issues	Hypothesis
1. Efficiency and size	H_0: bank size is positively related to X-efficiency of the bank
2. Efficiency, corporate governance and control	
(a) Stockholder ownership	H_0: publicly traded banks are more X-efficient (positive relationship)—*market discipline hypothesis*
(b) Corporate Governance and Control	H_0: CEO-Chairman affiliation is negatively related to X-efficiency—*agency theory hypothesis*
(c) Public versus private ownership	H_0: state-owned banks are less X-efficient than private banks
(d) Domestic versus foreign ownership	H_0: foreign-owned banks are more X-efficient than domestic banks
3. Efficiency and market power	H_0: market power is negatively (positively) related to cost (profit) efficiency—*structure-performance hypothesis*
4. Efficiency and product diversity	H_0: banks with greater diversification have lower (overall) cost and higher allocative efficiency
5. Efficiency and balance sheet composition	
(a) Loan production	H_0: banks with bigger loan portfolio have higher profit efficiency—*efficient structure hypothesis*
(b) Purchased funds	H_0: banks with bigger purchased funds have lower profit efficiencies
6. Efficiency and risk variables	
(a) Financial capital	H_0: well-capitalized firms are more X-efficient—*moral hazard theory hypothesis*
(b) Non-performing loans	H_{01}: non-performing loans are negatively associated with cost efficiency—*bad luck hypothesis* H_{02}: non-performing loans are negatively associated with cost efficiency—*bad management hypothesis* H_{03}: non-performing loans are positively associated with cost efficiency—*skimping hypothesis*
8. Efficiency and age	H_0: *de novo* banks are less efficient—*learning by doing hypothesis*

where, x_0 is a vector of explanatory variables and β is the set of parameters to be estimated; $\varepsilon_0 \sim N(0, \sigma^2)$ denotes the error term. The term y_0^* is a latent variable and y_0 is the profit efficiency score obtained from the first stage DEA models.

Using the profit efficiency scores as the dependent variable, we estimate the following regression model:

$$\begin{aligned}\Theta_{jt} = {} & \beta_0 + \sum_{k=93}^{04} \beta_k YR\_k + \beta_1 SIZE_{jt} + \beta_2 LISTING_{jt} + \beta_3 DEP\_SI_{jt} + \beta_4 PRO\_DIV_{jt} + \beta_5 AGE_{jt} \\ & + \beta_6 PUBLIC_{jt} + \beta_7 PRIVATE_{jt} + \beta_8 (PRIVATE \times AGE)_{jt} + \beta_9 TERM\_D_{jt} + \beta_{10} CURRENT\_D_{jt} \\ & + \beta_{11} LOAN_{jt} + \beta_{12} LIQUIDITY_{jt} + \beta_{13} AST\_G_{jt} + \beta_{14} NNPA_{jt} + \beta_{15} CRAR_{jt} + \beta_{16} RWA_{jt} + \varepsilon_{jt}\end{aligned} \tag{8}$$

where, Θ_{jt} is the profit efficiency of the jth bank in period 't' obtained from the DEA model.

The independent variables capture the various facets of banking activity. On the liability side, we include three variables: the share of deposits in total deposits (*DEP_SI*) as a proxy indicator of individual bank's market control or concentration. If concentration leads to higher prices and profits, the coefficient of this variable would be positive. Second, we include the proportion of term deposits to total deposits (*TERM_D*). A large share of term deposits in total deposits in an environment of falling interest rates is expected to lead to higher cost and, therefore, we expect a negative coefficient of this variable. Berger and Mester (2003) also report that banks those rely more on purchased funds (core deposits) tend to have lower profit efficiencies. Third, we include the proportion of current deposits to total deposits (*CURRENT_D*) to ascertain the effect of heterogeneity in liability structure on efficiency. Since size and concentration of deposits vary significantly across ownership and size classes, banks

with higher proportion of this variable is expected to have a lower interest outgo, and with unchanged revenues, higher profits. Consequently, the sign on this variable is expected to be positive.

Two variables are included on the asset side. The loan ratio (*LOAN*), defined as the ratio of loans to total assets, takes into consideration the most risky bank asset. An increase in the loan ratio implies a higher risk profile of the bank balance sheet and therefore, a rise in risk-weighted assets. To the extent that such credit extension is accompanied by prudent risk management practices, this is expected to raise interest incomes and consequently, profits. Besides, higher loan-to-asset ratio might imply higher market power in loan markets. Second, the proportion of liquid assets to total assets (*LIQUIDITY*) is included to capture banks' cash management practices.[7] A high proportion of liquid assets could be indicative of poor cash management which results in low interest income. The coefficient on this variable, is, therefore, expected to be negative. We include a variable *PRO_DIV* to capture the product diversity of the bank.[8] Product diversity is closely related to scope efficiency, whether a bank is producing the most cost efficient combination of products. Therefore, banks shifting towards producing a broader mix of services are expected to experience higher profit efficiencies. Among other bank-specific controls, we include bank size (*SIZE*), measured in terms of logarithm of total assets. We also include the growth of total assets (*ASST_G*). While an over-extension of credit by banks is likely to engender faster asset growth with concomitant rise in profits, on the flip side, this can lead banks to compromise on their credit risk management practices, leaving them with higher delinquent loans on their books and thereby, lower profitability levels. The sign on this variable is, therefore, ambiguous.

