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Evaluation of Efficiency, Size & Ownership of Commercial Banks in India

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Abstract – This paper attempts to estimate financial performance in terms of profit and cost efficiency levels using frontier analysis based on panel data of 52 domestic banks in India during 2000-2006. The findings show on an average bank is 88% cost efficient and 67% profit efficient in India. Efficiency ratios are comparable with international studies on efficiency of financial institutions. As against the popular belief, no significant difference in mean efficiency of public sector banks and private sector banks is found. Bank size is found to be associated with higher cost efficiency but not profit efficiency. Banks, which are inefficient in risk management, are found to be under performing. Efficiency gains of competition are clearly evident in the study.

Key Words: X-Efficiency, Efficiency Correlates. Full Translog Model

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1. INTRODUCTION

The efficiency of financial system and in particular banking firms is recognized as a pre-condition for macroeconomic growth and stability. The banking industry's efficiency and productivity thus has great implications to the functioning of the economy's growth as a whole. Banks, as financial intermediaries provide various services for depositors and borrowers. Banks maintain a system that allows financial and real resources to flow relatively freely to their highest return uses. Thus efficiency problems in the banking industry can have significant implications across a wide range of financial and non- financial firms (Berger and Humphrey, 1993). The Indian banking industry has experienced dramatic deregulation involving innovations, automation and competition which has significantly affected the industry's performance. Banks are increasingly concerned about efficiency in terms of cost-control and revenue improvements. The paper attempts to employ cost minimization and profit maximization approach to efficiency analysis of banks during the sample period 2000-2006. The concept of cost and profit efficiency is related to economic optimization in reaction to market prices and competition, rather than being based solely on the use of technology. Specifically, the analysis in the paper benchmarks the relative performance of Indian banks using frontier analysis and explores possible correlates that explain variation in the efficiency levels. The present paper is divided into **six sections** including Section 1, which is introductory in nature. Section 2 outlines literature review on efficiencies of financial institutions. Section 3 provides an overview of issues in efficiency measurement of banks and the empirical design employed. Section 4 gives description of the data used in the study. Section 5 presents empirical results and Section 6 concludes.

2. LITERATURE REVIEW

Research studies using frontier analyses differ in their approaches in terms of use of efficiency concepts, definition of inputs and outputs, functional form, range of bank size and efficiency correlates. In an application of frontier efficiency approach to the recent international data, **Gary D. Ferrier and A.A. Knox Lovell** (1990) compares the two popular techniques viz. econometrics and linear programming for estimating production economics and efficiencies using sample of 575 U.S. banks for the year 1984. The study concluded that the two different techniques give similar results regarding cost economies and dissimilar results regarding cost efficiencies. Banks operate inefficiently with observed cost roughly 20-30 percent above minimum for all banks. **Loretta.J. Mester (1994)** makes use of stochastic econometric cost frontier approach to investigate efficiency and cost economies of banks operating in Third Federal Reserve District using 1991-92 data with the sample of 214 banks. Study reported average X-inefficiency at banks is of the order 6-9 percent and indicates that banks appear to be operating at cost efficient output sizes and product mixes. **Giberto turati (2001)** estimated evolution of cost efficiency scores in European banking markets from 1992 to 1999 and look at its relationship with profitability. The mean efficiency ranges from 0.84 in 1992 to 0.805 in

