# Financial Deregulation and Profit Efficiency: A Non-parametric Analysis of Indian Banks

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# Financial Deregulation and Profit Efficiency: A Non-parametric Analysis of Indian Banks[*]

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***Abstract***

The paper investigates the performance of Indian commercial banking sector during the post reform period 1992-2004. The results indicate high levels of efficiency in costs and lower levels in profits, reflecting the importance of inefficiencies on the revenue side of banking activity. The decomposition of profit efficiency shows that a large portion of outlay lost is due to allocative inefficiency. The proximate determinants of profit efficiency appears to suggest that big state-owned banks performed reasonably well and are more likely to operate at higher levels of profit efficiency. A close relationship is observed between efficiency and soundness as determined by bank's capital adequacy ratio. The empirical results also show that the profit efficient banks are those that have, on an average, less non-performing loans.

***JEL classification****:* D61; G21; G34

**Keywords:** Indian Banks; Deregulation; Profit efficiency; DEA model

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# Financial Deregulation and Profit Efficiency: A Non-parametric Analysis of Indian Banks[*]

## I. Introduction

In recent years, a growing body of literature has analysed the efficiency of banks and financial institutions, mostly centering around costs and technical efficiency and predominantly on developed countries. 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. Banks that show the highest inefficiencies and incur the highest cost might be able to generate greater profits than more cost efficient banks (Berger and Humphrey, 1997; Berger and 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. A number of factors make the study of banking in India an interesting one. First, over the 1990s, India has undergone significant 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 permitting the establishment of *de novo* 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] It would be

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[1]The banking system in India comprises commercial and co-operative 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 being with the Reserve Bank of India) and its associate banks (majority

of interest 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 (Bhattacharya et al., 1997; Das, 1997; Shanmugam and Das, 2004; Das et al., 2005; Das and Ghosh, 2006; Chatterjee, 2006).[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 used in the empirical efficiency analysis due to unavailability of data on 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 beginning from 1992 and therefore offers an ideal vehicle to ascertain whether the financial sector reforms have had any salutary effect on the cost and profit efficiency of Indian banks. The findings so obtained may be representative of the impact of liberalization on profit efficiency of banks across different ownership groups in other emerging markets.

In the light of the aforesaid discussion, the present study estimates the cost and profit efficiency of Indian commercial banks during the post reform period, 1992-2004. Towards this end, we employ the non-parametric 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 profitability levels, supporting the importance of inefficiencies on the revenue side of banking activity. More importantly, the variation in terms of profit efficiency was observed to be greater than in terms 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.

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equity holding being with State Bank of India). Besides, state-owned banks and State Governments jointly sponsor a number of Regional Rural Banks. These banks account for, on an average, over 70% of commercial banking assets.

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

[3] Non-parametric 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 of production relationship among inputs and outputs and allows for a random error.

The remainder of the paper proceeds as follows. Section 2 presents a brief overview of efficiency studies on banking. Section 3 provides the conceptual framework for measuring profit efficiency and its decomposition. The specifications of DEA models for estimating profit efficiency are presented in Section 4. The issue of defining banks inputs, and outputs and data are discussed in Section 5. Section 6 discusses the empirical findings, followed by the concluding remarks.

## 2. Review of Literature

Most of these studies on profit efficiency are based on 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 studies referring to the US banking system (Berger and Humphrey, 1997). Contrary to expectations, their findings revealed that profit efficiency is not positively correlated with cost efficiency, suggesting the possibility that cost and revenue inefficiencies may be negatively correlated. Recently, Amel et al. (2004) provided a comparative international review of profit efficiency in the context of consolidation within the financial sector. They found an average level of profit efficiency of about 50% and cautioned that such estimates are very sensitive to 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 alternative and standard 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% between 1986 to 1991. Based on German banking sector during 1989-1996, Altunbas et al. (2001) studied ownership-efficiency relationship based on parametric cost and profit function approach and found little evidence that suggest privately owned banks are more efficient than their public-sector counterparts. In a broader set-up, Maudos and Pastor (2001) analyzed the cost and profit efficiency of a sample of 14 countries of the European Union, as well as Japan and the USA. The evidence indicates that since the start of the 1990s, increasing competition has led to gains in profit efficiency in the USA and Europe but not so in the Japanese banking system. More recently, Bonin *et al.* (2005) examined both cost and profit efficiency for 11 transition countries during 1996 to 2000 based on stochastic frontier approach and conclude that privatization, by itself, is not sufficient to increase bank efficiency as government-owned banks are not appreciably less efficient than domestic private banks.

