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Efficiency of Indian commercial banks during the reform period

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This article contributes to the banking efficiency literature by measuring technical efficiency of banks in four different ownership groups in India during the reform period, 1992–1999. It employs the stochastic frontier function methodology for panel data. The results indicate that the efficiency of raising interest margin is time invariant while the efficiencies of raising other outputs-non-interest income, investments and credits are time varying. The state bank group and foreign banks are more efficient than their counterparts. The reform period witnessed a relatively high efficiency for augmenting investments, which is consistent with economic growth objective of the reform measures. However, there are still larger gaps between the actual and potential performances of banks.

I. INTRODUCTION

Studies estimating the efficiency of financial institutions (FIs) such as banks have relied on accounting measures such as costs, outputs and profit due to unavailability of engineering information on the technology of FIs (Berger and Humphrey, 1997).[1] Although these studies are numerous and recent, most of them concern with developed nations such as USA, Sweden and Finland (Berg *et al*., 1993).[2] However, a few studies analyse the efficiency of banks in developing countries. This article is an attempt to contribute to this sparsely researched issue from the perspective of developing economies, particularly India.

Indian banking is particularly interesting because of different and changing regulatory environment and the diversity of bank ownership: State bank of India (SBI) group, nationalized banks (NBs), privately owned domestic as well as foreign banks.[3] The public sector banks (SBI and NBs) acquired a place of prominence in the financial intermediation process over the years. They made significant strides in expanding geographical coverage, mobilizing savings and providing funds for investments in agriculture/small-scale

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[1] They use at least five different approaches to evaluate the performance of FIs: data envelopment approach (DEA), free disposal hull (FDH), stochastic frontier approach (SFA), distribution free approach (DFA) and thick frontier approach (TFA).These methodologies differ due to the assumptions imposed on the data in terms of (i) the functional form of the frontier function (Berger and Mester, 1997), (ii) more restrictive parametric form versus less restrictive non-parametric form (Giokas, 1991), (iii) whether or not account is taken of random error, and iv) if there is random error, the probability distributions assumed for the one-sided inefficiency term (half normal, truncated normal, exponential and gamma) used to disentangle the inefficiency term from the random error. Excellent reviews on these approaches are available in Berger and Humphrey (1997), Greene (1993), Bauer (1990) and Kalirajan and Shand (1994).

[2] Berger and Humphrey (1997) found after reviewing 130 studies on the efficiency of FIs from 21 countries that 116 studies were published during 1992–1997 and most of them analysed the efficiency of US banks.

[3] The banking system forms two-thirds of the financial system in the country. According to CSO figures, this sector (along with insurance sector) contributed about 1% of GDP in 1950–1951. Its share increased to 2.8% in 1980–1981. Further, it reached a peak of 7.8% in 1996–1997 from 5.3% in 1990–1991.

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industry. Such a progress was achieved within a highly regulated environment with interest rates, credit allocation and entry being controlled by the Reserve Bank of India (RBI). However, during the late 1980s, most banks were plagued with poor profitability and under capitalization with a high proportion of non-performing assets and huge administrative expenditures. They lagged behind the international standards in introducing computers, communication technologies and product innovations and the quality of consumer service was unsatisfactory.

Government of India set up the Narasimham committee to review the functioning of entire financial services industry in the country. Based on the recommendations of the committee (submitted in November 1991), the RBI initiated major reform/liberalization measures that sought to improve bank efficiency through entry deregulation, branch delicensing and deregulation of interest rates and to allow the public sector banks to raise up their equity in the capital market. The reform also sought to improve banking profitability through gradual reduction of the cash reserve ratio, the statutory liquidity ratio and relaxation of several quantitative restrictions on the composition of selected portfolios.[4]

Since 1992–1993, the structure of the Indian banking system has undergone significant changes in terms of scope, opportunities and operational buoyancy. The commercial banks have been facing an increasing degree of competition in the intermediation process from term lending institutions, non-banking intermediaries (like mutual funds and leasing companies), chit funds and the capital market. Besides, new banking services (ATM machines and Internet banking) have been emerging due to the advancement of computers and information technology. The performance of public banks has become more market driven with growing emphasis placed on profitability. In this context, it is essential to study whether the reform measures are really beneficial to the banking industry, thereby efficiency improvement. Although a few studies (Bhattacharyya *et al*., 1997; Das, 1997) measured the efficiency of Indian banks, they applied DEA approach and provided the efficiency values up to 1991.[5] No estimates are available after the reform initiation period.