We also examine the impact of prudential parameters on the estimated profit efficiency. A deterioration in the quality of bank asset exacerbates the total cost incurred with a possible dampening effect on profits. To control for this possibility, we include the ratio of non-performing loans (*NNPA*), net of loan loss provisions, to total loans and expect the coefficient on this variable to be negative. Second, we incorporate the ratio of total capital to risk-weighted assets (*CRAR*). Empirical evidence suggests that well-capitalized banks are more profit efficient (Ishik & Hassan, 2003). Third, the ratio of risk-weighted assets to total assets (*RWA*) is included to control for the risk-composition of the banks' asset portfolio.[9] To control for various macroeconomic, regulatory and other factors, we include several dummy variables. First, the dummy variable (*LISTING*) equals 1 in the year in which a bank (state-owned or private) made an equity offering and for all subsequent years thereafter and zero, otherwise (Das & Ghosh, 2006). Second, *AGE* is included as an indicator variable which equals one if the bank became operational before 1992 and zero otherwise. Third, we include dummies to control for bank ownership. Accordingly, we include the variable *PUBLIC* which equals one for state-owned banks, zero otherwise. Likewise, a dummy variable *PRIVATE* is defined for private banks. The interaction of *PRIVATE* with *AGE* is included to ascertain the differential behaviour of *de novo* private banks (established post-reform in 1992) as compared with old private banks (in existence prior to 1992) on profit efficiency. Finally, we include year dummies for the period 1993–2004 (excluding the year 1992) to account for changes in the macroeconomic environment and in the regulatory treatment of banks over time.

We estimated four variants of the Tobit model (Models 1–4) depending on the availability of data. The base model is estimated for the entire period 1992–2004 (Model 1), while the second model is estimated for the period 1993-2004 since one year of observation is lost with the inclusion of *ASST_G* as an additional variable (Model 2). Models 3 and 4 sequentially include the bank soundness and portfolio risk variables, respectively, and are estimated over a shorter time span, coinciding with the

[7] Comprising cash in hand, balances with the central bank, money at call and short notice and liquid securities.

[8] This variable is defined as $PRO\_DIV = -\ln \sum_{i=1}^{n} f_i^2$, where f_i represents the fraction of revenue generated from product i. Since f_i's are fractions, we have multiplied by (-1) to convert the index to a positive number. Owing to non-availability of revenue data at disaggregated level, we have used broad classifications as available in banks' annual accounts. These include revenues generated from (a) loans and advances, (b) investments portfolio, (c) other interest bearing assets, (d) commission, exchange, brokerage, and (e) other non-interest income. It is to be noted that revenues under (d) and (e) purely come from direct servicing activities. The index assumes value zero if the bank produces a single output and increases if it is producing multiple products.

[9] The data of risk-weighted assets for individual banks are not available in public domain. However, exact risk categories (for 2003) are available under master circulars on the RBI website (http://rbidocs.rbi.org.in/rdocs/notification/DOCs/38743.doc). We matched the detailed classifications of published balance sheet items (including off-balance sheet items) to these risk categories as close as possible and arrive at an approximate value of risk-weighted assets.

Table 3
Cost and profit efficiency of Indian banks, 1992–2004.

Year	No. of banks	Cost efficiency		Profit efficiency	
		Mean	Std. Dev.	Mean	Std. Dev.
1992	64	0.7916	0.1483	0.4277	0.2721
1993	64	0.8305	0.1267	0.4576	0.2793
1994	66	0.8564	0.1344	0.4774	0.2900
1995	66	0.8746	0.1022	0.4392	0.2978
1996	75	0.8174	0.1776	0.4509	0.2419
1997	74	0.8669	0.1513	0.4846	0.2365
1998	74	0.8800	0.1348	0.5491	0.2256
1999	74	0.8310	0.1808	0.5871	0.2234
2000	75	0.8000	0.2159	0.6067	0.2223
2001	75	0.7772	0.1957	0.5479	0.2285
2002	74	0.7706	0.2062	0.5765	0.2357
2003	72	0.8077	0.1869	0.5846	0.2421
2004	71	0.8477	0.1865	0.6170	0.2500

Note: Indian banks refers to banks operating in India, including state-owned, private and foreign banks.

availability of bank-level data on these variables. The specified Tobit model in (8) is estimated with heteroscedasticity option using the maximum likelihood method.[10]

4. Empirical results

4.1. Cost and profit efficiency of Indian banks

Table 3 presents the year-wise distribution of cost and profit efficiency scores. High level of relative average cost efficiency scores (along with low standard deviation) of Indian banks illustrates that most of the banks lie close to the benchmark cost frontier. The average cost-inefficiency of Indian banks was found to be low and remained below 23% during 1992–2004. In other words, both technical efficiency (input-oriented) and allocative efficiency (input-oriented) of Indian banks are at a reasonably high level. That is, banks are able to control the underutilization and wastage of valuable input resources and to a great extent managed to choose proper input-mix as against their competing demands.