[4] 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.

Among the earliest studies on the efficiency of Indian banking, Bhattacharya *et al.* (1997) found that Indian public sector banks were the best performing banks and these banks improved their efficiency in the deregulated environment. The study, however, essentially pertained to the pre-deregulation era. Since the liberalization of the banking sector was initiated in 1991-92, it is likely that its effect on efficiency would have manifested itself only at a later date. A more recent study addresses this lacuna by covering both the pre- and post-liberalization era (Kumbhakar and Sarkar, 2003). Using the generalized shadow cost function, the 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 post deregulation and importantly, there was no evidence of narrowing of performance differentials across ownership category following deregulation. Subsequently, Shanmugam and Das (2004) observed that technical efficiency of raising interest margin of Indian commercial banks during 1992-99 is time invariant, while the efficiencies of raising other outputs-non-interest income, investments and credits are time varying. Based on non-parametric approach, Rammohan and Ray (2004) and Das et al. (2005) compared the various efficiency measures of banks across different ownership groups during the post liberalization period. The broad finding emanating from these studies was that state-owned banks performed significantly better than private sector banks on revenue maximization efficiency, although the efficiency differential between state-owned and foreign banks was not significant. The evidence of a few very recent studies indicates 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. It seems likely that medium sized state-owned banks are more likely to be operating at higher levels of technical efficiency and have, on an average, less non-performing loans (Kumbhakar and Sarkar, 2005; Das and Ghosh, 2006; Chatterjee, 2006).

While these studies have enhanced out 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, by itself, is not sufficient to achieve high profitability and in order to address the underperformance of banks, it is necessary to juxtapose both cost and profit efficiency to address the performance problems.

## 3. Data and Methodology

Although there is no consensus on the best method for measuring technical efficiency, the most popular approach used for banks is frontier analysis. However, the major measurement problem is distinguishing variations in technical efficiency from random error (Bauer et al., 1998). To overcome this shortcoming, we employ the non-parametric Data Envelopment Analysis (DEA) in our exercise. The use of non-parametric techniques to calculate the frontier is in many cases a preferable alternative to parametric techniques because they enable efficiency scores to be obtained without having to assume any distribution function for inefficiencies or to specify any functional form for the frontier. However, these techniques do not consider the existence of an error term, so its existence may bias the results. Accordingly, we employs a univariate cross-tabulation approach to examine the empirical correlates of cost and profit (in)efficiency across different ownerships and size classes and thereafter, employ a two-stage approach to identify the proximate causes of (in)efficiency.

The reminder of the section continues as follows. We first describe the data and choice of inputs and outputs and thereafter, briefly describe the methodology of computation of cost and profit efficiency. Accordingly, a univariate cross-tabulation approach is employed to examine the empirical correlates of cost and profit (in)efficiency across ownerships and size classes. Subsequently, we detail the disaggregation of profit efficiency and the two-stage approach towards computation of efficiency.

### 3.1 Data Sample and Choice of Inputs and Outputs

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 much more difficult to alter – especially in the short run. For this reason, we treat equity as quasi-fixed in our measurement of 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 measures- 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

[5] Typically, public sector 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.

fee-based activities. Illustratively, the fee income of 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 on per rupee of investment and average interest earned on 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. Thus, we have 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.

**[Table 1]**

Our sample covers all commercial banks in India and span over 13-year period beginning with the financial year 1992 up to 2004. Based on this criterion and availability of data, we have 72 banks in the year 1991-92 and 85 banks in the terminal year of the study. These banks accounted for more than 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*, a yearly publication by the Reserve Bank of India, the Indian central bank which publishes balance sheet numbers and profit and loss information of individual banks and *IBA Bulletin*, a yearly publication by the Indian Banks Association.

