Comparing the Technical Efficiency of Indian Banks Operating Abroad and Foreign Banks Operating in India: A Stochastic Output Distance Function Approach

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The aim of this paper is to compare the technical efficiency of Indian Banks operating abroad and foreign banks operating in India and to investigate the effect of openness of the country, ownership pattern of the banks on their technical efficiency. Furthermore, we test whether the banks operating in developed and developing countries have different level of technical efficiency. This paper is based on the information collected through annual surveys on International Trade in Banking Services conducted by the Reserve Bank of India for the period 2006-2007 to 2008-09 supplemented with the data collected from various issues of statistical tables relating to banks and bank scope database. The results reveal that Indian Banks operating abroad are more efficient than the foreign banks operating in India and banks operating in developed countries are found to be more efficient than the banks operating in developing countries. The effect of openness of the country as well as ownership pattern of the Indian banks operating outside India has no significant effect on their technical efficiency.

Introduction

As a consequence of liberalisation and globalisation in Indian economy, trade between economies has increased tremendously. Besides, the financial institutions are getting the favorable environment to open

branches/ subsidiaries abroad and provide the services in cost effective manner. Financial sectors play an important role in fostering the international trade in services among countries as all the international transactions are routed through the financial institutions directly or indirectly. There was a steady increase in the share of financial services in total services from 4.5 percent in 2003 to 9.0 percent in 2007. However, in 2008 and 2009, the share of financial services in total services reduced to nearly 7.5 percent reflecting the implication of global financial turmoil. Furthermore, foreign direct investment in banking in the form of branches, agencies and subsidiaries, or by the means of cross-border mergers and acquisitions, increased considerably between early 1980s and the late 1990s (Gkoutzinis, 2005).

It is important for policy makers to assess the services generated by the Indian banks operating abroad and foreign banks operating in Indian and also to assess the expansion of Indian banks branches abroad would be effective measured in terms of efficiency. The Reserve bank of India launched the survey 'International trade in banking services' to bridge the data gap to capture the services rendered by the Indian banks' branches / subsidiaries abroad and foreign bank's branches/subsidiaries operating in India. It has been observed that the foreign banks operating in India have been generating more fee income than Indian bank branches by rendering the services. It might be due to two reasons (i) Indian banks are not using the same amount of input as the foreign banks are using, (ii) Indian banks are not using their inputs efficiently, *i.e.*, Indian banks operating outside India are not as efficient as the foreign banks in India. In this paper, we attempt to compare the technical efficiency of Indian banks operating abroad with that of foreign banks operating in India. An attempt is also made to compare the performance of banks operating in developed countries with those operating in developing countries.

The remainder of the paper is organised as follows. Section II presents a brief overview of literature on bank efficiency with particular focus on Indian banking. Section III presents the methodology adopted in this study for the measurement of the efficiency levels. Section IV describes the data followed by Section V on the empirical results. Section VI summarises and concludes the study.

Section II
A Brief Literature Review

Recent years witnessed an explosion in research on bank performance across the globe [See Alam, 2001 and Berger and Mester, 2003 for discussions of recent literature]. Much of the literature is mainly based on comparisons of foreign banks and domestic banks operating within the same country. However, existing research on the comparative performance of foreign banks and domestic banks showed conflicting conclusions. Studies based on cross country samples found that foreign banks were more profitable than domestic banks in developed countries while it was the other way round in developing countries (Claessens *et al.*, 2000). To cite some country-specific studies, in the United States, foreign banks were found to be less efficient than domestic banks (Hasan and Hunter, 1996). In the contrary, other studies found that foreign banks were nearly as efficient as domestic banks in developed countries other than the U.S. (Vennet, 1996 and Hasan and Lozano-Vivas, 1998). For the transition economies of Central and Eastern Europe, it has been found that foreign banks are less efficient than domestically owned private banks and state-owned banks (Yildirim and Philippatos, 2007). In the case of Latin America, some studies found that foreign banks were more productive than domestic banks (Barajas *et al.* 2000) while some others reported little difference between the performance of the foreign and domestic banks (Crystal *et al.* 2001).

Among the earliest studies on the efficiency of Indian banking, Bhattacharya *et al.* (1997) found that state-owned banks (SOBs) were the best-performing ones and these banks improved their efficiency in the deregulated environment. Based on a nonparametric approach, Ram Mohan and Ray (2004) and Das *et al.* (2005) compared various efficiency measures of banks across different ownerships during the post liberalisation period. These studies broadly concluded that state-owned banks performed significantly better than private sector banks on revenue maximisation criteria, although the efficiency differential between state-owned and foreign banks was not significant. Sreeramulu *et al.* (2010) compared the efficiency of Indian banks during the period 1999-2008 using Cobb Douglas stochastic frontier model. They found substantial efficiency improvement in the Indian banking sector during 2004-08

compared with late 1990s. Also, domestic private sector banks were found to be most efficient in generating the banking output measured in terms of total business and total income. The improvements in the Indian banking sector are mainly attributed due to globalisation, deregulation and advances in information technology. Mahesh and Rajeev (2007) studied the Total Factor Productivity (TFP) of Indian commercial banks for the period 1985-2004 using Malmquist productivity index approach. They found that TFP improved significantly after liberalisation across bank groups. Recently, Sensarma (2006) found that foreign banks are less efficient than either public or private domestic banks in India.