Unlike cost efficiency, profit efficiency estimates suggest wide divergence among banks. More specifically, banks appear to lie well inside the efficient profit frontier. For the period 1992–1997, average profit efficiency was below 50%. In the latter half of the sample period, as commercial considerations gained prominence, a greater number of banks performed relatively close to the benchmark which manifested itself in profit efficiency enhancement. These results imply the existence of market power in the setting of prices and variation in the quality of bank output as reflected in the differences in realized prices. These findings are consistent with cross country studies which indicate a low level of profit efficiency of banks (Altunbas et al., 2001; Amel et al., 2004; Bonin et al., 2005; Lozano, 1997; Maudos & Pastor, 2003). Economically, it is not difficult to envisage why profit efficiency scores are consistently lower than cost efficiency in India. In a policy environment where banks have little leeway in choosing their input prices, the inter-bank variation in output-mix, given relative factor prices, plays a significant role. This leaves considerable room for improvement in productivity and profitability by prudent choice of credit and investment mix coupled with better resource management. These results are at variance with Bauer, Berger, Ferrier, and Humphrey (1998) who observed that X-inefficiency is the major source of performance problems among financial institutions. Besides, insofar as profit efficiency is concerned, high and persistent standard deviation does not lend credence to the conjecture that deregulation has resulted in convergence of performance of Indian banks.

[10] Heteroscedasticity option is warranted as the dependent variable is an estimated parameter. Estimation is performed using SAS QLIM procedure (version 9.1).

Table 4
Cost and profit efficiency of domestic Indian banks, 1992–2004.

Year	No. of banks	Cost efficiency		Profit efficiency	
		Mean	Std. Dev.	Mean	Std. Dev.
1992	51	0.9072	0.0854	0.5049	0.2338
1993	51	0.8754	0.0911	0.4258	0.2361
1994	51	0.9124	0.0811	0.4275	0.2586
1995	51	0.9191	0.0647	0.4004	0.2466
1996	61	0.9047	0.0894	0.4591	0.2603
1997	59	0.9418	0.0656	0.4880	0.2494
1998	59	0.9606	0.0480	0.5615	0.2337
1999	58	0.9267	0.0748	0.5975	0.2347
2000	59	0.9546	0.0679	0.6382	0.2285
2001	58	0.9370	0.0673	0.6270	0.2331
2002	57	0.8566	0.1243	0.6503	0.2189
2003	56	0.8621	0.1237	0.6624	0.2144
2004	55	0.8921	0.1122	0.7063	0.2066

Note: Domestic Indian banks include state-owned and private banks.

Like domestic state-owned and private Indian banks, foreign banks have branch operations in India for several decades. However, these banks are located mainly in metropolitan areas and their clientele comprises mostly corporate and high net worth individuals. They tend to rely more on wholesale deposits as compared to high retail deposits of domestic banks. Therefore, given the business profile and risk appetite, their inclusion in the sample could contaminate the results. To negate this possibility and to analyse the robustness of the efficiency estimates, DEA models were also estimated without this bank group. Exclusion of foreign banks resulted in a better performance of domestic Indian banks; however overall trends suggested that profit efficiency was noticeably lower than cost efficiency (Table 4). The dispersion of both efficiency estimates was also less pronounced, once these banks were removed from the dataset. Therefore, the presence of foreign banks induced a large degree of heterogeneity in performance of Indian banks.

4.2. Correlation of efficiency measures with financial performance

With a view to complement the results of efficiency estimates, the trends of two important accounting measures of bank performance *viz*., return on equity (RoE) and return on assets (RoA), vis-à-vis various efficiency measures are examined (Fig. 2).[11] Prior to the inception of financial sector reforms, income used to 'accrue' in the books of banks once a loan was made, irrespective of whether it was 'realized' or not. In such a situation, the profitability numbers were biased upwards. Accordingly, when the criteria for income recognition, loan classification and provisioning were introduced in 1992, it was found that banks were saddled with a large quantum of non-performing loans on their books. Their capital adequacy ratios, as computed under the Basel I norms, were also found wanting. The restructuring exercise which followed the financial sector reforms enabled banks to conduct business based on commercial considerations as against the global standards. Banks were advised to gradually shore up their provisioning levels. At the same time, with several banks increasing their capital base, the government decided to write-off their losses, thereby making their valuations attractive. This, in turn, lowered their leverage, resulting in low ROE. The net effect of these measures was a large dip in banks' net profits during the initial years following deregulation. As a result, till 1994, both RoE and RoA fell markedly; but subsequently maintained a steady improvement and the progress has been significant since 2001. Concomitantly, profit efficiency also picked up gradually during the same period.[12]

[11] Return on equity (ROE) = net profit/(capital + reserves) and return on assets (ROA) = net profit/total assets.

