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ABSTRACT

Assessments of the performance of Indian commercial banks are not new in the literature. However, most of the earlier studies consider relatively partial measures such as technical efficiency of the banks in assessing their performance. We have considered overall (Malmquist) total factor productivity improvement achieved by 68 Indian commercial banks from 1998-99 to 2006-07, the true liberalised era in some senses, and decomposed it into the three of its economically meaningful components, namely technical change, technical efficiency change and scale (efficiency) change factor using Data Envelopment Analysis (DEA) methodology. Our results suggest that public-sector banks are, on an average, adjusting themselves to the changing environment better and improving their performance relative to their counterparts under private and foreign ownership. The latter were widely believed to do better under the new regime because of their relatively more flexible operating systems as well as better market orientation. This finding clearly has important policy implications in determining the government's attitude towards overall market-orientation of the Indian banking sector. To be specific, the government should more cautiously approach liberalising the banking sector and should not blindly invite more foreign players to it. The lesson becomes particularly more relevant at a time when we are witnessing a severe global crisis which, although began with the bursting of the US housing market bubble, gathered momentum from a series of bankruptcies of the so-called "too big to fail" banks with Lehman Brothers in the lead.

JEL Classification: C43, D24, G28

Key Words: Total Factor Productivity; Technical Change; Technical Efficiency Change; Scale (Efficiency) Change Factor; Data Envelopment Analysis; Liberalisation

1. Introduction

A recognition of the need of an efficient financial sector to promote overall economic development can be traced all the way back to the early 20th century when Joseph Schumpeter (1911) argued in his *Theory of Economic Development* that scarcity of finance is a serious obstacle to development. Cross-country experience also suggests that the existence of a healthy, efficient and competitive financial sector, which Joseph Stiglitz (1998) termed the "brain" of the economy, is a necessary pre-condition for rapid economic development. This necessity is more pronounced in the case of backward or so-called developing economies because the opportunity cost of capital is more in them, coupled with underdeveloped financial markets (Smith, 1998). Further, inefficiency in financial intermediation carries with it the possibility of misallocation of funds, which could result in more non-performing assets (Barman, 2007).

Financial intermediaries such as banks are major players in any financial market, and their overall performance is therefore an important determinant of the performance of the financial sector concerned, in particular, and that of the overall economy, in general. Over time, the banking systems in many developing economies performed poorly, and researchers diagnosed it as a direct consequence of the excessive regulations that were in place. However, the experience with deregulation in the banking sector has been mixed in nature.

Empirical studies in the US show that measured cost productivity actually decreased following deregulation (Bauer, Berger and Humphrey, 1993; Humphrey and Pulley, 1997; Berger and Mester, 2001). On the other hand, a study by Chaffai (1997) analysed the deregulation experience in Tunisia and found that total factor productivity (TFP) of banks increased following a liberalisation programme initiated in 1986. However, the rate of technical progress was higher than the rate of productivity growth, implying that the banks, on an average, became less efficient after liberalisation.[1] Thus the issue of whether financial deregulation actually helps overall development or sometimes can be so counterproductive as to hinder the process of development may be an interesting subject of debate. The issue becomes more relevant in view of the on-going global economic crisis, which originated in the US mortgage lending market and soon spread to others. As noted by analysts, uncontrolled financial innovations introduced by investment agencies and other banks, as well as by some other financial institutions, was one of the major causes of the crisis. The objective of the present paper is to study the overall performance of major Indian commercial banks in the post-financial deregulation period through a thorough analysis of their TFP growth and its major components.

It is useful to briefly recall here the nature of the Indian banking system at the time financial sector reforms were initiated in the early 1990s. This would facilitate a greater clarity of the rationale and basis of reforms. The Indian financial system in the pre-reform period essentially catered for the needs of planned development in a mixed economy where the government sector played a dominant role in economic activity. The strategy of planned economic development required huge development expenditure, which was met thorough the government ownership of major banks, an automatic monetisation of the fiscal deficit

1 See Casu and Molyneux (2003) for an extensive survey of the relevant literature on performance of banks.

and by subjecting the banking sector to large pre-emptions—both in terms of the statutory holding of government securities (statutory liquidity ratio, or SLR) and the administrative direction of credit to preferred sectors. Further, a complex structure of administered interest rates prevailed, guided more by social priorities, necessitating cross-subsidisation to sustain the commercial viability of institutions. These not only distorted the interest rate mechanism but also adversely affected development of the financial market (Rangarajan, 2007).

Contrary to this, financial reforms in India created an enabling environment for banks to overcome external constraints and operate with greater flexibility. Such measures related to dismantling the administered structure of interest rates, and the removal of several pre-emptions to do with reserve requirements and credit allocation to certain sectors. Interest rate deregulation was carried out in stages, allowing sufficient resilience to build up in the system. This was an important component of the reform process, which has made resource allocation more efficient. A parallel strengthening of prudential regulation, improved market behaviour, gradual financial opening and, above all, underlying improvements in macroeconomic management helped the liberalisation process run smooth. Interest rates have now been largely deregulated, except for certain specific classes such as savings deposit accounts, non-resident Indian (NRI) deposits, small loans up to Rs. 2 lakh, export credit, and the like. Other major objectives of banking sector reforms were enhancing efficiency and productivity through increased competition and, for that, modifying the overall legal environment for conducting banking business in India. Establishment of new banks was allowed in the private sector and foreign banks were also permitted more liberal entry. Yet another step towards enhancing competition was allowing foreign direct investment in private-sector banks up to 74% from all sources. As for the modification of the legal environment, the Securitisation Act was enacted in 2002 to enhance protection of creditor rights. To combat the abuse of the financial system

for crime-related activities, the Prevention of Money Laundering Act was also enacted in 2002 to provide the enabling legal framework. The Negotiable Instruments (Amendments and Miscellaneous Provisions) Act 2002 expanded the erstwhile definition of “cheque” by introducing the concept of “electronic money” and “cheque truncation”. The Credit Information Companies (Regulation) Act 2005 is expected to enhance the quality of credit decisions and facilitate faster credit delivery.