While researchers have used a variety of approaches to measure bank performance, all the above studies were confined to banks operating within a particular country. Banks that operate in different nations often face very different prudential supervisory and regulatory conditions that may affect their performance. Similarly, measured efficiency differences could reflect differences in labor laws, usury ceilings, antitrust regulation and enforcement, or other legal conditions under which the banks function. Recently, Berger (2007), in an updated review paper, provided critical assessment of 100 studies across countries, mostly relating to the banking industry's transformation towards unprecedented consolidation and cross-border activities. If the existing literature concludes that foreign banks operating in India are less efficient than the domestic banks of India, then above-mentioned reasons might be the factors for their inefficiency. Therefore, it would be quite interesting to compare the technical efficiency of the Indian banks operating outside India with foreign banks operating in India, as then Indian banks will also face a different kind of supervisory and regulatory conditions as foreign banks operating in India are facing. The major objective of this study is, therefore, to compare technical efficiency of Indian banks operating abroad with foreign banks operating in India by controlling the factors that can affect their efficiency. The present paper uses data for period 2006-07 to 2008-09 to assess the relative performance of different groups of Indian banks, *i.e.*, public sector banks and private sector banks operating abroad and foreign banks operating in India. We also try to study the impact of trade openness of the economy on bank performance.

Traditionally, the methods to measure efficiency in production can be divided into two groups: one is linear programming model such as data envelopment analysis (DEA), and the other is stochastic frontier analysis using econometric regression. However, both of these approaches have a range of advantages and disadvantages probably influencing the results in a particular application. The principal advantage of the DEA approach is that it does not require the specification of a particular functional form for the technology, but it cannot measure the statistical noise. The principal advantage of the stochastic frontier analysis is that it considers the statistical noise and outliers, but it requires the assumed underlying technology and functional form. In addition, the non-parametric nature of the DEA approach makes it easy to handle multiple outputs and multiple inputs, but stochastic frontier analysis is limited by its assumed functional form and cannot be directly used for multi-output production analysis or multi-input cost analysis. The majority of econometric studies which attempted to model a multiple-output technology either: (a) aggregated the multiple outputs into a single index of output; or (b) modeled the technology using a dual cost function [Schmidt and Lovell (1979) or Ferrier and Lovell (1990) for details]. These approaches, however, require certain assumptions to be made. The first of these methods require that output prices be observable (and reflect revenue maximizing behavior), while the latter approach requires an assumption of cost-minimising behaviour. There are a number of instances, however, when neither of these requirements are met. In order to overcome such difficulties, this study employs the stochastic output-oriented distance function [e.g., Lovell *et al.* (1994), and Grosskopf *et. al.* (1997)] which can accommodate both multiple outputs. With regard to the banking efficiency literature, studies using the distance function approach are very few as compared to those using the production or cost function approaches. For instance, Cuesta and Orea (2002) employed this procedure to Spanish savings banks, and Marsh *et al.* (2003) to the U.S. commercial banks. In contrast, the applications involving distance functions have become common in recent literature of public services industry (English *et al.* 1993; Fare *et al.* 1993; Coelli and Perelman, 1999; and Grosskopf *et al.* 1997). In the next section, we briefly describe the distance function method.

Section III

Theoretical Framework

Distance Function method and efficiency estimation

In this study, the output distance function is used. It should be stated that a production technology should be determined before an output distance function is defined. Let a multiple-input and multiple-output production technology (S) at time t be defined as:
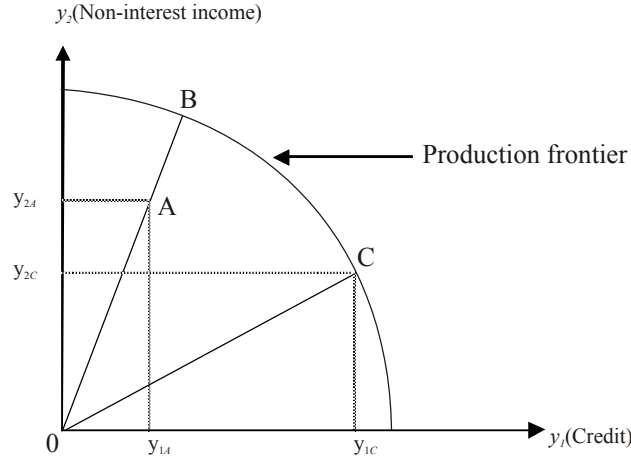
$$S = \{(x^t, y^t): x^t \text{ can produce } y^t\}, t = 1,...,T. \tag{1}$$

