Productivity of Indian Banks since 2000s: Impact of Technology

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Abstract

In the first decade of the onset of the process of liberalization, the objective of the banking sector was to increase productivity, profitability and efficiency of banks. In the second decade, i.e., in the 2000s, more emphasis was given on technology and innovation in order to become more modern, competitive and of course, efficient. Introduction of various IT-embedded products such as Internet banking, mobile banking, RTGS are testimony to this trend. In our paper, we make a modest attempt to find whether this widespread technological transformation has translated into higher productivity and efficiency. For this, we have estimated the non-parametric Malmquist total factor productivity (TFP) index for the period 2001-2010. We have considered deposit, advance and investment as three outputs whereas interest expenses, payments to and provisions for employees and non-employee expenses have been treated as the three inputs. We find the direction of TFP and technological change almost same for the entire time span. The only aberration was the year 2007 which coincided with the global financial recession. The study further finds negative association between TFP and business generated per employee, giving adequate indication of the generation of bad loans.

Keywords: *Liberalization, Banks, Efficiency, Total Factor Productivity*

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Introduction

The aim of the banking sector reforms initiated in India in the early 1990s was to enhance the productivity, profitability and efficiency of banks. However, majority of the banking reform measures in the first decade of liberalization were essentially centred on various relaxations, deregulation, and easing of norms pertaining to the financial operating environment. Diffusion of technology and innovations were not given much importance in the early phase of liberalization. In the second decade of liberalization, this scenario has changed.

In fact, since 2000s, Indian banks started to give more emphasis on technology and innovation in order to become more modern, competitive and of course, efficient. Introduction of various IT-embedded products such as Internet banking, mobile banking, core banking solutions (CBS), real time gross settlements (RTGS) have transformed the Indian banking arena since then.

Technology has turned out to be an integral part of banking. It has not only made availing of institutional financial services easier, but also made it more profitable for the service providers. The perceived idea is that wider usage of technology would augment productivity and efficiency. Studies also suggest that improved IT culture in the banking space enhances competitiveness, capitalisation and lowers costs (Leeladhar, 2006; Rishi and Saxena, 2004; Das and Ghosh, 2004). In our paper, we make a modest attempt to find whether this widespread technological transformation has translated into higher productivity and efficiency. For this, we have employed non-parametric Malmquist total factor productivity (TFP) index. We have taken public sector banks (PSBs) in India during the period 2001-2010 for this study. We have made an attempt to see whether technological growth has indeed been translated into higher productivity of the PSBs. The year-over-year change in TFP, pure technical change and efficiency change are assessed critically in order to find some trend in technology adoption of the Indian banks. The paper also makes an attempt to assess the role of the banking staff in influencing banks' productivity in the age of increased technology adoption. Also, the cost implications of heightened technology absorption are evaluated.

Importantly, banking productivity and efficiency studies provide useful inputs to policymakers to make decisions on adhering to or declining a set of policy initiatives. This type of analysis brings to the fore successful technology adoption stories of some types of banks, thereby providing huge connotations for policy makers.

This is a preliminary and limited attempt to decipher the relationship between productivity and technology adoption by PSBs which perform multifarious activities, including some social obligations. Moreover, TFP is also a complicated economic parameter which entails both technical and economic efficiency. Our paper gives some evident signs of a positive correlation between productivity growth and technical change. Our paper is divided into six sections. Section 2 deals with the understanding behind the Malmquist TFP index. In section 3, we review some important studies showcasing the relationship between technology change and productivity, mainly in the context of Indian banks. Section 4 briefly introduces and describes the data used in the study. In section 5, we describe our findings. And, in section 6, we conclude.

