Productivity and Risk of Indian Commercial Banks: An Empirical Evaluation

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Abstract:

The paper attempts to estimate and analyze the productivity of the Indian commercial banking sector for the time period 1996-97 to 2007-08 to investigate whether financial reforms in India have been successful in raising the productivity of Indian commercial banks. We have employed DEA technique to calculate the non-radial Malmquist total productivity index for this purpose. It tries to find out the effect of different explanatory factors upon productivity of banking sector. Further, attempts have been made to explain the inter relationship between productivity and risk exposure of banks. Our findings revealed that the public sector banks have been the most productive bank group followed by the foreign bank group. However, technological progress was the primary source of increased productivity of banks in India. Evidences suggest that there is an interlinkage between productivity growth and risk exposure of Indian commercial banks during our study period.

Keywords: Productivity, Indian banking, Malmquist productivity index, Risk exposure of Indian commercial banks, Data Envelopment Analysis.

JEL Classification: C33, C140, D220, D240, D810, G210.

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Introduction:

The primary aim of financial liberalization is to strengthen market mechanism by eliminating relative price distortion in order to increase efficiency and productivity of the financial sector. Keeping pace with the global changes in banking sector, India has resorted to liberalization and deregulated banking sector to cope with the ongoing reforms in the real sectors. The reforms measures aimed at strengthening the prudential norms relating to income recognition, asset classification, provisioning for bad and doubtful debts and capital adequacy for the banking system in addition to expedite market mechanism. These measures provided greater operational flexibility and functional autonomy to boost efficiency, productivity, growth. A large number of countries have been successful in raising productivity of their banks in the years following deregulation [Kumbhakar and Lozano-Vivas (2001)]. The unidirectional relation between liberalization and growth may not always be true. Some studies revealed the opposite conclusion [Berger, DeYoung, Genay and Udell (2000); Denizer, Dinc and Tarimcilar (2007)]. However, most of the studies in this field estimated the performance of banks in terms of efficiency [Bhattacharya, Lovell and Sahay (1997), Ram Mohan and Ray (2004), Kumbhakar and Sarkar (2003)]. There were only few studies which attempted to evaluate the performance of the banks in terms of their productivity growth over time. Kumbhakar and Sarkar (2003) estimated Total Factor Productivity (TFP) growth and its components using a generalized shadow cost function approach for public and private banks from 1986 to 1996. Their study concluded that the anticipated increase in TFP growth did not materialize after deregulation. While private sector banks improved their performance mainly due to the freedom to expand output, public sector banks did not respond well to take the challenges of the deregulation. Study by Sensarma (2008) established that the foreign owned banks are the worst performers.

The economic development of a country necessitates not only an efficient and productive banking industry, but also a secure one [Pastor, Perez and Quesada (1997)]. The general perception is that even if the productivity of financial institutions is likely to improve, the risk exposure of the banks is also likely to be multiplied in the following years of financial deregulation. The interlinkage between capital and risk revealed that changes in bank capital and risk positioning by bank management are simultaneously determined and affected by both endogenous and exogenous factors [Hughes, Mester and Moon (1995); Jacques and Nigro...
Empirical evidences suggested that there is a tradeoff between the performance of banks and their risk preference [Kwan and Eisenbeis (1997); Hughes, Mester and Moon (2001)]. As a result, it explores the question of the existence of the trade-off between banks’ performance parameters and financial security.

The purpose of this paper is to investigate the performance of Indian commercial banking sector with the help of slack based Malmquist productivity index in the liberalized regime. Although the reforms process in India was initiated in 1991, the pace of transformation was very slow in initial years of reform and its convergence to a fully competitive price setup was effective only after a couple of years. Therefore, in order to understand the comprehensive effect of financial liberalization on the performance of the commercial banks, the period of study should be 1995 onwards. In this exercise, however, we have tried to circumvent these problems by choosing a more appropriate period of study. To evaluate the performance of the Indian commercial banks, we have employed the non-radial Malmquist productivity index (slack-based). We have also tried to investigate the inter relationship between productivity, risk and capitalization of the banks, if there is any, in the deregulated era. The rest of this paper is as follows: Section 2 describes the methodology used for our investigation. In section 3, we present the description of the variables used in our study as well as the data source. Section 4 presents the empirical findings and section 5 concludes.

**Methodology**

One may be interested in focusing on how performance of a production firm changes over time. Total factor productivity is the ratio of an index of output and an index of total input usage. Total factor productivity growth refers to the change in productivity over time. Caves, Christensen, and Diewert (1982) developed productivity indices in the spirit of Malmquist (1953) to decompose productivity change into change in efficiency and change in technology over time. It constructs a production frontier representing the technology and estimates total factor productivity of a firm using distance function approach. Here, we focus on the non-radial slack based Malmquist productivity index estimated using non parametric Data Envelopment Analysis (DEA). In this paper, Malmquist total factor productivity index, change in efficiency (“catch-up”), and change in technology (“frontier shift”) are calculated using output-oriented DEA approach introduced by
Fare, Grosskopf and Lovell (1993). It calculates the distance functions directly in the “goods” space by linear programming, thus bypassing the price information and considering inefficiencies from the production structure.