1999.The study concluded that there exist no linear between cost efficiency and profitability Inefficient banks translate their higher cost to higher prices for consumers and continue to earn higher profits. **Elavia and Bansal, (1993)** used profit function approach to analyze economies of scale in the Indian Banking Industry. The results indicated that there exist economies of scale in Indian Banking System as a whole. Among the various groups, SBI group has larger scope to increase its output. Further, better utilization of existing branches rather than branch expansion holds the key in order to improve the profits. **Goutam chatterjee (1997)** examined scale economies of banking using Tran slog model to cost function and confirmed the existence of scale economies in the Indian banking industry for the banks with deposit size up to Rs.7000crores provided the expansion of output is done from the existing branches than the expansion through new branches keeping the output mix constant. **Abhiman Das** (1997) examines efficiency of public sector banks in India using non-parametric programming approach and applying intermediation approach for the period 1970-1996. The overall efficiency is decomposed into technical, allocative and scale efficiency. The overall efficiency of major banks stood as low as 42%. The overall average technical inefficiency constitute about 28% and overall average allocative inefficiency constitute 42% and scale inefficiency is about .04%. The foreign banks appeared to be more efficient than their counterparts in the banking industry. **Pradeep Srivastava (1999)** evaluated cost structure for Indian Banking Industry to analyze the overall cost efficiency, scale and scope economies in banks divided on the basis of size using data of 85 banks for the year 1995-96. It is concluded that there exists substantial level of economies of scale in Indian banks at the branch level but not at the firm level which means an increase in output can lower cost provided this is done with the existing branch network and not opening more branches and the level of scale economies appear greater for large public sector banks. **Ketkar, Noulas and Aggarwal (2003)** analyze technical efficiency and scale efficiency of Indian banking sector from 1990-95 using Data Envelopment Analysis methodology with a sample of 39 banks applying intermediation approach to define output of a bank The average level of technical efficiency estimated for the whole period was approximately 69%. Foreign banks appeared to be more efficient and have shown increase in efficiency during 1990-95. Size was found to be positively related to technical efficiency and negatively related to number of branches. The survey of efficiency studies on Indian banking industry reveals that the use of cost and profit function to give empirical estimates of efficiency levels in India is limited and the focus is mainly on estimation of cost economies. Comparative analysis of alternative efficiency estimates are not attempted using the same data set. Further, there is a relatively scant literature on analysis of efficiency correlates i.e. factors explaining differences in efficiency. The present paper attempts to contribute to existing literature in Indian context by providing efficiency estimates of commercial banks applying alternative model specifications and analyzing efficiency correlates.

3. EFFICIENCY MEASUREMENT

Traditionally, performance of a bank is analyzed by focusing on certain simple efficiency and profitability ratios such as labor productivity, expenses to total deposit or asset, cost to revenue, ROA, ROE, interest margin etc. The principal advantage of ratio analysis is its simplicity. The ratio analysis, however, fails to control for the difference in product mix, input prices, capital structure and gives one- dimensional view of a service. The study makes use of frontier efficiency methodology as it circumvents the problems associated with the traditional methods and summarizes firm's efficiency in a single statistic that controls for differences among firms in a sophisticated multidimensional framework. The study uses cost efficiency and alternative profit efficiency concept to analyze the firm's performance. Cost efficiency gives a measure of how close a bank's actual cost is to what a best practice institution's cost would be for production of an identical output bundle under comparable conditions. The cost efficiency of a bank say i is defined (using Berger and Mester notation) as the estimated cost needed to produce bank i's output vector if the bank is as efficient as the best practice banks in the sample facing the same exogenous variable (w,q,z,h) divided by the actual cost banks, adjusted for the random error i.e.

$$CostEff^i = \frac{C^{min}}{C^i} = \frac{\exp[f(w^j,q^j,z^j,h^j)]\times\exp[IN\mu_c^{min}]}{\exp[f(w^j,q^j,z^j,h^j)]\times\exp[In\mu_c^i]} = \frac{\mu_c^{min}}{\mu_c^i} \qquad (1)$$

Where μ_c^{min} is the minimum μ_c^i across all banks in the sample.

Where C measures total cost; w is the vector of prices of inputs, y is the vector of quantities of output, z denotes fixed inputs which cannot be changed quickly, h is the set of environmental or market variables that may affect performance, μ_i denotes an inefficiency factor that may raise cost above the best practice level and v_i denotes the standard statistical random error that incorporates measurement error or luck or chance factors that may temporarily give banks high or low cost. The function 'f' denotes some functional form and represents the best practice frontier. Cost efficiency estimates thus ranges between 0&1 and equals 1 for the best practice firm with in the observed data and 0 for the most inefficient bank. The alternative profit function is used to estimate the profit efficiency. It uses the same specification as the cost function (equation1), the dependent variable is now $IN(\pi+\theta)$ where is π profits of the firm, and $\theta = |\pi^{min}| + 1$ is a constant added to every firm's profit so that the natural log is taken of a positive number $|\pi^{min}|$ is the absolute value of the minimum value of profits in the data set. This adjustment is necessary since some banks in the

sample may exhibit negative profits in the sample period and as such the dependent variable is log (1)=0 for the bank with the lowest value of profits. The alternative profit efficiency is the ratio of predicted actual profits to the predicted maximum profits for a best- practice bank:

$$Alt\pi Eff^{b} = \frac{a\,\pi}{a\,\pi} = \frac{\left\{\exp\left[f\left(w^{i},q^{i},z^{i},b^{i}\right)\right]\times\exp\left[ln\,u^{b}_{a\,\pi}\right]\right\}-\theta}{\left\{\exp\left[f\left(w^{i},q^{i},z^{i},b^{i}\right)\right]\times\exp\left[ln\,u^{\max}_{a\,\pi}\right]\right\}-\theta} \quad (2)$$