[12] Both ROA and ROE are estimated using net profit, adjusted for provision. The profit defined in profit efficiency estimation using DEA does not take into account of provision element. As a result till 1994, both ROA and ROE fell markedly due to the effect of higher provisioning on net profit, which was not reflected in profit efficiency estimates.

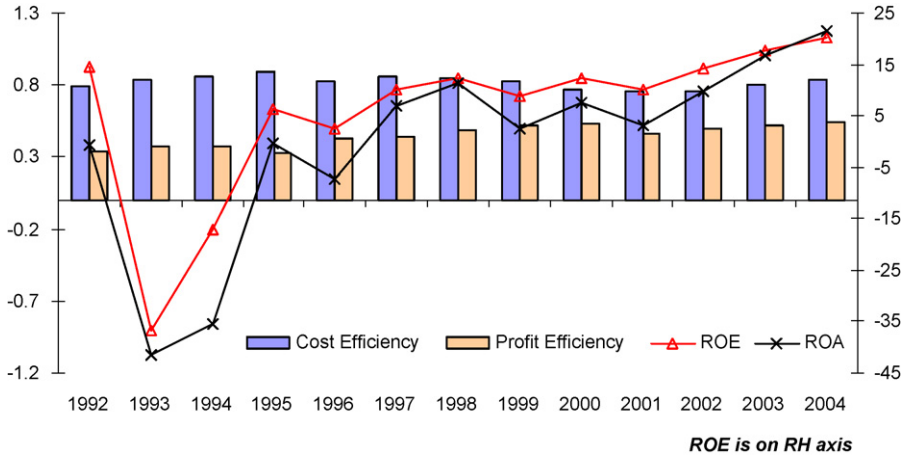

Fig. 2. Trends in return on assets (RoA), return on equity (RoE) and efficiency measures.

To examine this statistically, we compute the Spearman's rank correlation coefficients among the efficiency and accounting measures of performance (Table 5). The results indicate that profit efficiency and proxy measures of performance, RoE in particular, have a strong and positive association, except for the initial years after deregulation. Since 1997, correlation between profit efficiency and RoE is statistically significant for most of the years. On the other hand, cost efficiency does not seem to have a consistent association with performance measures.

4.3. *Empirical correlates of efficiency: univariate approach*

Under the univariate approach, the estimates of cost and profit efficiency scores obtained from the DEA models are cross tabulated and analysed to examine how cost and profit efficiency varies across ownerships and size classes. As the difference in cost efficiency scores are not perceptibly large, we restricted our analysis only to profit efficiency. The reasons why different ownership structure of banks may produce different efficiency levels have been extensively explored in the finance literature. The dominant model of the effect of ownership utilizes the principal agent framework and public choice theory to highlight the importance of the extent to which management is constrained by capital mar-

Table 5
Spearman's rank correlation between performance and efficiency estimates—1992–2004.

Year	Cost efficiency		Profit efficiency	
	ROE	ROA	ROE	ROA
1992	−0.171	−0.030	−0.246**	−0.201
1993	0.085	0.151	0.234	0.196
1994	0.015	0.026	0.249**	0.202
1995	−0.165	−0.165	0.198	0.090
1996	−0.150	−0.366*	0.129	−0.098
1997	−0.017	−0.253**	0.264**	−0.105
1998	0.204	0.161	0.208**	0.126
1999	0.331*	0.151	0.423*	0.307*
2000	0.095	0.280**	0.246**	−0.034
2001	0.050	−0.120	0.177	0.096
2002	0.065	0.167	0.184	−0.114
2003	0.098	−0.068	0.308*	0.045
2004	0.158	−0.301**	0.346*	−0.236

* Statistical significance at 1% level.
** Statistical significance at 5% level.

Table 6
Ownership and profit efficiency of Indian banks, 1992–2004.

Year	SBI and its associates		Nationalized banks		Indian private banks		Foreign banks	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
1992	0.5763	0.2189	0.3911	0.1810	0.3574	0.2735	0.4891	0.3536
1993	0.7087	0.2396	0.3471	0.2010	0.4744	0.2384	0.4410	0.3559
1994	0.7824	0.2278	0.4293	0.2410	0.4437	0.2600	0.4318	0.3303
1995	0.7876	0.2391	0.3918	0.2066	0.3982	0.2679	0.3823	0.3476
1996	0.8026	0.2451	0.4134	0.1874	0.4164	0.2413	0.3902	0.1610
1997	0.7817	0.2261	0.5125	0.2288	0.4075	0.2083	0.4524	0.1932
1998	0.8522	0.2107	0.5364	0.2219	0.5116	0.1928	0.4852	0.1925
1999	0.8253	0.2041	0.6220	0.2193	0.5122	0.1977	0.5682	0.2094
2000	0.8568	0.2018	0.6872	0.2179	0.5463	0.1837	0.5091	0.1948
2001	0.7680	0.2117	0.6560	0.1939	0.4686	0.1640	0.4681	0.2635
2002	0.8031	0.1989	0.6883	0.1946	0.5359	0.1939	0.4164	0.2338
2003	0.7941	0.1635	0.7363	0.1933	0.5575	0.1913	0.3487	0.1959
2004	0.8340	0.1363	0.7686	0.1818	0.6069	0.1982	0.3461	0.1999

ket discipline. The theoretical argument is straightforward: lack of capital market discipline weakens owners control over management, enabling the latter to pursue their own interests, and giving fewer incentives to be efficient.