Let us suppose that there is a set of ‘n’ firms or Decision Making Units (DMUs) \( [(x_j, y_j) \ j = 1, 2, \ldots, n] \), each producing ‘q’ outputs using ‘m’ inputs over the time periods 1 and 2. Therefore, the production possibility set \((X, Y)\) for ‘t’th period \([t=1,2]\) is:

\[
(X, Y)^t = \{(x, y) \mid x \geq \sum_{j=1}^{n} \lambda_j x'_j, \quad 0 \leq y \leq \sum_{j=1}^{n} \lambda_j y'_j, \quad L \leq e\lambda \leq U, \quad \lambda \geq 0\},
\]

Where, \(x_j \in \mathbb{R}^m\), \(y_j \in \mathbb{R}^q\), \(\lambda_j \in \mathbb{R}^n\), \(\lambda\) is the intensity vector and \(e\) is a row vector with all elements equal to one. \(L\) and \(U\) are the lower and upper boundary of the sum of the intensities. \((L, U) = [(0,\infty), (1, 1), (1, \infty), (0,1)]\) corresponding to the CRS, VRS, IRS and DRS models of production. This production possibility set consists of the production frontiers such that it is impossible to improve any input or output without worsening some other input or output.

The Malmquist productivity index combines the catch-up effect, i.e., the change in efficiency of the firm and the frontier shift effect or the effects due to shift of the production frontier itself as a result of technological changes.

Malmquist Index (MI) = (Catch-up effect) \times (Frontier shift effect) \tag{1}

Catch-up effect is simply the ratio of the efficiency of the DMUs in two different periods. So, catch-up effect for a specific DMU\(_0\) [we denote it by \((x_0, y_0)^t\) in ‘t’ th period, \(t = 1, 2\)], is the ratio of the efficiency of DMU\(_0\) at period 2 to that of DMU\(_0\) at period 1.

\[
\text{Catch up} = \frac{\text{efficiency of } (x_0, y_0)^2 \text{ with respect to period 2 frontier}}{\text{efficiency of } (x_0, y_0)^1 \text{ with respect to period 1 frontier}} \tag{2}
\]

Evidently, a catch-up effect with value greater than unity refers to a progress in the relative efficiency from period 1 to period 2 and catch-up effect with value less than unity indicates just the opposite. No change in efficiency of the firm gives the value of the catch up term equal to unity.
\( \delta^t(x_0, y_0)^s \) refers to the efficiency score of DMU \((x_0, y_0)^s\) measured by the frontier technology \(s\) for \(t = 1, 2\) and \(s = 1, 2\). Using this notation, (2) becomes,

\[
\text{Catch up} = \frac{\delta^2(x_0, y_0)^2}{\delta^1(x_0, y_0)^1}
\] (3)

Frontier shift effect at \((x_0, y_0)^1\) is evaluated by the following expression:

\[
\Phi_1 = \frac{\delta^1(x_0, y_0)^1}{\delta^2(x_0, y_0)^1}
\] (4)

Similarly the frontier shift effect at \((x_0, y_0)^2\) is evaluated by the following expression:

\[
\Phi_2 = \frac{\delta^1(x_0, y_0)^2}{\delta^2(x_0, y_0)^2}
\] (5)

Using \(\Phi_1\) and \(\Phi_2\), we define frontier-shift effect by their geometric mean, i.e.,

\[
\text{Frontier shift effect} = \Phi = \left[ \frac{\delta^1(x_0, y_0)^1}{\delta^2(x_0, y_0)^1} \times \frac{\delta^1(x_0, y_0)^2}{\delta^2(x_0, y_0)^2} \right]^{1/2}
\] (6)

Ultimately, the Malmquist index, as a product of the catch up effect and frontier shift effect, is:

\[
MI = \left[ \frac{\delta^1(x_0, y_0)^2}{\delta^1(x_0, y_0)^1} \times \frac{\delta^2(x_0, y_0)^2}{\delta^2(x_0, y_0)^1} \right]^{1/2}
\] (7)

Expression (7) presents Malmquist productivity index as the geometric mean of two efficiency ratios. Among the four terms, \(\delta^1(x_0, y_0)^1\) and \(\delta^2(x_0, y_0)^2\) are the efficiency scores measured in terms of the same period frontier. Other two terms, \(\delta^1(x_0, y_0)^2\) and \(\delta^2(x_0, y_0)^1\) indicate intertemporal comparison of efficiency. If \(MI > 1\), it reflects an improvement in the productivity of DMU from period 1 to period 2. \(MI < 1\) indicates deterioration in the productivity of the same. \(MI = 1\) means there is no change of productivity of the DMU during this period.

Here, we consider the output oriented slack based measure. It evaluates the efficiency of the firm \((x_0, y_0)^s\), \((s = 1, 2)\) with respect to the evaluator set \((X, Y)^t\) \((t = 1, 2)\), with the following linear programming problem:

\[
\delta^s((x_0, y_0)^t) = \min_{\lambda, \alpha^t} \frac{1}{1 + \frac{1}{m} \sum_{i=1}^{m} x_{i0}^t / y_{i0}^t}
\]

Subject to,

\[
x_{0i}^t \geq x^t \lambda
\] (8)
\[ y'_0 = \mathcal{Y} \lambda - s^* \]
\[ L \leq e\lambda \leq U \]
\[ \lambda \geq 0, \quad s^* \geq 0. \]

Where \( \mathcal{X}_s = (x'_1, x'_2, \ldots, x'_n) \) and \( \mathcal{Y}_s = (y'_1, y'_2, \ldots, y'_n) \) are the input and output sets respectively by the firm in period ‘s’. \( s^+ \in \mathbb{R}^n \) denote the output slacks. As this is output oriented model, it takes into account the output slacks, but not the inputslacks.

