PRODUCTION EFFICIENCY OF COMMERCIAL BANKS IN INDIA

(A stochastic frontier approach)

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Production efficiency is estimated for 87 commercial banks operating in India during 1996-97 with the help of a stochastic frontier function. The function is computed with cross-section data relating to one output and three inputs. A bank is assumed to produce investments and advances by employing purchased funds, labour, and physical capital as inputs. The efficiency scores vary from 38 to 97%, with the least and most efficient banks appearing to be foreign banks. The group of state banks is most efficient. The productivity of the funds is the highest. Total assets and capital adequacy ratio are the main explanatory factors for the efficiency variations. Moreover, ownership contributes to the efficiency levels of foreign banks in India.

INTRODUCTION

The banking sector of India is undergoing economic reforms with the aim of improving the financial performance of its banks. The financial performance, usually measured in terms of profits, of a bank depends to a large extent on its efficiency in the utilisation of resources at its disposal. The bank converts its resources, mainly consisting of money deposits from the public, into income-earning assets by using labour and physical capital as inputs. Unless the conversion process is carried out above a reasonable index of efficiency, the banks may find it difficult to survive in the present environment of changing regulatory conditions, improving communication and information technology, and accelerating financial innovations. This scenario requires of low efficiency banks to implement the reforms more rigorously if they want to function in competition with high efficiency banks. Obviously, if the sector could have some efficiency estimates for its banks, it would be able to rank its banks on the efficiency scale from 0-100, and to find out what possibilities exist for improving the operations of its inefficient banks. But how can the efficiency scores be calculated for its banks? In the present study, we are making an attempt to estimate the efficiency scores for its banks with the help of a statistical technique widely known as a stochastic frontier function. The rest of the paper is divided into four parts: methodology, data, results, and conclusion.

METHODOLOGY

Technical/production efficiency is a relative term. It compares the actual output of a firm with a certain norm. Our norm is empirical

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one, calculated in the framework of a frontier production function.[1] A frontier function, computed with the input-output observations across a number of firms, indicates the maximum output that a firm could have obtained from the same combination of inputs as engaged for its actual output. This way, the technical efficiency of a bank in a group of banks is defined as the ratio of its actual output to the frontier output, and is estimated as follows:

$$\lambda = \frac{Y(s)}{Y_f(s)}, \quad 0 \leq \lambda \leq 1 \qquad (1)$$

where Y(s) refers to the actual output of the bank from the sth combination of inputs, $Y_f(s)$ the frontier (maximum) output from the same combination of inputs, and λ the efficiency index, with the index lying between zero and one.

This method of measuring the technical efficiency of a bank is meaningful for three reasons. One, the method assumes that every bank tries to economise on the use of its inputs in the production of income-earning assets. This is a reasonable assumption to make because the earnings from such assets must at least cover interest payments to the deposit holders and operating expenses of the bank. Two, the method may help the management of an inefficient bank to find out the factors responsible for causing the inefficiency, by comparing its input-output combinations with those of the frontier (most efficient) bank. Finally, the method generates efficiency estimates for all the banks. The pattern of these efficiency scores may provide the banking industry or a group of banks enough guidance to coordinate the operations of its banks in a more economical manner.

What are our concepts of output and inputs of a bank? For the definitions of these four variables, we have mainly relied on the works by Gropper (1991), Indiastuti (1998), Chang (1998), and Simper (1999). In the present study, a bank is considered to generate one output of productive assets with three factors of production: purchased funds, Rs. Lakhs; labour, no. of workers, and physical capital, Rs. Lakhs.

For the purpose of estimating λ, we take the following stochastic form of the Cobb-Douglas production function in three variables:[2]

$$\text{Ln } Y = \alpha_0 + \alpha_1 \text{ Ln } X_1 + \alpha_2 \text{Ln } X_2 + \alpha_3 \text{Ln } X_3 + v - \mu \ldots (2)$$

where Y stands for productive assets, Rs. lakhs; X_1 purchased funds, Rs. Lakhs; X_2 number of workers; and X_3 physical capital, Rs. Lakhs. On the other hand, α_0 is a constant, and α_1, α_2, and α_3 are three coefficients. The rest of (2) has two components. One is v, a random term, which represents statistical noise. This term follows $N(0, \sigma^2_v)$. The other is μ, a non-negative term, which indicates technical inefficiency. This term follows a distribution derived from $N(0, \sigma^2_\mu)$ truncated from left at zero.