2. Understanding behind the Malmquist TFP index

Productivity is generally defined in terms of the input and output produced by a firm. In a simple sense, it is defined as the ratio of output and input. The larger values of this ratio are associated with better performance of a firm. Productivity is also defined in terms of efficiency improvement and technical changes with which inputs are transformed into outputs in the production process. When multiple inputs and outputs are involved, productivity measure is the simple ratio of the output and input quantities called TFP or Multi Factor productivity (MFP). It is an

overall indicator of productivity of a firm which shows how it optimally uses all of its resources to create its yield. Furthermore, TFP is a broader measure of economic and technical efficiency reflecting several other factors including managerial efficiency, economies of scale and human capital utilization; TFP can be split into two major components -- technological progress and improvement in technical efficiency. Technological progress is often directly related to TFP, especially in banking. A characteristic of the banking sector is its predominance of new technology which may be attributed to the introduction of latest technology, technology based service mechanisms, management, etc., which lead to the expansion of the best production frontier and thereby results in higher output with the given input of resources. An interested reader may refer to Coelli et al. (2005) for more details about productivity, efficiency and its measurements. Malmquist indices can be estimated either by using an input-oriented approach or an output-oriented approach.

Conceptually, input orientation means how much input quantities can be proportionally reduced without changing the output quantity produced. Output orientation means how much output quantities can be proportionally expanded without altering the input quantities used.

Jaffry et al. (2007) pointed out that output orientation is more appropriate given the objectives of a developing country's banking industry. In order to calculate the Malmquist Output Oriented TFP Change Index, the first step is to define distance functions with respect to two different time periods.

A convenient way to describe a multi-input, multi-output production technology is to use the technology set, S. Following Fare and Primont (1995), the notations X and q are used to denote an N x l input vector of non-negative real numbers and a non-negative M x l output vector, respectively. The technology set is defined as

$$S = \{(X, q): X \text{ can produce } q\} \quad (1)$$

This set consists of all input-output vectors (X, q) such that X can produce q.

Production technology defined by the set S, may be equivalently defined by the output set P(x) which represents the set of all output vector q, that can be produced by input vector X. The output set is defined by:

$$P(x) = \{(X, q) \in S\} \quad (2)$$

The output distance function is defined on the output set $P(x)$ as:

$$d_0(x, q) = Min\{\delta : (q/\delta) \in P(x)\} \quad (3)$$

where δ is the ratio of two points in the production set. The Malmquist TFP Index in Fare et al. (1994) measures the TFP change between two data points by calculating the ratio of the distances of each data point relative to a common technology. Due to this, no longer do we have a situation where the ratio of the distance functions provides a measure of TFP change that is identical to technical change (that is, frontier shift). Thus, when panel data are available, one can obtain a measure of TFP change that has two components -- a technical change component and a technical efficiency change component.

The Malmquist (output-oriented) TFP Change Index between period s (the base period) and period t is can be written as:

$$m_0^t = (q_s, x_s, q_t, x_t) = \frac{d_0^t(q_t, x_t)}{d_0^t(q_s, x_s)} \quad (4)$$

Alternatively, if in the period s reference technology is used, it is defined as:

$$m_0^s = (q_s, x_s, q_t, x_t) = \frac{d_0^s(q_t, x_t)}{d_0^s(q_s, x_s)} \quad (5)$$

In these equations the notation $d_0^s(q_t, x_t)$

represents the distance from the period t observation to the period s technology. A value of greater than one indicates positive TFP growth from period s to period t while a value less than one indicates a TFP decline. The Malmquist TFP Index is often defined as the geometric mean of these two indices in the spirit of Caves et al. (1982). That is:

$$m_0^s = (q_s, x_s, q_t, x_t) = \left[\frac{d_0^s(q_t, x_t)}{d_0^s(q_s, x_s)} \times \frac{d_0^t(q_t, x_t)}{d_0^t(q_s, x_s)} \right]^{1/2} \quad (6)$$

The distance functions in this productivity index can be rearranged to show that it is equivalent to the product of a technical efficiency change index and an index of technical change:

$$m_0^s = (q_s, x_s, q_t, x_t) = \frac{d_0^t(q_t, x_t)}{d_0^s(q_s, x_s)} \left[\frac{d_0^s(q_t, x_t)}{d_0^t(q_t, x_t)} \times \frac{d_0^s(q_s, x_s)}{d_0^t(q_s, x_s)} \right]^{1/2} \quad (7)$$