This study is an attempt to measure the technical (in)efficiency of the Indian banking industry from 1992 to 1999. It employs the stochastic frontier methodology for panel data, which allows us to test whether TE varies over time or not.[6] Although this study relates to India, it has a broader appeal. The Indian experience during the liberalization period provides us a unique opportunity to verify whether the reform process really benefits the banking industry from the perspective of developing countries. The results of the study could help other developing nations, initiating reform process to take appropriate strategy to improve the banking efficiency. The rest of the paper proceeds as follows. Section II explains the methodology. Data and model are explained in Section III. Section IV presents the empirical results. The main conclusions are given in Section V.

II. METHODOLOGY

This article utilizes the stochastic frontier production function model for panel data to measure technical efficiency (TE). The frontier production function, $f(.)$ is defined as the maximum feasible output that can be produced by a bank with a given level of inputs and technology. The actual production function of a bank can be written as:

$$Q_{it} = f(x_{it};\beta)\exp(-u_{it});\ 0 \le u_{it} < \infty;\quad i = 1,2,\ldots,n;\qquad t = 1,2,\ldots,T; \tag{1}$$

where Q_{it} represents the actual output for the sample bank i in period t; x_{it} is a vector of inputs and β is a vector of parameters that describe the transformation process; and u_{it} is a one-sided (non-negative) residual term. If the operation of a bank is inefficient (efficient), its actual output is less than (equal to) the potential output. Therefore, one can treat the ratio of the actual output Q_{it} and potential output $f(.)$ as a measure of TE of a bank in period t.

The residual term u_{it} is zero when the bank produces the potential output (full TE) and is greater than zero when production is below the frontier (less than full TE). In general, the residual term u_{it} (= TE effect) and a bank's TE are inversely related. In order to capture the effects of omitted variables/measurement errors, a random noise v_{it} (i.i.d normal with mean 0 and variance σ_v^2) can also be included in Equation 1 as:

$$Q_{it} = f(.)\exp(v_{it} - u_{it}) \tag{2}$$

Following Battese and Coelli (1992), one can write:

$$u_{it} = u_i\eta_{it} = u_i\exp\{-\eta(t - T_i)\};\qquad i = 1,\ldots,n, t \in g(i) \tag{3}$$

[4] The committee also recommended strengthening of banking system through the BIS norm of 8% capital adequacy ratio, income recognition, assets classifications, etc.

[5] In the DEA approach, all banks share a common frontier and any variations in bank efficiency are measured relative to this frontier. Hence, this approach ignores any random factors that influence the efficiency of a bank. Moreover, the results of this approach are very sensitive to the selection of variables and data errors.

[6] Aigner *et al*. (1977), and Meeusen and Broeck (1977) independently developed the stochastic frontier approach to measure TE using cross-section data. In recent years, the stochastic frontier approach has been extended to estimate time specific TE using panel data (see Bauer, 1990; Greene, 1993; Kumbhakar *et al*., 1997 for reviews).

