DIGITAL FINANCIAL SERVICES (DFS) AND PRODUCTIVITY OF INDIAN BANKING SECTOR - EMPIRICAL EVIDENCE USING MALMQUIST PRODUCTIVITY INDEX AND PANEL DATA REGRESSION

Sreekanth Peringanam Veluthedan\textsuperscript{A}, Kunjangada Bheemaiah Kiran\textsuperscript{B}

\begin{table}[h]
\centering
\begin{tabular}{|l|}
\hline
\textbf{ARTICLE INFO} \\
\hline
\textbf{Article history:} & \\
\textbf{Received} & 20 June 2023 \\
\textbf{Accepted} & 14 September 2023 \\
\hline
\textbf{Keywords:} & \\
Digital Financial Services (DFS); Productivity; Malmquist Productivity Index; Panel Data Regression. \\
\hline
\end{tabular}
\end{table}

\begin{table}[h]
\centering
\begin{tabular}{|l|}
\hline
\textbf{ABSTRACT} \\
\hline
\textbf{Purpose:} The aim of this study is to examine the impact of Digital Financial Services (DFS) on the productivity of banking sector in India. \\
\textbf{Theoretical framework:} This research considered various digital banking services offered by bank and how it affects the actual bank performance in terms of productivity, by adopting a two-stage model i.e., Malmquist Productivity Index (MPI) and panel data regression. \\
\textbf{Design/Methodology/Approach:} The empirical study was based on eight-year balanced panel data from 2012 to 2020. The sample of the study consists of forty-four commercial banks from India. This study is completely based on secondary data collected from the website of the database of the Indian economy and the National Payment Corporation of India (NPCI). To achieve the research goals, a two-stage approach has been used. Initially, Malmquist Productivity Index (MPI) was employed to estimate the total factor productivity changes. In the second phase, panel regression analyses were used to study the impact of Digital Financial Services (DFS) on bank productivity. \\
\textbf{Findings:} The findings show that the Digital Financial Services (DFS) variables such as mobile banking, online banking, Automatic Teller Machines (ATM) and Point of Sale (POS) transactions are significantly improved the productivity of the Indian banking industry. \\
\textbf{Research, Practical & Social implications:} The study addresses the issues such as identifications of factors affecting the productivity of banks including Digital Financial Services (DFS). In the world of digital revolution, it analyses whether bank can retain, continue and enhance their performance by offering modern product and services to their customers. \\
\textbf{Originality/Value:} This article has conducted extensive analyses of Digital Financial Services (DFS) and banks' productivity. The authors also provide suggestions for the policymakers for the future implementation of digital banking services. \\
\textbf{Doi:} https://doi.org/10.26668/businessreview/2023.v8i9.1904
\end{tabular}
\end{table}

\textsuperscript{A} Research Scholar. School of Humanities, Social Sciences and Management (SHSSM), National Institute of Technology Karnataka. India. E-mail: sreekanth06vijay@gmail.com

\textsuperscript{B} PhD in Economics. Professor. School of Humanities, Social Sciences and Management (SHSSM), National Institute of Technology Karnataka. India. E-mail: kunjangadabkiran2@gmail.com

Orcid: https://orcid.org/0000-0002-4573-5911

Orcid: https://orcid.org/0000-0002-9370-3690
SERVICIOS FINANCEIROS DIGITALES (DFS) E PRODUTIVIDADE DO SETOR BANCÁRIO INDIANO - EVIDÊNCIA EMPÍRICA USANDO ÍNDICE DE PRODUTIVIDADE MALMQUIST E REGRESSÃO DE DADOS EM PAINEL

RESUMO
Objetivo: O objetivo deste estudo é examinar o impacto dos Serviços Financeiros Digitais (DFS) na produtividade do setor bancário na Índia.

Referencial teórico: Esta pesquisa considerou diversos serviços bancários digitais oferecidos pelo banco e como isso afeta o desempenho real do banco em termos de produtividade, adotando um modelo de dois estágios, ou seja, Índice de Produtividade de Malmquist (IPM) e regressão de dados em painel.

Concepcão/Metodologia/Abordagem: O estudo empírico baseou-se em dados de painel equilibrados de oito anos, de 2012 a 2020. A amostra do estudo consiste em quarenta e quatro bancos comerciais da Índia. Este estudo é totalmente baseado em dados secundários coletados no site do banco de dados da economia indiana e da National Payment Corporation of India (NPCI). Para atingir os objetivos da pesquisa, foi utilizada uma abordagem em duas etapas. Inicialmente, o Índice de Produtividade Malmquist (IPM) foi empregado para estimar as mudanças totais na produtividade dos fatores. Na segunda fase, foram utilizadas análises de regressão em painel para estudar o impacto dos Serviços Financeiros Digitais (DFS) na produtividade bancária.