The ratio outside the square brackets in equation 7 measures the change in the output-oriented measure of Farrell technical efficiency between periods s and t. The remaining part of the index in equation 7 is a measure of technical change. It is the geometric mean of the shift in technology between the two periods, evaluated xt and also at xs. Thus, the two terms in equation 7 are:

Efficiency Change (EC)

$$= \frac{d_0^t(q_t, x_t)}{d_0^s(q_s, x_s)} \quad (8)$$

Technical Change (TC)

$$= \left[\frac{d_0^s(q_t, x_t)}{d_0^t(q_t, x_t)} \times \frac{d_0^s(q_s, x_s)}{d_0^t(q_s, x_s)} \right]^{1/2} \quad (9)$$

Technical efficiency change can be decomposed into scale efficiency and 'pure' technical efficiency components when the distance functions in the equations given earlier are estimated relative to a Constant Return to Scale (CRS) technology.

This decomposition involving scale efficiency has been widely used in the literature.

Review of Literature

Considerable research studies have been done on the productivity and performance of Indian banks on various banking parameters. The objective of the economic reforms of 1990 was to enhance the efficiency, profitability and productivity of banks. But after 2000, application of technology in the banking sector got priority and it enabled to significantly improve the performance of Indian banks. The following existing literature relating to use of technology in banks in the context of performance analysis has been reviewed.

Das and Ghosh (2006) examined the inter-relationship among risk, capital and productivity changes in public sector banks in India from 1995-96 through 2000-2001. They concluded that higher productivity led to a decrease in credit risk and a positive influence on bank capitalization. Poor performers were more prone to risk taking than better performing organizations. The study supported the fact that productivity, capital and risk-taking tend to be determined jointly and that these compensated each other.

Janki (2002) analysed the effect of technology on the productivity of employees for 1986-91 by employing the DEA methodology. He found that public sector banks had the highest efficiency followed by foreign banks. Private banks were found to be the least efficient.

Ram Mohan and Ray (2004) attempted a comparison between public sector banks and their private sector counterparts based on measures of productivity during 1992-2000. They used Tornqvist and Malmquist Total Factor Productivity growth for comparison. They found that there was no significant difference in productivity growth between the public and private sectors in the period under study.

Bhandari (2010) studied Total Factor Productivity improvement achieved by 68 Indian commercial banks from 1998-99 to 2006-07. He decomposed the TFP into technical change, technical efficiency change and scale

(efficiency) change. The results suggest that public sector banks were, on an average, adjusting themselves to the changing environment better and improving their performance relative to their counterparts under private and foreign ownership.

Koutsomanoli et al. (2009) studied bank efficiency and productivity change across Central and Eastern European (CEE) countries and across banks with different ownership status for 1998–2003 using the directional technology distance function. Their results demonstrate strong links of competition and concentration with bank efficiency. Productivity for the whole region initially declined but improved more recently with further progress on institutional and structural reforms. Overall, productivity change in CEE was driven by technological change rather than efficiency change.

Mittal and Dhingra (2007) assessed the impact of computerization on productivity and profitability of Indian banks employing DEA. Private sector banks, which took more IT initiative, were found to be more efficient in productivity and profitability parameters than public sector banks. Out of the many factors analysed, increased IT investments was one of the vital contributing factors for enhanced performance.

Rajput et al. (2011) studied the impact of IT on the Indian commercial banking industry based on the DEA technique. The results represented that all scheduled commercial banks showed a significant and improving trend in their performance due to the adoption of IT. There was an increasing trend in the performance of Indian banks because of IT innovations and enlarged investment in new information technologies during the recent time period 2005-10 as judged by a stochastic frontier analysis (Kumar et al., 2011). On both cost and profitability-based parameters, productivity and efficiency of Indian banks have seen a definite improvement over the last two decades.