In case of profit, efficiency could not be simplified to a ratio of $\mu's$ as in case of cost efficiency because of addition of θ to the dependent variable before taking logs and so the efficiency factor is not exactly multiplicatively separable in the profit function. The numerator and denominator are averaged over the sample period before dividing in the above equation. Unlike the cost efficiency measure, profit efficiency is not bounded at zero as a bank could inefficiently loose more than 100% of potential profits, which would cause profit efficiency to be negative. Thus, it ranges from $-\infty$ to 1 and equals 1 for the best practice bank in the sample. The study makes use of parametric Distribution Free Approach (DFA), where it is assumed that there is a core efficiency or average efficiency for each firm over time. It doesn't require distributional assumptions of error term and gives better indication of a bank's longer-term performance than any of the other methods which rely on a bank's performance under a single set of circumstances. The translog function is used to estimate cost and profit function. The following base cost model 1 is

$$\begin{aligned}\ln(C/w_1 z) = {} & \beta_0 + \sum_{i=1}^{2}\beta_i \ln(w_i/w_1) + \frac{1}{2}\sum_{i=1}^{2}\sum_{j=1}^{2}\beta_{ij}\ln(w_i/w_1)\ln(w_j/w_1) \\ & + \sum_{k=1}^{2}\gamma_k \ln(q_k/z) + \frac{1}{2}\sum_{k=1}^{2}\sum_{m=1}^{2}\gamma_{km}\ln(q_k/z)\ln(q_m/z) \\ & + \alpha_b \ln(b) + \alpha_{bb}\ln(b)\ln(b) + \sum_{k=1}^{2}\delta_k \ln(b)\ln(q_k/z) \\ & + \sum_{i=1}^{2}\rho_i \ln(b)\ln(w_i/w_1) + d_{pvt} + d_{for} + \ln\mu_c + \ln\varepsilon_c \end{aligned} \quad (3)$$

Where q refers to the output measures; w refers to the price of inputs measures; z is the amount of equity plus reserves included as fixed environmental variable; b is the branch variable; d_{pvt} is the dummy variable which takes value 1 if the bank is private bank and 0 otherwise. d_{for} is the dummy variable which takes the value 1 if the bank is the foreign bank and 0 otherwise.

μ_c denotes an inefficiency factor and ε_c denotes the standard statistical random error, which is normally distributed. ln denotes the natural logarithmic operator. Further cost and output quantities are shown as ratios to the fixed equity capital, z, to control for heteroskedasticity, to help control for scale biases in estimation (Loretta J.Mester, 1993). The profit function uses the same specification as the cost function as above. The dependent variable is now $IN(\pi / w_1 z + \theta)$ where is π profits of the firm, and $\theta = \left|(\pi / w_1 z)^{\min}\right| + 1$. Profit ($\pi$) means all operating profits that include total interest income and non-interest income minus the cost C used in the cost function. Cost and output quantities are shown as ratios to the fixed equity capital, z, to control for heteroskedasticity, to help control for scale biases in estimation (Loretta J. Mester, 1993)

3.1 Structural Tests

Three alternative specifications of cost and profit functions are estimated to test the robustness of the base models used for estimation of efficiency as follows:

- Alternate specification1: Cost and Profit Function without equity capital
- Alternate specification 2: Cost and Profit Function with financial assets, excluding other income as output
- Alternate specification 3: Cobb- Douglas Functional Form

In order to analyze consistency of efficiency estimates using frontier technique, the spearman's correlation between efficiency measures and the standard non- frontier performance measures is estimated. The important ratios considered are Cost to Asset ratio(C/GTA), Return of Asset (ROA) and Return on equity (ROE). The cost efficiency estimates should have negative rank-order with C/GTA ratio and positive with ROA and ROE. The consistency of signs of correlation with standard ratios would signify that the measured efficiencies are accurate indicators of actual accomplishments and not just artifacts of the assumptions of the efficiency approaches (Bauer and Berger, 1998).