It is observed that the State Bank and its associates score much higher than all other groups in terms of profit efficiency (Table 6). It is likely that this category of banks, by virtue of undertaking most of the government sponsored programs, such as personal provident fund collection, tax collection, etc., can generate significant fee-based income, and thus tend to be more profit efficient. In addition, variability of efficiency scores of these banks is slowly but steadily declining over the period. In other words, a large segment of public sector banking system has witnessed a gradual degree of convergence in performance after deregulation. Comparatively, the profit efficiency scores of the other segment of public sector banks, namely the nationalized banks, is found to be persistently lower than the former group. Over the years however, nationalized banks have been able to considerably improve their relative profit efficiency scores. Several reasons can be attributed to the low level of profit efficiency of nationalized banks. Firstly, nationalized banks are often perceived as having multiple goals: although the liberalization process have engendered an overt focus on profit maximization, certain peripheral objectives, *e.g.*, encouraging employment of low-skilled workers and promoting job opportunities in rural areas by opening additional branches still remain relevant. Second, in pursuance of government policy objectives, managers in these banks might have followed a strategy of advancing greater quantum of loans to priority sectors, which being lent at below-market rates, would have ended up yielding low return on advances. These banks are often criticized for 'lazy banking'; instead of focusing on credit extension and monitoring the associated risks, they have tended to invest in risk-free government securities. Recent empirical evidence based on individual loan accounts of a medium sized public sector bank in India corroborates the presence of 'lending inertia'. Despite alternative lending opportunities, nationalized banks have not been pro-active to seize the opportunities offered by liberalization possibly due to the 'fear of prosecution' (Banerjee, Cole, & Duflo, 2003).[13]

In contrast, average profit efficiency of Indian private banks and foreign banks operating in India has been much lower than that of state-owned banks. In particular, there is no clear evidence of relative improvement of profit efficiency over time for foreign banks. The average efficiency scores of Indian private banks have moved erratically over the years, although their performance seems to have improved slowly over the period. Taking this argument further, we investigate the difference in profit efficiency scores across ownership by performing the Kruskal–Wallis' nonparametric tests separately

[13] The fear of prosecution hypothesis argues the following: public sector employees, being Government servants are subject to anti-corruption legislation. As a consequence, a credit gone bad can have significant pecuniary and other (loan officer being relieved of the duties, transferred or passed over for promotion) effects. There are no explicit incentives for making good loans; therefore, simply renewing the loan without changing the amount is the easiest way to avoid responsibility ("fear of prosecution").

Table 7
Size and profit efficiency of Indian banks, 1992–2004[a].

Year/size	I-Small		II-Medium		III-Big		IV-Large	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
1992	0.3708	0.2926	0.3660	0.2697	0.4789	0.2529	0.4848	0.2620
1993	0.4544	0.2771	0.4526	0.2887	0.4787	0.3091	0.4491	0.2798
1994	0.3960	0.2922	0.4557	0.2551	0.5736	0.2842	0.5226	0.2955
1995	0.3537	0.3021	0.4181	0.2576	0.5435	0.3150	0.4838	0.2832
1996	0.4175	0.2326	0.4642	0.2169	0.5195	0.2663	0.4369	0.2520
1997	0.4311	0.2409	0.4497	0.1438	0.5213	0.2350	0.5421	0.2627
1998	0.4629	0.1998	0.6103	0.1757	0.6378	0.2288	0.5631	0.2496
1999	0.5064	0.2074	0.5905	0.1946	0.6356	0.2216	0.6524	0.2393
2000	0.4943	0.1984	0.5899	0.1286	0.7220	0.1879	0.6765	0.2494
2001	0.4280	0.2145	0.4713	0.0833	0.6415	0.2253	0.6729	0.2083
2002	0.4287	0.2086	0.5236	0.1138	0.6809	0.2140	0.7120	0.2173
2003	0.4071	0.2275	0.5753	0.1316	0.6872	0.1725	0.7354	0.2049
2004	0.4342	0.2357	0.5910	0.1950	0.7467	0.1633	0.7618	0.1926

[a] Based on total assets, four size classes have been considered. These are: I: assets up to Rs. 50 billion, II: assets between Rs. 50 billion to Rs. 100 billion, III: assets between Rs. 100 billion to Rs. 200 billion, IV: assets above Rs. 200 billion.

for individual years.[14] The results indicate that, in most of the years, the average efficiency scores between various bank groups are significantly different. Efficiency estimates of public sector banks are significantly higher than Indian private or foreign banks. Significant efficiency differential between Indian private and foreign banks also underscored the need for separate treatment in designing specific policy guidelines within the private sector. Thus, evidence suggesting efficiency gains wrought in by broad-basing the ownership of state-owned banks through reduction in government holding have, at best, been limited. This efficiency–ownership relationship is in line with Altunbas et al. (2001), wherein they found little evidence to suggest that privately owned German banks are more efficient than state-owned banks.