Constatações: As descobertas mostram que as variáveis dos Serviços Financeiros Digitais (DFS), como serviços bancários móveis, serviços bancários on-line, caixas eletrônicos (ATM) e transações em pontos de venda (POS), melhoram significativamente a produtividade do setor bancário indiano.

Implicações de pesquisa, práticas e sociais: O estudo aborda questões como a identificação de fatores que afetam a produtividade dos bancos, incluindo os Serviços Financeiros Digitais (DFS). No mundo da revolução digital, analisa se os bancos podem reter, continuar e melhorar o seu desempenho, oferecendo produtos e serviços modernos aos seus clientes.

Originalidade/Valor: Este artigo conduziu análises extensas dos Serviços Financeiros Digitais (DFS) e da produtividade dos bancos. Os autores também fornecem sugestões aos decisores políticos para a futura implementação de serviços bancários digitais.

Palavras-chave: Serviços Financeiros Digitais (DFS), Produtividade, Índice de Produtividade Malmquist, Regressão de Dados em Painel.

SERVICIOS FINANCIEROS DIGITALES (DFS) Y PRODUCTIVIDAD DEL SECTOR BANCARIO INDILO: EVIDENCIA EMPÍRICA UTILIZANDO EL ÍNDICE DE PRODUCTIVIDAD DE MALMQUIST Y REGRESIÓN DE DATOS DE PANEL

RESUMEN
Propósito: El objetivo de este estudio es examinar el impacto de los servicios financieros digitales (DFS) en la productividad del sector bancario en la India.

Marco teórico: esta investigación consideró varios servicios bancarios digitales ofrecidos por el banco y cómo afectan el desempeño real del banco en términos de productividad, mediante la adopción de un modelo de dos etapas, es decir, el índice de productividad de Malmquist (IPM) y la regresión de datos de panel.

Diseño/Metodología/Enfoque: El estudio empírico se basó en datos de panel equilibrados de ocho años de 2012 a 2020. La muestra del estudio consta de cuarenta y cuatro bancos comerciales de la India. Este estudio se basa completamente en datos secundarios recopilados del sitio web de la base de datos de la economía india y de la Corporación Nacional de Pagos de la India (NPCI). Para lograr los objetivos de la investigación, se ha utilizado un enfoque de dos etapas. Inicialmente, se empleó el índice de productividad de Malmquist (IPM) para estimar los cambios en la productividad total de los factores. En la segunda fase, se utilizaron análisis de regresión de panel para estudiar el impacto de los Servicios Financieros Digitales (SFD) en la productividad bancaria.

Hallazgos: Los hallazgos muestran que las variables de los Servicios Financieros Digitales (DFS), como la banca móvil, la banca en línea, los cajeros automáticos (ATM) y las transacciones en puntos de venta (POS), mejoran significativamente la productividad de la industria bancaria india.

Implicaciones de investigación, Prácticas y Sociales: el estudio aborda cuestiones como la identificación de factores que afectan la productividad de los bancos, incluidos los servicios financieros digitales (DFS). En el mundo de la revolución digital, analiza si el banco puede retener, continuar y mejorar su desempeño ofreciendo productos y servicios modernos a sus clientes.

Originalidad/Valor: este artículo ha realizado análisis exhaustivos de los servicios financieros digitales (DFS) y la productividad de los bancos. Los autores también ofrecen sugerencias a los responsables de la formulación de políticas para la futura implementación de servicios bancarios digitales.
INTRODUCTION

The banking sector is a significant facet of the financial services system in India. Banks play a vital role in the development of countries by mobilizing and efficiently allocating resources as outlined by Pathak (2010) and C. A. Kumar & Gireesh (2016). Since the 18th century, the banking industry has been developing and is known as one of the oldest type of businesses in the world, it has progressed and grown with every passing year. Phan Thanh Tam (2023) identified technology factors affect commercial banks’ service quality in Vietnam. Das et al (2005) and Das & Ghosh (2006) studied that there were remarkable changes seen in the Indian banking industry during the post-liberalization period. The use of core banking can be seen as a stepping stone to modern technological developments in banking. A significant part of Indian banking moved online with internet banking and mobile applications available for various financial services.

RM Shanmugam (2022) investigated that in this competitive banking scenario, banks require electronic banking services’ assistance to offer their customers the best satisfaction. Similarly, innovation and establishment of various digital financial products such as Automated Teller Machine (ATM), Point of Sale (POS), debit card and credit card, electronic funds transfer (EFT), e-banking, internet banking, Unified Payment Interface (UPI) etc have been as another area of development in recent years. These services are collectively known as Digital Financial Services (DFS). Agur et al. (2020) defined Digital Financial Services (DFS) as financial services (e.g., payments, remittances, and credit) accessed and delivered through digital channels using computers and mobile devices. The digital channels refer to the internet, mobile phones, ATMs, POS terminals etc.

