

STUDY OF CHANGES IN PRODUCTIVITY INDEX OF SELECTED INDIAN BANKS BY APPLYING DEA BASED MALMQUIST INDEX TECHNIQUE

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Abstract: The Malmquist Productivity Index (MI) is a DEA based valuable tool for assessing and comparing the efficiency of banks over time. Its ability to break down productivity changes into specific components makes it especially useful for understanding the underlying factors influencing a bank's performance. The Indian banking industry comprises of public sector banks, private sector banks and foreign banks. Over the number of years, the performance of Indian banks has been influenced by various factors, including economic conditions, regulatory changes, and global events. The Reserve Bank of India (RBI) introduced various regulatory measures to strengthen the banking system, enhance transparency, and ensure better risk management practices.

The present study is an attempt to evaluate the performance of three private sector banks, belonging to Indian banking sector using the Malmquist Productivity Index. Results of the study show that with adoption of technology by banks is underutilized; there is scope of improving the productivity if the technology is optimally used. Also the scale of operation of the banks is underutilised. The overall level of efficiency of the banks has increased by 0.6% in the time period selected for the present study.

Keywords: DEA Analysis, Efficiency, Indian Banking Sector, Malmquist Index (MI), Productivity, Private Banks.

Introduction: The Malmquist Productivity Index (MI) is a Data Envelopment Analysis (DEA) based valuable tool for assessing and comparing the efficiency of banks over time. Its ability to break down productivity changes into specific components makes it especially useful for understanding the underlying factors influencing a bank's performance. The Indian banking industry comprises of public sector banks, private sector banks and foreign banks. Over the number of years, the performance of Indian banks has been influenced by various factors, including economic conditions, regulatory changes, and global events. The Reserve Bank of

India (RBI) introduced various regulatory measures to strengthen the banking system, enhance transparency, and ensure better risk management practices.

Meaning & Definition: The Malmquist Productivity Index (MI) is a measure used in Data Envelopment Analysis (DEA) to assess changes in productivity over time. DEA is a non-parametric method used to evaluate the relative efficiency of a set of decision-making units (DMUs), such as firms or organizations. The Malmquist Index specifically focuses on productivity changes between two time periods.

The Malmquist Index is based on the concept of distance functions and is named after Swedish economist Erik Malmquist, who introduced the index in the context of frontier production functions. The index evaluates the productivity change as a combination of technical efficiency change and technological change. There are two main components of the Malmquist Productivity Index:

Technical Efficiency Change (TEC): This component measures the change in the efficiency of a DMU over time, focusing on how well the DMU utilizes its inputs to generate outputs. A value greater than 1 suggests an improvement in technical efficiency, while a value less than 1 indicates a decline.

Technological Change (TC): This component reflects the shift in the production frontier over time, capturing changes in technology or the ability to produce more outputs from the same inputs. A value greater than 1 indicates technological progress, while a value less than 1 suggests technological regress.

MI then calculated as the geometric mean of these two components:

$$\text{Malmquist Index (MI)} = \text{TEC} \times \text{TC}$$

The Malmquist Index provides a comprehensive measure of overall productivity change, accounting for both efficiency improvements and technological advancements. This method is used to compare the relative performance of different DMUs over different time periods and identify the sources of productivity changes.

Need and Importance of Malmquist Productivity Index (MI): The Malmquist Productivity Index is particularly useful in measuring the efficiency of banks over time by providing insights into the changes in their overall productivity and the factors contributing to these changes. Malmquist Index can be beneficial in evaluating the efficiency of banks in many different ways, few are listed below:

1. Comparison over time period: The Malmquist Index allows for the comparison of a bank's efficiency over different time periods. This is crucial for assessing whether a bank

is improving its productivity, experiencing a decline, or remaining relatively stable. Banks can use this information to identify trends and take appropriate actions.