The relationship between profit efficiency and bank size is presented in Table 7.[15] Both the big and large banks recorded relatively high efficiency scores; profit inefficiency was persistent primarily for small banks. These results indicate that except for the small banks, across all other size categories, banks moved progressively closer to the profit frontier and this trend gathered momentum during the latter half of the sample period. It is, therefore, clear that the banks in India can increase their profit performance significantly merely by adopting the best practices within their peer size groups. Low level of efficiency among the banks in the smallest size class indicates that with the existing scale of operations, these banks are operating far below the efficient frontier. On the other hand, big and large banks do not appear to exhibit major size related cost disadvantage compared to small banks. Efficiency differential across various size classes was also corroborated by Kruskal–Wallis' nonparametric tests, which indicate statistically significant differences in efficiency between small and big banks, as well as between small and large banks.[16]

4.4. Decomposition of profit efficiency

Following the earlier discussion, a simple additive decomposition of profit efficiency is presented in Table 8. It is observed that the loss or unrealized part of the maximum return on outlay (δ) has been declining over time. Indian commercial banks are losing very little profit due to their (input-oriented) technical inefficiency. For most of the years after deregulation, technical inefficiency has remained at around 5–6%. On the contrary, a large portion of return on outlay lost is from the high levels of

[14] The results are available upon request from the authors.
[15] Following Mohan (2006), four size classes have been considered. These are: I-small: assets up to Rs. 50 billion, II-medium: assets between Rs. 50 billion to Rs. 100 billion, III-big: assets between Rs. 100 billion to Rs. 200 billion, IV-large: assets above Rs. 200 billion.
[16] The results are available upon request from the authors.

Table 8
Decomposition of profit efficiency: 1992–2004.

Year	Mean			Std. Dev.		
	δ	δ_T	δ_A	δ	δ_T	δ_A
1992	1.1199	0.0511	1.0689	0.5981	0.0835	0.5611
1993	0.7697	0.0677	0.7020	0.4459	0.1054	0.4257
1994	0.8323	0.0571	0.7753	0.5270	0.0817	0.4969
1995	0.9968	0.0639	0.9329	0.6139	0.0715	0.5741
1996	0.8260	0.0662	0.7598	0.5238	0.1108	0.4940
1997	0.7702	0.0656	0.7046	0.5274	0.0988	0.4920
1998	0.6712	0.0416	0.6296	0.4828	0.0952	0.4739
1999	0.5149	0.0739	0.4409	0.4996	0.1417	0.4765
2000	0.5214	0.0701	0.4514	0.5227	0.1306	0.5085
2001	0.5276	0.0876	0.4400	0.4655	0.1473	0.4696
2002	0.5032	0.0755	0.4277	0.4541	0.1491	0.4200
2003	0.5599	0.0553	0.5047	0.4965	0.1024	0.4970
2004	0.5384	0.0507	0.4877	0.4840	0.1098	0.4972

δ: unrealized portion of the return on outlay. δ_T: input oriented technical inefficiency. δ_A: return on outlay lost due to allocative inefficiency.

allocative inefficiency. Dimensionally, allocative inefficiency alone accounted for more than 85% return on outlay lost and such phenomenon is fairly persistent even after a decade of deregulation. As the cost efficiency estimates are reasonably high, it seems that the major problems of Indian banks stem from the allocative inefficiency relating to outputs. Given the current factor prices, the present level of output mix is not sufficient to generate maximum profit. Traditionally, banks in India support the government borrowing programs by way of large investments in government securities. In addition, strict capital regulations also induced Indian banks to divert resources from conventional lending to risk-free government securities. Therefore, as competition intensifies, banks will need to undertake pro-active measures to further improve their efficiency.

4.5. Regression results

We corroborate the findings of the univariate approach by undertaking a multivariate regression analysis. The results are set out in Table 9. In Model 1, the positive and statistically significant coefficient on *SIZE* is consistent with the fact that larger banks are better able to adjust their optimal mix and scale of outputs and hence raise their profit efficiency. Second, the coefficient on *DEP_SI* is positive and statistically significant. Banks in less competitive markets can charge higher price for their services and eventually make supernormal profits. Empirical results for the US banking industry also confirm a similar phenomenon (Stiroh & Strahan, 2003). As markets become more open, the link between performance and market share intensifies. Over time, these competitive dynamics reallocate control of the banking industry toward the better-run banks. The coefficients on both *AGE* and *PRIVATE* × *AGE* are statistically not significant, suggesting that age does not exert any perceptible bearing on profit efficiency.