Nowadays, it is possible to see banks are competing with each other to provide financial services to their customers in digital mode. The decision of banks to add more digital solutions at all operational levels will have a significant impact on performance. The analysis of bank performance is become a complex process since they are providing intangible services. Bikker & Bos (2008) and Ahmad et al. (2020) analysed bank performance in terms of productivity, efficiency and profitability. Productivity is measured as an alternative measure of a bank’s performance. Roghanian et al. (2012) explored the productivity of a bank is a considerable factor while measuring the performance of an organization.
Productivity of banking sector is important, because the banking sector is a major supplier of intermediate services (such as payment services and financing facilities) to the economy. In India, according to World Bank Group, 2017, about 46.2% of total production comes from the service sector, including banks. This means that bank productivity is an important element in the development of the Indian economy.

The productivity is the ratio between the output of goods and services and the input of resources used to produce them. Productivity is considered as the ability and willingness of an economic unit to produce the maximum possible output with given inputs and technology. Narthe et al. (2019) observed that a productivity increase leads to improves cost efficiency, proper allocation of resources, improved service quality, better performance and a general increment in the entire economy’s productivity. Berger & Humphrey (1997) and Casu et al. (2004) studies that consequently, productivity analysis in the banking sector have gained interest among key stakeholders Several studies have been conducted on the productivity of Indian banks such as Kamath (2007), Mondal & Ghosh (2012) and Soriya & Narwal (2015). There are very few studies which is establishing the relationship between Digital Financial Services (DFS) and bank’s productivity.

The objective of this study is to analyse the possible effects of digital banking on bank productivity, a two-stage empirical methodology is followed as per recent studies. In the first phase, the Malmquist Productivity Index (MPI) was employed to estimate banks' productivity indices, employing a decomposition that isolates the contributions of technical, efficiency and scale changes. Then, in the second stage, panel data regressions to test the impact of digital banking on productivity.

**LITERATURE REVIEW**

The concept of productivity refers to the performance of the sector as a whole and effectively combines changes in efficiency and technological advances. Increasing productivity implies that more output is produced with the same number of inputs or comparatively fewer inputs are required to produce the equal level of output. This productivity growth encompasses the change in efficiency, as a further increase in efficiency definitely raises productivity (Rogers, 1998). Kaur et al. (2012) studied the impact of Information Technologies (IT) on the branch productivity of Indian banking in the transformation era. Business per branch has been selected as dependent variable to evaluate the impact of Information Technologies (IT). The independent variables comprise the variables such as computerized branches, ATMs per...
branch, credit cards per branch, internet banking, mobile banking and telebanking. The study concludes that IT, along with other factors, improves productivity at an excellent rate and fully IT-oriented banks are the most beneficiaries, whereas partially IT-oriented banks proved to increase in productivity in the post-e-banking period but still not harmonized with fully IT-oriented banks.

Mashal (2006) investigated the impact of Information Technology (IT) investment on productivity and profitability of Arab Bank, one of the top banks in Jordan, during the period 1985 to 2004. IT capital, non-IT capital, IS labor expenses and non-IS labor expenses were used as independent variables, and loans and advances and net income are the proxies of the dependent variable. The results shows that there are substantial returns due to an increase in investment in IT capital.

Pereira (2004) empirically studied the impacts of Information Systems and Technology (IST) on the productivity and competitiveness of the Portuguese banking sector during the period 1994-1999. The Information Systems and Technology (IST) variables include capital spent on hardware, software, external IST services, number of IST employees and computers. The investment in IST in Portuguese banks is high and the acceptance by their clients of electronic solutions (like POS, ATMs and Internet access) is also high. There is an increase of 162.2% in the amount of money in POS and ATM transactions during the period of analysis. However, there was just an increase of 105.5% in the number of ATMs and POS transactions which shows the excellent acceptance and use of electronic channels by clients.

Casolaro & Gobbi (2007) analysed the effects of an investment in Information Technologies (IT) in the Italian financial sector using panel data from a 600 Italian banks over the period 1989-2000. The explanatory variable used in the regressions are the log of IT capital price, wages paid to IT personnel, the share of IT expenses, number of phone and electronic banking accounts, Number of ATMs etc. Overall, over the past decade, IT capital-deepening contribution to the total factor productivity growth of the Italian banking industry can be assessed between 1.3 and 1.8 percent per year. Boris et al. (2014) investigated the impact of Information and Communications Technology (ICT) capital on productivity in Serbian banks and found that the banks as financial service sectors in developed countries are pretty similar in terms of efficiency and that efficiency and productivity depend more and more on ICT capital.

Gul et al. (2021) aim to investigate the impact of data analytics on the productivity of banks in Pakistan. The findings suggest that the productivity is increased 5.9% on an average
for the banks that are invested in data analytics. The study also found that productivity increase is associated with an investment in data analytics compared to a mere investment in any software. It is recommended that banks in Pakistan should invest in those data analytics that have predictive, visualizing and analytical capabilities. The use of these innovative technologies should be combined with training and human capital development to ensure sustainable firm performance.