However, as pointed out by Barman (2007), two distinct phases are discernable in the reform of the Indian banking system. The first phase, 1992-98, can be thought of as a period of transition from a regulated regime to one in which there was a gradual adaptation of international standards. The second phase, the post-1998 period, can be considered the “true” post-liberalisation period. In this regime, banks were able to enjoy almost full freedom in pricing their products. In sharp contrast to the earlier phase, this regime was perceived as more accommodative towards competition. Further, the entry of new private banks and some foreign banks to the industry made a significant change in the structure of the Indian banking sector. For one, there has been increasing competition among banks (as reflected in their share of expenditure on advertising and publicity as a proportion of total operating cost), and the share of publicly owned banks, though still the largest among the major bank groups, has been gradually diminishing over time (Table 1). These changes necessarily make the individual players more market-oriented and call for them to improve their performance. Our concern in this paper is whether such anticipation holds good for the Indian banking industry in the ‘‘true’’ post-liberalisation period. For that, we have examined TFP changes that have taken place in the last year we have considered, 2006-07, over the year 1998-99. We also decompose such TFP changes into its major components such as technological change, change in technical efficiency of banks and so on to identify the principal driving force(s) of TFP changes in Indian banking over this period.

Table 1: Some Important Indicators of the Major Indian Commercial Bank Groups

Important Indicators	Year	SBI and its Associates	Nationalised Banks	Other Scheduled Commercial Banks	Foreign Banks
Share in Total Deposits	1999	30.3	58.0	7.2	4.6
	2000	30.1	57.0	8.6	4.3
	2001	31.2	55.0	9.4	4.5
	2002	30.5	54.1	11.1	4.4
	2003	29.8	52.9	12.4	4.9
	2004	28.4	52.8	13.9	4.9
	2005	28.3	52.1	15.1	4.6
	2006	25.8	51.3	17.7	5.1
	2007	24.1	51.8	18.6	5.5
Share in Total Assets	1999	32.1	54.8	7.0	6.0
	2000	32.2	53.5	8.4	5.9
	2001	32.9	51.6	9.1	6.4
	2002	30.6	48.5	14.8	6.1
	2003	30.1	48.7	14.8	6.5
	2004	28.8	49.0	15.6	6.6
	2005	27.4	50.1	16.2	6.3
	2006	25.6	48.9	18.6	6.9
	2007	24.0	48.6	19.7	7.7
Expenditure on Advertisement/ Publicity as Percentage of Operating Expenditure	1999	0.3	0.4	1.5	6.0
	2000	0.3	0.4	1.6	5.8
	2001	0.3	0.3	2.9	7.0
	2002	0.3	0.4	1.9	5.1
	2003	0.4	0.5	2.4	4.5
	2004	0.7	0.8	2.6	5.6
	2005	0.6	0.9	3.1	6.6
	2006	0.8	1.0	3.1	10.9
	2007	0.7	1.2	2.8	9.5

Source: Reserve Bank of India.

In this connection, we briefly review some of the important recent work on the performance of the Indian banking sector. Using data envelopment analysis (DEA) to analyse data on 70 Indian commercial banks from 1986 to 1991, Bhattacharyya et al (1997) found that publicly owned Indian banks are the most efficient among all ownership categories considered in the study, followed by foreign-owned banks and Indian private banks respectively. However, they also found something odd (and almost diametrically opposite) when the inter-temporal behaviour of such performance was considered. Evidence of temporal improvement was seen in the performance of foreign-owned banks, virtually no such trend in that of Indian private banks and a temporal decline in that of the publicly owned banks. They explained these patterns in terms of the government's evolving regulatory policies. A study by Sarkar et al (1998) (with the motive of evaluating enterprise performance under different ownership patterns) confirmed that in the absence of a well-functioning capital market, there might not be any significant difference in the performance of public- and private-sector banks. Their analysis highlighted the importance of creating an appropriate institutional background before pushing privatisation in developing economies. Kumbhakar and Sarkar (2003) analysed the relationship between deregulation and TFP growth in the Indian banking industry using a generalised shadow cost function approach. Analysing disaggregated panel data on a population of public and private banks from 1985 to 1996, they found evidence in favour of a significant decline in regulatory distortions and also non-materialisation of anticipated TFP growth until 1996. Using DEA, Sathye (2003) measured the productive efficiency of banks in India for the year 1997-98. The efficiency scores, for three groups of banks—publicly owned, privately owned and foreign—were measured. The study showed that the mean efficiency score of Indian banks compared well with the world mean efficiency score and the efficiency of private-sector commercial banks as a group was paradoxically lower than that of public-sector banks and foreign banks in India. The study also recommended that the existing policy of reducing non-performing assets and rationalisation of staff

and branches might be continued to obtain efficiency gains and make Indian banks internationally more competitive. Chakrabarti and Chawla (2005) used DEA to evaluate the relative efficiency of Indian banks during 1990-2002 and observed that on a "value" basis, foreign banks as a group had been considerably more efficient than all other bank groups, followed by Indian private banks. However, from a "quantity" perspective, the Indian private banks seemed to be doing very well while the foreign banks were the worst off. This, as it can be easily understood, might be a reflection of the general policy of foreign banks to "cherry-pick" more profitable businesses, ignoring the social obligation of offering banking services to a wider section of society. Further, public-sector banks were seen to be lagging behind their private counterparts in performance. Das and Ghosh (2006) investigated the performance of the Indian commercial banking sector during the post-reform period 1992-2002. Using DEA, they applied all the three different approaches—intermediation approach, value-added approach and operating approach—to differentiate how efficiency scores varied with changes in inputs and outputs. The analysis also linked the variation in calculated efficiencies to a set of variables such as bank size, ownership, capital adequacy ratio, non-performing loans, management quality, and so on. Their findings suggested that medium-sized public-sector banks performed reasonably well and were more likely to operate at higher levels of technical efficiency. A close relationship was observed between efficiency and soundness as determined by a bank's capital adequacy ratio. Their empirical results also showed some evidence in favour of the expected relationship that technically more efficient banks were those that had, on an average, less non-performing loans. To evaluate the impact of computerisation[2] on the productivity and profitability of

2 Indian banks are now investing heavily in computerised technologies such as tele-banking, mobile banking, net banking, automated teller machines (ATMs), credit cards, debit cards, smart cards, call centres, customer relationship management (CRM), data warehousing and the like. All these facilities, which are new innovations in banking technologies, help the Indian banking system improve its service quality, particularly by lowering the time cost associated with each transaction, to a huge extent.

