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A Study on Productivity Changes in the Indian Banking Sector Using the Malmquist Index

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ABSTRACT

This study examines the productivity change in the Indian banking sector by employing the Malmquist index, a measure derived from Data Envelopment Analysis (DEA). Specifically, the efficiency of four prominent banks in India, namely Axis Bank, HDFC Bank, ICICI Bank, and State Bank of India, is evaluated over a seven-year period spanning from 2017 to 2023. The primary aim is to assess the productivity changes of the decision-making units (DMUs) of these banks utilizing Technical Efficiency Changes , Pure Technical Efficiency Changes and Scale Efficiency Changes. The analysis considers inputs such as Total Assets and Total Expenditure, along with outputs including Total Revenue and Total Income. The Malmquist index, derived from DEA, is employed to quantify productivity changes over time, allowing for a comparative assessment of each bank's resource utilization and income generation efficiency. Results highlight the disparities between Technical Efficiency (TE) and Pure Technical Efficiency (PTE) across the banks throughout the study period. These findings offer valuable insights into the operational dynamics of the aforementioned banks, providing stakeholders,

regulators, and policymakers within the banking sector with actionable information for strategic decision making and performance enhancement initiatives.

Introduction

The banking sector plays a crucial role in driving economic growth and development in India. As one of the fastest-growing economies globally, India's banking industry has witnessed significant changes and challenges over the years(M. Mishra et al., n.d.). In this dynamic landscape, assessing the efficiency and productivity of banks becomes paramount for ensuring sustainable growth and competitiveness. This study focuses on examining the productivity change within the Indian banking sector, utilizing the Malmquist index, a measure derived from Data Envelopment Analysis (DEA)(Bansal, Mehra, et al., n.d.). The efficiency of four prominent banks in India, namely Axis Bank, HDFC Bank, ICICI Bank, and State Bank of India, is evaluated over a comprehensive seven-year period spanning from 2017 to 2023.The primary objective of this research is to assess the productivity changes of these banks' decisionmaking units (DMUs), employing measures such as Technical Efficiency Changes, Pure Technical Efficiency Changes, and Scale Efficiency Changes. By considering inputs such as Total Assets and Total Expenditure, alongside outputs including Total Revenue and Total Income, this study provides a comprehensive analysis of the operational dynamics within these banking institutions. The Malmquist index, derived from DEA, serves as a powerful tool to quantify productivity changes over time, allowing for a comparative assessment of each bank's resource utilization and income generation efficiency(Gurjar et al., 2021). Through this analysis, the study aims to shed light on the performance disparities between Technical Efficiency (TE) and Pure Technical Efficiency (PTE) across the selected banks throughout the study period. The findings of this research are expected to offer valuable insights into the operational dynamics of the aforementioned banks, providing stakeholders, regulators, and policymakers within the banking sector with actionable information for strategic decisionmaking and performance enhancement initiatives. By understanding the factors influencing productivity changes within the Indian banking sector, this study contributes to the ongoing discourse on enhancing efficiency and competitiveness in the financial services industry.

Review of Literature

Several studies have been conducted to assess the productivity and efficiency of banks in India, employing various methodologies including Data Envelopment Analysis (DEA) and the Malmquist Total Factor Productivity Index (MTFPI)(Sharma & Dalip, 2014). One study utilized Malmquist DEA to evaluate the performance of commercial banks in India over the postliberalization period(Sharma et al., n.d.). Results indicated a regression in technological progress, alongside stagnation in technical efficiency, ultimately resulting in productivity decline. Another study focused on the efficiency of Indian banks using DEA, Malmquist, and Stochastic Frontier Analysis (SFA) with bad output(Gurjar et al., n.d.). Findings revealed that technological changes significantly contributed to the growth of total factor productivity among public sector banks in India(Kundu & Banerjee, 2022). Similarly, a study investigated the productivity changes in public sector banks in India from 1998 to 2013 using Malmquist Total Factor Productivity Index(Chauhan et al., n.d.). Results showed that while some banks experienced a decrease in overall productivity, others demonstrated positive growth, with technological changes playing a major role(Uae et al., n.d.). Additionally, positive relationships were observed between indicators such as the debt-to-equity ratio and capital adequacy with efficiency(Ambarkhane et al., n.d.). Another study analysed the performance of commercial banks in India using a non-parametric Malmquist index-based DEA approach. This study aimed to estimate the relative efficiencies of public and private sector banks over the period, providing insights into the efficiency scenario of the Indian banking industry(Kumar et al., 2010). It found heterogeneity in the technical efficiency of public and private sector banks and identified trends in productivity changes over the analysed years. Furthermore, a study investigated the efficiency of Indian banks utilizing three methodologies: DEA, Malmquist productivity index, and SFA(Rao Padi et al., n.d.). This study examined the impact of non-performing assets (NPAs) on banks' technical efficiency and productivity, particularly after the asset quality review in 2016(Goswami & Gulati, 2022). It found evidence of technical inefficiency in the