**32. Cost and profit efficiency using non-parametric DEA methodology**

The two types of efficiency analysed – cost and profit efficiency - corresponds to two important economic objectives: respectively, minimization of costs and maximization of profits, and are based on the comparison of observed values (of costs and profits) with the optima, determined by the respective frontier. Thus, cost efficiency (CE) is defined as the quotient between the minimum cost at which it is possible to produce a given vector of output as determined by the frontier (C*) and the cost actually incurred (C). Thus, a cost efficiency value of CE=C*/C implies that it would be possible to produce the same vector of production with a saving in cost of (1-CE)*100 per cent.

Unlike cost efficiency, profit efficiency relates the profits generated with a specific production vector (P) to the maximum possible profit associated with that vector as determined by the frontier (P*). Depending on whether or not we consider the existence of market power in the pricing of outputs, following Berger and Mester (1997), we can distinguish between two profit frontiers: the *standard* profit frontier and the *alternate* profit frontier.

Thus, the *standard* profit frontier expresses observed profits (P) as function of input prices (w), output prices (r) and the level of inefficiency in costs (u) according as:

$P = P(w, r, u)$

Standard profit efficiency is defined as the quotient between observed profit ($P$) and the maximum profit attainable as determined by the standard profit frontier given the prices of

inputs and outputs (*SP**). Thus, a standard profit efficiency value of *SPE=P/SP** implies that it would be possible to increase the profits of the firm by (1-*SPE*)·100 per cent given the input and output prices faced by the firm. The exogenous nature of the price of the output vector in the above concept of profit efficiency has the disadvantage that it implies assuming the non-existence of market power in pricing.

If instead of taking this price vector as given, we assume the possibility of imperfect competition or market power in the setting of prices, we will take as given the vector of output (*y*), but not that of output prices (*r*). In this case we will be looking at the *alternative* profit frontier:

$P = Pa\ (y,w,u)$

Observe that at the alternative profit frontier firms take as given the vector of outputs (*y*) and the vector of input prices (*w*) and maximise profits by adjusting the vector of output prices (*r*) and the amount of input (*x*). The measure of alternative profit efficiency is defined, as in the case of standard efficiency, as the quotient between observed profit (*P*) and the maximum profit as determined by the alternative profit frontier (*AP**). An alternative profit efficiency value of *APE=P/AP** implies that it would be possible to increase the company's profit by (1-*APE*)·100 per cent given the input and output prices faced by the firm. As indicated by Berger and Mester (1997) and Rogers (1998), alternative efficiency is a closer representation of reality whenever the assumption of perfect competition in the setting of prices is questionable, when there are differences in output quality among individuals of the sample, or when there are problems of information for the calculations of output prices.

### 3.2.1 Decomposition of profit efficiency

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

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

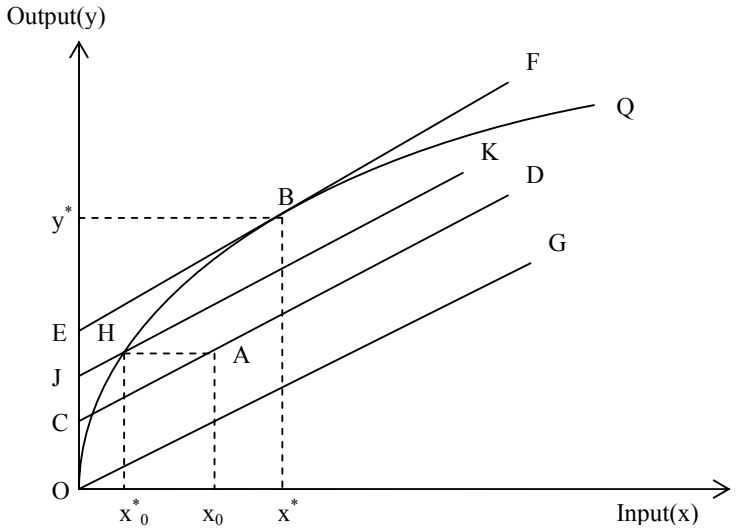
The standard profit-maximization problem of a competitive firm is

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

where $p = (p_1, p_2, \ldots\ldots, p_m)$ 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

$$y^* = f(x) = \max y: (x, y) \in T. \quad (2)$$




In figure 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 $\Pi=py_0 - wx_o$ with normalized profit $\pi_0=\Pi/p$ and normalized input price $\omega=w/p$. The set of all (x, y) through A which yield normalised profit $\pi_0$ 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 $x_o^*$ ($< x_o$). 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 $\pi_0$ to $\pi_T$ due to improvement in technical efficiency. As allocative efficiency improves, normalized profit further increases from $\pi_T$ to $\pi^*$ in the second stage.