Substituting \( \phi = \frac{s^+}{s^0} \), the above problem becomes,

\[
\delta^s((x_0, y_0)) = \min_{\lambda, \phi} 1/ \left( 1 \right) \frac{1}{m} \sum_{i=1}^{m} \phi_i
\]

Subject to,

\[
x'_0 \geq \mathcal{X} \lambda
\]
\[
(1 + \phi_i) y'_0 = \sum_{j=1}^{n} y'_j \lambda_j \quad i = 1, 2, \ldots, q. \quad (9)
\]
\[ L \leq e\lambda \leq U \]
\[ \lambda \geq 0, \quad \phi \geq 0. \]

This LP problem is always feasible in case of \( s = t \), but in case of \( s \neq t \), it may not have any feasible solution. In that case, we solve the output oriented super slack based model as follows:

\[
\delta^s((x_0, y_0)) = \min_{\lambda, \phi} 1/ \left( 1 - \frac{1}{q} \sum_{i=1}^{q} \phi_i \right)
\]

Subject to,

\[
x'_0 \geq \mathcal{X} \lambda
\]
\[(1- \varphi_j) y_{i0}^* = \sum_{j=1}^{n} y_{ij}^* \lambda_j \quad i = 1,2,.. q \quad (10)\]

\[L \leq e\lambda \leq U\]

\[\lambda \geq 0, \varphi \geq 0.\]

The output oriented model takes into account all output slacks but not the input slacks\(^1\).

To compute \(\delta^1((x_0, y_0)^1)\) and \(\delta^2 ((x_0, y_0)^2)\), we use (9). For the intertemporal scores \(\delta^1((x_0, y_0)^2)\) and \(\delta^2 ((x_0, y_0)^1)\), we solve the corresponding output oriented models. If they are feasible, they also result into scores not exceeding 1. In case they are infeasible and the scores exceed 1, we apply the corresponding super slack based model (10). In our study, to estimate the total productivity change and its decomposed components for the Indian commercial banks during our study period, we have used output oriented slack based Malmquist model based on the assumption of variable returns to scale.

The relationship between performance of banks and risk taking may be positive if more efficient banks with superior management access underwrite and monitor the risk parameters effectively. These make them capable of managing additional risks for greater return compared to the less efficient banks. However, the positivity of this relationship becomes less obvious if banks with lower efficiency are inclined to take greater risk to offset their inefficiency [Kwan and Eisenbeis (1995), Hughes, Mester and Moon (1995), Hughes and Mester (1998)]. Risk taking behaviour of a bank may affect its performance [Berger, De Young (1997)]. Poor bank management, after taking excessive risk, may fail to manage them efficiently. Poor risk management and high risk loans again may result into high operational cost and therefore poor productivity performance. Bank managers those are inefficient in managing and monitoring their risks, are unlikely to achieve high operational efficiency. Therefore, risk preference of banks may negatively affect productivity of a bank.

Similar ambiguity is present regarding the direction of linkage between bank’s capital and risk. In most of the cases, regulators or policy makers force the banks to raise its capital stock in
proportion with the additional risk taken as they consider capital base as a cushion for safe and sound banking practice. Moreover, if the bank itself efficiently monitors the market and finds its existing capital stock to be inadequate with respect to the risk taken by the bank, it may itself increase its capital strength [Berger, Herring and Szego (1995), Altunbas, Carbo, Gardener, Molyneux, (2007)]. In both cases, we find a positive relationship between capital stock of the bank and its risk position. An alternative hypothesis supports the negative relationship between bank capital and risk. For example if all the deposits are insured at a very flat rate, the marginal cost of increasing risk or declining capital becomes very low and banks may take excessive risk even with a very low capital stock [Altunbas, Carbo, Gardener, Molyneux, (2007)]. Again, some authors support the view that enforcement of capital adequacy norms sometimes reduces risk taking activities by banks [Deelchand and Padgett (2009)]. Therefore, bank’s productivity, capitalization and risk exposure are interrelated. Hence, the study of the interrelationship between bank’s productivity and risk exposure should take into account the capital base of the bank. This three interdependent variables can be modeled and analyzed best with the help of a simultaneous equations system. Here we have to adapt the three stage least square method. To check for the robustness of our 3SLS results, we have estimated the same equations again by SUR.

We have conducted our analysis on the basis of the following hypotheses regarding the effect of deregulation on the Indian banks:

Hypothesis 1: Indian commercial banks, on an average, have experienced significant improvement in productivity during our study period as a result of financial deregulation.

Hypothesis 2: Indian commercial banks, on an average, have experienced significant technological progress during our study period.

Hypothesis 3: On an average, Indian commercial banks have experienced significant improvement in efficiency during our period of investigation.

Hypothesis 4: Growth rate of productivity of the Indian commercial banks have been simultaneously determined with the risk exposure by the banks along with capitalization and some other exogenous factors to be specified later, in our study period.
Hypothesis 5: The financial deregulation in India has raised the risk exposure of the commercial banks.

3. Selection of Variables and Data Source

In our study, keeping in mind our objective of investigation, we have selected three inputs and three outputs those capture traditional ‘lending activities’ as well as ‘non-lending activities’ of commercial banks.

The selected input and output set to derive Malmquist productivity index using DEA is: Inputs: i) number of employees, ii) equity capital (core capital + reserves & surpluses), iii) total loanable fund (deposits + borrowings); Outputs: i) advances, ii) investments, iii) non interest income. Explanation of the three input variables is quite obvious. The first two are labour and capital inputs. As we consider commercial banks as financial intermediaries, its total loanable fund is treated as third input. As far as the outputs are concerned, the first two outputs stand for traditional lending activities of banks or two primary outputs of bank’s financial intermediation. The non interest income has been selected as a proxy for non-lending banking activities.