Assuming that Y_f is in the form of Cobb-Douglas production function, we can write equation (1) as follows:

$$\text{Ln } Y = \alpha_0 + \alpha_1 \text{ Ln } X_1 + \alpha_2 \text{Ln } X_2 + \alpha_3 \text{Ln } X_3 + v + \text{Ln } \lambda \ldots (3)$$

[1] For a detailed survey on frontier production functions, see P. Schmidt (1985-86).

[2] For theoretical properties of a stochastic production unction, see Aigner et al (1977), and Stevenson (1980).

From (3) and (2), we get

$$\lambda = e^{-\mu}, \mu \geq 0 \text{ and } 0 \leq \lambda \leq 1 \quad (4)$$

Term μ requires description. Its economic meaning is that the output of each bank must lie either on or below the frontier function. Any downward deviation from the function indicates inefficiency of the bank. The deviations are caused by the factors under the control of the bank. Some of such factors may be poor management skills, work stoppages, manual bottlenecks, and low staff's efforts. With the removal of such hurdles, the bank is expected to operate on the frontier function, showing the value of its μ as zero. Obviously, any bank with a very large μ is the most inefficient bank.

The efficiency index, λ, may vary from bank to bank. In order to explain the efficiency variations, we proceed along the lines of Kaparakis et al (1994) and Indiastuti (1998), where three determinants of efficiency are considered; namely, total assets, capital adequacy ratio, and ratio of purchased funds to total assets. The amount of total assets measures the size of a bank, the capital adequacy ratio (ratio of total equity to total assets) the financial safety and soundness of the bank, and the ratio of purchased funds to total assets the aggressiveness of the management behaviour towards mobilising purchased funds. In addition to these explanatory variables, we use four dummy variables to capture the impact of bank ownership on the efficiency scores. There are five types of bank ownership: Group-I, State banks; Group-II, Nationalised banks; Group-III, Old private sector banks; Group-IV, New private banks; and Group-V, Foreign banks operating in India. As a result, we estimate the following regression equation:

$$\lambda = \beta_0+\beta_1 S+\beta_2 K+\beta_3 F+\gamma_1 D_1+\gamma_2 D_2+\gamma_3 D_3+\gamma_4 D_4+\varepsilon \quad (5)$$

where S refers to total assets, Rs. Lakhs; K capital adequacy ratio, and F ratio of purchased funds to total assets. For the other part of the equation, there are four dummy variables: D_1, D_2, D_3, and D_4. D_1 is equal to 1 for Group-I and 0 otherwise; D_1 1 for Group-II and 0 otherwise; D_3 1 for Group-III and 0 otherwise; and D_4 1 for Group-IV and 0 otherwise. On the other hand, β_0 is a constant, and β_1, β_2, β_3, γ_1, γ_2, γ_3, and γ_4 are seven coefficients. Finally, e is an error term.

DATA

Equation (2) is expressed in one output and three inputs, on which we have got complete data for 87 banks operating in India during 1986-87. Our data source includes two reports of the Reserve Bank of India (1996-97A, and 1996-97B), which contain, apart from other financial data, income statements and balance sheets of all the commercial banks functioning in India during 1996-97.

In the present study, the output of a bank is taken in terms of productive assets consisting of investments and advances. The investments refer to investments made by the bank inside and outside India. The advances cover bills purchased and discounted, cash credits, overdrafts, loans, and term loans. The first input is the amount of purchased funds including deposits and borrowings. The deposits cover demand deposits, savings deposits, term deposits, deposits of the branches inside and outside India. The borrowings consist of the borrowings inside and outside India. The second input is labour. As no direct data were available on employment, we estimated it as the multiplication of two factors: (1) reciprocal of the profit per person, and (2) total profit (total earnings minus total expenses). Finally, the third input is physical

capital equivalent to the money value of fixed assets. These assets include premises and other fixed assets.

For the estimation of equation (5), we also took data on its seven variables from the RBI reports. Moreover, it shall be mentioned that all our 87 banks are distributed among five groups of ownership as follows: Group-I, State banks, 8 banks; Group-II, Nationalised banks, 17; Group-III, Old private sector banks, 23; Group-IV, New private sector banks, 9; and Group-V, Foreign banks operating in India, 30.