Like cost efficiency, a multiplicative decomposition of profit efficiency into technical and allocative components is not yet established in theory. However, Fare et al. (2000) and Ray

(2004) provided an alternative additive decomposition of profit efficiency. For multiple-input, multiple-output case, define:

$$\Delta = \Pi^* - \Pi_0 = (\Pi_T - \Pi_0) + (\Pi^* - \Pi_T)$$

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

where, $C_0$ is the actual cost of the firm with input-output bundle $(x^0, y^0)$. Here $\delta$ represents the lost or unrealized part of the maximum return on outlay. The first component of $\delta$ 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 $\beta$ lies between 0 and 1, $\delta_T$ also lies between 0 and 1. But $\delta_A$ ($\geq 0$) can actually exceed 1 and thus normalized difference measure of profit inefficiency can also exceed 1.

### 3.3 Univariate analysis and determinants of inefficiency

*Multivariate approach: a Tobit analysis*

In order to examine the sources of efficiency, efficiency estimates derived in the first stage DEA are regressed on several bank attributes. The primary goal of the second-stage analysis is to test various hypotheses on how efficiency is related to these factors by treating them as potential correlates of efficiency. Several hypotheses are postulated in the literature, mostly dealing with ownership, size, corporate governance, market power, risk, balance sheet composition and age.

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 (De Young and Hassan, 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 0 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, 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:

$$y_0^* = \beta' x_0 + \varepsilon_0$$

$$y_0 = y_0^* \text{ if } y_0^* > 0 \text{, and 0, otherwise} \qquad (6)$$

[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.

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 $y_0^*$ 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:

$$\Theta_{jt} = \beta_{0+} \sum_{k=93}^{04} \beta_k YR\_k + \beta_1 SIZE_{jt} + \beta_2 LISTING_{jt} + \beta_3 DEP\_SI_{jt} + \beta_4 PRO\_DIV_{jt} + \beta_5 AGE_{jt} + \beta_6 PUBLIC_{jt} + \beta_7 PRIVATE_{jt} + \beta_8 (PRIVATE*AGE)_{jt} + \beta_9 TERM\_D_{jt} + \beta_{10} CURRENT\_D_{jt} + \beta_{11} LOAN_{jt} + \beta_{12} LIQUIDITY_{jt} + \beta_{13} AST\_G_{jt} + \beta_{14} NNPA_{jt} + \beta_{15} CRAR_{jt} + \beta_{16} RWA_{jt} + \varepsilon_{jt} \quad (7)$$

Where,

$\Theta_{jt}$ is the profit efficiency of the j[th] 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. If concentration leads to higher prices and profits, then we expect a positive coefficient. 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) 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) in order to ascertain the effect of heterogeneity in liability structure on efficiency.

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 to 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. Product diversity is closely related to scope efficiency, whether a bank is producing the most cost efficient

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

combination of products. Therefore, banks shifting towards producing a broader mix of services are expected to experience higher profit efficiency.

Among the bank-specific controls, we include bank size (SIZE), defined as 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 lower profitability levels. The sign on this variable is, therefore, ambiguous. We also focus on the banks' asset quality, soundness and portfolio risk on the estimated profit efficiency.

Any analysis of efficiency needs to take on board the various macroeconomic, regulatory and other factors. To address this aspect, we include several dummy variable. 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, 2002; Ghosh and Das, 2006). Second, AGE is included as an indicator variable which equals one if the bank became operational after 1992 and zero otherwise. Third, we include dummies for bank ownership. Accordingly, we include the variable *PUBLIC* which equals one for state-owned banks, else zero. Likewise, a dummy variable PRIVATE equals one if a bank is private, else zero. The interaction of PRIVATE with AGE is included to ascertain the differential behaviour of *de novo* private banks (established post initiation of reforms in 1992) as compared with old private banks (in existence prior to 1992) on profit efficiency. Finally, we include year dummies for from 1993 to 2004 (excluding the base year 1992) to account for changes in the macroeconomic environment and in the regulatory treatment of banks over time.