2. Comparison with other banks: By comparing the Malmquist Index of one bank to that of its peers or industry benchmarks, analysts can gain insights into relative efficiency. This benchmarking exercise helps banks understand their position in the industry and whether they are keeping up with, surpassing, or lagging behind competitors in terms of productivity
3. Combination of Components: The Malmquist Index breaks down the overall productivity change into two components: Technical Efficiency Change (TEC) and Technological Change (TC). This breakdown helps to identify the specific factors driving productivity changes. For banks, it can reveal whether improvements are due to better utilization of inputs, adoption of new technologies, or a combination of both.
4. Helps in policy formation: Understanding the sources of productivity change (TEC or TC) provides valuable information for formulating policies and strategies. For instance, if a bank's Malmquist Index indicates that technological change is the primary driver of productivity improvements in the industry, the bank may consider investing in new technologies to remain competitive.
5. Helps in Decision Making: The Malmquist Index can assist bank management in making informed decisions. If a decline in productivity is observed, management can use the index to pinpoint whether the issue lies in technical efficiency or technological progress. This information can guide resource allocation, process optimization, and strategic planning.
6. Regulatory bodies may use the Malmquist Index to assess the efficiency and performance of banks. It can provide regulators with a quantitative measure to evaluate whether banks are operating efficiently and adopting technological advancements in line with industry standards.

Research Methodology: For the present research, three banks belonging to private sector are selected for the study. Data on the selected input and output variables are collected for three financial years 2019-20, 2020-21 and 2021-22. Data is collected from official website of banks, website of Reserve Bank of India (RBI) and reports of various agencies. For the purpose of data analysis Excel Spreadsheet and DEAP version 2.1 are employed. The following table 1 shows the decision making units selected for the present study.

Table 1
Decision Making Units

Name of Bank	Decision Making Unit
Axis Bank	DMU1
HDFC Bank	DMU2
ICICI Bank	DMU3

Input variables and output variables elected for the present study are listed in table 2 below. For the present study two input variables namely total deposits and total borrowings are selected; whereas the output variable selected is total advances.

Table 2
List of Input Variables and Output Variables

Input Variable	Notation	Output Variable	Notation
Total Deposits	X1	Total Advances	Y1
Total Borrowings	X2		

Analysis and Findings: The following table shows the Malmquist summary of annual means for the change in performance from year 1 to year 2 and year 2 to year 3. This reflects the change in productivity of the group of decision making units for the time period, based on summary of annual means. Analysis of the table shows that, efficiency change has recorded score of 1.019 showing an increase of 1.9% in the efficiency; technical change has improved by 2.5% showing the increase in productivity due to adoption of technology in the operational working of the banks. The total factor productivity change has improved by 4.4% in year 2 (2020-21) as compared to year 2019-20.