banking sector and highlighted the importance of addressing NPAs for improving efficiency(Goswami et al., n.d.). The reviewed literature provides a comprehensive analysis of various aspects related to bank productivity and efficiency, drawing on empirical data and methodological advancements(M. K. Mishra & Srivastava, 2021). Studies investigate the impact of non-performing assets (NPAs) and global financial crises (GFC) on Indian banks' total factor productivity (TFP), revealing a decline primarily attributed to efficiency loss post-GFC(Basri et al., 2018). Additionally, research explores the influence of Digital Financial Services (DFS) on Indian banking sector productivity, indicating significant

improvements linked to mobile banking, online banking, ATM, and POS transactions(Madhanagopal et al., n.d.). Efficiency analyses using techniques like data envelopment analysis (DEA) shed light on the productivity dynamics of Indian banking industry, offering insights into performance disparities between public and private sector banks(Bansal et al., 2022). Moreover, studies delve into the productivity changes and determinants in MENA Islamic banks, employing methodologies such as the bootstrapped Malmquist index approach to identify factors affecting productivity growth during periods of economic turbulence(Chen et al., 2011). Further, the literature discusses the theoretical underpinnings and practical applications of productivity indices like the Malmquist index, particularly in assessing commercial banks' performance, thus contributing to a deeper understanding of bank productivity dynamics(Bahrini, 2015). The literature review encompasses studies on the efficiency and productivity of banking institutions across South Asia, particularly in India, Kenya, and Sri Lanka(Thayaparan et al., n.d.). Using methodologies like data envelopment analysis (DEA), Malmquist productivity index (MPI), and non-radial DEA, these studies evaluate factors influencing efficiency changes, including technological progress, ownership structures, and policy effectiveness(Ghosh et al., 2013). Findings suggest varying levels of efficiency among countries, with Nepal and large microfinance institutions in India showing notable improvements(Nasieku et al., 2013a). However, challenges such as post-election violence and the Global Financial Crisis have impacted productivity trends in Kenya, highlighting the importance of resilience and adaptation in banking sectors(Ul Hassan Shah et al., 2022). Overall, these studies contribute to understanding the complex dynamics of banking efficiency and productivity in diverse economic contexts(Arrow, 2009). The literature review examines various aspects of banking sector efficiency and productivity across different countries, with a focus on India, Malaysia, Bangladesh, Kenya, and others(Nasieku et al., 2013b). Studies utilize methodologies such as Data Envelopment Analysis (DEA), Malmquist Productivity Index (MPI), Hicks-Moorsteen approach, and metafrontier Malmquist index to assess efficiency levels, productivity changes, and the impact of regulatory reforms on banking performance(Hicks, 1935). Findings reveal factors influencing efficiency, including technological progress, regulatory changes, ownership structures, and external environmental factors(Kenjegalieva et al., 2009). While some studies highlight improvements in efficiency driven by technological advancements, others point out challenges such as economic slowdowns and regulatory reforms impacting productivity growth(Asmild & Matthews, 2012). Overall, the literature contributes to a nuanced understanding of banking sector performance in diverse economic contexts, providing insights for policymakers and industry stakeholders. These studies collectively contribute to the understanding of productivity, efficiency, and performance dynamics within the banking sectors of

various regions, offering insights into the impact of factors such as digitalization, financial crises, and regulatory frameworks on bank productivity.

Objectives

1. To analyse the efficiency changes and
2. To study productivity changes of banking industries.

Hypothesis

H1: There is significance difference between the efficiency and factor productivity change in the banks throughout the years.

Research Methodology

In this study Malmquist Productivity Index is used which is one of the method of Data Envelopment Analysis (DEA) . (Cooper et al., 1999)It's a non-parametric method used in operations research and economics for assessing the efficiency of decision-making units (DMUs), such as organizations, companies, or institutions. DEA evaluates the relative efficiency of DMUs by comparing their input and output levels(Mandal & Ghosh Dastidar, 2014). The Malmquist Productivity Index (MPI) is used in this study to assess changes in total factor productivity (TFP) of banks over time(Bansal, Kumar, et al., n.d.). It compares the productivity of the banks at different points in time, usually years, by evaluating the efficiency change and technological change. The Malmquist Productivity Index is calculated using data envelopment analysis (DEA) and measures the distance between two production frontiers across different time periods(Simar & Wilson, 1999). Specifically, it evaluates how efficiently inputs are transformed into outputs over time, accounting for changes in technology and efficiency levels(*Indian Banks, Malmquist Index - Google Scholar*, n.d.). The data for this study was from the official websites of the respective banks: Axis Bank(*Annual Report*, n.d.), HDFC Bank(*2017*, n.d.) ,ICICI Bank(*ICICI Bank*, n.d.), and State Bank of India(*SBI AR 2021-2022*, n.d.). The study spans a period of seven years, from 2017 to 2023. The key inputs considered are the total assets and total expenditure of each bank, while the outputs analysed include total income and net profit. This comprehensive dataset enables a thorough examination of the productivity and efficiency trends across these prominent Indian banks over the specified time frame. This research methodology provides a robust framework for analysing productivity dynamics within the banking industry.