3.2 Second- Stage Regression: Efficiency Correlates

In the second-stage regression the efficiency estimates are then regressed with a set of variables describing the characteristics being investigated using the cross- section multiple regression. Some of these factors may be neither inputs nor outputs in the production process, but rather circumstances faced by a particular bank. These factors explore the effects of number of potential correlates of bank's efficiency and include various banks, market and regulatory characteristics that are at least partially exogenous to efficiency and so may help to explain observed differences in efficiency across banks. The following linear regression using OLS is estimated:

$$\text{Cost (Profit) Eff.} = a + b_1 x_1 + b_2 x_2 + b_3 x_3 + b_4 x_4 + \text{------} \quad (4)$$

The Cost (Profit) Eff as the dependent variable is the cost (profit) efficiency so measured by using cost and profit equation in the first stage regression. The

independent variables (x_n) used as determinants of efficiency are described as follows:

Bank Size (x_1): Bank size is measured by taking natural log of average total assets. There is no consistent relationship between size and efficiency from the previous empirical studies on developing countries (Ali Ataullah &Hang Le, 2006). **Loan to Asset Ratio (x_2):** reflects the strategic niche of the bank. Its relationship with efficiency might reflect bank's return on advances or the market power that exist in the loan market and expected to be positively related to efficiency. **Standard Deviation of Return on Equity (SDROE) (x_3)** is included as a direct measure of bank risk. The riskier banks may be more profit efficient if they are trading off between risk and return. Alternatively, banks that are poor at operations might also be poor at risk management, which would imply a negative relationship between profit and cost efficiency and risk. **Number of Branches(x_4)** measures the extent to which bank offers convenience to its customers but managing the large network of branches especially in the rural areas could unnecessary increase in cost and so negatively related to cost efficiency. **Bank's Age (x_5):** The bank's age might be related to efficiency since bank "learns by doing" (Mester, 1993). It is measured as number of years a bank existed before 2006 and captures the difference between new and old banks.**Net interest margin (NIM) to Cost Ratio (x_6)** NIM is the difference between interest income and interest expenses to total operating cost. It measures the proportion of operational cost covered by the financial margin. A higher ratio is associated with more efficient management. Thus, the higher ratio will likely to be positively related with cost and profit efficiency. **Purchased Funds to Total Assets (x_7)** measures the reliance of banks on the borrowed funds. Since the cost of managing these funds is higher so we expect the banks that use more of these funds tend to have lower cost efficiency. **Fixed Assets to Gross Total Assets (x_8)** measures the extent to which management is likely to use funds into non-earning assets. The higher values of fixed assets will likely to lower the profit efficiency and increase cost inefficiency of commercial banks. **Market Concentration (x_9):** The Herfindahl Index (HERF) as adopted by Tapas Kumar Chakrabarty (1986) is used as a measure of the market concentration in the deposit market and is defined as:

$$HerfindahlIndex(HI) = \sum_{i=1}^{n}\left(\frac{vi}{\Sigma vi}\right)^2 \qquad (5)$$

Where HI = overall Index, vi = ith unit's share of deposits, n = number of units

Publicly traded bank (Listed) listed is included as a dummy variable in order to account for any systematic difference in efficiency levels of publicly traded banks and unlisted banks. Listed takes the value 1 for banks listed stock exchange and 0 for unlisted banks.

4. DATA

The cost and profit efficiency of Indian banks is analyzed during the period 2000-2006 by using annual data of a sample of 52 banks. Data on the number of employees are collected from the performance highlights of banks published by Indian Bank's Association. The data on the rest of the variables are collected from the Annual Accounts of Scheduled Commercial Banks published by Reserve Bank of India. The sample includes all public sector and private banks operating in India that have continuous data on all years of period of study. Very small banks with only one branch may bias the results are not included in the study. Any bank having negative value on any of the output measure used in the study is also excluded. This left us with 27 public sector and 25 private sector banks. Data are expressed in real values using wholesale price index with 1993-94 as the base year. The sample constitutes around 90 percent of total deposits 94 percent of total assets and of total employment of banking sector as a whole. Table1 gives the summary statistics of the cost and profitability ratios of sample banks through the year 2000 to 2006. The total cost as a percentage of total assets (C/GTA) of all banks on an average has fallen from 9% to 6%. Both public and private banks maintain the falling trend. The profitability of banks as measured by Return on Assets (ROA) of all banks has increased from 0.5% to 1.1% in 2005 but falls to 0.4% in 2006.