Indian banks, Mittal and Dhingra (2007) applied DEA methodology to Centre for Monitoring Indian Economy (CMIE) data on 27 selected Indian commercial banks over the years 2003-04 and 2004-05. They observed that private-sector banks, which took more information technology (IT) initiatives, were more efficient in terms of the productivity and profitability parameters than their counterparts under public ownership. Das, Ray and Nag (2009)[3] used DEA to measure the labour-use efficiency of individual branches of a public-sector bank with a large network of branches across India. They found considerable variation in the average levels of efficiency of bank branches across the four metropolitan regions considered in the study. They also introduced the concept of area or "spatial efficiency" for each region relative to the nation as a whole. The results suggested that the policies, procedures, and incentives handed down from the corporate level could not fully neutralise the detrimental influence of local work culture across different regions. Most of the potential reduction in labour cost appeared to be coming from possible downsizing of the clerical and subordinate staff.

We thus see that the issues raised earlier are yet to be explored to a great extent and that is precisely the objective of this paper. The paper is organised as follows. Section 2 briefly states the analytical methodology we consider here. Section 3 describes the data set we have used and our major findings from analysing it, and Section 4 concludes.

2. Analytical Methodology

The productivity of a firm is measured by the quantity of output produced by it per unit of input. In the simplest single-input–single-output case, it is merely the ratio of the quantity of the firm's output to its input. But in a more general case where a number of inputs are used

3 However, this study is to some extent different to the others mentioned above in the sense that the others deal with different Indian commercial banks while this one deals with different branches of a single public-sector bank.

to produce a number of outputs, outputs (in the numerator) as also inputs (in the denominator) are to be meaningfully aggregated so that the productivity still remains the ratio of two scalar values. The productivity index of a firm for a current period relative to a base period measures the relative change in its productivity in the latter period relative to the earlier. Such a productivity index may be of two types—positive and normative. Positive measures are those measurements where one need not know the production technology. The Fisher productivity index and the Tornqvist productivity index are two such popular positive measures discussed in the literature. On the other hand, measurement of the Malmquist productivity index, a normative measure, requires knowledge about the benchmark production technology. Since our objective in this paper is to measure the productivity change of Indian commercial banks over the last eight years and decompose such change into economically meaningful components such as technical change, technical efficiency change and the scale (efficiency) change factor to get the relative importance of these factors causing changes in TFP, we consider the Malmquist productivity index here.[4]

Malmquist Productivity Index and its Decomposition

As we have already mentioned, the Malmquist productivity index is a normative measure; an associated benchmark technology has to be taken into account to measure it. Since production technology itself may change over time, either of the technology of the base period and the current period may be used as the benchmark. To be specific, let us assume that (x_0, y_0) and (x_1, y_1) are the input-output combinations of a firm in the periods 0 and 1 respectively. Then change in the Malmquist TFP index from period 0 to period 1 can be written as

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4 Interested readers may look up Ray (2004, Chapter 11) for a detailed discussion on popular productivity indices of both the positive and normative kind.

$$\Pi_i \quad \frac{\frac{y_1}{x_1}}{\frac{y_0}{x_0}} \quad \frac{\frac{y_1}{f^i(x_1)} \cdot \frac{f^i(x_1)}{R^i(x_1)} \cdot \frac{R^i(x_1)}{x_1}}{\frac{y_0}{f^i(x_0)} \cdot \frac{f^i(x_0)}{R^i(x_0)} \cdot \frac{R^i(x_0)}{x_0}} \qquad i = 0,1$$

where $f^i(\bullet)$ and $R^i(\bullet)$ are the production frontiers of the i^{th} period, assuming that the production technology exhibits variable returns to scale (VRS) and constant returns to scale (CRS) respectively, and the two concerned production possibility set be denoted by T and T^C respectively.[5] Therefore, Π_0 and Π_1 may be different if the production technology itself changes from period 0 to period 1. To get rid of such complexity, the conventional way is to measure the index once considering the base period technology as the benchmark and once again considering the technology of the current period, and then take the geometric average of these two measures to obtain the overall change in the Malmquist TFP index. Thus the overall measure of changes of the Malmquist TPF index can be written as follows:

$$\Pi = [\Pi_0 \times \Pi_1]^{1/2}$$

Let us discuss first the concepts of technical efficiency (TE) and scale efficiency of a production unit with the help of the diagram below. Let ATBC (in Figure 1) be the production frontier (exhibiting VRS technology with other usual desirable properties). An (output-oriented) measure of TE of firm F, as defined to be the ratio of actually produced amount of output to the frontier level of output for the given level of input used by this firm, is given by $\frac{FX_1}{BX_1} = \frac{FX_1/OX_1}{BX_1/OX_1}$ which is equal