Table 1: Input, Output and Description

Input/Output	Variables	Description
Input 1	Total Assets	Current Assets + Fixed Assets
Input 2	Total Expenditure	Interest Expended + Operating Expenses
Output 1	Total Income	Interest Earned + Other Income
Output 2	Net Profit	Net Profit for the year

Components of DEA

- Efficiency Factor Changes (EFFCH)
- Technical Efficiency Change (TECHCH)
- Pure Efficiency Change (PECH)
- Scale Efficiency Change (SECH)
- Total Factor Productivity Change (TFPCH)

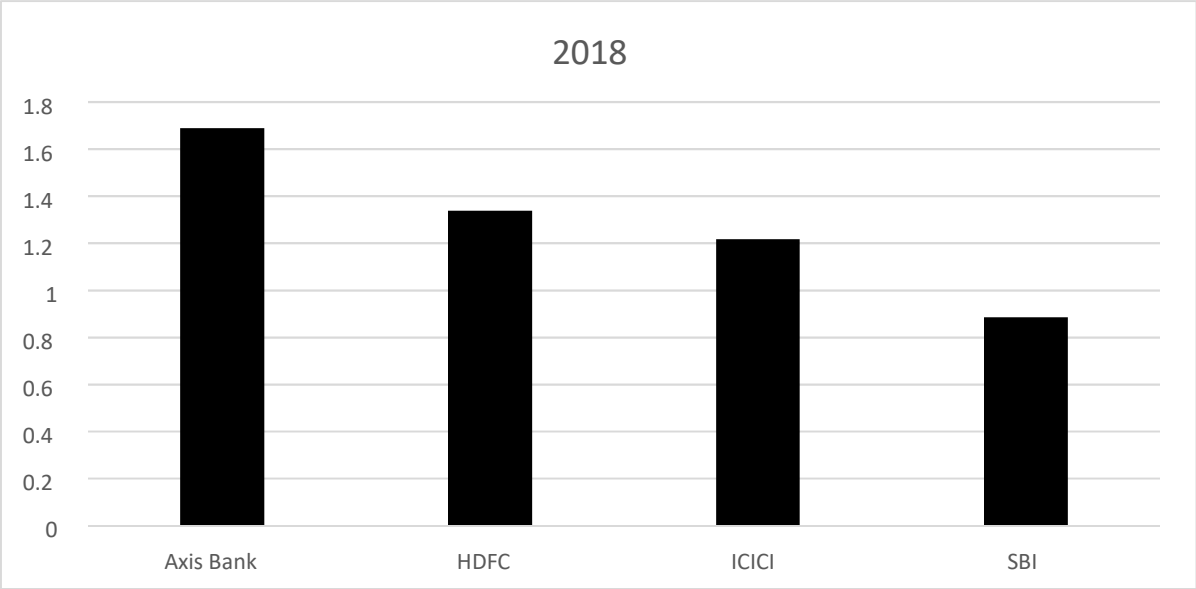
Analysis and Interpretation

In this research the productivity change of four prominent banks : Axis Bank, HDFC Bank, ICICI Bank and State Bank of India for the period of 7 years is shown.