Table 1: Cost and Profitability Ratios

	Cost to Assets Ratio			Return on Assets			Return on Equity		
Year	All Banks	Public Banks	PVT. Banks	All Banks	Public Banks	PVT. Banks	All Banks	Public Banks	PVT. Banks
2000	0.096	0.091	0.1	0.006	0.005	0.008	0.112	0.113	0.111
2001	0.09	0.09	0.09	0.007	0.006	0.009	0.139	0.127	0.151
2002	0.09	0.09	0.09	0.005	0.004	0.005	0.107	0.089	0.126
2003	0.087	0.085	0.088	0.008	0.008	0.009	0.15	0.157	0.143
2004	0.081	0.078	0.083	0.01	0.011	0.01	0.183	0.202	0.163
2005	0.07	0.067	0.072	0.012	0.013	0.011	0.197	0.228	0.164
2006	0.063	0.061	0.065	0.005	0.009	0.002	0.076	0.153	-0.008
Average	0.082	0.080	0.084	0.007	0.007	0.007	0.14	0.015	0.12
Std. Dev	0.012	0.012	0.011	0.002	0.003	0.003	0.043	0.049	0.059
t-value$_{12}$		0.565 0.583)^{ns}			0.103(0.919)^{ns}			1.06(0.309)^{ns}	

SOURCE: Authors Own Calculations. Value in parentheses denotes p- value of the t-test for difference in means of cost and profitability ratios between public and private sector banks with degree of freedom as subscript. ns: not significant at conventional levels.

The fall in ROA is witnessed both among public and private sector banks in 2006 but this fall is more dramatic among private banks (Pvt. Banks) than in public sector banks (PSBs). Return on Equity (ROE) increases from 11% in 2000 to 19% in 2005 and falls to 7.5% in 2006 for all banks, turning negative for private sector banks. T-test results in Table 1 reveals no significant difference in the performance of Pvt. Banks and PSBs in terms of cost and returns ratios over the sample period 2000-2006.

5. EMPIRICAL RESULTS

5.1. Efficiency Estimates Based On Base Translog Models:

The estimated functions are used to obtain the cost and profit X- efficiency estimates for banks in India. The banks with smallest (largest) intercept comprise an estimate of the cost (profit) frontier of the banks in the sample. The exponent of the difference of a bank specific constant from the frontier is an estimate of that bank's relative efficiency. These results are summarized in **Table2**. The estimated relative cost efficiencies range from 0.67 to 1 with an average of 0.88. This indicates that banks could save on an average around 12% of their realized costs if X-inefficiencies are eliminated. The profit efficiency ranges from 0.34 to 1 with an average of 0.67 and standard deviation of 0.14. This indicates that banks could increase on an average around 33% of their realized profits if X- inefficiencies are eliminated. The profit efficiencies seem to be quite dispersed, with many firms earning considerably more or less than the average figure. By contrast, the cost efficiencies are more tightly distributed with a standard deviation of 0.067. The average cost (profit) efficiency of public sector bank is 0.88 (0.66) and of private bank is 0.87 (0.68).

Table 2: Efficiency Estimates (Full Translog Model)

	Cost Efficiency			Profit Efficiency		
	All	*Public*	*Private*	*All*	*Public*	*Private*
Average	0.88	0.88	0.87	0.67	0.66	0.68
Std. Dev	0.06	0.05	0.08	0.14	0.12	0.17
Maximum	1.00	1.00	0.98	1.00	0.95	1.00
Minimum	0.67	0.79	0.67	0.34	0.43	0.34
Median	0.86	0.88	0.88	0.67	0.66	0.70
No. of Banks	52	27	25	52	27	25
t-value(50) †		0.618^{ns}			0.511^{ns}	
P-value	0.539			0.612		

SOURCE: Authors Own Calculations. ns: not significant.

Figures in parenthesis denote degree of freedom. † t-test is used to analyze the difference between average efficiency estimates between public and private banks with degree of freedom in parentheses.

The t-test in Table2 indicates that the profit and cost efficiencies levels of public and private sector banks are not significantly different. **T T Ram Mohan and Subhash C Ray (2004)** too have reported the convergence of performance between public and private sector banks in the post reform era. **Table 3** below indicates average efficiency based on size of banks. Banks are categorized as small, medium and large on the basis of average assets held during the sample period. Banks having average assets below first quartile are categorized as small, greater than third quartile as large and between first and third quartile as medium-sized banks. There is difference of cost efficiency between small (83%) and large banks (87%) but no statistically significant difference exist as far as profit efficiency estimates are concerned **(Table3).** So as banks grow larger it is able to control its cost may be due to better technology or large-scale economies but it gets difficult to generate higher revenues.

5.2 Efficiency Estimates Based On Specification 1 (Equity Capital Is Eliminated From Cost and Profit Equations):

Table 4 reports the average efficiency estimates based on the model that eliminates equity capital from the cost and profit equation.