The complex relationship among productivity, risk taking and capitalization of commercial banks has become more relevant and interesting in recent times as a large number of countries of the world are opting for deregulation and financial liberalization to boost efficiency and productivity of its financial institutions. We therefore attempt to specify a simultaneous equations system to disentangle the differing incentives for management in managing risk, producing intermediation services and leveraging the organization. We construct a simultaneous equations system [equations (11)-(13)] to investigate the interrelationship of productivity, capitalization and risk exposure of Indian commercial banks as follows.

\[
\text{TFP} = f_1(\text{CRAR, NNPA, ADVGR, ADVGRSQ, ROA, GGDP, HERPHINDAHL, OWNERSHIPDUMMIES}) \tag{11}
\]

\[
\text{NNPA} = f_2(\text{CRAR, TFP, PRIADV, UNSEC ADVGR, ADVGRSQ}) \tag{12}
\]

\[
\text{CRAR} = f_3(\text{TFP, NNPA, SIZE, RCRAR1, RCRAR2}) \tag{13}
\]

TFP: Total Factor Productivity with respect to adjacent years

CRAR: Risk adjusted Capital Adequacy Ratio
NNPA: Net Non-performing assets as a proxy for credit risk

GGDP: Growth rate of Gross Domestic Product

SIZE: Size of the bank

ADVGR: Growth rate of advances

ADVGRSQ: Square of the growth rate of advances

ROA: Return on assets

PRIADV: Ratio of priority sector advances to total advances

UNSEC: Ratio of unsecured advances to total advances

HERPHINDAHL: Herfindahl Index of total business of banks

RCRAR1, RCRAR2: Regulatory pressure variables

Ownership Dummies: Dummy variables for public sector and foreign bank group

The estimated Malmquist TFP index for the previous adjacent years has been used for the time period 1997-98 to 2007-08 to estimate the equations. Even if commercial banks in this deregulated regime have to face a number of risks, in our study, we have considered two major risks faced by banks – credit risk and financial leverage or liquidity risk. The credit risk has been measured in the conventional way, i.e. by the ratio of net non performing assets to net advances (NNPA). The financial leverage is conventionally measured by the risk weighted capital adequacy ratio (CRAR) as the CRAR is considered to be the financial cushion that works against financial leverage risk of the bank. CRAR of a bank otherwise represents the capital strength of the bank as well. Therefore these three variables – TFP, NNPA and CRAR may be treated as three endogenous variables those are mutually determined and interdependent in our simultaneous equations system.

In the productivity equation, the endogenous variable used to estimate the productivity growth is the Malmquist total productivity index for the adjacent years. NNPA and CRAR have been included as two explanatory variables. The growth rate of Gross Domestic Product of the country
(GGDP) has been included to account for the impact of overall economic growth of the country on the productivity growth of its banking sector. An effect of loan growth on productivity is captured by two variables, yearly percentage rate of growth of advances (ADVGR) and square of ADVGR (ADVGRSQ). ADVGRSQ has been added to allow for the possibility of a non-linear relationship between yearly loan growth and productivity. To estimate the influence of the competitiveness in the banking industry, Herfindahl Index of total business (HERPHINDAHL) of the bank for respective years has been included. Quality of assets is estimated by the proxy variable return on assets (ROA) added to the equation to estimate its effect on the productivity. Another important determinant of bank productivity level is the ownership structure of the banking firm. To allow for this, we have included the dummy variables for government and foreign ownership.

Now consider the credit risk or NNPA equation of our model. The variables ADVGR and ADVGRSQ have been added to capture the effects of growth rate of advances on the credit risk of the bank. However, the proportion of nonperforming assets is not only related to the amount or growth rate of the total advances, but also the composition of the total advances of the bank. Thus we include the percentage of advances to the priority sector (PRIADV) as a separate variable. Further, one can expect that unsecured advances affect the amount of NPA. Consequently, the proportion of unsecured advances to total advances (UNSEC) has been included as an exogenous variable in the credit risk equation.

The last equation of our model is the financial capitalization or the CRAR equation. Apart from the endogenous variables TFP and NNPA, exogenous variable SIZE has been included. Size of the bank has been measured by the log value of the total asset size of the bank. In this equation, we bring in two special variables to capture the degree of regulatory pressure brought about by the risk based capital standards. Previous studies incorporating this type of variables, estimated it as the difference between the inverse of the bank’s CRAR and the inverse of the regulatory minimum risk based ratio [Jacques and Nigro (1997)]. In India, the percentage of the minimum required risk based capital base is 8 per cent. Hence, we included two regulatory pressure variables RCRAR1 and RCRAR2, where RCRAR1 equals \((1/CRAR - 1/8)\) for all banks having CRAR less than 8 per cent and zero otherwise. RCRAR2 equals \((1/8 - 1/CRAR)\) for all banks with CRAR more than 8 per cent and zero otherwise.
The estimation procedure of the Malmquist total productivity index requires a balanced panel data set. We have used a panel data of the period from 1996-97 to 2007-08 of 69 banks (28 public banks, 21 domestic private banks and 20 foreign banks). The data has been collected from the Reserve Bank of India publications “Statistical Tables relating to Banks of India” and “The Trend and Progress of Commercial Banks” provided in the Reserve Bank of India website (www.rbi.org.in). We have deflated the data of relevant variables by GDP deflator of respective years as and when it is applicable.

**Empirical Findings**

We have calculated the output oriented slack based Malmquist productivity index based on variable returns to scale for 69 Indian commercial banks for each year from 1998 to 2008. We have further decomposed the productivity index into two components of productivity change – catch up effect i.e. change in technical efficiency and frontier shift effect i.e. the effects of technological change. Estimations have been made with respect to the initial year 1997 as the base year. The selection of an exceptionally ‘good’ year or ‘bad’ year as the starting point may make the performance scores biased and unreliable. To overcome this problem, the comparison of productivity with respect to the adjacent previous year is important. Again, estimations have also been performed relative to the sequence of technology of the previous adjacent periods starting from 1997.