Very few literature studies have addressed the issue of productivity changes in the Indian banking industry. S. S. Kumar (2013) attempted to study the impact of Information Technology (IT) on the productivity of the Indian banking sector using Malmquist Productivity Index (MPI) and a multiple regression model. Explanatory variables considered are electronic transactions, total cheque value and intermediation cost as a proxy of investment for technology systems. The results show that the Indian banking industry experienced a growth in productivity as judged by Malmquist Productivity Index during 2008-10. The succeeding years showed a diminished growth in productivity of Indian banks. Further, the multiple regression analysis suggests that increased electronic transactions in the banking sector have resulted in an increase in productivity.

Mittal & Dhingra (2007) evaluated the impact of computerization on the performance of Indian banks in terms of their profitability and productivity. Indian banks are investing heavily in the digital banking such as telebanking, mobile banking, net banking, Automated Teller Machine (ATMs), credit cards, debit cards, smart cards, call centers, Customer Relationship Management (CRM), data warehousing etc. Data Envelopment Analysis (DEA) is used to study the impact of computerization on Indian banks' profitability and productivity. The private sector banks, which took more information technology initiative, were found to be more efficient in productivity and profitability parameters than public sector banks.

Productivity analysis alone has been widely used in the literature to measure the banks' performance, namely Narwal & Pathneja (2016), Nartey et al. (2019) and Huljak et al. (2022). The banks' productivity alone was studied by different authors in a different context. In the view of the absence of prior studies relating digital banking to the productivity of banks, the empirical analysis in this paper draws on the established literature linking digital banking to the productivity of banks. The main focus of this paper is thus to test the impact of digital banking on bank productivity.
MATERIALS AND METHODS

This study has selected 44 banks as sample from three groups (18 public, 20 private and 6 foreign banks) on the basis of availability of data to represent the entire Indian banking sector. The data from 2012-13 to 2019-20 was considered with a time span of eight years, which constitute a balanced panel data with 352 observations. Malmquist Productivity Index (MPI) and Panel Data Regression Analysis used to investigate the impact of digital financial services on bank productivity growth, we use a two-stage approach as used by S. S. Kumar (2013). The Malmquist Productivity Index (MPI) is a bilateral index that can be used to compare the production technology of two economies and was introduced by Professor Sten Malmquist. This approach is the most popular nonparametric method used to obtain Total factor Productivity (TFP) growth estimates. Here, the productivity indices are calculated by using set of inputs and outputs. Here, the selection of inputs and outputs for the estimation applying Malmquist index on the basis of the intermediation approach, which assumes that banks collect funds, using labor and physical capital, to transform them into loans and other earning assets (OEA) as outlined by Sealey Jr & Lindley (1977).

The majority of the empirical literature such as Isik & Hassan (2002), Bader et al. (2008), Sufian et al. (2012), Sufian et al. (2013) and Kamarudin et al. (2014) adopted a modified version of intermediation approach as opposed to the production approach for selecting input and output variables to construct the TFP frontiers. Therefore, current study uses three inputs of deposits, labor and physical capital and two outputs, namely, loans and advances and other earnings assets (investments). According to Banker et al. (1989) there is a rough rule of thumb that needs to be met to select the numbers of input and outputs used in the analysis. The sample size $n \geq \max \{m \times s, 3(m + s)\}$. As the total numbers of DMUs in this study are 44 banks, it is higher than the number of input and output variables $44 \geq \max \{3 \times 2, 3(3 + 2)\}$. Therefore, the selection of variables is valid as they comply with the rule of thumb, which allows the productivity of DMUs to be measured. The description of the selected input and outputs given in the table 1 below;

<table>
<thead>
<tr>
<th>Variables</th>
<th>Definition</th>
<th>Description</th>
<th>Citation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input X1</td>
<td>Deposits</td>
<td>Total Deposits</td>
<td>(Lyroudi &amp; Angelidis, 2006), (Casu &amp; Girardone, 2006), (Ariss, 2010), (Sufian, 2011), (S. S. Kumar, 2013), (Kamarudin et al., 2017), (Kamarudin et al., 2020), and (Jubilee et al., 2021),</td>
</tr>
<tr>
<td>Input X2</td>
<td>Labor</td>
<td>Total Personnel Expenses</td>
<td></td>
</tr>
<tr>
<td>Input X3</td>
<td>Physical Capital</td>
<td>Fixed Assets</td>
<td></td>
</tr>
<tr>
<td>Output Y1</td>
<td>Loans and Advances</td>
<td>Total Loans &amp; Advances</td>
<td></td>
</tr>
<tr>
<td>Output Y2</td>
<td>Other Earnings Assets</td>
<td>Investment in Securities</td>
<td></td>
</tr>
</tbody>
</table>

Source: Prepared by the researchers based on the citations given above
The DEA-Based Malmquist Productivity Index (MPI) decomposed into five productivity indices. They are, Total Factor Productivity Change (TFPCH), Technological Change (TECHCH), Efficiency Change (EFFCH), Pure Efficiency Change (PECH) and Scale Efficiency Change (SECH). Any value greater (lower) than 1.000 will indicate total factor productivity growth (regress) between two periods, whereas value equivalent to 1.000 signals no change.