5 Clearly $f(\bullet)$ and R $(\bullet)$ are the north-western boundary of T and T^C respectively.

to the ratio of productivity, as defined to be the amount of output per unit of input used, at the point F to that at the point B. Note that TE is identical (and equal to unity) at all points on the frontier, but productivity is not. It is easy to see that productivity is the highest at the point T among all feasible points (that is, those that lie within the production possibility set). Hence, OX^* is the size relating to the concept of technically optimal production scale (TOPS) (*a la* Frisch, 1965), and the widely known, most productive scale size (MPSS) (*a la* Banker, 1984) in the diagram. Output-oriented scale efficiency of a firm is defined to be the ratio of productivity at its (output-oriented) projection on to the frontier to that at the MPSS. Similarly, input-oriented measure of scale efficiency of a firm is the ratio of productivity at its (input-oriented) projection on to the frontier to that at the MPSS. In other words, scale efficiency is a measure of the relative productivity of a firm with respect to productivity at the MPSS, if the firm becomes able to eliminate its technical inefficiency in production and, therefore, naturally it lies between 0 and 1.[6] So, scale efficiency of any firm lies on the vertical line BX_1 is, $\frac{BX_1/OX_1}{TX^*/OX^*}$ which is the ratio of productivity at point B to that at point T, and (the input-oriented) scale efficiency of any firm that lies on the horizontal line B_1F is the ratio of productivity at the point B_1 to that at point T. But, productivity at point T is equivalent to that of the hypothetical firms at point D and D_1. Although, these points are not feasible under the VRS technology, they are on the graph of the CRS technology. Thus, $\frac{BX_1/OX_1}{TX^*/OX^*} = \frac{BX_1/OX_1}{DX_1/OX_1} = \frac{BX_1}{DX_1} = \frac{FX_1/DX_1}{FX_1/BX_1}$

6 Note that scale efficiency does not state anything about the actual scale of production relative to the MPSS, in the sense that one cannot say whether the firm is actually practising more or less than the MPSS by simply observing its scale efficiency score.

and similarly we can show that the ratio of productivity at B_1 to that at D_1 is equal to the ratio $\frac{Y_1D_1/Y_1F}{Y_1B_1/Y_1F}$. So, scale efficiency of a firm is the ratio of its TE under the CRS technology to that under the VRS technology, irrespective of the *orientation* of the measurement of technical efficiency.

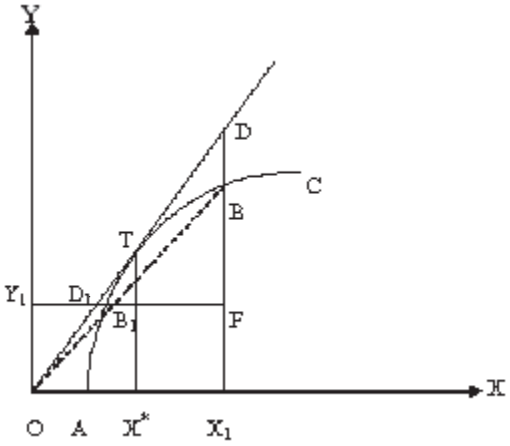

Figure 1

Let us now define the concept of output-oriented distance function (*a la* Shephard, 1953) here. The (output-oriented) distance function evaluated at any input-output pair (x, y) is given by $D_{V(\text{or } C)}(x,y) = \min \delta : \left(x, \frac{y}{\delta}\right) \in T\left(\text{or } T^C\right)$ if production technology is assumed to exhibit VRS (or CRS). So, it can be easily understood that the (output-oriented) TE and the (output-oriented) distance function are the same. However, using distance functions, Π can be shown, *a la* Ray and Desli (1997), to be the product of three economically meaningful components: technical change (TC), technical efficiency change (TEC) and scale (efficiency) change factor (SCF) and these components can be shown as follows:

$$TC=\left[\frac{f^1(x_0)}{f^0(x_0)}\times\frac{f^1(x_1)}{f^0(x_1)}\right]^{1/2}=\left[\frac{D_V^0(x_0,y_0)}{D_V^1(x_0,y_0)}\times\frac{D_V^0(x_1,y_1)}{D_V^1(x_1,y_1)}\right]^{1/2},$$

$$TEC=\left[\frac{y_1/f^1(x_1)}{y_0/f^0(x_0)}\right]=\left[\frac{D_V^1(x_1,y_1)}{D_V^0(x_0,y_0)}\right] \quad \text{and}$$

$$SCF=\left[\frac{f^1(x_1)/R^1(x_1)}{f^1(x_0)/R^1(x_0)}\times\frac{f^0(x_1)/R^0(x_1)}{f^0(x_0)/R^0(x_0)}\right]^{1/2}=\left[\frac{\dfrac{D_C^1(x_1,y_1)}{D_V^1(x_1,y_1)}}{\dfrac{D_C^1(x_0,y_0)}{D_V^1(x_0,y_0)}}\times\frac{\dfrac{D_C^0(x_1,y_1)}{D_V^0(x_1,y_1)}}{\dfrac{D_C^0(x_0,y_0)}{D_V^0(x_0,y_0)}}\right]^{1/2}$$

where superscript and subscript of D are used to indicate, respectively, the period of technology considered as the benchmark and assumed returns to scale specification for the technology respectively.[7] Before Ray-Desli, Färe et. al. (1992) introduced a decomposition of the Malmquist TFP index assuming that the true production technology exhibits CRS. According to their decomposition, Π can be shown to be the product of two different components: a measure of technical change, $\left[\frac{R^1(x_0)}{R^0(x_0)}\times\frac{R^1(x_1)}{R^0(x_1)}\right]^{1/2}$ which is the (un-weighted) geometric mean of the shift in the true (CRS) production function at input levels x_0 and x_1, and technical efficiency change $\frac{y_1/R^1(x_1)}{y_0/R^0(x_0)}$,– again using the true (CRS) production function as the benchmark. Note that, if the production technology truly exhibits CRS, the last component, that is, SCF of Ray-Desli decomposition disappears whereas the other two

7 V for VRS and C for CRS.

components exactly match these two components of Färe et al (1992). Since globally CRS is a restrictive assumption about the underlying technology, when CRS does not hold everywhere, Färe et al (1992) decomposition is not particularly meaningful. In an effort to accommodate VRS, Färe et al (1994) proposed the extended decomposition according to which the Malmquist TFP index can be written as a product of three different components: a measure of technical change , $\left[\frac{R^1(x_0)}{R^0(x_0)} \times \frac{R^1(x_1)}{R^0(x_1)}\right]^{1/2}$; a measure of technical efficiency change, $\left[\frac{y_1 / f^1(x_1)}{y_0 / f^0(x_0)}\right]$; and a measure of scale efficiency change, $\left[\frac{f^1(x_1)/R^1(x_1)}{f^0(x_0)/R^0(x_0)}\right]$.