(Table1 approximately here)

(Table2 approximately here)

In table 1, we portray the ownership wise productivity growth; catch up effect and frontier shift effect during the study period relative to the technology of the base year, 1997. In table 2, we exhibit the index of total productivity growth together with the decomposed components for Indian banks according to their ownership pattern with respect to the previous adjacent year frontier. Some important inferences can be made from those tables. First, we observe that during this twelve year time span, Indian commercial banks have witnessed an increase in the productivity by almost 50 per cent, when compared to that of 1997. Considering the ownership wise productivity growth measured by the Malmquist index, table1 clearly shows that all types
of banks irrespective of their ownership have shown an increase in productivity with respect to
the base year 1997. Productivity growth has been highest for the public sector banks (71 per
cent) followed by the domestic private sector banks (38 per cent) during this period. Foreign
banks have shown a rise in productivity by 31 per cent with respect to the base year frontier. In
the initial years up to 2004 showed continuous and perpetual growth every year. In 1998, there
was productivity growth of 19.6 per cent of all Indian banks. Afterwards, all the years up to 2004
witnessed positive growth in the productivity of Indian commercial banks taken altogether,
though the magnitude of growth varied widely. In 2005 and 2006, there was deterioration in the
banking productivity. Again in 2007, there was productivity growth of 1.9 per cent and in 2008,
it was 16 per cent.

Table 2 reveals that the productivity of Indian public sector and domestic private sector banks in
2005 and 2006 was bad compared to the respective adjacent years. It seems that the year 2005
and 2006, has been a ‘bad’ phase for Indian banking industry because, the growth rate of
productivity for the banking sector has decreased. In 2008, the Indian commercial banks have
somewhat recovered and have shown trend of upward productivity growth. For the domestic
private banks the bad phase continued till 2007. In 2007, the public sector banks improved their
productivity and in 2008 an average public sector bank managed to produce close to its earlier
maximum level of outputs given the inputs. Though the private banks managed to perform better
than the previous year it failed to produce the maximum output given the inputs of the earlier
period. Foreign banks accomplished productivity growth for each year of our study period
except 2006.

Even if foreign owned banks scored the highest growth in productivity during initial years of our
study, with time, the public banks’ productivity growth increased and superseded that of the
foreign banks. According to general perception private ownership are supposed to perform better
than their public sector counterpart. However, on the basis of above findings, we do not find any
evidence in support for the superiority of the performance by private sector in India. On the
contrary, we find greater TFP growth for the public sector banks than that of by the domestic
private sector banks as well as foreign owned banks during our study period.
We find that the contribution of improvement of efficiency change to growth of productivity of the Indian commercial banks is not significant and the efficiency increase is sixteen percentages only in the period of our investigation. However, rate of change of efficiency is neither uniform nor positive from the adjacent year over the period. In 1999 and 2001, Indian commercial banks witnessed decrease in efficiency compared to that of the previous year. For the following three years after 2001, the Indian banking industry again depicted rise in efficiency relative to the previous year. Table 2 shows regress in efficiency relative to that of the previous year for Indian commercial banks in 1999, 2001 and 2006, 2006 being the worst affected year when efficiency deteriorated by almost 11 per cent. In 2007 and 2008, the banks improved their efficiency levels. Obviously, on an average, we get a clear picture of poor performance in efficiency improvement with respect to the adjacent previous year’s production frontier for all banks taken together during our study period.

Tables reveal that even if there were minor improvements in efficiency of the public sector banks compared to that of the base year 1997 in the initial three years of our study period, in 1999 the efficiency decreased relative to that of the previous year. In 2001, public sector banks faced a slight fall in the efficiency relative to the previous year, whereas the following four years were those of positive changes in technical efficiency, though the rate of was very low. The ownership wise catch up component or efficiency change reveals very poor performance of the public sector banks. Except the 24.5 per cent progress in efficiency in 2008, throughout the study period, this score did not exceed 1 per cent. The situation is even worse in the years 2001, 2006 and 2007, when there were reductions in the catch up by 7.8 per cent, 15 per cent and 0.1 per cent respectively. The domestic private banks of India also exhibit poor performance in terms of efficiency change during our study period. In the first three years of our study period, there was insignificant improvement in efficiency relative to that of the base year. The domestic private banks were the worst performer in terms of technical efficiency change compared to the frontier of adjacent previous year. Years 2002 and 2008 were exceptions, when there were enhancement of the technical efficiency of the private sector banks by 20 per cent and 15.9 per cent respectively. The rate of progress in efficiency was below 1 per cent in 1998, 2000 and 2003. Except these five years, all through there were regress in the catch up of the domestic private banks with respect to the adjacent previous year. The tables reveal that the Indian foreign bank
group is the only Indian bank group which witnessed efficiency gain throughout our study period. Moreover, the foreign banks experienced maximum gain in efficiency among three different groups of banks all through the study period. An average foreign bank operating in India exhibits remarkable efficiency gain in 1998 compared to that of 1997. In 2001 efficiency level declined compared to the previous year. As far as the catch up effect with respect to the adjacent previous year is concerned, even the performance of the foreign banks was also not satisfactory. Though the increase in catch up was 43 per cent in 1998, it continuously deteriorated in the following three years. In 2002, it again rose by 18.6 per cent. The next year 2003 was a bad year depicting a reduction in technical efficiency of foreign banks. In 2004 and 2005, there were hikes in catch up by 16 per cent and 17 per cent respectively. Again after a bad year 2006 with reduction by almost 10 per cent, there was, to some extent, a recovery in technical efficiency in 2008.