In order to assess and evaluate the various factors determining total factor productivity and its components, the panel data regression is used. Productivity scores estimated using data envelopment analysis that is total factor productivity change (TFPCH) and efficiency change (EFFCH) are used as dependent variables. All other independent variables are discussed in Table no 2.

<table>
<thead>
<tr>
<th>Table 2 Detailed Description of Variables Selected for Panel Regression</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type</strong></td>
</tr>
<tr>
<td>Dependent Variables</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Bank Specific Determinants</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Market Specific Determinants</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Digital Financial Services Determinants</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

Source: Prepared by the researchers based on the citations given above.

This research was divided into two stages, wherein the first stage determined the productivity scores of the intermediate function of banks from 2013 to 2020. The second stage approached the panel regression analysis which determined the influence of the bank specific, industry specific and digital financial services activity on the defined productivity scores.
Veluthedan, S. P., Kiran, K. B. (2023)
Digital Financial Services (DFS) and Productivity of Indian Banking Sector - Empirical Evidence Using Malmquist Productivity Index and Panel Data Regression

Stage I - Malmquist Productivity Index (MPI)

**Figure 1. Stage I**

![Diagram showing Stage I - Malmquist Productivity Index (MPI)]

Source: Prepared by the author

Stage II - Panel Data Regression Analysis

\[
\text{TFPCHit} = \alpha + \beta_1 \text{Size}_{it} + \beta_2 \text{NPA}_{it} + \beta_3 \text{CTD}_{it} + \beta_4 \text{OVERHEAD}_{it} + \beta_5 \text{ROE}_{it} + \beta_6 \text{LNIM}_{it} + \beta_7 \text{INFL}_{it} + \beta_8 \text{GFD}_{it} + \beta_9 \text{GCF}_{it} + \beta_{10} \text{LATMPOS}_{it} + \beta_{11} \text{LMBANK}_{it} + \beta_{12} \text{LONLINE}_{it} + \varepsilon_{it} \quad (1)
\]

\[
\text{TECHCHit} = \alpha + \beta_1 \text{Size}_{it} + \beta_2 \text{NPA}_{it} + \beta_3 \text{CTD}_{it} + \beta_4 \text{OVERHEAD}_{it} + \beta_5 \text{ROE}_{it} + \beta_6 \text{LNIM}_{it} + \beta_7 \text{INFL}_{it} + \beta_8 \text{GFD}_{it} + \beta_9 \text{GCF}_{it} + \beta_{10} \text{LATMPOS}_{it} + \beta_{11} \text{LMBANK}_{it} + \beta_{12} \text{LONLINE}_{it} + \varepsilon_{it} \quad (2)
\]

RESULTS AND DISCUSSION

The descriptive statistics of the variables selected for the Malmquist Productivity Index (MPI) presented in table 3. The total deposits include demand deposits, savings bank deposits, term deposits from customers and other banks of branches in India and outside India. The labour measured by total personnel expenses, i.e., payments to and provisions for employees inclusive of total expenditures on employees such as salaries, employee benefits and reserve for retirement pay. The physical capital measured by fixed assets such as premises, fixed assets under construction and other fixed assets. Loans and advances include bills purchased and discounted, cash credits, overdrafts & loans and term loans to customers and other banks. The other earnings assets measured by investments includes investments in government securities, other approved securities like shares, debentures and bonds and subsidiaries and/or joint ventures both in India and abroad.
Table 3 Summary Statistics of the Inputs and Outputs Variables (Amount in Crores)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min.</th>
<th>Max.</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deposits (I)</td>
<td>225554.45</td>
<td>358719.72</td>
<td>3723.63</td>
<td>3241620.7</td>
<td>352</td>
</tr>
<tr>
<td>Labour (I)</td>
<td>2602.29</td>
<td>4711.31</td>
<td>53.79</td>
<td>45714.97</td>
<td>352</td>
</tr>
<tr>
<td>Physical Capital (I)</td>
<td>2472.58</td>
<td>4642.17</td>
<td>13.23</td>
<td>42918.92</td>
<td>352</td>
</tr>
<tr>
<td>Loans and Advances (O)</td>
<td>170639.6</td>
<td>275520.01</td>
<td>2155.19</td>
<td>2325289.6</td>
<td>352</td>
</tr>
<tr>
<td>Other Earnings Assets (O)</td>
<td>74512.78</td>
<td>119450.44</td>
<td>1035.6</td>
<td>1060986.7</td>
<td>352</td>
</tr>
</tbody>
</table>

Source: Prepared by the researchers based on the data collected from Database of Indian Economy (www.dbie.rbi.org.in)

The productivity indices were estimated using 3 input and 2 output DEA based MPI techniques. Average value of TFPCH and its components for all the years are reported in the table 4. The value greater than one in changes TFP indicates the presence of productivity growth in the second period relative to the first period using the same level of input to produce output. It is evident from the results that the financial year 2017-18 has recorded the highest changes in TFP to the extent of 8.4%. On the other hand, 2019-20 has recorded negative TFPG to the tune of 7.4%. This mainly contributed by the negative growth in technological change to the extent of 13.8%.