Sujeesh Kumar S. (2013) analysed the impact of information technology on the total factor productivity of Indian banking sector and found that Indian banking industry was productive as judged by the Malmquist Productivity Index during 2008 to 2010 compared with the preceding and succeeding years in the time band 2005-12. According to him, the average annual productivity growth rate in 2008-10 was 11 per cent which was mainly due to the result of a 28 per cent technological progress during the period. Further, it is observed that increased electronic transactions in the banking channel resulted in increase in productivity.

Pal, Bishnoi (2009) applied Malmquist TFP index on panel data of 63 commercial banks operating in India from 1996-2005 with a focus on three major approaches (a) asset approach (b) value added approach and (c) income approach. He found that national public sector banks had attained the highest growth in overall productivity and its components under the asset and income approaches. The foreign sector banks had performed better than other categories of banks for value addition approach.

Pandey and Singh (2015) attempted to assess bank productivity in India during the period 2008-2013, using Malmquist Productivity Index of Total Factor Productivity (TFP) growth into technical change and change in scale efficiency using panel data of 40 banks including 26 public sector banks, 10 private banks and 4 foreign banks, following an intermediation approach, taking two outputs and three input variables. Outputs taken were 1) loans and advances 2) Profits; inputs used were 1) Branches 2) Staff 3) deposits. They found that the whole banking system in India had a positive growth during the period of study.

Sivramkrishna (2018) used sectoral T-accounts and analysed the implication of bank bail-outs and bail-ins. It is believed that bank bail-outs do not utilize taxpayers' money. Moreover, bank bail-outs funded through recapitalization bonds or deficit financing and bail-ins have similar net effects on sectoral balance sheets. They have shown that questions of moral hazard and normative issues of fairness must not be ignored.

Gaur and Mohapatra (2019) argued that the main reason for NPAs could be attributed to the types and patterns of lending. They made a comparison between NPAs in priority and non-priority sectors with respect to private and public sector banks in India. An attempt has been made to distinguish NPAs in priority sector in the private sector and public sector banks.

Handa (2020) conducted a study of 36 banks operational in India in the time period of ten years (2007-2016). Financial performance of banks is found to share a statistically significant relationship with the number of committees of the board. This relationship is confirmed for its non-linear effect on both Return on Assets (ROA) and Return on Equity (ROE). This relationship establishes the pertinent role of board committee structures in shaping the financial performance of struggling Indian banks.

Data used in the Study

In order to find out Malmquist total factor productivity index, we have adopted the production approach, propounded by Benston (1965), which considers banks as the providers of services to customers. Under this approach, banks operate like a production unit. Banks use various resources like employees, equipment, payments to the employees, other non-interest expenses etc. as inputs to produce outputs such as deposits, assets, interest income, non-interest income etc. There is a large volume of literature on bank efficiency which treats banks as production units. Berger and Humphrey (1997) suggest production approach to be more apt to evaluate efficiency at the branch level rather than the bank level.

In our study, by following the production approach, we have considered deposit (dep), advance (adv) and investment (inv) as three outputs, whereas interest expenses (ie), payments to and provisions for employees (ee) and non-employee expenses (nee) have been treated as the three inputs.

For empirical analysis, we have relied on the data supplied by Reserve Bank of India (RBI). We have taken data of 25 public sector banks on both inputs and outputs for the period of 2001-2010. Data on deposits, investments and advances have been taken from RBI bank-wise data on assets and liabilities. In the data set, deposits are presented in the liabilities side and advances and investments are presented in the asset side. Data on interest expenses, labour expenses and non-labour expenses are obtained from the RBI bank-wise data on incomes and expenses. A brief description of the variables used in the study has been given in Table 1. Among all these variables, the highest degree of variation has been observed with respect to the variable non-employee expenses.