We find that the growth of productivity of the Indian commercial banks is primarily attributed to the technological change (40 per cent) rather than the efficiency change (16 per cent). We can infer that, in the banking industry of India as a whole, there has been technological improvement compared to the frontier of the base year 1997 all along our study period. The situation is somewhat better as far as technological progress of Indian banks with respect to the adjacent year is concerned. Except 2005 and 2007 with technological regress by 8.5 per cent and 3 per cent respectively, all through our study period, there is evidence of technological progress, in the Indian banking industry, though the progress is neither uniform nor satisfactory in all the years of our investigation. It was the highest at 17.4 per cent in 1999.

The decomposed components of total factor productivity change for public sector banks show that technological diffusion is the primary source of growth. A close look reveals perpetual progress in technology in all years except 2005 and 2008. This group experienced 63% progress in technology between 1997 and 2008 and the maximum progress in technology was witnessed in 2007.

Starting with a merely 5 per cent technological progress of the public sector banks in 1998, from 1999 to 2003, there is picture of fair technological enhancement for the public sector banks. In 2004, the technological progress score was only 1 per cent and in the following year, the frontier
shift effect was negative. The years 2006, 2007 and 2008 witnessed little recovery with low rate of technological upgradation for the Indian public sector banks.

The table reveals technological improvement by the domestic private banks of India by 34.6 per cent in 2008 from 1997 level. The domestic private bank group is in the second best performing group in terms of technological progress with respect to the base year. We find that except years 2000 and 2001, when there were technological progress by 23 per cent and 12 per cent respectively, during our study period, the score of the frontier shift effect with respect to that of the previous year was below 1 per cent. Besides the years 2003, 2005 and 2008 showed evidences of technological regress for the domestic private sector banks of India.

The foreign bank group exhibits least technological progress among banks with different ownership groups. Compared to the maximum technological progress of 66.9 per cent and 41.5 per cent for the public sector banks and domestic private sector banks respectively, the maximum percentage of technological change was only 24.2 per cent for the foreign owned banks in the period of our investigation. In fact in the years 1999, 2005 and 2007, the foreign banks witnessed technological regress compared to the frontier of the adjacent previous year. In fact there is no systematic pattern of changes in the productivity growth, catch up or frontier shift among all banks and banks of different ownership during our study period.

Evidently, the growth of productivity of foreign banks in our study period is attributed more to the progress in their efficiency than to technological upgradation. On the contrary rapid productivity growth of the public sector banks has been possible primarily due to massive technological improvements. Technological progress of the public owned banks is higher than the domestic private banks in each year. The public banks superseded the foreign banks in terms of productivity in recent years. Another point worth noting is that all the banks irrespective of their ownership pattern have shown technological progress.

We now turn to our 3SLS and SUR estimation results of the simultaneous equations model and the inferences. Both the models gave similar results. Thus, findings of SUR estimation reinforce the inferences drawn from the 3SLS estimation and vice versa. In table 3, we present estimation results of equation (11). The table reveals some important conclusions.
First, the CRAR has positive impact on the total factor productivity growth with respect to the adjacent year’s productivity in both the models, 3SLS and SUR, though not statistically significant. It is expected that better capitalized banks will be the higher productive banks [Girardone, Molyneux and Gardener (2004), Reddy (2004)]. The case may be that the management of the banks with high or minimum required capital base gets some privilege and flexibility from the regulatory authority and this raises their productivity. Secondly, it is predictable that banks with superior quality of assets will be more productive. We obtained a statistically significant positive relationship of TFP and ROA as expected in case of SUR. This positive relationship is again supported by 3SLS model, though not significant. But as seen in table 3, we find a positive relationship between productivity growth variable TFP and the proxy for credit risk, NNPA in both of our estimation results, even if not statistically significant.

Now, we turn to the results of estimation of the NNPA equation or equation (12) in which NNPA is the dependent variable. Table 4 incorporates the 3SLS and SUR results of that equation. First, it reveals a significant negative relationship between TFP and NNPA in case of both 3SLS and SUR. It implies that with increasing productivity, problem loan of the bank falls. This outcome is quite expected as efficient and productive banks are likely to manage their credit risk effectively and competently. Secondly, banks with stronger capital base seem to have significantly higher ratio of NNPA as the table shows, CRAR has significant positive coefficients for both our estimations. Thirdly, both the estimation results revealed that higher priority sector advances lead to lower amount of non-performing assets, though not statistically significant. Estimated coefficient of the ratio of unsecured advances to total advances is statistically significant with negative sign. This indicates that banks are much more selective in choosing the clients for unsecured advances and spend scarce managerial resources efficiently to sanction unsecured loans, as a result the credit risk decreases.
Table 5 shows a significant negative relationship between the CRAR and non-performing assets of the bank, in both the estimation results. This outcome is somewhat obvious due to the well-established notion that sound capital base of the bank, to a large extent reduces its credit risk and therefore its stock of non-performing assets. Secondly, in both the models, significant negative relationship between CRAR and SIZE implies that the smaller banks of India are better capitalized banks or banks with higher financial leverage. Thirdly, in both 3SLS and SUR, the regulatory pressure variable RCRAR2 has a highly significant positive impact on CRAR because of the fact that banks with high capital base generally increase their capital adequacy under regulatory pressure. In other words, it is actually the regulatory pressure that influences these banks to raise their capital adequacy.