Table 3: Bank Size and Efficiency Estimates

	Cost Efficiency			Profit Efficiency		
	Small Banks	Medium Banks	Large Banks	Small Banks	Medium Banks	Large Banks
Average	0.83	0.90	0.87	0.65	0.66	0.68
Std. Deviation	0.078	0.05	0.05	0.16	0.15	0.12
N	13	25	14	13	25	14
t-value$_{36}$(small vs. medium)	3.52(0.0012)**			0.336(0.739) ^{ns}		
t-value$_{37}$(medium vs. large)	1.687(0.100)*			0.466(0.644) ^{ns}		
t-value$_{25}$(small vs. large)	1.77(0.088)*			0.744(0.464) ^{ns}		

SOURCE: Authors Own Calculations. Figures in parentheses denote p-value. Figure as subscript denotes degree of freedom for t- test.** Significant at 5% level of significance.* Significant at 10% level of significance. ns: not significant.

Table 4: Efficiency Estimates (Translog Function without Equity Capital)

	Cost Efficiency			Profit Efficiency		
	All	*Public*	*Private*	*All*	*Public*	*Private*
Average	0.86	0.89	0.83	0.44	0.54	0.34
Std. Dev	0.10	0.04	0.14	0.21	0.21	0.18
Maximum	1.00	0.98	1.00	1.00	1.00	0.70
Minimum	0.54	0.82	0.54	-0.14	-0.14	0.09
Median	0.89	0.89	0.86	0.45	0.52	0.34
No. Of Banks	52	27	25	52	27	25
t-value(50) †	2.538**			3.555***		
P-value	0.014			0.0008		

SOURCE: Authors Own Calculations.*** Significant at 1% level of significance. ** Significant at 5% level of significance. Figures in parenthesis denote degree of freedom. † t-test is used to analyze the difference between average efficiency estimates between public and private banks.

From Table 2 and Table 4, it is clear that by using without equity model there is little effect on the average level or dispersion of cost efficiency (it falls from 0.88 to 0.86 statistically not significant), although the firms are ranked differently, as compared to the base model that includes equity capital (not shown). The average profit efficiencies, however, fell from means of about 67% to 44% for all banks in comparison of base model. This is quite expected. As discussed above, the specification of equity as input in base model reduces the scale bias that may be created by the fact that the equity capital of small banks cannot be expanded to match that of large banks and allow them to expand their asset portfolios greatly. The dependent variables, profit levels, in this model are not comparable between large and small banks but in case of base model they are comparable and so help to control the scale bias. To further

analyze this issue we compare average profit efficiency levels based on size, when equity capital is removed from the profit equation. **Table5** provides the efficiency estimates of large and small banks using base and without equity model.

Table 5: Test of Scale Bias in Profit Efficiency Estimates using Specification 2

	Base Model		Model without equity	
Profit Efficiency Estimates	Small Banks	Large Banks	Small Banks	Large Banks
Average	0.65	0.68	0.21	0.58
Std. Dev	0.16	0.12	0.09	0.27
t-value(25)†	0.74^{ns}		4.601***	
P-value	0.47		0.0001	

SOURCE: Authors Own Calculations. ns not significant at conventional levels. Figures in parenthesis denote degree of freedom. *** Significant at 1% level of significance. † t-test is used to analyze the difference between average efficiency estimates between small and large banks in base and without equity model.

The t- test in Table 5 clearly indicates that the difference between average profit efficiency levels between large and small banks is quite significant. It is around 21% for small banks and 58% for large banks. But profit efficiency estimates of large and small banks are not significantly different statistically using base model. Thus the removal of the equity control variable rewards large banks that have high level of profits by virtue of their equity positions but these firms may not have very high levels of ROA and ROE. The evidence from this variation strongly supports our specification of equity capital as a control to reduce scale bias.

5.3 Efficiency Estimates Based on Specification 2 (Two- Output Model)

Table 6 reports the average efficiency estimates with loans and broad measures of investments as output measures. The average cost efficiency level (0.88 for all banks) is not affected by the specification however the profit efficiency levels (0.61 for all banks) are under reported when the non-interest income is eliminated from the cost and profit equation and thus supports the model that includes non-interest income as output. The rank correlation coefficient of efficiency between base model and restricted model is significantly high both in cost and profit efficiency though slightly lower in case of profit efficiency **(Table7).** Further, log-likelihood ratio test rejects the restrictive two-output model in favor of full translog model both in case of profit and cost function. The log-likelihood is much lower for two- output specification, and a log-likelihood test rejects the two- output restriction. Two-Output model is not nested in the full model.

5.4 Translog VS. Cobb-Douglas Model

Table8 illustrates, that Cobb-Douglas model is clearly inferior to the translog model. The log-likelihood is much lower for Cobb-Douglas specification, and a log-likelihood test rejects the Cobb-Douglas restriction.