RESULTS

Equation (2) was estimated with the help of a computer program we received from T.J. Coelli (1991), University of New England, Australia. The program was modified with regard to input and output statements on a personal computer, and when the program had run successfully on the test problem meant for the program, we worked out our exercise. The estimates of efficiency so obtained for all the eighty seven banks are mentioned in Table 1, where the mean efficiency of a group refers to the simple average of the efficiency scores of its banks.

The table brings out four main features of the banks operating in India. First, the efficiency index ranges from 38 to 97% across all the banks, with the most and the least efficiency banks belonging to Group-V. Despite the wide efficiency range, the industry is utilising its resources in a desirable manner, in the sense that less than one-third of its banks are functioning below its efficiency index, which is 88%. Never the less, these banks of low efficiency should compare their input-output ratios with those of the most efficient banks, and upgrade their operations accordingly. Second, Group-I is most efficient, in the sense that the average efficiency of its banks is the highest. Group-II is almost as efficient as Group-I, indicating that state and nationalised banks are equally competent to transform most of a given amount of funds into earning assets. Third, Groups-IV and V have the same efficiency score, showing that the new private sector and foreign banks are adapting their operations to Indian conditions in an identical manner. Fourth, the least efficient is Group-III. The old private sector banks may have not been able to modernise their operations in accordance with those of the banks of other groups.

We shall now turn to the computed values of the coefficients of equation (2). The equation represents a production function in four parameters: α_0 , α_1 , α_2, and α_3. The maximum likelihood estimates of which are 1.57, 0.77, 0.06, and 0.10 respectively. Their respective t-values are 5.43, 23.37, 3.24, and 4.58. Obviously, all these t-values are statistically significant at 1% level.

From that much information, we can easily infer two features about the production process of the banking industry. One, there are diminishing returns to scale prevailing in the industry, as the sum of the values of α_1 , α_2, and α_3 is less than unity. As a result, if the industry increases all of its inputs by one percent, the growth in output will be less than one percent. The other, the input of funds is the most contributory factor in the generation of output, as it is evident from its coefficient being the highest. If the funds are increased by one percent, the industry will be able to raise its output of investments and advances by 0.77 percent.

TABLE-1: Efficiency indices for banks in India, percentage

Group/Banks		Efficiency Index (%)
Group-I State banks		
1	SB of India	94
2	SB of Bikaner & Jaipur	93
3	SB of Hyderabad	93
4	SB of Indore	91
5	SB of Patiala	92
6	SB of Saurashtra	92
7	SB of Travancore	93
8	SB of Mysore	92
#Mean efficiency for Group-I		**92**
Group-II Nationalised banks		
1	Allahabad	90
2	Andhra	92
3	Bank of Maharashtra	90
4	Corporation	92
5	Central Bank of India	92
6	Syndicate	92
7	Punjab & Sind Bank	91
8	Bank of Baroda	93
9	Canara	92
10	Indian Overseas	91
11	Punjab National Bank	92
12	Dena	92
13	Bank of India	92
14	Union Bank of India	89
15	Vijay Bank	86
16	UCO Bank	90
17	Oriental Bank of Commerce	93
#Mean efficieny for Group-II		**91**
Group-III Old private sector banks		
1	Benares State Bank Ltd	81
2	Development Credit Bank Ltd	82
3	Catholic Syrian Bank Ltd	87
4	City Union Bank Ltd	85
5	Federal Bank Ltd	90
6	Bharat Overseas Bank Ltd	85
7	Karur Vysya Bank Ltd	86
8	Lakshmi Vilas Bank Ltd	86
9	Ratnakar Bank Ltd	80
10	United Western Bank Ltd	83
11	South Indian Bank Ltd	90
12	Tamilnad Mercantile Bank Ltd	89
13	Dhanalakshmi Bank Ltd	84
14	SBI Comm & Inter Bank Ltd	75
15	Nedungadi Bank Ltd	89
16	Lord Krishna Bank Ltd	86
17	Karnataka Bank Ltd	88
18	Sangil Bank Ltd	80
19	Vysya Bank Ltd	91
20	Ganesh Bank of Kurundwad Ltd	66
21	Bank of Madura	81
22	Bank of Rajasthan Ltd	87
23	Nainital Bank Ltd	67
#Mean efficiency for Group-III		**83**
Group IV New private sector banks		-
1	UTI Bank Ltd	87
2	Centurion Bank Ltd	91
3	ICICI Banking Corporation Ltd	85
4	Bank of Punjab Ltd	87
5	Global Trust Bank Ltd	89
6	IDBI Bank Ltd	91
7	IndusInd Bank Ltd	93
8	Times Bank Ltd	89
9	HDFC Bank Ltd	86
#Mean efficiency for Group-IV		**87**
Group-V Foreign banks in India		-
1	Barclays Bank Ltd	88
2	Chase Manhattan Bank	93
3	Bank of Nova Scotia	93
4	ANZ Grindlays Bank Ltd	89
5	Mashreq Bank	90
6	Citibank NA	91
7	Deustch Bank	92
8	Banque Nationale de Paris	85