where x^t is an $(N \times 1)$ input vector and y^t is an $(M \times 1)$ output vector. Then the output distance function at time t is defined as:

$$D_o^t(x^t, y^t) = \min\{\mu > 0 : (y^t / \mu) \in S\}, t = 1,...,T. \tag{2}$$

where the subscript O indicates the output distance function. It follows that $D_0^t(x^t, y^t) \leq 1$ if $y^t \in S$, and $D_0^t(x^t, y^t) = 1$ if y^t is located on the outer boundary of S^t. The output distance function is defined as the reciprocal of the maximum proportional expansion of the output vector, y^t, given input vector, x^t, under period t technology. The output distance function can be viewed as Farrell's output-oriented measure of technical efficiency. In other words if the output vector is on the boundary or frontier of technology, then the value of the distance function is one, *i.e.* the production is technically efficient, otherwise it is less than one, *i.e.* the production is technically inefficient. Also note that the output distance function is non-decreasing, positively linear homogeneous and convex in outputs and decreasing in inputs (Lovell *et al.*, 1994).

Figure 1 illustrates these concepts in a simple two-output setting. Let us assume that two decision-making units in frontier analysis terminology, *A* and *C*, dispose of equal input endowments to produce outputs *viz.*, credit (y_1) and non-interest income (y_2) . Then *C* is efficient $D_0^t(x^t, y_A^t) \equiv \mu_C = 1,$ because it lies on the boundary of the output possibility set, whereas *A*, an interior point, is inefficient at a rate given by the radial distance function $D_0^t(x^t, y_A^t) \equiv \mu_A = OA/OB$ where $D_0^t(x^t, y^t) \equiv \mu \in [0,1]$.

Figure 1. The Output Distance Function

y_2(Non-interest income)

B

Production frontier

y_{2A}

A

y_{2C}

C

0   y_{1A} y_{1C} y_1(Credit)

In this study, a translog functional form is used to specify the banks' output-oriented distance function. Thus, the translog distance function for the case of inputs $(x_1, x_2,..., x_N)$ and outputs $(y_1, y_2,..., y_M)$ is of the following form:

$$\ln D_0^t(y^t, x^t, t) = \alpha_0 + \sum_{k=1}^{N} \alpha_k \ln x_k^t + \sum_{j=1}^{M} \beta_j \ln y_j^t + \frac{1}{2}\sum_{k=1}^{N}\sum_{h=1}^{N} \alpha_{kh} \ln x_k^t \ln x_h^t + \frac{1}{2}\sum_{j=1}^{M}\sum_{l=1}^{M} \beta_{jl} \ln y_j^t \ln y_l^t$$

$$+ \frac{1}{2}\sum_{k=1}^{N}\sum_{l=1}^{M} \gamma_{kl} \ln x_k^t \ln y_l^t + \varphi_t t + \frac{1}{2}\varphi_{tt} t^2 + \sum_{k=1}^{N} \alpha_{tk} t \ln x_k^t + \sum_{j=1}^{M} \beta_{tj} t \ln y_j^t \qquad t = 1,...,T \qquad (3)$$

where t is a time trend and is used as an index of technology.

The parameters of the translog output distance function presented in (3) can be estimated only if the restriction of homogeneity of degree +1 in outputs is imposed. This is achieved by using an arbitrary output, y as the numeraire to normalize the other outputs.

The property of homogeneity implies that the distance function can be written as:

$$D_0(wy, x, t) = wD_0(y, x, t) \text{ for any } \mu > 0 \qquad (4)$$

Thus, by setting $w = 1/y_M$, (4) becomes:

$$D_0(y/y_M, x, t) = D_0(y, x, t)/y_M \qquad (5)$$

Let the general form of a translog output distance function with homogeneity of degree +1 in outputs is represented as:

$$\ln (D_{0ij} / y_{Mij}) = \mathrm{TL}(y_{ij} / y_{Mij}, x_{ij}, \zeta) \tag{6}$$

where subscript "ij" indicates i^{th} bank operating in j^{th} country and ζ is a vector of parameters to be estimated. From Eq. (6) the following is obtained:

$$\ln (D_{0ij}) - \ln (y_{Mij}) = \mathrm{TL}(y_{ij} / y_{Mij}, x_{ij}, \zeta) \tag{7}$$

and thus

$$- \ln (y_{Mij}) = \mathrm{TL}(y_{ij} / y_{Mij}, x_{ij}, \zeta) - \ln (D_{0ij}) \tag{8}$$