But Ray and Desli (1997) rightly argued that the first component of Färe et al (1994) is not an appropriate measure of technical change when production technology does not follow CRS globally.

However, one particular disadvantage of the Ray-Desli decomposition is that at most two (namely, the first and the third ones) of their three decomposed components may not be obtained for some observations if the quantity of any individual input of an observation in the base (current) period is smaller than the smallest quantity of the corresponding input across all firms in the current (base) period. However, we follow only the Ray-Desli measure[8] in our study.

From the description of the distance function provided earlier, it is easy to see that the (Shepherd) distance function is identical to Farrell's (1957) measure of (output-oriented) technical efficiency and can, therefore, be obtained straightway by solving the various DEA linear

8 Simar and Wilson (1998) decomposed the Malmquist TFP index further and provide more economically meaningful interpretation of both of the technical change and the scale change factor of the Färe et al (1994) and Ray-Desli (1997) measures. Interested readers may look up the paper for this decomposition. However, we do not consider their decomposition in the present study.

programming (LP) problems for alternative technological specifications. For instance, the "same-period" VRS distance function for the k^{th} production unit can be shown to be $D_V^t(x_t, y_t) = 1/\varphi_k^*$ where $\varphi_k^* = \max \varphi$ such that the four constraints: (i) $\sum_{i=1}^{N} y_i^t \lambda_i^t \geq \varphi y_k^t$, (ii) $\sum_{i=1}^{N} x_i^t \lambda_i^t \leq x_k^t$, (iii) $\sum_{i=1}^{N} \lambda_i^t = 1$ and (iv) $\lambda_i^t \geq 0$ for all *i*, are satisfied. Similarly the "cross-period" VRS distance function for the k^{th} production unit can be shown to be $D_V^s(x_t, y_t) = 1/\varphi_k^{**}$ where $\varphi_k^{**} = \max \varphi$ such that the four constraints: (i) $\sum_{i=1}^{N} y_i^s \lambda_i^s \geq \varphi y_k^t$, (ii) $\sum_{i=1}^{N} x_i^s \lambda_i^s \leq x_k^t$, (iii) $\sum_{i=1}^{N} \lambda_i^s = 1$ and (iv) $\lambda_i^s \geq 0$ for all *i*, are satisfied. We have to solve these two LP problems without the constraint (iii) to get the CRS distance functions for same-period and cross-period respectively.[9] In the above LP problems, any one of *s* and *t* can be used as an indicator of the base period and the other as an indicator of the current period.

3. Data Used and Empirical Findings

A major problem one has to face in empirical banking research is defining the "inputs" and "outputs" of banks. Due to its ambiguous nature of use, an asset/liability may either be considered as an output of a bank or as its input used to produce some other output. For instance, if we view banks as service providers to their customers, as the production approach does,[10] deposits of banks should be taken as an output. On the other hand, it should be included in the set of inputs if we consider a bank to be an intermediating entity between savers and investors whose

9 Interested readers may look up Ray (2004, Ch. 2, 3) for an explicit discussion on the formation of the respective production possibility set for alternative technological specifications and how the associated LP problems are structured from that.

10 Which we shall discuss later in detail.

goal is to earn profit through lending and investing resources collected from customers in the form of deposits. In view of such complexity, four approaches have come to dominate the literature on banking output—the production approach, the intermediation approach, the operating (income-based) approach and, more recently, the modern approach.[11] We use a variant of the intermediation approach (subject to our data availability constraint) where deposits and borrowings and other liabilities, together with real resources such as labour, are defined as inputs whereas the output set includes earning assets such as loans and investments (Model I, hereafter).[12] We also use the production approach (Model II, hereafter) to see whether the basic results to the performance-related issues considered in the present study change drastically or not due to merely changes in the approach to defining the inputs and outputs of banks.

We use individual bank-level (yearly) data for 68 major Indian commercial banks for the years 1999[13] and 2007. The data is taken from the Reserve Bank of India (RBI) website. On a totality, we have data on eight State Banks of India (SBI) and its associates and 20 banks each from the other publicly owned, privately owned and foreign-owned categories. The input and output variables we have used in our analysis are discussed below.

Model I

As we have already mentioned, number of employees, total deposits and sum of borrowing and other liabilities are considered as three inputs whereas investments and advances are considered as two outputs.

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11 Interested readers may look up Berger et. al. (1992), Frexias et. al. (1997), Mohan (2006), for detailed discussions on these approaches.

12 This is also known as the "asset approach".

13 The year 1999 refers to the financial year beginning in April 1998 and ending in March 1999. Similarly, the year 2007 refers to the financial year April 2006 – March 2007. We adopt this convention throughout the paper.

Model II

As per the production approach, the total number of deposits created by a bank is considered its output. Since we have no information about these numbers for all the three types of deposits a bank creates (viz., demand deposits, saving deposits and term deposits), we have taken their values and consider two different outputs—demand deposits and ST deposits (which is the sum of savings deposits and term deposits). Here we have considered the total number of employees, amount of fixed assets and operating expenses *less* payments to and provision for employees (as a proxy of materials used by the bank) as three inputs.

We have adjusted the nominal figures of the variables mentioned above by discounting/adjusting them using suitable interest rate/price indicators. For instance, 2007 values of the variables investments and advances are discounted by the average value of the SBI lending rate; deposits are discounted by the average value of the deposit rate; and borrowing and other liabilities are discounted by the average value of the bank rate over the eight-year period (2000-2007). Similarly, variables used in Model II are also adjusted by the average values of the proper variables over this period. For instance, demand deposits and ST deposits are discounted by the short-term (one to three years) and long-term (more than three years) deposit rates respectively, fixed assets are adjusted by the wholesale price index (WPI) of the machinery and equipment group and the proxy variable for material used is adjusted by the WPI of manufactured products.