Group/Banks		Efficiency Index (%)
9	Bankque Indosuez	80
10	Abu Dhabi Comm Bank Ltd	90
11	Societe Generale	89
12	Oman Inter Bank	82
13	Bank of America	94
14	Siam Comm Bank	94
15	Commerz Bank	90
16	Hongkong Bank	88
17	Sanwa Bank	93
18	State Bank of Mauritius Ltd	96
19	Sakura Bank	93
20	American Express Bank Ltd	92
21	Standard Chartered Bank	90
22	ABN AMRO Bank	93
23	British Bank of Middle East	89
24	Bank of Tokyo-Mitsubishi Ltd	93
25	Cho-Hung Bank	93
26	Credit Lyonnals	94
27	Development Bank of Singapore	84
28	Bank of Bahrain and Kuwait BSC	89
29	Fuji Bank Ltd	97
30	Sonali Bank	38
#Mean efficiency for Group-V		**87**
Mean efficiency of all the banks		**88**

As regards the estimation of equation (5), we shall say that the equation was computed on the several transformed forms of S, K, and F variables. Keeping the level of statistical significance at 1%, we came upon the following computed form of the equation as the most appropriate in our context, with the t-values mentioned in the brackets.

$$\lambda = -40.29 + \underset{(-2.82)}{10.61}\ \underset{(7.92)}{LnS} + \underset{(6.95)}{37.92}\ LnK - \underset{(-5.78)}{3.07}\ (LnS)\ (LnK)$$

$$- \underset{(-1.43)}{3.18}D_1 - \underset{(-3.92)}{6.82}\ D_2 - \underset{(-3.78)}{5.01}\ D_3 - \underset{(-0.92)}{1.73}\ D_4 \qquad \ldots (6)$$

$$R^2 = 0.66$$

Equation (6) reveals two main features about the pattern of efficiency estimates. One, it is the size and the financial position of a bank that contribute to its technical efficiency. A bank with a greater amount of total assets and a higher capital adequacy ratio will be more efficient in its production process. This is expected because such a bank can afford to modernise its operations and to make more risky investments. The other, ownership structure bears on efficiency scores across the groups of banks. The ownership of state banks does not affect their efficiency scores, as is evident from the first dummy variable being insignificant. The same is also true in the case of Group-IV. On the other hand, the other two dummy variables are significant but negative, indicating that the ownership structures of the banks of second, and third groups do not have a favourable attitude towards making their respective banks more efficient in the production process. However, the ownership structure of the foreign banks contributes to the improvement of their efficient scores, and this can be known by assigning zero values to all the dummy variables.

CONCLUSION

Our conclusion includes five main findings. First, the banks of Group-I are most efficient, suggesting that the banks of other groups should adjust their input-output combinations in accordance with those of the state banks. Second, out of our 87 banks, there are 27 low efficiency banks, as their individual levels of efficiency are below the national efficiency index of 88%. These banks should try to improve their operations drastically if they want to work in competition with other banks. Third, there are diminishing returns to scale prevailing in the Indian banking sector, with the productivity of the purchased funds being the highest. Fourth, the size and the financial performance of a

bank contribute to its efficiency index. Finally, the ownership structure of the foreign banks in India plays a significant role in increasing the production efficiency of its banks. However, a few more similar studies are needed to examine the validity of our findings.

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