**Concluding Remarks**

This paper makes an effort to investigate whether the financial deregulation has been successful in its goal of raising the productivity of the Indian banks. Attempts have also been made to analyze the recent trend of the productivity growth in Indian banking sector. We further compared the trend of productivity growth of banks of different ownership in India. Moreover, the task of decomposition of the productivity growth into change in efficiency and frontier shift effect has been performed to estimate their relative influence on the productivity growth of banks. Our study urges to find out a simultaneous relationship between productivity growth, capital strength and risk taking behaviour of the Indian commercial banks. While estimating the simultaneous equations system, some exogenous factors, those are likely to have impacts on productivity growth of banks or the capitalization and risk behaviour of banks, were specified and incorporated. Thereafter, the magnitude of their impact on the productivity growth and risk of the banks had also been explored.

This study reveals several important findings and inferences. After a decade of the initiation of the financial reforms, we can see clear indications that the commercial banks, on an average, have been improved in terms of their productivity growth with respect to the base year 1997, irrespective of their ownership pattern. Therefore, it is beyond arguments that, financial deregulation has successfully increased the productivity for the Indian banking sector. Although foreign banks were the most productive banks in the initial years of our study, with time, Indian
banks have outweighed them. Contrary to general perception, our investigation revealed that public banks have secured the position of the most productive banks followed by the domestic bank group in recent years. With this result, we strongly argue against further privatization of public banks. Even in the changed scenario of ‘level-playing field’ and increased competition, the nationalized banks have been proved to be the most productive banking firms. We should mention that the growth in productivity of the Indian public sector banking industry is not due to the improvement in their efficiency level, but mainly because of the massive technological adoption in the banking industry. It clearly envisaged that with proper technological adoption Indian commercial banks can compete with large multinational banking corporations.

The interconnection between productivity growth, capitalization and risks of the banks and several exogenous factors reveals banks with superior quality of assets is more productive. Our finding implies that with increasing productivity, problem loan of the bank falls. This outcome is quite expected as efficient and productive banks are likely to manage their credit risk effectively and competently. It divulges that banks with stronger capital base prefer higher risk. Estimated coefficient of the ratio of unsecured advances to total advances is statistically significant with negative sign. This indicates that banks are much more selective in choosing the clients of unsecured advances and spend scarce managerial resources efficiently to sanction unsecured loans, as a result the credit risk decreases. The result of our study to a great extent established the widespread notion that sound capital base of the bank, to a large extent, reduces credit risk and therefore its stock of non-performing assets. Our finding implies that the smaller banks of India are better capitalized banks and banks with high capital base generally increase their capital adequacy under regulatory pressure. In other words, it is actually the regulatory pressure that influences these banks to raise their capital adequacy.

References:


Table 1: Average TFP Change during 1997-2008 (With Respect to Base Year Frontier)

<table>
<thead>
<tr>
<th>Year</th>
<th>PUB</th>
<th>PVT</th>
<th>FRN</th>
<th>ALL</th>
</tr>
</thead>
<tbody>
<tr>
<td>98-97</td>
<td>1.096</td>
<td>1.126</td>
<td>1.411</td>
<td>1.196</td>
</tr>
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<td>99-97</td>
<td>1.231</td>
<td>1.13</td>
<td>1.444</td>
<td>1.262</td>
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<td>00-97</td>
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<td>1.357</td>
<td>1.527</td>
<td>1.416</td>
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<tr>
<td>01-97</td>
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<td>1.314</td>
<td>1.56</td>
<td>1.438</td>
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<td>1.514</td>
<td>1.577</td>
<td>1.553</td>
</tr>
<tr>
<td>03-97</td>
<td>1.688</td>
<td>1.633</td>
<td>1.503</td>
<td>1.618</td>
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<tr>
<td>04-97</td>
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<td>1.642</td>
<td>1.705</td>
<td>1.717</td>
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<td>1.419</td>
<td>1.48</td>
<td>1.541</td>
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<td>06-97</td>
<td>1.502</td>
<td>1.34</td>
<td>1.429</td>
<td>1.432</td>
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<tr>
<td>07-97</td>
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<td>1.288</td>
<td>1.268</td>
<td>1.345</td>
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<td>08-97</td>
<td>1.712</td>
<td>1.385</td>
<td>1.311</td>
<td>1.497</td>
</tr>
</tbody>
</table>

Note: PUB- Public sector banks, PVT- Domestic private sector banks, FRN- Foreign owned banks. The column with a heading 98-97 indicates calculations based on the TFP index of 1998 with respect to the base year 1997, and so on. Source: Author's own calculations

Table 2: Average TFP Change during 1997-2008 (With Respect to Adjacent Year Frontier)

<table>
<thead>
<tr>
<th>Year</th>
<th>PUB</th>
<th>PVT</th>
<th>FRN</th>
<th>ALL</th>
</tr>
</thead>
<tbody>
<tr>
<td>98-97</td>
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<td>1.126</td>
<td>1.411</td>
<td>1.196</td>
</tr>
<tr>
<td>99-98</td>
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<td>1.008</td>
<td>1.016</td>
<td>1.071</td>
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<td>00-99</td>
<td>1.165</td>
<td>1.228</td>
<td>1.099</td>
<td>1.165</td>
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<tr>
<td>01-00</td>
<td>1.076</td>
<td>1.043</td>
<td>1.074</td>
<td>1.065</td>
</tr>
<tr>
<td>02-01</td>
<td>1.17</td>
<td>1.276</td>
<td>1.224</td>
<td>1.218</td>
</tr>
<tr>
<td>03-02</td>
<td>1.166</td>
<td>1.024</td>
<td>1.19</td>
<td>1.085</td>
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<tr>
<td>04-03</td>
<td>1.052</td>
<td>1.004</td>
<td>1.218</td>
<td>0.927</td>
</tr>
<tr>
<td>05-04</td>
<td>0.89</td>
<td>0.814</td>
<td>1.098</td>
<td>0.919</td>
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<tr>
<td>06-05</td>
<td>0.854</td>
<td>0.97</td>
<td>1.098</td>
<td>1.019</td>
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<tr>
<td>07-06</td>
<td>1.013</td>
<td>0.974</td>
<td>1.075</td>
<td>1.16</td>
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### Table 3: 3SLS and SUR Results of the TFP Equation