Empirical Findings

We have used the econometric/statistical package SHAZAM to solve the various DEA LP problems to determine the individual bank-wise scores on TFP change and its components. The results we have obtained are given in Table 2. As discussed earlier, one of the objectives of using two alternative models in the present study is to see whether the basic results regarding the performance-related issues of Indian

Table 2: TFP Change and Its Components of Indian Banks between 1999 and 2007

Name of Bank	Model I				Model II			
	TC	TEC	SCF	TFP	TC	TEC	SCF	TFP
State Bank of India	1.18	1.00	0.89	1.05	1.34	1.00	0.81	1.08
State Bank of Bikaner & Jaipur	0.90	1.07	1.08	1.04	1.06	1.21	0.80	1.02
State Bank of Hyderabad	0.97	0.95	1.04	0.96	1.17	0.95	0.74	0.82
State Bank of Indore	0.96	1.03	1.09	1.07	1.11	1.34	0.75	1.12
State Bank of Mysore	0.94	1.07	1.03	1.04	1.14	0.76	0.77	0.67
State Bank of Patiala	1.10	1.03	0.97	1.10	1.04	1.00	0.78	0.82
State Bank of Saurashtra	0.92	1.04	1.11	1.06	0.93	0.97	0.91	0.83
State Bank of Travancore	0.92	1.08	1.07	1.07	1.11	0.88	0.81	0.79
Average of State Bank Group	**0.98**	**1.03**	**1.03**	**1.05**	**1.11**	**1.00**	**0.79**	**0.88**
Allahabad Bank	0.97	1.04	1.19	1.19	1.24	1.14	0.79	1.12
Andhra Bank	0.86	1.03	1.16	1.03	1.15	0.96	0.73	0.81
Bank of Baroda	1.24	1.00	1.05	1.30	1.35	1.00	0.70	0.95
Bank of India	1.29	0.98	0.88	1.11	1.23	1.00	0.68	0.83
Bank of Maharashtra	0.80	1.00	1.12	0.90	1.08	0.84	0.76	0.70
Canara Bank	1.13	1.00	1.04	1.16	1.29	1.00	0.77	1.00
Central Bank of India	0.79	1.00	1.08	0.85	1.05	1.16	0.93	1.13

cont'd....

Corporation Bank	1.06	0.98	0.98	1.02	1.37	1.00	0.62	0.84
Dena Bank	0.95	0.98	1.14	1.07	1.17	0.91	0.83	0.88
IDBI Bank/Ltd.	1.25	1.00	0.47	0.59	1.25	1.00	0.58	0.73
Indian Bank	0.82	1.07	1.00	0.87	1.13	0.92	0.81	0.84
Indian Overseas Bank	1.09	1.02	0.95	1.05	1.18	1.01	0.79	0.94
Oriental Bank of Commerce	0.89	1.00	1.25	1.12	1.47	1.00	0.66	0.97
Punjab & Sind Bank	0.77	1.04	1.17	0.94	1.05	0.84	0.94	0.83
Punjab National Bank	0.99	1.00	1.05	1.04	1.17	1.00	0.79	0.93
Syndicate Bank	1.04	0.97	1.07	1.08	1.28	1.03	0.79	1.05
UCO Bank	0.95	1.02	1.01	0.99	1.07	1.07	0.88	1.01
Union Bank of India	0.91	1.00	1.06	0.96	1.33	1.05	0.78	1.09
United Bank of India	0.59	1.00	1.13	0.67	0.86	0.97	0.90	0.75
Vijaya Bank	0.94	1.05	1.15	1.13	1.15	1.17	0.78	1.05
Average of Other Nationalised Banks	**0.95**	**1.01**	**1.03**	**0.99**	**1.19**	**1.00**	**0.77**	**0.91**
UTI/Axis Bank	1.09	1.00	0.61	0.66	1.48	1.00	0.56	0.83
Bank of Rajasthan	0.88	1.04	1.10	1.00	1.00	1.17	0.88	1.03
Catholic Syrian Bank	0.86	1.01	1.12	0.97	0.99	0.90	0.96	0.85
City Union Bank	0.96	0.98	1.19	1.12	1.10	0.92	0.87	0.88

cont'd....

Development Credit Bank	0.82	0.93	1.04	0.80	1.26	0.71	0.68	0.61
Dhanalakshmi Bank	0.96	0.84	1.18	0.95	1.07	0.54	0.86	0.50
Federal Bank	1.03	0.97	1.07	1.07	1.17	1.07	0.86	1.07
HDFC Bank	1.10	1.00	0.62	0.68	1.77	1.00	0.37	0.66
ICICI Bank	1.35	1.00	0.37	0.50	1.67	1.00	0.28	0.46
IndusInd Bank	0.65	1.00	0.83	0.54	0.91	1.00	0.63	0.57
Jammu & Kashmir Bank	0.98	1.07	1.34	1.40	1.07	1.00	0.82	0.87
Karur Vysya Bank	0.98	1.07	1.21	1.27	1.21	0.90	0.84	0.92
Lakshmi Vilas Bank	0.98	0.98	1.17	1.12	1.20	1.25	0.89	1.35
Lord Krishna Bank	0.84	1.03	0.95	0.82	1.16	0.67	0.87	0.68
Nainital Bank	0.72	0.74	1.36	0.72	0.81	1.00	1.17	0.95
Ratnakar Bank	0.85	0.97	1.07	0.88	0.80	1.08	1.15	1.00
Sangli Bank	0.55	0.96	1.19	0.62	0.82	0.42	1.01	0.35
SBI Comm. & Intern. Bank	0.71	0.91	1.03	0.67	0.79	1.16	0.86	0.79
South Indian Bank	1.01	0.98	1.27	1.26	1.12	0.97	0.87	0.94
Tamilnad Mercantile Bank	0.92	1.09	1.33	1.34	1.06	0.84	0.81	0.72
Average of Private-Sector Banks	**0.89**	**0.97**	**1.01**	**0.88**	**1.10**	**0.90**	**0.77**	**0.76**
ABN Amro Bank	1.13	0.91	0.60	0.62	1.44	1.43	0.54	1.12
Abu Dhabi Commercial Bank	0.70	0.75	0.89	0.46	0.84	0.81	0.92	0.62

cont'd....