The unobservable term $\ln (D_{0ij})$ in (7) can be viewed as a random term referring to inefficiency. Furthermore, by appending a statistical noise term the stochastic form of (8) is obtained:

$$- \ln (y_{Mij}) = \mathrm{TL}(y_{ij} / y_{Mij}, x_{ij}, \zeta) + v_{ijt} - u_{ijt} \tag{9}$$

where u_{ijt} is a non-negative random variable allowing for technical inefficiency and v_{ijt} is a two-sided random variable indicating random error, which is assumed to be independent of u_{ijt}. In order to specify (9) the flexible translog functional form of (3) with two outputs and two inputs and homogeneity of degree +1 in outputs imposed, is used to represent the technology of the banking industry, including a set of dummy variables to capture ownership-specific (public, private or foreign) and country-specific (Developed or Developing) factors. Thus (9) becomes:

$$- \ln y_{2ijt} = \alpha_0 + \sum_{k=1}^{2} \alpha_k \ln x_{kijt} + \beta_1 y^*_{1ijt} + \frac{1}{2}\sum_{k=1}^{2}\sum_{h=1}^{2} \alpha_{kh} \ln x_{kijt} \ln x_{hijt} + \beta_{11}\left(\ln y^*_{1ijt}\right)^2 + \sum_{k=1}^{2}\gamma_{k1} \ln x_{kijt} \ln y^*_{1ijt}$$

$$+ \varphi_t t + \frac{1}{2}\varphi_{tt} t^2 + \sum_{k=1}^{2} \alpha_{tk} t \ln x_{kijt} + \beta_{t1} t \ln y^*_{1ijt} + \xi_{PUB} d_{PUBt} + \xi_{PRV} d_{PRVt} + \xi_{DEV} d_{DEVt} + v_{ijt} - u_{ijt}$$

$$t = 1,\ldots,T \tag{10}$$

where $y^*_{1ijt} = y_{1ijt} / y_{2ijt}$; y_{1ijt} and y_{2ijt} denote outputs of the ith bank operating in j^{th} country at the t-th time period ($t = 1,2,3$) and correspond to non-interest income (NI) and loans and advances (LO) respectively; x_{1ijt} and x_{2ijt} represent inputs of the ith bank operating in j^{th}

country at the tth time period and correspond to deposit (DE) and non-interest expense (NE) respectively; t is a linear time trend which is used as an index of technology; d_{PUBt} and d_{PRVt} are ownership dummies that take value one if the bank belongs to the public sector and private sector respectively at the t-th time period. The only other sector is foreign, which becomes the base for interpreting the ownership dummies. d_{DEVt} is a country specific dummy variable that takes value one if the bank is operating in developed country otherwise zero; v_{ijt} is the random error which is assumed independent and identically distributed $N(0, \sigma_v^2)$ and depends on factors that beyond the control of the bank, *i.e.* errors due to extraneous factors; u_{ijt} is a non-negative random variable associated with technical inefficiency and measures the extent to which the observed output falls below the potential output for given levels of inputs and technology. It has usually been assumed that this component has an independent and identically half-normal distribution, even though a variety of other distributional assumptions are possible [Green, 1997]. However, in the Battese and Coelli (1995) model, is specified as a function of firm-specific factors, believed to influence technical inefficiency. More specifically, is defined by the truncation (at zero) of the distribution where the general form of the bank-specific mean, is specified as follows:

$$\mu_{ijt} = z_{ijt}\delta + \varepsilon_{ijt} \qquad (11)$$

where, z_{ijt} is a vector of variables explaining technical inefficiency of banks, δ is a vector of parameters to be estimated and ε_{ijt} accounts for statistical noise (Battese and Coelli, 1995). In this study, the technical inefficiency effects model (11) is specified as follows:

$$\mu_{ijt} = \delta_0 + \delta_{10} \ln O_{ijt} + \delta_{20} \ln n_{ijt} + \delta_t t + \delta_c c_{ijt} + \delta_{PUBt} d_{PRBt} + \delta_{PRV} d_{PRVt} + \delta_{DEV} d_{DEVt} + \varepsilon_{ijt} \qquad (12)$$

where O_{ijt} represents the trade openness of the economy of the jth country where i^{th} bank is operating and is measured as the total export plus total imports in goods and services divided by the Gross Domestic Product (GDP) at t^{th} time period; n_{ijt} indicates the number of branches for the ith bank in j^{th} country; c_{ijt} is the service concentration, which is the sum of the squared ratios of the value of each output to total value of outputs of the ith bank operating in j^{th} country.

The method of maximum likelihood is used for simultaneous estimation of the parameters of the stochastic frontier translog distance function (10) and the technical inefficiency effects model (12). Battese and Coelli (1993) present the likelihood function and its partial derivatives with respect to the parameters of the model. It is worth noting that the likelihood function is expressed in terms of the variance parameters $\sigma^2 = \sigma_v^2 + \sigma_u^2$ and $\gamma = \sigma_u^2 / (\sigma_u^2 + \sigma_v^2)$ because this transformation facilitates the estimation process (Battese and Corra, 1977). The variance parameter $\gamma = \sigma_u^2 / (\sigma_u^2 + \sigma_v^2)$ takes values between zero and one. Values of γ close to zero indicate that the symmetric error v_{ijt} dominates the one-sided error u_{ijt}. This implies that the disparity between the observed output and the frontier output is primarily due to factors beyoned the control of the banks. On the other hand, values of γ close to one indicate that the one-sided error u_{ijt} dominates the symmetric error v_{ijt} implying that the disparity between the observed output and the frontier output is mainly attributed to technical inefficiency. Predictions of technical efficiency of the ith bank at the tth time period are calculated according to the following equation:

$$TE_{ijt} = E\left[\exp(-u_{ijt}) \,\middle|\, \varepsilon_{ijt}\right] \text{ where } \varepsilon_{ijt} = v_{ijt} - u_{ijt} \tag{13}$$