<table>
<thead>
<tr>
<th>Variable</th>
<th>3SLS Coefficient</th>
<th>3SLS P Value</th>
<th>SUR Coefficient</th>
<th>SUR P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>27.272</td>
<td>0.924</td>
<td>24.819</td>
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<td>0.150</td>
<td>0.852</td>
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<tr>
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<td>0.977</td>
<td>0.137</td>
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<tr>
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<td>-0.771</td>
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</tr>
<tr>
<td>ADVGRSQ</td>
<td>0.608</td>
<td>0.976</td>
<td>0.375</td>
<td>0.598</td>
</tr>
<tr>
<td>ROA</td>
<td>0.196</td>
<td>0.964</td>
<td>0.350</td>
<td>0.000 ***</td>
</tr>
<tr>
<td>GGDP</td>
<td>-6.301</td>
<td>0.924</td>
<td>-5.259</td>
<td>0.956</td>
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<tr>
<td>HARPINDAHL</td>
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<td>0.924</td>
<td>-24.641</td>
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<tr>
<td>PUBDUMMY</td>
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<td>0.924</td>
<td>-2.594</td>
<td>0.843</td>
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<tr>
<td>FRNDUMMY</td>
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<td>0.924</td>
<td>-3.476</td>
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<tr>
<td>Adjusted R Square</td>
<td>0.945</td>
<td></td>
<td>0.012</td>
<td></td>
</tr>
</tbody>
</table>

Note: CRAR: Risk adjusted capital adequacy ratio; NNPA: Ratio of net non-performing assets to net advances; ADVGR: Growth rate of advances; ADVGRSQ: Square of the growth rate of advances; ROA: Return on assets; GGDP: Growth rate of Gross Domestic Product of the country; HERPHINDAHL: Herfindahl Index of total business of bank; PUB_DUMMY: Dummy variable for the public sector banks; FRN_DUMMY: Dummy variable for the foreign banks. *, ** and *** indicate significance at 10, 5 and 1 per cent, respectively.
Table 4: 3SLS and SUR Results of the NNPA Equation

<table>
<thead>
<tr>
<th>Variable</th>
<th>3SLS Coefficient</th>
<th>P Value</th>
<th>SUR Coefficient</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>4.385</td>
<td>0.995</td>
<td>4.248</td>
<td>0.995</td>
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<tr>
<td>TFP</td>
<td>-26.007</td>
<td>0.008</td>
<td>***</td>
<td></td>
</tr>
<tr>
<td>CRAR</td>
<td>0.049</td>
<td>0.066</td>
<td>-25.902</td>
<td>0.000</td>
</tr>
<tr>
<td>PRIADV</td>
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<td>0.130</td>
<td>0.040</td>
<td>0.000</td>
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<tr>
<td>UNSEC</td>
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<td>0.001</td>
<td>-0.126</td>
<td>0.483</td>
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<tr>
<td>ADVGR</td>
<td>-0.195</td>
<td>0.515</td>
<td>0.001</td>
<td>0.532</td>
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<tr>
<td>ADVGRSQ</td>
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<td>0.584</td>
<td></td>
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<tr>
<td>Adjusted R Square</td>
<td>0.715</td>
<td></td>
<td>0.964</td>
<td></td>
</tr>
</tbody>
</table>

Note: TFP: Total factor productivity; CRAR: Risk adjusted capital adequacy ratio; PRIADV: Ratio of advances to the priority sectors to total advances; UNSEC: Ratio of unsecured advances to total advances; ADVGR: Growth rate of advances; ADVGRSQ: Square of the growth rate of advances. *, ** and *** indicate significance at 10, 5 and 1 per cent, respectively.

Source: Author’s own calculations.

Table 5: 3SLS and SUR Results of the CRAR Equation

<table>
<thead>
<tr>
<th>Variable</th>
<th>3SLS Coefficient</th>
<th>P Value</th>
<th>SUR Coefficient</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
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<td>-0.625</td>
<td>0.945</td>
</tr>
<tr>
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<td>0.727</td>
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<td>0.712</td>
</tr>
<tr>
<td>NNPA</td>
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<td>0.023</td>
<td>-2.013</td>
<td>0.012</td>
</tr>
<tr>
<td>RCRAR1</td>
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<td>0.210</td>
<td>10.179</td>
<td>0.433</td>
</tr>
<tr>
<td>RCRAR2</td>
<td>502.410</td>
<td>0.000</td>
<td>541.295</td>
<td>0.000</td>
</tr>
<tr>
<td>SIZE</td>
<td>-5.957</td>
<td>0.000</td>
<td>-4.752</td>
<td>0.000</td>
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<tr>
<td>Adjusted R Square</td>
<td>0.547</td>
<td></td>
<td>0.556</td>
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</tbody>
</table>

Note: TFP: Total factor productivity; NNPA: Ratio of net non-performing assets to net advances; RCRAR1, RCRAR2: Regulatory pressure variable; SIZE: Log of total asset of the bank. *, ** and *** indicate significance at 10, 5 and 1 per cent, respectively.

Source: Author’s own calculations.