Table 1: Descriptive Statistics of Outputs & Inputs (Amount in Rs. Lakh)

	Investment	Advance	Deposit	Interest Expenses	Employee Expenses	Non-employee Expenses
Mean	2679743.4	4630413.73	7099165	404863.94	104670.0223	52696.42012
CV	139.4	150.91	134.35	137.2	144.2814563	153.2093472
Max	29578520	63191415.2	80411623	4732247.8	1275464.57	756342.43
MIN	355032.07	428671.12	760828.7	60173.71	19999.58	6590.78

Source: Authors' Calculation

This indicates a higher disparity among different PSBs so far as operating expenses other than the expenses related to the payments to and provisions for employees is concerned. Among the output variables, there is large variation among different banks in terms of the advances generated. This implies that some banks have generated higher amount of loans compared to their counterparts. Among all these variables, the least variation has been observed in deposits generated by different public sector banks.

Findings of the Study

The findings we arrive at comprise of two exercises. At the beginning, we provide the estimate of Malmquist TFP index which hinges on resource use. However, this is only half the story. Consequently, we embark upon finding some causes behind the difference in productivity by employing multiple regression analysis.

Malmquist TFP index Result

Table 2 depicts the decomposition of TFP of the public sector banks in India during the period 2000 to 2010. From the table, it is evident that the years 2003, 2004, 2007, 2009 and 2010 witnessed positive growth in TFP. It is also evidenced from the table that out of these 5 years of positive TFP growth, in four years (2003, 2004, 2009 and 2010), growth in TFP was aided by technological progress. Only in 2007, direction of changes in technological progress and productivity growth is opposite. The year 2007 saw a lag in technology adoption by the Indian PSBs. Importantly, the year 2007 coincided with the financial recession that shook the global financial system. Indian banking system was however relatively unscathed, thanks to relatively orthodox stance taken by the Indian banks. However, the positive productivity growth of 2007 may be due to improved managerial performance, better utilization of human capital and economies of scale.

Table 2: Decomposition of TFP in the Indian Banking Sector for 2001-2010

Year	Efficiency change (EC)	Technological change (TC)	Pure technical efficiency change (PTEC)	Scale efficiency change (SEC)	Total factor Productivity (TFP)	Growth in total factor productivity	Growth in technological change
2002	1.005	1.055	1.006	0.999	1.06		
2003	0.982	1.108	0.998	0.985	1.088	2.641509	5.023697
2004	1	1.127	0.995	1.005	1.127	3.584559	1.714801
2005	1.03	1.042	1.013	1.018	1.073	-4.79148	-7.54215
2006	0.995	0.982	0.995	0.999	0.977	-8.94688	-5.75816
2007	1.014	0.977	1.015	0.999	0.991	1.432958	-0.50916
2008	0.988	0.961	0.993	0.995	0.95	-4.13724	-1.63767
2009	0.993	1	1	0.993	0.993	4.526316	4.058273
2010	0.985	1.102	0.991	0.994	1.085	9.264854	10.2
Mean 2001-2010	0.999	1.038	1.001	0.999	1.037	-4.42396	

Source: Authors' Calculation

During the period of study, the year 2010 witnessed maximum growth in TFP (9.3%), which was supported by maximum growth in terms of technology up-gradation/adoption by the Indian PSBs. The year 2009-10 was in fact a landmark year for the Indian banks, in terms of technology assimilation, as many banks put into practice the Core Banking Solutions and other related technologies, which actually aided in productivity growth.

In 2003 and 2004, both the TFP and the technological adoption saw positive growth in the Indian PSBs. It was in the early 2000s that under the Information Technology Act, technological globalization started to make inroads into the Indian banking arena. During this period, electronic banking transactions were being facilitated. IT-based delivery channels, enhancing customer services at banks (introduction of

Automated Teller Machines, card-based transactions, cash-delivery, settlements, etc.) were introduced.

The succeeding years (2005 and 2006) witnessed a slowdown in productivity growth. This may be partly due to time taken by the PSBs to adjust themselves to the changed situation. The negative growth in productivity is the indicator of the impact of a new situation and gradual adjustment.