Eq. (13) indicates that predictions of technical efficiency are obtained utilising the conditional expectation of $\exp(-u_{ijt})$ given the error term of the stochastic distance function, ε_{ijt} and evaluated using the estimated parameters of the distance function (Jondrow *et al.* 1982; Battese and Coelli, 1988).

Section IV

The Data Specification of Inputs and Outputs

In this study, the data are drawn from the annual survey on International Trade in Banking Services (ITBS) conducted by Reserve Bank of India for the period from 2006-07 to 2008-09 supplemented with the data collected from various issues of Statistical Tables Relating to Banks and the Bank Scope database. The first survey on 'International Trade in Banking Services (ITBS)' was launched by the Reserve Bank of India in January 2008 for the period 2006-07. The latest article based

on the ITBS survey for the period 2008-09 was published in October 2010 issue of the monthly Bulletin of the Reserve Bank of India. The primary objective of the ITBS survey was to collect disaggregated information relating to various banking services rendered by the overseas branches of Indian banks as well as the banking services rendered by the foreign bank branches operating in India along with the primary information relating to their business such as total credit, total deposit, interest income, total number of employees *etc.*

Study covers 41 banks operating in 28 countries including India. Among these 41 banks, there are 11 Indian public sector banks and 2 private sector banks operating abroad in 27 and 5 countries, respectively. Remaining, 28 banks are foreign banks operating in India. The observation corresponding to i[th] bank operating in j[th] country is taken as a single observation. The final data set is an unbalanced panel of observations (a total of 244) on outputs and inputs. The descriptive statistics of the data for the period 2006-2007 to 2008-09 is presented in Table 1.

To select the relevant variables, we follow the asset approach proposed by Sealey and Lindley (1977) which views the institution as using labour, capital and deposits to produce earning assets. This approach is the most common in the conventional literature. In this approach, the bank accepts deposits from customers and transforms them into loans to clients. The inputs are labour, material and deposits, and output are loans and other income generating activities (banking services) (Mester, 1997). In the intermediation approach, banks perform two major

Table 1: Full period descriptive statistics of selected variables

(in thousands)

Descriptive Statistics	Fees and Commissions (FC) y_1	Loans and Advances (LO) y_2	Deposits (DE) x_1	Non-interest Expenses (NE) x_2
Mean	14,13,288	3,99,21,582	3,66,50,125	22,73,435
S.D.	42,31,090	8,97,15,610	96,49,41,86	66,88,144
Max	2,96,47,257	94,96,11,800	94,96,11,800	5,82,06,202
Min	76,829	26,03,781	36,51,768	1,73,749

roles of mobilising and distributing resources efficiently in order to smoothen investment activities in the economy. According to Colwell and Devis (1992) , the disadvantage of this approach is the absence of the trust operation that causes increases in the unit cost of large banks. Moreover, banking literature has found that different approaches to measuring output have generally led to similar conclusions concerning the cost structures of financial firms (Mester, 1993).

More specifically, we include two different outputs and two different inputs whose information were available in the survey. The outputs are total fee or commission (y_1) charged to the customers for financial auxiliaries services such as (i) deposit account management services, (ii) credit related services, (iii) financial leasing services, (iv) trade finance related services, (v) payment and money transmission services, (vi) fund management services, (vii) financial consultancy and advisory services, (viii) underwriting services, (ix) clearing and settlement services, and (x) derivative, stock, securities and foreign exchange trading services; total credit (y_2) which includes total loans and advances provided by the banks. The inputs are total deposits (x_1) which includes bank bonds and sight; saving and time deposits, and Non-interest expenses (x_2) *i.e.* total operating expenses. The information related to important variables such as fixed asset, borrowings, investment are not available in the survey, therefore these variables are not included. Although, the data on total number of employees available but since this information is already captured by the variable (x_2), as a part of "Payments to and provisions for employees" it has not been separately included in the study.

In the inefficiency model (12), various variables are included to explain the technical inefficiency of banks. First, the ownership-specific dummy variables d_{PUBt} and d_{PRVt} are included. The effect of each ownership-specific dummy variable indicates how the efficiency level of Indian public sector banks and Indian private sector banks operating outside India is changing in relation to the foreign banks operating in India. It should be noted that the same set of ownership-specific dummy variables is included in the distance function (10). In this case, the effect of each dummy variable indicates how the distance function of Indian public sector banks and Indian private sector banks operating outside India is shifting in relation to the distance function of foreign banks operating in India.