Table 4 Annual Averages Malmquist productivity index decompositions

<table>
<thead>
<tr>
<th>YEAR</th>
<th>EFFCH</th>
<th>TECHCH</th>
<th>PECH</th>
<th>SECH</th>
<th>TFPCH</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013-14</td>
<td>1.002</td>
<td>0.980</td>
<td>0.996</td>
<td>1.007</td>
<td>0.980</td>
</tr>
<tr>
<td>2014-15</td>
<td>0.983</td>
<td>0.995</td>
<td>0.991</td>
<td>0.993</td>
<td>0.975</td>
</tr>
<tr>
<td>2015-16</td>
<td>0.970</td>
<td>1.016</td>
<td>0.967</td>
<td>1.004</td>
<td>0.985</td>
</tr>
<tr>
<td>2016-17</td>
<td>1.071</td>
<td>0.890</td>
<td>1.042</td>
<td>1.028</td>
<td>0.953</td>
</tr>
<tr>
<td>2017-18</td>
<td>0.933</td>
<td>1.162</td>
<td>0.971</td>
<td>0.961</td>
<td>1.084</td>
</tr>
<tr>
<td>2018-19</td>
<td>0.906</td>
<td>1.167</td>
<td>0.957</td>
<td>0.949</td>
<td>1.057</td>
</tr>
<tr>
<td>2019-20</td>
<td>1.086</td>
<td>0.862</td>
<td>1.028</td>
<td>1.060</td>
<td>0.926</td>
</tr>
<tr>
<td>Average</td>
<td>0.993</td>
<td>1.010</td>
<td>0.993</td>
<td>1.000</td>
<td>0.994</td>
</tr>
</tbody>
</table>

Source: Prepared by the researchers based on the outputs of the statistical program DEAP 2.1

After estimating the level of total factor productivity for banks, then employed the panel regression technique to investigate both the bank-specific and macroeconomic determinants of the TFP for banking group. In this section, the results of regression analysis which mainly focus on determining the relationship between banks’ total factor productivity levels and the explanatory variables are explained. The selection of determinants factors was guided by the previous literatures. In this study, used three types of environmental variables which are based on bank-specific and market specific along with digital banking variables. These environmental variables have selected based on the literature survey and assume a significant impact on banking productivity. The explanatory variables are drawn from previous studies in banking productivity literature. The table 2 reports the bank-specific and market-specific and digital banking predictors of productivity changes.
The panel data analysis technique was used to identify the predictors’ impact on total factor productivity change. Various diagnosis tests were conducted before running the regression analysis such as unit root test, multicollinearity, heteroscedasticity and serial correlation. Hausman test is also conducted to check whether the panel data follows fixed effects or random effects. An important concern in data analysis is whether a series is stationary or not stationary. Therefore, the unit-roots test of Levin et al. (2002) was used. The analysis states that all the variables are free from unit-roots. It means data is stationary.

Multicollinearity measured by using VIF factor as recommended by Mansfield & Helms (1982). VIF factor presented in Table 5. A study by O’brien (2007) reveals that any variables with a VIF higher than 10 is probably a matter of concern. In this case, VIF of the variables and all variables are within the rule of thumb 10. So, it can be concluded that there is no multicollinearity problem.

<table>
<thead>
<tr>
<th>Variables</th>
<th>VIF</th>
<th>1/VIF</th>
</tr>
</thead>
<tbody>
<tr>
<td>GFD</td>
<td>8.927</td>
<td>0.112</td>
</tr>
<tr>
<td>LSIZE</td>
<td>8.849</td>
<td>0.113</td>
</tr>
<tr>
<td>LONLINE</td>
<td>8.626</td>
<td>0.116</td>
</tr>
<tr>
<td>INFLA</td>
<td>7.562</td>
<td>0.132</td>
</tr>
<tr>
<td>LATMPOS</td>
<td>3.843</td>
<td>0.26</td>
</tr>
<tr>
<td>GCF</td>
<td>3.564</td>
<td>0.281</td>
</tr>
<tr>
<td>NIM</td>
<td>3.164</td>
<td>0.316</td>
</tr>
<tr>
<td>NPA</td>
<td>2.87</td>
<td>0.348</td>
</tr>
<tr>
<td>ROE</td>
<td>2.776</td>
<td>0.36</td>
</tr>
<tr>
<td>OVERHEAD</td>
<td>2.533</td>
<td>0.395</td>
</tr>
<tr>
<td>LMBANK</td>
<td>2.433</td>
<td>0.411</td>
</tr>
<tr>
<td>CTD</td>
<td>1.33</td>
<td>0.752</td>
</tr>
</tbody>
</table>

Source: Prepared by the researchers based on the outputs of the statistical program Stata 17

Hausman test is significantly provided a test of random effects versus fixed effects. An application of the Hausman test is conducted, focusing on testing between fixed and random effects within a panel data model. Hausman test analysis shows that the fixed effect model is appropriate for all the models.