Multiple Regression Result

The multiple regression model has been used to check whether business generated by employees (BPE) might have any influence on the total factor productivity. The relationship between operating expenses per branch (OEPB) with productivity has also been assessed. In fact, lower expense in managing a branch indicates improvement in technology. Lower operating expenses per branch should result in higher productivity. The following multiple regression model is estimated:

$$\text{Ln (TFP)} = \beta_0 + \beta_1 \text{ Ln (BPE)} + \beta_2 \text{ Ln (OEPB)} + \varepsilon \quad (10)$$

ε is the error term independently and identically distributed with N(0,σ2). Following De bandt and Davis (2000), the log linear form is chosen as it improves the goodness fit of the model and may lower a simultaneity bias. The multi-collinearity aspect has also been taken into consideration.

Here, since the number of independent variables is two, the underlying test that is carried out is the t test. However, by observing the p-value, we can make the decision about the nature of the relationship between the dependent and the independent variables.

Table 3: Dependent Variable: TFP

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.104437	0.020722	5.039889	0.0000
BPE	-0.045087	0.010395	-4.337526	0.0000
OEPB	-0.000628	0.002988	-0.210342	0.8336

Source: Authors' calculation

From the regression results, it is evident that BPE negatively influences the TFP. This may be due to the fact that a part of the advance generated by the system actually turns out to be unproductive for the banking system. In other words, higher credit growth amplifies bank fragility. In terms of policy implications, there is huge need for giving priority to risk-based supervision as a way to contain the potential risks associated with rapid credit growth (Ghosh, 2010).

Interestingly, operating expenses per branch, which is a relatively robust indicator of technological penetration in the banking sector, has turned out to be an insignificant factor influencing the total factor productivity. Instead, the proliferation of bad loans has proved to be the pervasive and prominent factor impacting total factor productivity.

Applicability, Generalizability and Conclusion

Efficiency analysis involves resource use pattern. In the era of heightened liberalization, when the PSBs in India are ushering in new technology adoption, the assessment of effective resource usage becomes very important. These kinds of studies prove to be very crucial for management practitioners and policy makers to help them find the root cause of inefficiency and meet challenges.

Our results show that direction of technological change and total factor productivity growth have mostly been the same for the Indian public sector banks during the period 2002-2010. In other words, increased usage of technology has translated into improved productivity. The only exception being the

year 2007, which coincided with unprecedented global financial recession. Indian banks, though relatively unscathed, might have had some retrograding effect in terms of technology assimilation. The global mayhem has forced Indian banks to exercise more restraint in imbibing technology in day-to-day operations of the banks. However, Indian PSBs recorded positive growth in TFP in 2007, indicating improved managerial performance, better utilization of human capital and economies of scale.

The negative relation between TFP and BPE provides ample hint that total business generated by a typical PSB does not lead to higher productivity and efficiency of the banks. In other words, generation of unworthy business in the form of bad loans eventually cripples the banking system. This generation of bad loans which have a corrosive effect on banks' productivity calls for adequate risk management and strengthening prudential norms for banks.

Our study supports the standard claim that technology assimilation has a positive bearing on banks' productivity. However, it does not eliminate the problems of huge bad loans handicapping all the banks, including the PSBs in India. Instead, this actually opens up a new research question - whether technology plays a stimulating role in the generation of NPAs. This requires a separate study. So, the impact of technology on banks' productivity must be taken with a pinch of salt. Technology, per se, should not be a deterrent to the basics of banking business, i.e., to accumulate deposits and to lend only to deserving candidates.

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[i]Banks execute various activities and offer a bouquet of products and services to the customers. Choice of inputs and outputs in the banking efficiency studies like Data Envelopment Analysis (DEA) depends upon the purpose and aim of the studies conducted by the researchers. According to Berger and Humphrey (1992), in the DEA analysis of banks, specification of inputs and outputs is fraught with controversies.

Inadequacy of data often makes selection of inputs and outputs of the banks difficult. Many of the financial services are jointly produced by the bank. Prices are allocated to a bundle of financial services too. This makes measurement of the output and the cost of a bank difficult. There is also ambiguity on what banks produce. The most dubious variable in this regard is deposit. Different opinions have cropped up whether to treat deposit as an input or an output. Two different and widely applicable approaches available in the banking efficiency studies are the *production approach* and the *intermediation approach* (Sealey and Lindley, 1977).

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