Second, the variable O_{ijt} indicates the trade openness of the economy. A negative (positive) coefficient of the variable signifies that inefficiency decreases (increases) with the trade openness.

Third, the variable n_{ijt} indicates the number of branches for the ith bank operating in jth country. The reasons for opening new branches by the banks are either for efficient utilisation of excess capacities or just for enlargement of the geographical coverage of the market. It should be stated, however, that banks facing entry (or threat of entry) by an out-of-market bank may have strategic motive to expand their branching network as a means of defending their market share. In this case, the setting up of new branches is not expected to have a favorable influence on the bank's efficiency. A positive (negative) coefficient of n_{ijt} indicates that inefficiency increases (decreases) with the expansion of branching network.

Fourth, country-specific dummy variable d_{DEVt} is included which takes value one if the bank is operating in developed country and zero if it is operating in developing countries. A positive (negative) coefficient of variable indicates that inefficiency increases (decreases) for the banks operating in developed countries.

Fifth, the variable c_{ijt} is the service concentration, which is the sum of the squared ratios of the value of each output to total value of outputs of the ith bank operating in jth country. Service concentration is used to measure a bank's degree of specialisation. Values of service concentration close to one indicate that a bank is specialized in a single product. A positive (negative) coefficient of this variable suggests that specialization increases (decreases) inefficiency. Sixth, the variable t is a linear time trend which indicates how efficiency changes with time. A positive (negative) coefficient of t shows that inefficiency increases (decreases) over time.

All variables have been mean-corrected prior to estimation. That is, each output and input variable has been divided by its geometric mean. In this way, the first-order coefficient can be interpreted as distance elasticities evaluated at the sample means. In addition, the linear homogeneity in outputs is imposed using the output (y_2) as a numeraire.

Section V

Empirical Results

Following Battese and Coelli (1995), maximum likelihood estimation is employed to simultaneously estimate the parameters of the stochastic translog output distance function (10) and the technical inefficiency effects model (12). The model parameters are estimated using the FRONTIER 4.1 program (Coelli, 1996). The estimation results for the translog distance function (10) and the technical inefficiency effects model (12) are presented in Table 2. The t-statistics presented in Table 2 provide an indication of the statistical significance of the corresponding coefficients. The t-statistics of the coefficients of the translog distance function indicate that 18 out of 26 estimated coefficients are significantly different from zero, which suggests that the model provides a fairly good fit to the explanatory variable.

All the first order parameter estimates are statistically significant and they have theoretically consistent signs, indicating that the distance function is increasing in outputs and decreasing in inputs at the sample mean.

Inclusion of the ownership-specific dummy variables, *i.e.*, d_{PUBt} and d_{PVTt} allows the estimated distance function of Indian public banks and Indian private banks operating outside India in relation to the distance function of the foreign banks operating in India. The estimated coefficient corresponding to dummy variable d_{PVTt} is statistically significant indicating that the intercept of estimated distance function corresponding to Indian private banks operating outside India is shifted by the ownership-specific factors *vis-a-vis* the arbitrarily foreign banks intercept. Furthermore, the estimated coefficient of the developed-countries dummy variable, *i.e.*, D_{DEVt} is statistically significant indicating that the distance function is shifting for the banks operating in developed countries in relation to the banks operating in developing countries.

The parameter estimates for the inefficiency model, *i.e.* the δs which are presented in Table 2, suggest a number of factors which may explain technical inefficiency. 7 out of 8 parameters are statistically significant at the five percent level, which suggests a fairly good fit of the inefficiency model. All the estimated coefficients of the ownership-specific dummy

Table 2: Maximum-likelihood estimates for parameters of the distance function (10) with the inefficiency effects model (12)

Variable	Parameter	Estimated values	Standard error	t-statistic
Stochastic distance function(10)				
Constant	α_0	0.0110	0.0298	0.3689
In *DE*	α_1	-0.2751	0.0889	-3.0952**
In *NE*	α_2	-0.3315	0.0927	-3.5767**
In (*FE/LO*)	β_1	0.2017	0.0879	2.2954**
(In *DE*)^2	α_{11}	-1.6502	0.3129	-5.2741**
(In *NE*)^2	α_{22}	-1.5409	0.3195	-4.8233**
(In(*FE/LO*))^2	β_{11}	1.0416	0.1619	6.4330**
(In *DE*)*(In *NE*)	α_{12}	1.4397	0.2809	5.1254**
(In *DE*)(In (*FE/LO*))	γ_{11}	0.1403	0.2752	0.5098
(In *NE*)(In (*FE/LO*))	γ_{21}	0.1143	0.2209	0.5174
t	φ_t	-0.0484	0.0285	-1.6982*
t^2	φ_{tt}	0.0212	0.0138	1.5298
t In *DE*	α_{t1}	-0.0844	0.0402	-2.1013**
t In *NE*	α_{t2}	0.0450	0.0396	1.1359
t In (*FE/LO*)	β_{t1}	0.0525	0.0369	1.4228
d_{PUR}	ξ_{PUR}	0.0121	0.0145	0.8355
d_{PRV}	ξ_{PRV}	-0.0504	0.0186	-2.7118**
d_{DEV}	ξ_{DEV}	-0.0343	0.0106	-3.2242**
Inefficiency model (12)				
Constant	δ_0	0.5226	0.1662	3.1447**
In *O*	δ_{10}	-0.0012	0.0240	-0.0517
In *n*	δ_{20}	-0.2308	0.0701	-3.2940**
t	δ_t	-0.0592	0.0284	-2.0858**
d_{PUR}	δ_{PUR}	-0.2488	0.0807	-3.0826**
d_{PRV}	δ_{PRV}	-0.2524	0.0991	-2.5467**
d_{DEV}	δ_{EEV}	-0.4228	0.1591	-2.6578**
c	δ_c	-0.4416	0.1546	-2.8566**
Variance parameters				
σ^2		0.0247	0.0073	3.4074**
γ		0.9497	0.0170	55.9242**
Log Likelihood		367.38		
Mean efficiency		0.9532		