<table>
<thead>
<tr>
<th>Models</th>
<th>Statistic</th>
<th>Prob</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Factor Productivity Changes (TFPCH)</td>
<td>60.38</td>
<td>0.000</td>
<td><strong>Fixed Effect Model is appropriate</strong></td>
</tr>
<tr>
<td>Technical Change (TECHCH)</td>
<td>49.23</td>
<td>0.000</td>
<td></td>
</tr>
</tbody>
</table>

Source: Prepared by the researchers based on the outputs of the statistical program Stata 17
To check heteroscedasticity and serial correlation, Modified Wald statistics for heteroscedasticity and Wooldridge test were used, respectively. The results of Modified Wald test heteroscedasticity describes that the test results with p-value is greater than 5%, indicating that the model has no heteroscedasticity problem for all the models. The results of Wooldridge test for autocorrelation reports that there is no autocorrelation between variables in the models. So, the present study adopted fixed effect model to analyse the results. The first model considers Total Factor Productivity Changes (TFPCH) as dependent variable. The F value of this model is less than 0.01 which means this model is pretty good. The R square value of Model 1 is 0.363 which indicates 36.3% of variability is explained by the model. The credit risk (NPA) and operating expense ratio (OVERHEAD) negatively significant and liquidity risk (CTD) positively significant as expected. But surprisingly bank size (LSIZE) and Net Interest Margin (NIM) negatively significant. Macro environmental variables like fiscal deficit (GFD) negatively significant and gross capital formation (GCF) is positively significant as expected. The results also shows that digital banking variables are positively affecting total factor productivity but only ATMPOS transactions and Mobile banking transactions are significant and online banking transactions are not significant. It indicates that increase in ATMPOS and mobile transactions will enhance productivity. Overall, it evident from the results that digital banking significantly increases the productivity of nationalized banks in India.

Table 7 Regression Results: Model I – TFPCH as Dependent Variable

<table>
<thead>
<tr>
<th>TFPCH</th>
<th>Coef.</th>
<th>St.Err.</th>
<th>t-value</th>
<th>p-value</th>
<th>[95% Conf Interval]</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>LSIZE</td>
<td>-0.3611</td>
<td>0.077</td>
<td>-4.70</td>
<td>0.000</td>
<td>-0.513 -0.210</td>
<td>***</td>
</tr>
<tr>
<td>NPA</td>
<td>-0.0131</td>
<td>0.005</td>
<td>-2.64</td>
<td>0.009</td>
<td>-0.023 -0.003</td>
<td>***</td>
</tr>
<tr>
<td>CTD</td>
<td>0.4804</td>
<td>0.115</td>
<td>4.19</td>
<td>0.000</td>
<td>0.255 0.706</td>
<td>***</td>
</tr>
<tr>
<td>OVERHEAD</td>
<td>-31.871</td>
<td>4.845</td>
<td>-6.58</td>
<td>0.000</td>
<td>-41.41 -22.32</td>
<td>***</td>
</tr>
<tr>
<td>ROE</td>
<td>0.0004</td>
<td>0.001</td>
<td>0.50</td>
<td>0.620</td>
<td>-0.001 0.002</td>
<td></td>
</tr>
<tr>
<td>NIM</td>
<td>-0.1153</td>
<td>0.035</td>
<td>-3.26</td>
<td>0.001</td>
<td>-0.185 -0.046</td>
<td>***</td>
</tr>
<tr>
<td>INFL</td>
<td>0.0380</td>
<td>0.020</td>
<td>1.87</td>
<td>0.062</td>
<td>-0.002 0.078</td>
<td>*</td>
</tr>
<tr>
<td>GFD</td>
<td>-10.947</td>
<td>3.708</td>
<td>-2.95</td>
<td>0.003</td>
<td>-18.25 -3.644</td>
<td>***</td>
</tr>
<tr>
<td>GCF</td>
<td>2.396</td>
<td>0.551</td>
<td>4.35</td>
<td>0.000</td>
<td>1.311 3.482</td>
<td>***</td>
</tr>
<tr>
<td>LATMPOS</td>
<td>0.061</td>
<td>0.026</td>
<td>2.31</td>
<td>0.021</td>
<td>0.009 0.112</td>
<td>**</td>
</tr>
<tr>
<td>LMBANK</td>
<td>0.013</td>
<td>0.005</td>
<td>2.38</td>
<td>0.018</td>
<td>0.002 0.023</td>
<td>**</td>
</tr>
<tr>
<td>LONLINE</td>
<td>0.061</td>
<td>0.046</td>
<td>1.33</td>
<td>0.186</td>
<td>-0.029 0.150</td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>2.962</td>
<td>0.613</td>
<td>4.83</td>
<td>0.000</td>
<td>1.754 4.17</td>
<td>***</td>
</tr>
</tbody>
</table>