where u_is are non-negative random variables, assumed to be independently and identically distributed as truncated normal with mean μ and variance σ_u^2, η is an unknown parameter to be estimated and $g(i)$ is the set of T_i time periods for which observations for bank i are available. Hence, the TE effect of bank i in period t (i.e. u_{it}) depends on η and number of remaining periods ($t-T_i$). When $t=T_i$, u_{it} equals u_i which can be treated as the TE effect of bank i in the last period T_i. From Equation 3, one can show that as t increases, u_{it} decreases, remains constant, or increases, depending on whether η is greater than, equal to, or less than zero. Therefore, a bank's TE increases, remains the same, or decreases over time, according to whether η is positive, zero, or negative. Following the model specified by Equations 2 and 3, the conditional expectation of $\exp(-u_{it})$, given the composite error term ε_{it} $(= v_{it}-u_{it})$, that is $E[\exp(-\eta_{it}u_i)|\varepsilon_{it}]$ would provide the measure of TE of bank i in period t.

The model can be estimated by the maximum likelihood (ML) method. Various parametric restrictions in the model lead to a number of interesting cases. Setting $\mu=0$ reduces the model to the traditional half-normal distribution model.[7] If $\eta=0$, then TE is time-invariant (i.e. banks never improve their TE). The value of $\gamma=\sigma_u^2/\sigma^2$ (where $\sigma^2=\sigma_u^2+\sigma_v^2$) will lie between 0 and 1. If $u_i=0$ (full TE), then γ equals zero and deviations from the frontier are entirely due to noise v_{it}. In this case, the Ordinary Least Squares (OLS) estimates of the remaining parameters are also ML estimates. When $\gamma=1$, all deviations from the frontier are due to technical inefficiency. One can test the null hypothesis that $\gamma=\eta=\mu=0$ using the generalized likelihood-ratio test statistic, which equals twice the difference between the logarithmic likelihood values of the unrestricted and restricted ($\gamma=\eta=\mu=0$) ML estimates. The test statistic is a mixed χ^2 (with degrees of freedom equal to 3).[8]

III. DATA AND MODEL

There is a debate in the literature over what banks produce (output) and what resources banks consume in that process (inputs). Most banking studies have adopted either the production approach or the intermediation approach.[9] The former approach considers that banks use capital, labour and other non-financial inputs to provide (deposits and advances) services for account holders (Ferrier and Lovell, 1990). In the latter, banks are intermediating funds between savers and investors and incur interest expense and other operating expenses to provide revenue-generating services. Therefore, investments, advances and deposits are treated as outputs.[10]

The Indian commercial banks have multiple goals.[11] Although they are profit-oriented, the regulatory agency (RBI) has the objectives of fostering economic growth and preserving the safety and soundness of the banking system. Considering these objectives, the study considers four outputs (Q_i)-net interest margin (interest earned minus interest paid, reflecting the gain in financial intermediation process), non-interest income (commission, brokerage, etc. reflecting revenues from other services), credits and investments (in government/approved securities). The first two would reflect the profit goal, while the rest the economic growth and safety objectives. The inputs used are deposits (D), borrowings (B), labour (L) and fixed assets (A).[12] The data on inputs and output of commercial banks in India from 1992 to 1999 have been compiled from the Statistical tables relating to banks in India published by the RBI. All monetary values are converted into 1980–1981 prices using appropriate deflator. Due to missing data, 94 banks belonging to 4 ownership groups are included in the empirical analysis. The final data set is an unbalanced panel of observations (a total of 618) on outputs and inputs. The following Cobb–Douglas functional form was employed (as it provides the best fit):

$$\ln Q_{it} = \beta_{0t} + \beta_{1t}\ln D_{it} + \beta_{2t}\ln \beta_{it} + \beta_{3t}\ln L_{it} + \beta_{4t}\ln A_{it} + v_{it} - \eta_{it}u_i \quad (4)$$

Table 1 provides the means and standard deviations of variables used in the study.