The empirical evidence strongly supports the claim that banks with greater reliance on term deposits (*TERM_D*) are less profit efficient. Typically, private and foreign banks finance their business expansion with expensive term deposits. Their average share of term deposits hovered around 70% of total deposits, while for state-owned banks, this share was much lower at around 60%. In fact, the coefficient of term deposits was found to be negative and statistically significant in 3 out of the 4 models. Therefore, high input cost is a key determinant of low profit efficiency of the Indian banking sector. The positive coefficient on the *LOAN* variable supports the efficient structure hypothesis: due to their ability to manage operations more productively, relatively efficient banks might have lower production cost, which enables them to offer more loan on more competitive terms and ultimately garner larger market shares. This evidence is in conformity of the presence of market power in loan markets and might stem from the ability of the bank to generate private information about loan customers that is costly to duplicate by other lenders. Evidence regarding the existence of such relationship lending

Table 9
Parameter estimates of Tobit regression.

Parameters	Model 1	Model 2	Model 3	Model 4
INTERCEPT	−0.1978 (0.1517)	−0.1933 (0.1604)	0.1392 (0.1621)	0.0893 (0.1727)
SIZE [=log(assets)]	0.0249 (0.0087)*	0.0209 (0.0089)**	−0.0027 (0.0091)	0.0038 (0.0100)
DEP_SI [=share in total deposits of all banks]	1.3939 (0.3320)*	1.3989 (0.3374)*	1.7464 (0.3275)*	1.6239 (0.3445)*
TERM_D [=proportion of term deposits in total deposits]	−0.3028 (0.1233)**	−0.3501 (0.1300)*	−0.2519 (0.1270)**	−0.0684 (0.1424)
CURRENT_D [=proportion of current deposits in total deposits]	−0.6979 (0.1749)*	−0.6756 (0.1849)*	−0.3458 (0.1774)***	−0.0774 (0.1993)
LOAN [=proportion of loans to total assets]	1.0948 (0.1338)*	1.1630 (0.1356)*	0.9878 (0.1317)*	1.0864 (0.1470)*
LIQUIDITY [=proportion of liquid assets to total assets]	0.5719 (0.1396)*	0.5659 (0.1429)*	0.2556 (0.1404)***	0.0976 (0.1527)
PRO_DIV [=indicator of product diversity]	0.1089 (0.0630)***	0.1302 (0.0638)**	0.1421 (0.0593)**	0.2188 (0.0670)*
AGE [=dummy indicating the presence of the bank before 1992]	−0.0418 (0.0362)	−0.0282 (0.0368)	0.0091 (0.0373)	0.0231 (0.0499)
PUBLIC [=dummy indicating state-ownership of banks]	0.0534 (0.0365)	0.0855 (0.0375)**	0.1725 (0.0374)*	0.1094 (0.0419)*
PRIVATE [=dummy indicating private-ownership of banks]	−0.0201 (0.0261)	0.0033 (0.0270)	0.0358 (0.0254)	−0.0194 (0.0314)
PRIVATE × *AGE*	−0.0028 (0.0436)	−0.0203 (0.0444)	−0.0056 (0.0435)	−0.0209 (0.0557)
LISTING [=dummy indicating stock market listing of banks]	0.1171 (0.0560)**	0.1162 (0.0579)**	0.1093 (0.0544)**	0.1557 (0.0705)**
ASST_G [=asset growth]		0.0001 (0.0002)	0.0001 (0.0002)	0.0001 (0.0002)
NNPA [=non-performing loan ratio]			−0.0064 (0.0017)*	−0.0055 (0.0020)*
CRAR [=capital to risk-weighted assets ratio]			−0.0146 (0.0018)*	−0.0144 (0.0019)*
RWA [=proportion of risk-weighted assets to total assets]				−0.2800 (0.0783)*
YR_93 [=dummy for year 1993]	0.0331 (0.0384)			
YR_94 [=dummy for year 1994]	0.0772 (0.0386)**	0.0615 (0.0372)***		
YR_95 [=dummy for year 1995]	0.0092 (0.0384)	−0.0111 (0.0370)		
YR_96 [=dummy for year 1996]	0.0099 (0.0379)	0.0129 (0.0373)		
YR_97 [=dummy for year 1997]	0.0566 (0.0390)	0.0411 (0.0371)	0.0550 (0.0296)	
YR_98 [=dummy for year 1998]	0.1105 (0.0393)*	0.0961 (0.0374)**	0.1357 (0.0302)***	0.0680 (0.0297)**
YR_99 [=dummy for year 1999]	0.1577 (0.0398)*	0.1453 (0.0379)*	0.1916 (0.0309)*	0.1226 (0.0303)*
YR_00 [=dummy for year 2000]	0.1751 (0.0400)*	0.1611 (0.0382)*	0.2057 (0.0310)*	0.1372 (0.0308)*
YR_01 [=dummy for year 2001]	0.1052 (0.0407)*	0.0936 (0.0388)**	0.1425 (0.0312)*	0.0732 (0.0309)**
YR_02 [=dummy for year 2002]	0.1212 (0.0412)*	0.1078 (0.0396)*	0.1215 (0.0319)*	0.0217 (0.0335)
YR_03 [=dummy for year 2003	0.1319 (0.0418)*	0.1192 (0.0405)*	0.1854 (0.0341)*	0.0906 (0.0351)*
YR_04 [=dummy for year 2004]	0.1695 (0.0422)*	0.1550 (0.0408)*	0.2330 (0.0353)*	0.1477 (0.0355)*
Period	1992–2004	1993–2004	1996–2004	1997–2004
N [=no. of observations]	924	860	664	589
Log likelihood	105.778	125.681	224.639	204.716

Figures in bracket indicate standard errors.