American Express Bank	0.82	1.04	1.00	0.85	1.53	0.54	0.77	0.64
Arab Bangladesh Bank	—-	1.00	—-	—-	—-	1.00	—-	—-
Bank International Indonesia	0.64	1.00	0.89	0.58	2.05	2.07	0.37	1.55
Bank of America	0.79	1.00	1.10	0.87	2.27	1.00	1.20	2.72
Bank of Bahrain & Kuwait	0.96	1.10	0.98	1.04	0.76	1.20	0.98	0.90
Bank of Ceylon	0.69	0.54	0.98	0.36	—-	1.00	—-	—-
Bank of Nova Scotia	0.82	1.00	0.98	0.80	1.46	1.09	0.86	1.37
Barclays Bank	0.81	1.00	0.87	0.70	1.22	0.53	1.04	0.67
Citibank	1.21	0.97	0.56	0.66	1.46	1.00	0.64	0.94
DBS Bank	0.63	0.84	1.01	0.54	2.06	1.27	1.15	3.02
Deutsche Bank	0.91	1.00	0.81	0.74	2.00	1.00	0.84	1.67
HSBC	1.16	0.83	0.75	0.72	1.82	1.03	0.65	1.22
Krung Thai Bank	—-	1.00	—-	—-	—-	1.00	—-	—-
Mashreq Bank	1.12	1.02	0.90	1.02	1.94	0.58	0.59	0.67
Oman International Bank	0.63	1.17	1.00	0.74	1.05	0.85	0.71	0.63
Societe Generale	0.97	1.08	0.92	0.97	1.29	0.91	1.01	1.18
Sonali Bank	0.84	0.85	0.98	0.70	—-	1.00	—-	—-
Standard Chartered Bank	1.27	0.94	0.64	0.76	1.70	1.29	0.70	1.52
Average of Foreign Banks	**0.87**	**0.94**	**0.87**	**0.71**	**1.49**	**0.98**	**0.78**	**1.13**

commercial banks changes by simply changing the sets of their inputs and outputs. Our answer to this question is clearly "no", at least for the sets of inputs and outputs we have considered. For instance, we present scatter plots of TFP changes as well as of three of its components, showing the correlation between these scores experienced by the individual banks through one model relative to the other in Figure 2. In two—those of technical change and scale (efficiency) change factor—of the total four cases, there is clearly a positive correlation between the two sets of scores. Although there is no such evidence of any positive correlation in the remaining two cases, there is undoubtedly *no negative correlation* between the two sets of scores. The positive correlation for both technical change and scale (efficiency) change factor is also confirmed by the Spearman's rank correlation coefficient between the rankings of the banks on the basis of the two sets of scores obtained through Model I and Model II. We observed that this correlation coefficient is statistically significantly different from zero[14] for these two components of TFP change experienced by the 68 Indian commercial banks we have considered.

Now we turn to the overall changes in the performance of the Indian banks over the period 1999 to 2007. As can be easily understood from our methodological discussion, technical change is a measure of the extent of shift of the concerned frontier production function, it is,

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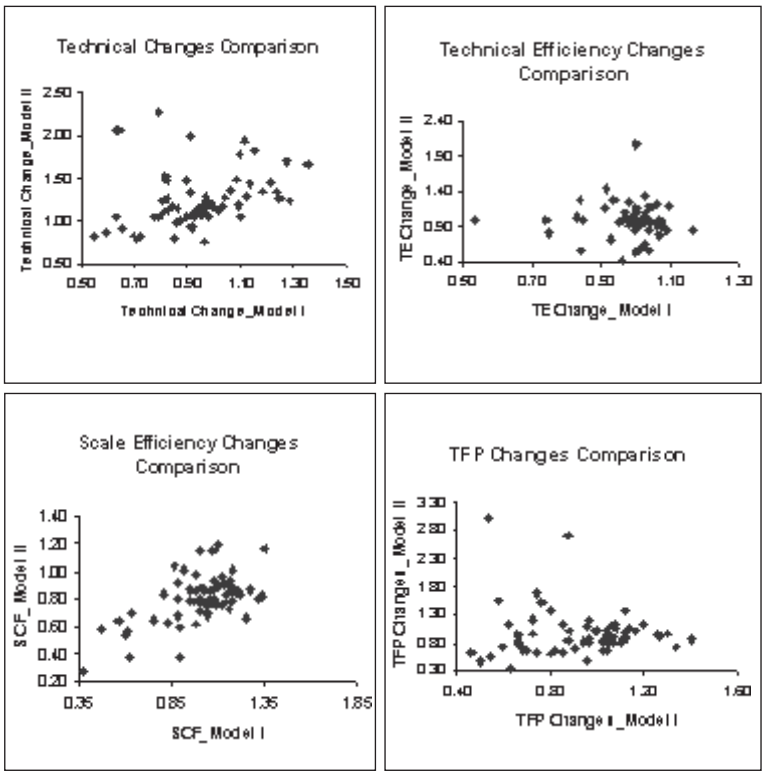
14 We know that for sample size (n) more than or equal to 40, $r_s\sqrt{n-1}$, is approximately normally distributed with mean zero and variance unity, where $r_s = 1-\left(6\sum_{i=1}^{n} d_i^2 \Big/ n\left(n^2-1\right)\right)$, , is the Spearman's rank correlation coefficient between the two sets of ranks of the observations and d_i is the difference between these two sets of ranks for the i^{th} observation. In our sample, values of this statistic are 3.39 and 3.70 for technical change and scale (efficiency) change factor respectively, which clearly exceed the concerned tabulated value even at 1% level of significance.