IV. EMPIRICAL RESULTS

Table 2 shows the ML estimation results of Equation 4. Column 2 of the table presents the results of interest margin ($\ln Q_1$) equation with μ and η unrestricted. Since the asymptotic t values on the estimated value of η is not statistically significant at 5% level (indicating that the bank effects are time invariant), we have imposed a restriction

[7] This model will not check for other distributions such as gamma and exponential distributions.
[8] In this model, TE is monotone over time and one rate of change (over time) applies to all sample firms.
[9] Berger *et al.* (1992) provide a detailed discussion of these alternative approaches. Since these approaches utilize different but overlapping sets of inputs/outputs, the extent to which they generate different empirical results concerning the bank performance remains an open question (Bauer *et al.*, 1998).
[10] Bhattacharyya *et al.* (1997) consider investments, advances and deposits as outputs of Banks in India.
[11] Coates (1990) provides a comprehensive discussion of the objectives of the Indian banking system, for which the production approach would be inappropriate.
[12] The labor input is measured as the number of employees since the skill specific employment details are not available.

$\eta = 0$, and then re-estimated the equation.[13] Column 3 provides the revised estimation results. All inputs have positive effects. However, only the effects of deposit and borrowing variables are statistically significant at 5% level. But the labor coefficient is significant only at 10% level. The deposit is the dominant factor in determining the interest margin, as its parameter is the largest (0.66). The significant μ term indicates that u follows a truncated normal distribution. σ^2 and γ terms are positive and statistically significant at 5% level, indicating that the observed level of interest margin significantly differ from frontier level due to factors, which are within the control of banks. The estimated value of γ indicates that 64% of the difference between actual and potential output is due to technically inefficient performance of banks.

The ML estimates of non-interest income (ln Q_2), investments (ln Q_3) and credits (ln Q_4) are shown in columns 4–6 of Table 2. In all cases, parameters of all inputs are positive. Notably, all are statistically significant at 5% level, except the assets variable in the investments equation. However, this variable is significant at 10% level. The deposit variable is again the dominant factor in determining all these output measures. The likelihood ratio test rejects the null hypothesis of $\gamma = \mu = \eta = 0$ in all three equations. Interestingly, σ^2 and γ are positive and statistically significant at 5% level in all cases, revealing inefficient performance of banks in producing these outputs. The estimated values of γ are 0.84, 0.26 and 0.54 in non-interest income, investment and credit equations. The η and μ terms are statistically significant at 5% level in all cases, indicating that u follows a truncated normal distribution and the bank specific effects associated with TE are time varying in all.

Table 1. *Descriptive statistics*

Variables	Units of measurement	Mean	Standard deviation
Interest margin (Q_1)	Rs. in Crore	61.69	151.29
Non-interest income (Q_2)	Rs. in Crore	17.21	51.52
Investments (Q_3)	Rs. in Crore	693.30	1547.86
Credits (Q_4)	Rs. in Crore	871.56	2036.26
Deposits (D)	Rs. in Crore	1667.21	3604.86
Borrowings (B)	Rs. in Crore	101.97	333.81
Fixed assets (A)	Rs. in Crore	27.65	46.67
Labour (L)	Numbers	12302.83	28978.50

Notes: The total sample is 618. All monetary values are in 1980–1981 prices.

Technical efficiency estimates

Table 3 shows means, standard deviations and coefficient of variations (C.V) of time invariant TE values of raising interest margin by bank groups. The mean TE value of 44.6% indicates that on an average the sample banks realize only 45% of their technical abilities in raising interest margin. That is, more than half of their technical potential is not yet utilized. The SBI group ranks first with mean TE value of 59%. The privately owned foreign banks ranks second (52.4%), the nationalized group third (46%) and the privately owned domestic banks the last. The ANOVA (F) test value also indicates that mean differences of efficiencies in different groups are significant.