** Significant at 5% level of significance. *Significant at 10 % level of significance.

variables, *i.e.*, d_{PUBt} and d_{PVTt} are statistically significant indicating that the efficiency level of Indian public banks and Indian private banks operating outside India is shifted relative to the efficiency of the foreign banks operating in India. The estimated coefficient corresponding to the variable representing openness of the economy is found to be negative but statistically insignificant indicating that openness of the economy has no role to play in the inefficiency of the banks. The estimated coefficient of the number of branches, *i.e.*, n_{ijt}, is negative and statistically significant indicating that inefficiency decreases with the expansion of branch network. Thus the expansion of new branch network by banks signifies efficient utilisation of excess capacity. The estimated coefficient of the countries-specific, *i.e.*, developed-countries dummy variable is negative and statistically significant implying that inefficiency decreases for the banks operating in developed countries. The estimated coefficient of the service concentration, *i.e.*, c_{ijt}, is negative and statistically significant indicating that inefficiency decreases with specialisation. This finding is consistent with that of Rezitis (2006) but contradicts Christopoulos *et al.* (2001) whose results indicate that output diversification increases bank efficiency. Finally, the coefficient on time (t) is negative and statistically significant showing that the inefficiency decreases with the time.

Table 3 presents the results of certain generalised likelihood ratio tests regarding the estimated parameters of the output distance function (10) and the inefficiency effects model (12). Test 1 examines the validity of the null hypothesis that there is not any technical change against the alternative of the presence of technical change. The null hypothesis is rejected by the likelihood ratio test at the five percent significance level and hence favors the presence of technical change. Test 2 verifies whether the null hypothesis that the Cobb–Douglas specification is an appropriate representation of the output distance function against the alternative translog functional form. The null hypothesis is rejected by the likelihood ratio test at the five percent significance level and hence favors the translog specification. Test 3 examines the null hypothesis that the variables included in the inefficiency effects model have no effect on the level of technical inefficiency, *i.e.* all the ä-parameters except the intercept term are zero. Again, the null hypothesis is rejected at the five

Table 3: Generalized likelihood ratio tests of hypotheses for parameters of the distance function (10) and inefficiency effects model (12)

Test	Null Hypothesis	λ^a	$\chi^2_{0.05}$	Decision
1.	$H_0: \varphi_t = \varphi_{tt} = \alpha_{t1} = \alpha_{t2} = \beta_{t1} = 0$ No technical change	11.16	$11.05(5)^b$	Reject H_0
2.	$H_0: \alpha_{11} = \alpha_{22} = \alpha_{12} = \beta_{11} = \gamma_{11} = \gamma_{21} = 0$ Cobb-Douglas	77.66	12.59(6)	Reject H_0
3.	$H_0: \delta_0 = \delta_{10} = ... = \delta_c = 0$ The inefficiency model is not appropriate	52.56	15.51(8)	Reject H_0
4.	$H_0: \gamma = \delta_0 = \delta_{10} = ... = \delta_c = 0$ Technical efficiency	81.78	$16.92^d(9)$	Reject H_0

^{a} λ is the generalized likelihood ratio test.
^{b} Numbers in parentheses represent degrees of freedom.
^{d} The critical value for the generalized likelihood ratio test involving $\gamma=0$ is obtained from Table 2 of the paper by Kodde and Palm (1986).

percent significance level indicating that the joint effect of the variables included in the inefficiency effect model is statistically significant. The final test examines the null hypothesis of whether the inefficiency model is appropriate. In other words, the null hypothesis examines if all the δ-parameters and the intercept term are zero. The null hypothesis is rejected indicating that at least one of the parameters of the inefficiency effects model is different from zero at the five percent significance level.