Mean dependent var 0.994  SD dependent var 0.162
R-squared 0.363  Number of obs. 308
F-test 11.990  Prob > F 0.000
Akaike crit. (AIC) -380.208  Bayesian crit. (BIC) -331.717

*** p<0.01, ** p<0.05, * p<0.1
Source: Prepared by the researchers based on the outputs of the statistical program Stata 17
Overall, the study found that the determinants such as size of the bank (LSIZE), credit risk (NPA), management efficiency (OVERHEAD), profitability (NIM) and fiscal deficit (% GVA) have negative significant relation with productivity of the banks. The banks size is significantly declining productivity of the banks. A large bank is talented to produce diversities of products at low cost compared to the small banks. However, there might be higher risks associated with the larger banks due to their diverse products. In such a situation, a larger bank may not be productive due to the diseconomy of scale.

Non-Performing Assets (NPA) have significant impact on banking productivity. It is often believed that the increase in the NPAs will enhance the credit risk and decline the investment, thereby declining banking productivity. Liquidity risk, which we measured as the credit-deposit ratio is significantly increasing bank productivity. The higher the ratio, the higher the loan assets created from the deposits, which lead to more income generation options for the banks. The positive impact on the productivity indicates the better management skill of Indian banking industry.

The results revealed that bank overhead towards non-interest expense/total assets reduces productivity as expected. When bank suffers with huge expenses, definitely the productivity will decline. That is, the results suggest that inefficient banks have lower productivity. Unfortunately, the profitability measured in terms of (ROE and NIM) does not improve the productivity of the banks during the selected study period. The results revealed that the ROE is insignificant and NIM is negatively significant.
Among the market specific predictor, inflation has a greater role in banking performance. The impact of inflation depends on anticipation. If the inflation is anticipated, then banks will adjust interest rates quickly, resulting in the higher revenue than the cost. So, inflation has an expected positive impact on banking productivity. However, our results suggested that positive and significantly impact of inflation on productivity, thereby suggesting that the inflation is anticipated and banks are able to cope with the changes with the inflation. Capital formation to GVA ratio is positively significant. It provides an indication that the banks have very much succeeded in reinvesting total factor income in new fixed assets. The fiscal-deficit ratio is negatively and significantly affecting productivity of banks. It might be due to the increase in the fiscal deficit which declines the cash holding capacity of the banks. Therefore, the low cash availability restricts the investment opportunities of banks in high level of earning assets.

This results also reinforces that ATMPOS and mobile banking transactions significantly improve productivity of commercial banks in India. The ATMPOS transaction increases income of the bank by imposing annual maintenance charges, fees for each transaction, card processing fees etc. The revenue from ATM and POS systems is a significant contributor to the overall revenue being generated by commercial banks. The banks are also able to sell more products and services to a large number of existing customers through mobile banking with a low cost. The mobile banking transactions can improve productivity by realizing reduced costs affected by mobile banking. The study also finds that online banking transactions are positive, but, increased online banking transactions have no relation with the productivity of banks. The banks may be utilizing these online transactions as a strategic advantage of the banks.

The overall findings of the study have importance in managerial policy implications in the area of bank performance and its relevance in the context of ongoing digital revolution in the Indian banking industry. The study suggests that the digital financial services could enhance the productivity of commercial banks in India.

CONCLUSION

Performance evaluation has always been a prime and focal activity for any organization. As it helps them to identify not only the current status of their operations, but also helps them to identify their areas of improvement. As per the Reserve Bank of India (RBI), India’s banking sector is sufficiently capitalised and well-regulated. The financial and economic conditions in the country are far superior to any other country in the world. Credit, market and liquidity risk
studies suggest that Indian banks are generally resilient and have withstood the global downturn well. The digital payments system in India has evolved the most among 25 countries with India’s Immediate Payment Service (IMPS) being the only system at level five in the Faster Payments Innovation Index (FPII). Several initiatives were taken by RBI to facilitate the development of digital banking in India. Productivity in simple terms can be defined as the proportion between input and output. The primary objective of this research is to evaluate the productivity performance of banks, with special emphasis on investigating the impact of digital banking services. The results from the various statistical tools including panel data regression, Malmquist Productivity Index etc., indicate that the digital financial services are significantly improves efficiency and productivity of Indian banking industry.

REFERENCES


Pathak, B. V. (2010), "The Indian financial system: Markets, institutions and services", Pearson Education India.