Table 2. *Maximum likelihood estimates of stochastic frontier functions for Indian banks*

Variables	Interest margin (Q_1)		Commission, brokerage etc. (Q_2)	Investments (Q_3)	Credits (Q_4)
(1)	(2)	(3)	(4)	(5)	(6)
Constant	−0.7437 (4.480)	−0.7651 (4.241)	−1.9789 (13.372)	−0.2591 (2.727)	1.2932 (14.219)
Ln D	0.6914 (14.529)	0.6611 (15.222)	0.4690 (12.536)	0.8484 (27.103)	0.6013 (19.187)
Ln B	0.0491 (3.349)	0.0441 (4.046)	0.1130 (9.802)	0.0516 (5.343)	0.1277 (14.061)
Ln A	0.0433 (1.665)	0.0244 (1.095)	0.1162 (5.129)	0.0307 (1.774)	0.0701 (4.115)
Ln L	0.0069 (0.181)	0.0472 (1.641)	0.1718 (5.665)	0.0539 (2.645)	0.0743 (3.187)
σ^2	0.2896 (5.166)	0.2868 (5.869)	0.3731 (5.089)	0.0731 (7.156)	0.0909 (7.837)
γ	0.6383 (10.028)	0.6401 (12.625)	0.8438 (56.098)	0.2637 (3.692)	0.5417 (10.809)
μ	0.8599 (4.795)	0.8569 (5.014)	1.1227 (8.134)	0.2777 (4.948)	0.4439 (6.347)
η	−0.0137 (0.994)	–	0.0115 (2.124)	0.0586 (3.745)	0.0241 (2.272)
Log-likelihood	−286.766	−287.767	−184.253	−38.947	−1.455
χ^2	257.579	255.577	564.716	106.939	202.990
Iterations	19	16	15	14	15

Notes: Figures in parentheses indicate the absolute asymptotic t-values.

[13] There are two basic methods of estimation if TE is time invariant: fixed effect and random effect. The choice of the estimation method rests on the type of effect. Hausman's statistics supports the random effect. The Lagrangian multiplier test also confirms a considerable heterogeneity across the sample units and rules out application of any simple least square technique. Hence, either GLS or MLE techniques can provide consistent estimates of parameters. The latter was chosen.

Table 4 shows the time varying mean TE values. The overall mean TE value of banks in raising non-interest income increased from 30% in 1992 to 32.8% in 1999. Similarly, the mean TE values of raising investments and credits went up from 65.7% and 58.7% in 1992 to 75.6% and 64.2% respectively in 1999. Lower mean value of TE for raising non-interest income (emanating from commission, exchange and brokerage which are essentially outputs of customer services) suggests that Indian banks are still not able to provide better customer services. However, a relatively high value of TE for augmenting investments in the reform period was a rational response towards operational flexibility, functional autonomy and portfolio choice as against embarking on risky bank credit portfolio. Lower TE for raising bank credit (as compared to TE for raising investments) should also be seen against strict capital adequacy measures imposed in the reform period.

Table 3. *Time invariant efficiency values of raising interest margin*

Category	Mean	SD	CV	Cases
SBI Group	58.94	14.55	24.68	8
Nationalized	46.31	14.06	30.37	19
Private-domestic	32.10	8.43	26.28	33
Private-Foreign	52.39	16.89	32.25	34
All Banks	44.59	16.61	37.25	94

Notes: ANOVA Results: mean square for between groups = 2972.26 and within groups = 186.01. The *F*-value is 15.98.

Table 5 provides the mean TE values for different bank groups in raising their other income, investments and credits. The mean TE values of raising non-interest income over the years were relatively high in SBI group (ranging between 48.7–51.4%) as compared to those in other groups due to the fact that the SBI undertake most of the government business transactions (including major borrowing programs), thereby earning more non-interest income than other groups. The mean TE values during the same

Table 4. *Summary of time varying efficiency values of banking industry*

	Commission etc.,			Investments			Credits			
Year	Mean	SD	CV	Mean	SD	CV	Mean	SD	CV	Cases
1992	30.06	16.12	53.61	65.70	10.18	15.5	58.70	13.52	23.03	67
1993	29.72	15.98	53.77	67.03	9.97	14.87	59.22	13.35	22.55	68
1994	30.30	15.95	52.63	68.77	9.71	14.12	60.24	13.51	22.42	70
1995	30.93	16.11	52.07	70.37	9.44	13.42	61.06	13.51	22.13	68
1996	31.20	15.84	50.76	71.27	8.82	12.38	61.65	12.73	20.65	81
1997	31.78	15.89	50.00	72.35	8.27	11.43	62.94	12.38	19.67	83
1998	32.56	16.45	50.51	74.04	8.57	11.58	63.66	12.67	19.91	92
1999	32.79	16.56	50.50	75.64	8.26	10.92	64.22	12.37	19.26	89