Figure 2: Scatter Plot of TFP Change and Its Components through One Model relative to the Other



therefore, collectively determined by all the firms. So, there is relatively little possibility of a firm in itself determining the index or score of its technical change. Rather, firms as a whole play the major role in determining it. Thus, although technical change of a firm is an important component of its TFP change, the firm itself has little contribution in determining it. Rather, two other components, namely technical efficiency change and scale (efficiency) change factor, of a firm are much more important determinants (in improving its overall performance) and they are influenced by its own activity. So, in judging the improvement of overall performance of a bank in our study we pay more attention to the two latter components of its TFP change and

relatively less to the earlier. Table 2 shows that, on an average, the group comprising the SBI and its associates improved its performance best in the light of overall TFP change or any of its three components under Model I. Other nationalised banks, private-sector banks and foreign banks follow one after another in the same order. Contrary to this, the order becomes foreign banks, other nationalised banks, the SBI group and private-sector banks in the light of overall TFP change under Model II. However, this improvement of the foreign bank group is mainly driven by technical changes among its various members. If we consider only technical efficiency improvement and improvement in scale (efficiency) change, the two indicators that are mostly determined by the activity of a bank itself, the story becomes almost the same as that which we have observed under the Model I. Here again, the SBI group comes first, followed by other nationalised banks, foreign banks and private-sector banks, one after another. Therefore, even in a truly changed liberal economic environment, the nationalised banks have adjusted and improved themselves better compared to their counterparts under private or foreign ownership.

We now turn to individual bank-wise performance by conducting some fractile group analysis. To be specific, we order the individual banks according to the change in their overall performance and three of its components and consider only the top 17 banks (that is, 25% or more) and see what their distribution is among the four bank groups. This distribution, given in Table 3a and Table 3b, [showing a similar distribution as that of the top 34 banks (that is, 50% or more)]. These two tables show almost an identical distribution, which demonstrates that public-sector banks have adjusted well to the changed scenario and improved their performance better than their private as well as foreign counterparts under Model I. On the other hand, under Model II, foreign banks followed by private-sector banks were doing better relative to their nationalised counterparts. Now the immediate question is why then is the overall performance of foreign banks low as per the latter two

Table 3a: Distribution of the Top Seventeen Banks according to the change in Different Performance Indicators

Bank Group	No. of Banks out of the Top Seventeen							
	Model I				Model II			
	TC	TEC	SCF	TFP	TC	TEC	SCF	TFP
State Bank of India and Its Associates	2	5	0	3	0	2	1	2
Other Nationalised Banks	7	4	8	7	3	4	4	4
Private-Sector Banks	3	4	9	7	3	5	6	2
Foreign Banks	5	4	0	0	11	6	6	9

Table 3b: Distribution of the Top Thirty-Four Banks according to the change in Different Performance Indicators

Bank Group	No. of Banks out of the Top Thirty-Four							
	Model I				Model II			
	TC	TEC	SCF	TFP	TC	TEC	SCF	TFP
State Bank of India and Its Associates	5	7	5	8	2	2	4	3
Other Nationalised Banks	12	11	14	14	12	10	7	12
Private-Sector Banks	10	9	14	9	7	8	15	8
Foreign Banks	7	7	1	3	13	14	8	11

indicators of TFP change even under Model II? The obvious answer is that there are a few foreign banks such as Abu Dhabi Commercial Bank, American Express Bank, Mashreq Bank, and Oman International Bank within the foreign group and those like Development Credit Bank, Dhanalakshmi Bank, and Lord Krishna Bank within the private group which pull down the respective group averages for technical efficiency change and scale (efficiency) change factor to excessively low levels.

By simply taking a close look at the output vector we have considered under Model II, it can be easily understood why nationalised banks are shown to be lagging behind their counterparts under foreign and private ownership in this model. We have already argued that the nationalised banks have more developmental as well as social obligations than the other two groups of banks and distribute their services among more and more economically backward regions, in general, and rural areas, in particular. Thus, one of their declared objectives, as a representative of the government, is to bring as many people as possible into the formal financial system and relieve them from the credit-cobweb of informal moneylenders. In doing so, they have a large number of small customers but the total deposits collected from them are also small. On the other hand, private-sector and foreign banks mainly target a fewer number of creditworthy customers and the total deposits collected from them are relatively large. Since we have used the total value of deposits created by a bank instead of the number of deposits created by it, as proposed by the production approach, foreign and private-sector banks seem to be better improving themselves when compared to their nationalised counterparts. The picture may show the opposite even under Model II if we were able to use the total number of deposits created by a bank as its output.

4. Concluding Remarks

Assessments of the performance of Indian commercial banks are not new in the literature. We have already discussed a few of them earlier

in this paper. As evident from our discussion, some earlier studies have observed that nationalised banks perform relatively better than their more liberalised counterparts under private and foreign ownership, whereas others have got it the other way around. However, most of the earlier studies considered relatively partial measures such as the technical efficiency of the banks. We have considered overall TFP improvement achieved by the individual banks and decomposed it into the three of its economically meaningful components. Furthermore, we have considered, in some sense, the "true" liberalised era of the Indian banking sector as our study period and assessed the extent to which individual banks have adjusted themselves to the new regime and improved in this period. Our results suggest that public-sector banks are, on an average, better adjusting themselves to the changing environment and improving their performance relative to their counterparts under private and foreign ownership. The latter were widely believed to do better under the new regime, given their relatively more flexible operating systems as well as their better market orientation. This finding clearly has important policy implications for the government's attitude towards overall market orientation of the Indian banking sector. To be specific, the government should more cautiously approach liberalising its banking sector and not blindly invite more foreign players to it. The lesson becomes particularly more relevant at a time when we are witnessing a severe global crisis which, although began with the bursting of the US housing market bubble, gathered momentum from a series of bankruptcies of the so-called "too big to fail" banks, with Lehman Brothers in the lead.

However, we have used DEA methodology, which is based on mathematical programming techniques, without considering the possible error structures that may affect the analysis. Since any methodology has its relative advantages as well as disadvantageZs over its possible alternatives, our analysis is not free from its respective limitations.

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