Technical efficiency estimates

Table 4, 5 and 6 summarises the results of the output distance function model. The estimated mean technical efficiency is found to 0.953 during the period of 2006-08 (Table 2). Table 4 shows the time varying mean efficiency values of Indian banks operating abroad and foreign banks operating in India. The results reveal that the Indian banks

Table 4: Time-varying mean efficiency values by bank groups

Year	Indian Banks Operating outside India			Foreign Banks Operating in India		
	Mean	S.D.	Number	Mean	S.D.	Number
2006-07	0.961	0.034	47	0.927	0.061	25
2007-08	0.965	0.029	53	0.922	0.092	27
2008-09	0.967	0.024	64	0.940	0.050	28
Average	0.965	0.029	164	0.930	0.070	80

Table 5: Time-varying mean efficiency values by bank groups

Year	Public Sector Banks Operating outside India			Private Sector Banks Operating outside India		
	Mean	S.D.	Number	Mean	S.D.	Number
2006-07	0.963	0.032	42	0.941	0.051	5
2007-08	0.964	0.030	46	0.969	0.022	7
2008-09	0.968	0.025	57	0.963	0.025	7
Average	0.965	0.028	145	0.959	0.033	19

operating abroad are on average (0.965) more efficient than foreign banks operating in India (0.930). The Mann Whitney U- test indicates that mean difference of efficiency between Indian banks operating abroad and foreign banks operating in India is statistically significant at the 1% level (p-value =0.000). Another feature of technical efficiency is noteworthy. Our model allows us to assess the variations in technical efficiency over time. The mean technical efficiency goes from 0.961 in 2006-07 to 0.967 in 2008-09 for Indian banks operating outside India while for foreign banks operating in India, it first decreases to 0.922 in 2007-08 and then increases to 0.940 in 2008-09. However, as revealed by the standard deviation, which is higher than that for the Indian banks operating outside India, the efficiency differences among the foreign banks operating in India are quite large in each year.

Table 5 shows the time varying mean efficiency values of Indian public sector banks and Indian private sector banks that are operating abroad. The results reveal that the efficiency level of public sector banks is on average (0.965) marginally higher than private sector banks operating abroad (0.959). However, the Mann Whitney U- test indicates that mean difference of efficiencies between public sector banks and private sector banks operating outside India is not statistically significant even at the 10% level (p-value = 0.3511). The technical efficiency of public sector banks increases from 0.963 in 2006-07 to 0.968 in 2008-09 while the technical efficiency of private sector banks first increases to 0.969 in 2007-08 than slightly decreases to 0.963 in 2008-09. Also, comparing Table 4 and Table 5, it is found that the both Indian public sector banks as well as Indian private sector banks operating abroad are more efficient than the foreign banks operating in India.

Table 6: Time-varying mean efficiency values by country-specific group.

Year	Banks Operating in Developed countries			Banks operating in developing countries		
	Mean	**S.D.**	**Number**	**Mean**	**S.D.**	**Number**
2006-07	0.969	0.018	31	0.934	0.057	41
2007-08	0.973	0.016	34	0.934	0.076	46
2008-09	0.974	0.018	39	0.947	0.042	53
Average	0.972	0.017	104	0.939	0.059	140

Table 6 shows the time varying mean efficiency values of banks operating in developed countries and in developing countries. The results reveal that the banks operating in developed countries are on average (0.972) more efficient than banks operating in developing countries (0.939). The Mann Whitney U- test indicates that mean differences of efficiencies between banks operating in developed countries and in developing countries are statistically significant at the 1% level (p-value = 0.000).

The technical efficiency of banks operating in developed countries increases from 0.969 in 2006-07 to 0.972 in 2008-09 while the technical efficiency of banks operating in developing countries remains same at 0.934 in 2006-07 and 2007-08 and then increases to 0.939 in 2008-09. Since India itself is a developing country, therefore, it may be a reason of having small efficiency of foreign banks operating in India in comparison to Indian banks operating outside India.

Section VI
Concluding Remarks

In this paper, the technical efficiency of Indian banks operating outside India was compared with foreign banks operating in India using an output distance function approach. The distance function has the advantage that it does not require information about prices, avoiding the possible market power problem. The main finding of the study is that the Indian banks operating abroad are more efficient than the foreign banks operating in India and banks operating in the developed countries are more efficient than those in developing countries. The openness of

the economy has no effect on the technical efficiency of the banks. It is also found that there is no statistical difference between the technical efficiency of Indian private banks and Indian public sector banks operating outside India. As the Indian banks are working efficiently abroad, it strengthens the case for easing the policy /giving incentives to the Indian banks to open their branches abroad. It will help to generate the foreign exchange receipts and also helpful for the Indian exporters/ importers to get the financial services through the Indian bank branches abroad in an effective manner.

This paper is based on the information collected through annual surveys on International Trade in Banking services conducted by Reserve Bank of India from 2006-2009. This paper is limited to include some of the important variables like capital, investments, borrowings and total fixed asset of the banks in the distance function since the information were neither collected under the ITBS survey nor published anywhere. The present paper can be improved further if the data on the above cited variables are available.

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