Table 5. *Time-varying mean efficiency values by bank groups*

Year	Commission etc.	Investment	Credit	Cases	Year	Commission etc.	Investment	Credit	Cases
1. State bank group					2. Nationalized banks				
1992	48.70	66.73	70.30	8	1992	23.41	70.59	64.13	19
1993	49.09	68.27	70.88	8	1993	23.79	71.97	64.79	19
1994	49.49	69.75	71.44	8	1994	24.18	73.29	65.44	19
1995	49.88	71.18	72.00	8	1995	24.57	74.57	66.09	19
1996	50.26	72.56	72.55	8	1996	24.96	75.80	66.72	19
1997	50.65	73.88	73.09	8	1997	25.35	76.98	67.35	19
1998	51.04	75.15	73.63	8	1998	25.74	78.12	67.97	19
1999	51.42	76.38	74.15	8	1999	26.13	79.20	68.58	19
3. Private domestic banks					4. Private foreign banks				
1992	19.77	56.86	48.8	21	1992	40.23	70.16	59.34	19
1993	19.98	58.33	49.51	22	1993	38.75	71.65	59.97	19
1994	20.34	60.11	50.33	22	1994	38.98	73.36	61.64	21
1995	20.56	61.83	50.86	21	1995	40.28	75.01	62.61	20
1996	23.36	64.86	55.18	31	1996	40.31	75.70	62.39	23
1997	23.13	66.24	56.09	31	1997	41.37	75.92	64.84	25
1998	23.77	68.37	56.36	33	1998	41.07	77.19	66.14	32
1999	24.20	69.75	57.68	32	1999	41.2	79.47	65.80	30

period ranged between 38.7–41.3% for foreign banks, 23–26% for nationalized and 19.8–24.2% for private domestic group. The nationalized group and private domestic groups seem to be most efficient in raising investments as compared to the SBI group and the private domestic group. In terms of the mean TE value of raising credits, the SBI group ranks first, the nationalized group the second, the private-foreign group third and private-domestic groups obtains the last rank.[14]

V. SUMMARY AND CONCLUSION

This article has analysed the efficiency of banks in India during 1992–1999. The data set is an unbalanced panel of 94 banks (a total of 618), belonging to four different ownership groups. Considering the objectives of individual banks and the regulatory agency (RBI), it has considered four outputs–interest margin, non-interest income, investment and credit. In order to measure bank efficiencies, it has utilized the stochastic frontier approach for panel data. The results indicate the dominance of deposit in producing all outputs. There are considerable evidences that the observed outputs are less than their respective potential outputs due to technical inefficiency of banks. The technical efficiency of raising interest margin is varied widely across sample banks and is time-invariant. Even though several reform measures have been introduced since 1992, they have not so far helped the banks in raising their interest margin. However, the banking industry shows a progress in terms of efficiency of raising non-interest income, investments and credits. The efficiency improvement is considerable in the case of investments in all banks, particularly in private banks. Thus, the result matches with the economic growth objective of the reform measure.

Besides, there appears to be wide variations in the achievement of efficiency among sample banks and among bank groups in raising non-interest income, investment and credit. Notably, about 50% of the sample banks have TE values, which are below average value in all cases, except the investments. Most of them are nationalized and private domestic banks. The results in general indicate that the state bank group and private-foreign group banks perform better than their counter parts. This study would be useful to international development agencies, economists and policy-makers in evaluating and improving the economic performance of banking sector in India.

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