Table 3
Malmquist Index Summary of Annual Means

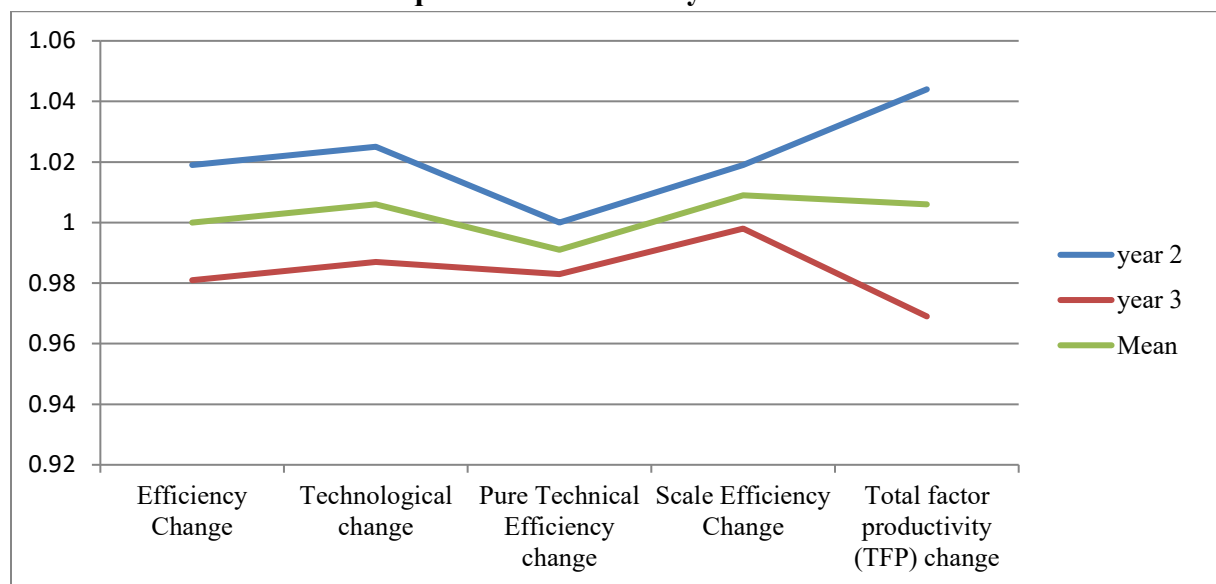
Year	Efficiency Change	Technological change	Pure Technical Efficiency change	Scale Efficiency Change	Total factor productivity (TFP) change
2	1.019	1.025	1.000	1.019	1.044
3	0.981	0.987	0.983	0.998	0.969
Mean	1.000	1.006	0.991	1.009	1.006

Further analysis of table 3 shows that there is a decrease of 3.1% (0.969) in total factor productivity change in year 2021-22 as compared to 2019-20; as is resulted due to decrease in efficiency change (decrease of 1.9%), technological change decreased by 1.3%, pure technical efficiency change decreased by 1.7% and scale efficiency decreased by 0.2%. The reduction in productivity of the banks may be the effect of pandemic Covid19 which affected the normal workings of the banks in the end of the year 2019-20 and also for financial year 2020-21.

The following figure shows line graph for the annual means of the group of banks selected for the present study. The line graph in the middle reflects the mean score for the change in productivity for the time period starting from 1 to year 3.

The line graph for change in productivity from year 1 to year 2 shows improvement as it is above the score of 1 (on Y axis) and the line graph for productivity change from year 2 to year 3 reflects decrease in productivity and thus the graph lies below the score of 1 (on Y axis).