We estimated 4 variants of the Tobit model (Models 1 to 4) depending on the availability of data (Table 11). The base model is estimated over the entire period 1992-2004 (Model 1), while the second model is based on 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 frame, coinciding with the availability of bank-level data on these variables. The specified Tobit model in (8) is estimated with heteroscedasticity option using the maximum likelihood method. Given the unbalanced nature of the panel, we have a maximum of 1111 bank-years (as in Model 1) to a minimum of 575 bank-years, as in Model 4.

## 6. Empirical Results

The empirical results are classified into three broad heads: first, it describes the estimates of overall cost and profit efficiency during 1992-2004. Second, it employs a univariate cross-

tabulation approach to examine the empirical correlates of cost and profit (in)efficiency across different ownerships and size classes. This approach, however, does not satisfactorily address the interrelationship among various efficiency measures and bank financial parameters, since most bank characteristics would be correlated with each other. Thereafter, a multivariate regression framework is also employed to relate efficiency scores to bank characteristics.

*6.1 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 lies close to the benchmark cost frontier. The average cost-inefficiency of Indian banks was found to be relatively low. In other words, both technical efficiency (input-oriented) and allocative efficiency (input-oriented) of Indian banks are at a reasonably high level. In other words, the evidence suggests that these 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 a large asymmetry among banks. More specifically, banks appear to lie well inside the efficient profit frontier. For majority of the years, average profit efficiency was below 50%. In latter half of the sample period, as profit considerations of banks gained prominence, more number of banks performed relatively close to the benchmark which resulted in some improvement in profit efficiency, particularly after 2000. These results are in sharp contrast to the findings of Bauer *et al.* (1998) who observed that X-inefficiency is the major source of performance problems among financial institutions.

**[Table 2]**

*6.2 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 scores.

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 somewhat erratically over the years but their performance seems to have improved slowly over the period. In order to further investigate the difference in profit efficiency scores across ownerships, we perform Kruskal-Wallis' non-parametric tests separately for individual years. 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.

The relationship between profit efficiency and bank size is presented in Table 3.[8] 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.

**[Table 3]**

*6.3 Decomposition of profit efficiency*

Following from the earlier discussion, a simple additive decomposition of profit efficiency is presented in Table 6. It is observed that the loss or unrealized part of the maximum return on outlay (δ) has been declining over time. On the other hand, commercial banks are losing very little profit due to their (input-oriented) technical inefficiency. For most of the years after deregulation, technical inefficiency remained small around 5%. On the contrary, a large portion of return on outlay lost is emanating from the high levels of 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. Traditionally, banks in India support the government borrowing programs by way of large investments in government securities. In addition, strict capital regulations also instigated 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.

The results of the multivariate regressions are set out in Table 4. In Model 1, the positive and statistically significant coefficient on SIZE is consistent with the fact that larger banks are better able to reach 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

[8] 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.

less competitive markets can charge higher prices for their services and eventually make supernormal profits. Empirical results for the U.S. banking industry also confirm a similar phenomenon (Stiroh and Starhan, 2003). As markets become more open, the link between performance and market share intensifies. Over time, these competitive dynamics reallocated control of the banking industry toward the better-run banks. Third, the coefficient of *AGE* is observed to be negative and statistically significant. Age effect on profit efficiency of these banks, as captured by *PRIVATE*AGE*, has been positive and statistically significant.

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. 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 provides support to 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.

The results indicate a positive coefficient of size and it is statistically significant when the selected models control for asset quality and risk exposure. The larger banks might be better able to reach their optimal mix and scale of outputs and hence increasing profit efficiency. Besides, larger banks might become efficient simply by virtue of their ability to achieve optimal output, i.e., large banks may have higher profits for a given set of prices primarily because they were able to gain size over a period.

In the second model (Model 2), the coefficient on the asset growth variable is estimated to be positive and statistically significant. If banks asset base expand depending on the growth in demand for banking services, this greater 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 and Eisenbis, 1997).

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' (Berger and DeYoung, 1997). In other words, low profit efficiency is a manifestation of inadequate loan monitoring and control practices, a factor that is typically associated with subpar management quality.

Summing up, the evidence indicates that, large, listed banks with a bigger loan portfolio exhibit greater profit efficiency. Furthermore, well-capitalized and well-managed banks are able to generate higher profits. And finally, state-owned banks have been able to successfully withstand the competitive pressures from their private and foreign counterparts and in fact, their profit efficiency was observed to be higher than the private players.