* Statistical significance at 1%.

** Statistical significance at 5%.

*** Statistical significance at 10%.

in the Indian context has recently been adduced by Berger et al. (2008).

In Model 2, the coefficient on asset growth variable is positive, but not statistically significant. If the asset base of banks expands depending on the growth in demand for banking services, this increased demand might provide more opportunities to make profits in the short run. Thus, our results confirm the existence of external factors shaping the profitability of banks.

The third model includes the bank soundness (*CRAR*) and asset quality (*NNPA*) variables. Clearly, banks with higher regulatory capital were observed to be more profit efficient. One possible reason might be that efficient banks generate higher profits, which might lead to higher capital as a result of high reserve accumulation. Evidence for the US banking industry is also supportive of this fact (Kwan & Eisenbis, 1997). Alternately, the positive relationship between profit efficiency and regulatory capital may also indicate that, because of limited liability, managers in inefficient banks have less at stake in taking a risky gamble. Therefore, as the level of capital decreases, managers of such banks have growing incentives to 'gamble for resurrection' (Dewartipont & Tirole, 1994). As expected, asset quality has a dampening impact on profit efficiency.

In the final specification (Model 4), it is observed that banks with greater portfolio risk (*RWA*) exhibit lower profit efficiency. This finding concurs with the bad management hypothesis of Berger and DeYoung (1997). Put differently, low profit efficiency is a manifestation of inadequate loan monitoring and control practices, a factor that is typically associated with subpar management quality. Among others, the coefficient of *LISTING* is estimated to be positive and statistically significant for all the models. This indicates that broad basing the equity base has exerted a positive impact on profit efficiency. Presumably, the 'market discipline' engendered by induction of private shareholding has improved banks' corporate governance practices. Product diversity *(PROD_DIV)* is found to have no significant impact on profit efficiency.

Focusing specifically on the ownership issue, it is evident that the coefficients of the dummy variable *PUBLIC* were positive and statistically significant in 3 of the 4 models. This indicates that state-ownership of banks in India has a positive impact on profit efficiency. On the other hand, the estimated coefficient on *PRIVATE* was found to be not significant. Finally, the year dummy variables were positive and statistically significant for all year since 1998, irrespective of the model specification. Therefore, deregulation and associated competition may have altered the underlying production technology and associated cost function, and contributed towards improved performance of Indian banks during the latter half of the reform period.

Summing up, the evidence indicates that large and listed banks with a bigger loan portfolio exhibit greater profit efficiencies. Furthermore, banks with strong capital position and better management have been able to generate higher profits. From the ownership standpoint, state-owned banks appear to have been successful in withstanding the competitive pressures from their private and foreign counterparts and in fact, their profit efficiency was observed to be higher than private players.

5. Conclusion

Bank efficiency studies have typically focused on cost efficiency. Such studies have come under criticism for disregarding possible inefficiencies on the revenue side. Available empirical evidence also suggests that higher levels of inefficiency exist in profits than in costs. Against this background, the present analysis examines the cost and profit efficiency of Indian banks during the post-reform period using a nonparametric approach. The findings indicate high levels of efficiency in costs and lower levels in profits, testifying the importance of inefficiencies on the revenue side of banking activity. An analysis of the factors behind the possible differences in efficiency within a multivariate framework indicates that bank size, deposit mix, and prudential parameters such as capital position and delinquent loans are important factors that drive the differences in efficiency. Profit efficiency of banks which are listed in the stock market is notably higher as compared to their unlisted counterparts. Also profit efficiency is found to differ significantly across bank ownership.

The results have important policy implications. First, the liberalization of the banking sector in India has generally produced positive results in terms of improving the cost and profit efficiencies of banks. Second, the analysis underlines significant efficiency differentials between private and foreign banks. There appear to be distinct differences in the profit efficiency of the two categories of state-owned

banks as well. Taken together, this emphasizes the need for their differential treatment while designing policy guidelines, since their business strategies and customer orientation varies significantly (Berger et al., 2008). Thirdly, the banks in the smallest size class seem to be the least profit efficient, which would suggest that consolidation among these banks can potentially improve profit efficiency. The analysis also highlights an important role for market discipline, since banks which are listed on the stock exchanges tend to display higher profit efficiencies.

Financial sector reforms in India, initiated about one and a half decades ago, have strengthened the health of financial intermediaries, deepened financial markets and enhanced the instruments available in the financial system. Notwithstanding these salutary developments, there remains scope for further improvement of the performance of banks. In comparison with international standards, Indian banks would need to improve their technological orientation and expand the possibilities for augmenting their financial activities in order to improve their profit efficiency in the near future.

Acknowledgements

The authors would like to thank, without implicating, the Editor (Prof. E. Elyasiani) and two anonymous referees for their insightful and painstaking comments on an earlier draft which greatly improved the clarity and exposition of the paper.

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