Table 6: Efficiency Estimates (Translog Function with two-output Model)

	Cost Efficiency			Profit Efficiency		
	All	*Public*	*Private*	*All*	*Public*	*Private*
Average	0.88	0.88	0.87	0.61	0.60	0.63
Std. Dev	0.06	0.05	0.08	0.16	0.13	0.18
Maximum	1.00	1.00	1.00	1.00	0.78	1.00
Minimum	0.68	0.78	0.68	0.22	0.22	0.26
Median	0.88	0.88	0.89	0.61	0.61	0.63
No. of Banks	52	27	25	52	27	25
t-value(50)†	0.508^{ns}			0.848^{ns}		
P-value	0.610			0.40		

SOURCE: Authors Own Calculations. ns: not significant Figures in parenthesis denote degree of freedom.

† t-test is used to analyze the difference between average efficiency estimates between public and private banks.

Table7: Restrictive Two- Output Model vs. Base Model

	Cost Efficiency Estimates		Profit Efficiency Estimates	
	Two-Output Model	Full Model	Two-Output Model	Full Model
Average	0.878	0.875	0.61	0.67
Std.deviation	0.06	0.06	0.16	0.15
T-value$_{102}$†	0.18(0.86)^{ns}		1.721(0.08)^{ns}	
r††	0.99(0.000)***		0.88(0.000)***	
Log-Likelihood	569.35	577.48	-126.81	-77.19
LR chi-Sqr$_7$ Two-Output Model vs. Full Model	16.26		99.22	
Probability>Chi-Sqr	0.022**		0.000***	

SOURCE: Authors Own Calculations. Figures in parentheses denote p-value. Figure as subscript denotes degree of freedom for relevant test. ns not significant † t-test is applied to test significance of difference between average efficiency estimates of two- ouput model and base model. †† Spearman's correlation coefficient.

Table 8: Restrictive Cobb-Douglas vs. Full Translog Model

	Cost Function		Profit Function	
	Translog Model	Cobb-Douglas	Translog Model	Cobb-Douglas
Log-Likelihood	577.48	525.60	-77.19	-115.92
LR-Chi Sqr(21)	103.76		77.46	
Probability>Chi-Sqr	0.000***		0.000***	

SOURCE: Authors Own Calculations. *** Significant at 1% level of significance. Figure in parentheses denotes degree of freedom.

5.5 Comparison of Efficiency Estimates with Raw Data Performance Measures

Table 9 shows the rank- order correlations among the efficiency measures and commonly used financial ratios that may be considered as raw- data measures of efficiency. The correlation between cost and profit efficiency is positive which means the firms with high cost efficiency tend to have high profit efficiency.

Table 9: Correlation Coefficient@ between Efficiency Estimates and Raw Data Performance Measures

	Cost Efficiency	Profit Efficiency	Cost to Asset Ratio	ROA	ROE
Cost Efficiency	1				
Profit Efficiency	0.30(.03)**	1			
Cost to Asset Ratio	-0.45(0.0009)***	-0.26(.06)*	1		
ROA	0.59(0.000)***	0.42(0.002)**	-0.49(0.0002)***	1	
ROE	0.50(0.0002)***	0.36(0.009)**	-0.34(0.014)**	0.84(0.000)***	1

SOURCE: Authors Own Calculations. Value in parentheses denotes p- value of the test for zero correlation.

***,**,* Significant at 1%, 5%, 10% level of significance@ Spearman's Correlation Coefficient**.**

The correlations between the efficiency estimates and each of the raw-data measures follow the expected pattern. Efficiency by any definition is negatively and significantly correlated with the standard average cost ratio i.e. C/GTA and positively and significantly correlated with the standard profitability ratios ROA and ROE. These finding suggest that our efficiency measures are robust and not simply the consequences of our specification or methods and supports our choice of the translog model. In the next section the efficiency estimates derived from the base model are used to analyze efficiency correlates.