## 7. Conclusion

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 is enough scope for further improvements 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.

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**Table 1: Summary Statistics of Inputs, Outputs and Prices**

(Amount in Rs. billion)

| Year/variables | | 1992 | | 1998 | | 2004 | |
|---|---|---|---|---|---|---|---|
| | | Mean | Std. Dev. | Mean | Std. Dev. | Mean | Std. Dev. |
| *Inputs* | | | | | | | |
| $x_d$ | Deposits | 36.45 | 80.70 | 68.84 | 156.49 | 186.11 | 389.10 |
| $x_l$ | Labour – No. of employees | 12912 | 29328 | 10352 | 27728 | 10088 | 24742 |
| $x_k$ | Capital – fixed assets | 0.27 | 0.55 | 1.34 | 2.26 | 2.50 | 5.47 |
| $x_q$ | Quasi-fixed inputs - equity | 1.23 | 2.29 | 5.69 | 11.61 | 13.71 | 25.82 |
| *Input prices* | | | | | | | |
| $w_d$ | Price of deposits | 0.0635 | 0.0113 | 0.0769 | 0.0258 | 0.0480 | 0.0159 |
| $w_l$ | Price of labour | 0.0084 | 0.0051 | 0.0287 | 0.0258 | 0.0517 | 0.0648 |
| $w_k$ | Price of capital | 0.0077 | 0.0064 | 0.0049 | 0.0050 | 0.0075 | 0.0088 |
| *Outputs* | | | | | | | |
| $y_1$ | Loans and advances | 22.01 | 56.54 | 34.65 | 84.94 | 102.32 | 203.13 |
| $y_2$ | Investments | 13.54 | 30.45 | 29.06 | 65.18 | 94.80 | 218.89 |
| $y_3$ | Other income | 0.65 | 1.72 | 1.29 | 3.12 | 4.70 | 9.49 |
| *Output prices* | | | | | | | |
| $p_1$ | Price of loans and advances | 0.1551 | 0.0819 | 0.1349 | 0.0365 | 0.0935 | 0.0464 |
| $p_2$ | Price of investments | 0.0895 | 0.0132 | 0.1084 | 0.0262 | 0.0814 | 0.0216 |
| *Cost* | | 2.59 | 6.00 | 5.01 | 11.29 | 9.23 | 21.32 |
| *Revenue* | | 4.80 | 11.70 | 8.61 | 19.57 | 20.78 | 42.64 |
| *Profit* | | 2.22 | 5.82 | 3.59 | 8.35 | 11.56 | 21.92 |

All nominal variables have been deflated by the Wholesale price Index (Base 1993-94=100)

## Table 2: Cost and Profit Efficiency of Domestic Indian banks

| 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 refers to includes state-owned and private banks

## Table 3: Size and Profit Efficiency of Indian banks

| Year/Size | I-Small | | II-Medium | | III-Big | | IV-Large | |
|---|---|---|---|---|---|---|---|---|
| | Mean | Std. Dev. | Mean | Std. Dev. | Mean | Std. Dev. | Mean | Std. Dev. |
| 1992 | 0.2726 | 0.2395 | 0.2583 | 0.0971 | 0.4311 | 0.2056 | 0.4170 | 0.1910 |
| 1993 | 0.3407 | 0.2372 | 0.3568 | 0.1922 | 0.4559 | 0.2767 | 0.3720 | 0.2049 |
| 1994 | 0.2505 | 0.1813 | 0.3590 | 0.1399 | 0.5284 | 0.2605 | 0.4717 | 0.2437 |
| 1995 | 0.2167 | 0.1714 | 0.3295 | 0.1063 | 0.5005 | 0.2878 | 0.4174 | 0.2184 |
| 1996 | 0.3878 | 0.2382 | 0.4641 | 0.2169 | 0.5195 | 0.2663 | 0.4369 | 0.2520 |
| 1997 | 0.3486 | 0.2656 | 0.4497 | 0.1437 | 0.5213 | 0.2350 | 0.5421 | 0.2627 |
| 1998 | 0.3791 | 0.2403 | 0.6103 | 0.1757 | 0.6378 | 0.2288 | 0.5631 | 0.2496 |
| 1999 | 0.4183 | 0.2645 | 0.5905 | 0.1946 | 0.6356 | 0.2216 | 0.6524 | 0.2393 |
| 2000 | 0.3923 | 0.2541 | 0.5899 | 0.1286 | 0.7220 | 0.1879 | 0.6765 | 0.2494 |
| 2001 | 0.3232 | 0.2387 | 0.4713 | 0.0833 | 0.6415 | 0.2253 | 0.6729 | 0.2083 |
| 2002 | 0.3224 | 0.2459 | 0.5236 | 0.1138 | 0.6809 | 0.2140 | 0.7120 | 0.2172 |
| 2003 | 0.3395 | 0.2529 | 0.5753 | 0.1316 | 0.6872 | 0.1725 | 0.7354 | 0.2049 |
| 2004 | 0.3434 | 0.2739 | 0.5910 | 0.1950 | 0.7467 | 0.1633 | 0.7618 | 0.1926 |