Figure 1
Malmquist Index Summary of Annual Means



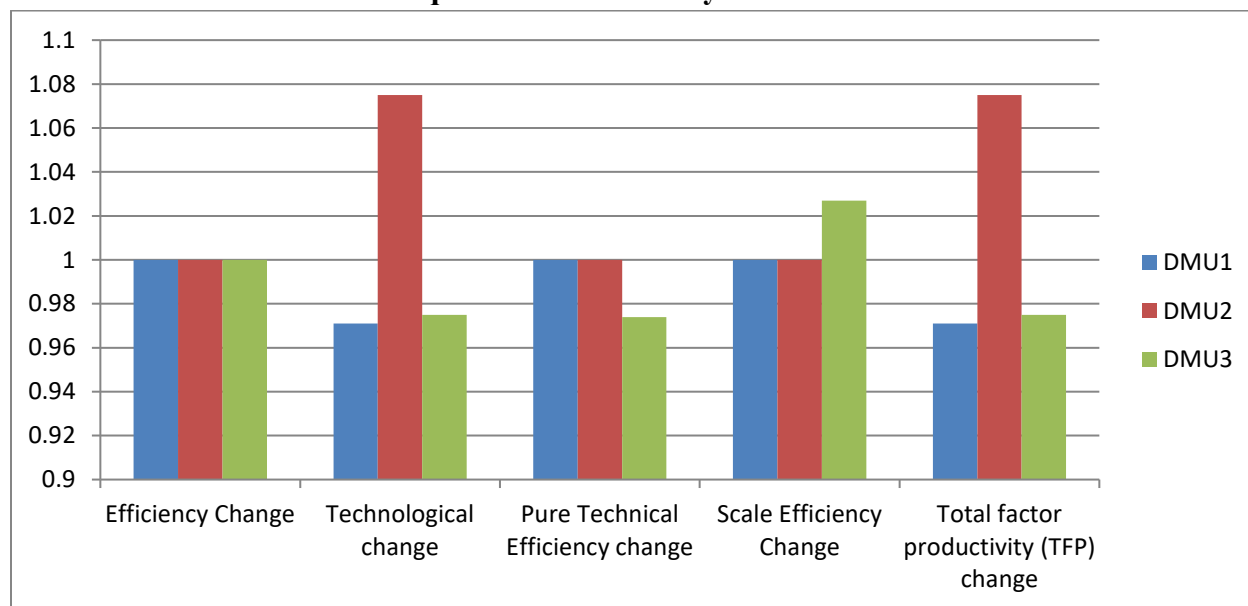
The following table shows Malmquist Index summary of firm means. Analysis of the table shows that for firm1 the total factor productivity change is recorded at 0.971 (97.1%) a decrease of 2.9%. thus efficiency of the bank decreased over the three years period. The second decision making unit shows an increase of 7.5% over the three years of the time period selected for the present study. Further analysis of the table shows that, the total factor productivity change for firm 3 has decreased by 2.5%. The table also shows the mean values of technical change and total factor productivity change which shows an overall increase. Thus there is improvement in the overall performance of the banks selected for the present study.

Table 4
Malmquist Index Summary of Firm Means

DMU	Efficiency Change	Technological change	Pure Technical Efficiency change	Scale Efficiency Change	Total factor productivity (TFP) change
1	1.000	0.971	1.000	1.000	0.971
2	1.000	1.075	1.000	1.000	1.075
3	1.000	0.975	0.974	1.027	0.975
Mean	1.000	1.006	0.991	1.009	1.006

The following figure shows the Malmquist index summary of firm means. DMU2 i.e. HDFC bank has shown improvement in technological change (score of 1.075) thus resulting a positive change in total factor productivity change as seen in the graph. DMU3 i.e. ICICI bank has decreased in its technological change and pure technological change resulting in decrease in total factor productivity change.

Figure 2
Malmquist Index Summary of Firm Means



Conclusion: Indian banks faced challenges related to non-performing assets (NPAs) during this period. A surge in bad loans, especially in public sector banks, led to concerns about asset quality and financial stability. The Indian government initiated several reforms to address the issues in the banking sector. Key measures included the Insolvency and Bankruptcy Code (IBC) to expedite resolution of stressed assets and recapitalization of public sector banks. Indian banks underwent a significant digital transformation, adopting technology to enhance customer experience and improve operational efficiency. The growth of digital banking and the adoption of FinTech solutions played a crucial role in reshaping the industry.

Also bank mergers played an important role and affected the performance of commercial banking sector. The government undertook a series of mergers in the banking sector to create larger, more robust entities. For example, the merger of several public sector banks in 2021 aimed to improve efficiency, governance, and risk management. The present study is an attempt to evaluate the performance of three private sector banks, belonging to Indian banking sector using the Malmquist Productivity Index. With technology adopted by banks is underutilized; there is scope of improving the productivity if the technology is optimally used. Also the scale of

operation of the bans is underutilised. The overall level of efficiency of the banks has increased by 0.6%.

The performance of Indian banks has been linked to the overall economic conditions in the country. Periods of economic growth and stability have generally benefited the banking sector, while economic downturns have posed challenges. The COVID-19 pandemic, which emerged in 2020-21, had a significant impact on the global and Indian economy. The banking sector faced challenges such as asset quality concerns, disruptions in business operations, and increased provisioning for potential loan losses.

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