5.6 Empirical Analyses of Efficiency Correlates

We use the average cost and profit efficiency estimates and the average values of the bank and other characteristics over the period 2000-2006. The results are shown in **Table10.** The bank size variable is a significant factor explaining the variations in the cost efficiency indicating that on average larger banks attain higher level of cost efficiencies in their operations. But in terms of profit efficiency the coefficient is negative though significant at 27% level of significance. The analysis implies that as banks grow larger, it is able to control cost to some extent but it becomes harder to generate revenues. Banks with higher ratio of loans to asset ratio are found to be more cost and profit efficient. Loans seem to be valued in the market. The standard deviation of return on equity as a direct measure of variability of returns and risk is negatively correlated with cost and profit efficiency. It suggests that banks with more variable returns tend to have lower profit efficiencies and also lower cost efficiencies and thus managers that are poor at operations are poor at risk management. A strong positive relationship between cost inefficiency and number of branches is evident. This suggests that higher overhead cost imposed by number of branches dominates the cost savings of broader deposit and larger revenue benefit of customer conveniences. Thus, banks can improve their performance by optimizing the size of their branch network and reducing the branches in the overlapping market. The older banks seem to be less cost efficient than the newer banks. This is because of the latest technology adopted by these banks that makes them more efficient than the old banks. Banks with the higher net interest margin tend to be more profit efficient. Further, Banks with higher reliance on purchases funds are found to be more profit efficient. The greater use of fixed assets is found to be negatively related to cost efficiency. The coefficient of HH index is positive in cost efficiency regression and significant at 10% level of significance. This is mainly due to the competitive pressures in the deregulated environment that forces even firms in concentrated market to improve their performance. Kumbhakar and Sarkar (2003) also found positive impact of competition on the productivity of banks in India. The public trading dummy variable (Listed) did not yield any significant relationship both in cost and profit efficiency.

Table 10: Regression Results of potential Efficiency Correlates

Variables	Cost Efficiency		Profit Efficiency	
	Coefficient	t-value	Coefficient	t-value
Bank Size (Log of Assets)	0.019738	2.12**(0.04)	-0.03108	-1.11(0.273)
Loan to Assets (Loans/assets)	0.356796	3.07***(0.004)	1.092488	3.13***(0.003)
Stdevroe (Standard Deviation of ROE)	-0.32709	-2.72**(0.01)	-0.77834	-2.15**(0.037)
Branches (no. of branches at the end of 2006)	-3.1E-05	-2.15**(0.037)	3.55E-05	0.83(0.414)
Age (no. of year bank existed before 2006)	-0.00045	-1.53(0.134)	-0.00065	-0.74(0.465)
Nim to cost (Net Interest Margin/Cost)	-0.09839	-1.11(0.273)	0.648766	2.44**(0.019)
Pur funds (Deposits +Borrowings)/Assets	-0.2774	-1.4(0.168)	1.034919	1.74*(0.089)
Fixed Asset (Fixed asset/Total assets)	-2.06089	-3.27***(0.002)	1.033857	0.55(0.587)
H-H index (measure of concentration in deposits)	4.184766	1.94*(0.059)	-4.49989	-0.7(0.491)
Listed (D_1)	-0.00666	-0.44(0.662)	-0.01599	-0.35(0.726)
Constant	0.939844	4.19***(0)	-0.58421	-0.87(0.391)
Adjusted R^2	0.60		0.30	

SOURCE: Authors Own Calculations. ***,**,* Significant at 1%,5%,10% level of significance. Figures in parentheses denote p-value.

6. CONCLUSION

The study examines cost and profit efficiency of Indian banking sector by employing distribution free approaches. The balanced panel of 52 banks is studied during 2000-06. Two –stage procedure of efficiency analysis is adopted wherein at first stage average cost and profit efficiency are estimated of each bank over the sample period. The efficiency scores are then regressed on bank and industry-specific factors. An attempt is also made to compare efficiency estimates of public sector banks with that of

private banks. Overall, average estimates suggest that an average bank should incur around 12% less of its actual cost to match its performance with the best-practiced bank. The alternative profit efficiency levels are found to be significantly lower relative to cost efficiency; approximately 33% of bank's profits are lost due to inefficiency. Performance of public sector banks in terms of profit and cost efficiency is not found to be significantly different statistically. The profit and cost efficiency estimates are positively correlated. Further, the efficiency estimates are positively correlated with profitability ratios and negatively with cost ratios. The effect of using restrictive definition of output, Cobb-Douglas functional form and excluding equity on the efficiency estimates is also explored. The results statistically support the use of translog functional form with broad definition of outputs. The inclusion of equity capital seems to reduce the scale bias in the efficiency estimation. The analysis of potential correlates of efficiency estimates shows that the higher efficiency level is associated with higher loans ratios and limited branch expansion and higher levels of purchased funds. Bank size is associated with higher cost efficiency but not profit efficiency. So as banks grow larger it is harder to generate higher revenues. Banks, which are inefficient in risk management, are found to be under performing. Efficiency gains of competition are clearly evident in the study.

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