* 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.

**Table 4: Parameter Estimates of Tobit Regression**

| Parameters | Model 1 | Model 2 | Model 3 | Model 4 |
|---|---|---|---|---|
| *Intercept* | 0.1989 | 0.1772 | 0.3610 | 0.1240 |
| | (0.1237) | (0.1344) | (0.1565) | (0.1834) |
| *SIZE* | 0.0320* | 0.0275* | 0.0189** | 0.0141 |
| | (0.0063) | (0.0067) | (0.0083) | (0.0105) |
| *LISTING* | 0.0147 | 0.0225 | 0.0395*** | 0.0451** |
| | (0.0175) | (0.0182) | (0.0206) | (0.0210) |
| *DEP_SI* | 1.2558* | 1.2356* | 1.2495* | 1.3604* |
| | (0.2979) | (0.3116) | (0.3565) | (0.3571) |
| *PRO_DIV* | -0.0090 | 0.0292 | 0.0029 | 0.0786 |
| | (0.0425) | (0.0453) | (0.0486) | (0.0639) |
| *AGE* | -0.1344* | -0.1369* | -0.1136* | -0.0500 |
| | (0.0222) | (0.0235) | (0.0273) | (0.0436) |
| *PUBLIC* | 0.0366 | 0.0613*** | 0.0831** | 0.0461 |
| | (0.0313) | (0.0326) | (0.0370) | (0.0428) |
| *PRIVATE* | 0.0144 | 0.0213 | 0.0057 | -0.0604*** |
| | (0.0262) | (0.0272) | (0.0297) | (0.0356) |
| *PRIV_AGE* | 0.1165* | 0.1228* | 0.1271* | 0.0630 |
| | (0.0311) | (0.0327) | (0.0370) | (0.0497) |
| *TERM_D* | -0.3478* | -0.3388* | -0.2697** | -0.0837 |
| | (0.1018) | (0.1088) | (0.1221) | (0.1463) |
| *DEMAND_D* | -0.1725 | -0.1366 | 0.0381 | 0.1852 |
| | (0.1145) | (0.1236) | (0.1413) | (0.1980) |
| *LOAN* | 0.3722* | 0.4154* | 0.2708* | 0.8914* |
| | (0.0815) | (0.0880) | (0.0944) | (0.1334) |
| *LIQUIDITY* | -0.0637 | -0.0554 | -0.0868 | 0.0538 |
| | (0.0866) | (0.0933) | (0.1007) | (0.1483) |
| *AST_G* | | 0.0004** | 0.0003** | 0.0001 |
| | | (0.0002) | (0.0002) | (0.0002) |
| *NNPA* | | | -0.0013 | -0.0001 |
| | | | (0.0010) | (0.0016) |
| *CRAR* | | | 0.0023* | 0.0051* |
| | | | (0.0004) | (0.0010) |
| *RWA* | | | | -0.3240* |
| | | | | (0.0758) |
| *Year dummies* | YES | YES | YES | YES |
| *N* | 1111 | 1008 | 788 | 575 |
| *Log Likelihood* | 197.9018 | 183.8397 | 163.9996 | 176.9841 |

Figures in bracket indicate standard errors.

***, ** and * indicate statistical significance at 1, 5 and 10%, respectively