Table 2: Table showing the productivity changes of banks for 7 years

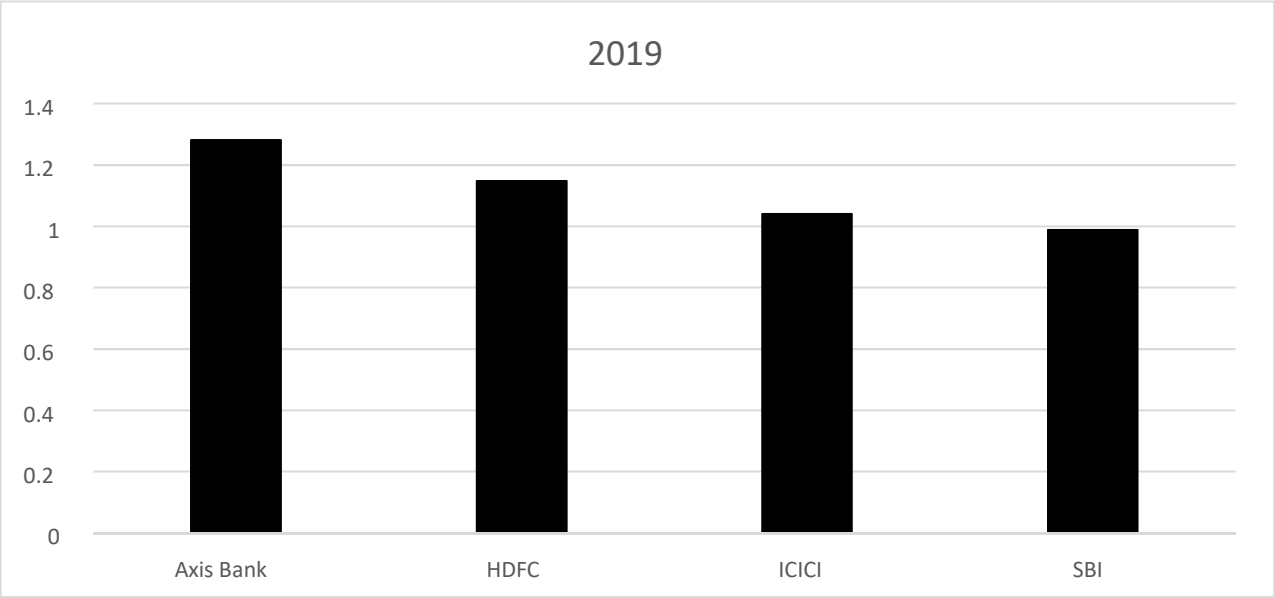
Banks	2018	2019	2020	2021	2022	2023
Axis Bank	1.689	1.282	1.127	1.218	1.112	0.956
HDFC	1.338	1.148	1.1	1.161	1.05	0.942
ICICI	1.217	1.04	0.995	1.052	1.009	0.917
SBI	0.886	0.988	0.968	0.955	0.907	0.932

Chart 1: Chart showing the productivity changes of banks in the year 2018



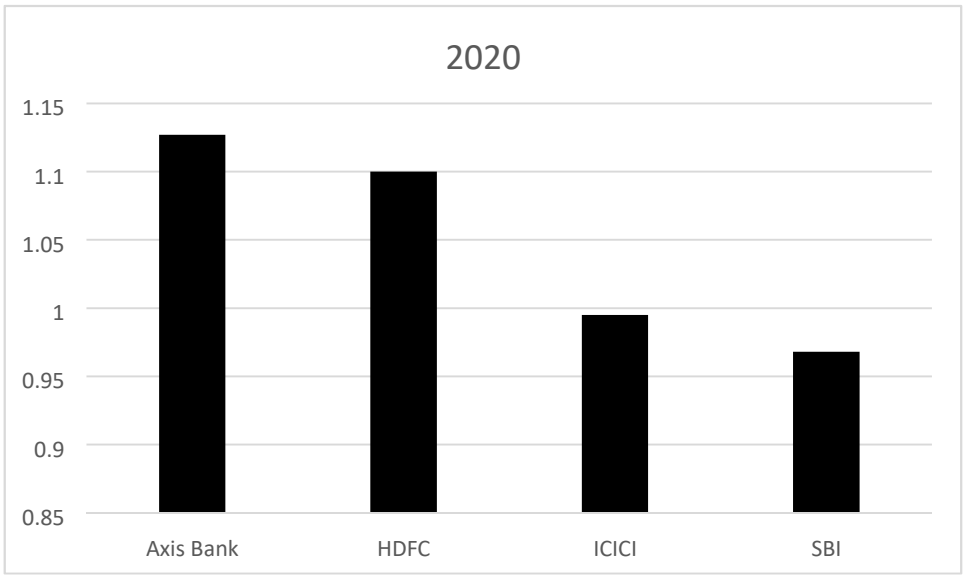
In 2018, Axis Bank demonstrated the highest productivity among the banks analysed, outperforming its counterparts. HDFC and ICICI exhibited similar levels of productivity, both ranging between 1.4 and 1.2. However, despite being productive, they did not surpass Axis Bank's productivity. SBI lagged behind with a productivity score of 0.886, indicating a lower level of efficiency compared to the other banks. This comparison underscores Axis Bank's leading position in terms of productivity, with HDFC and ICICI following closely behind but unable to match its performance.

Chart 2: Chart showing the productivity changes of banks in the year 2019



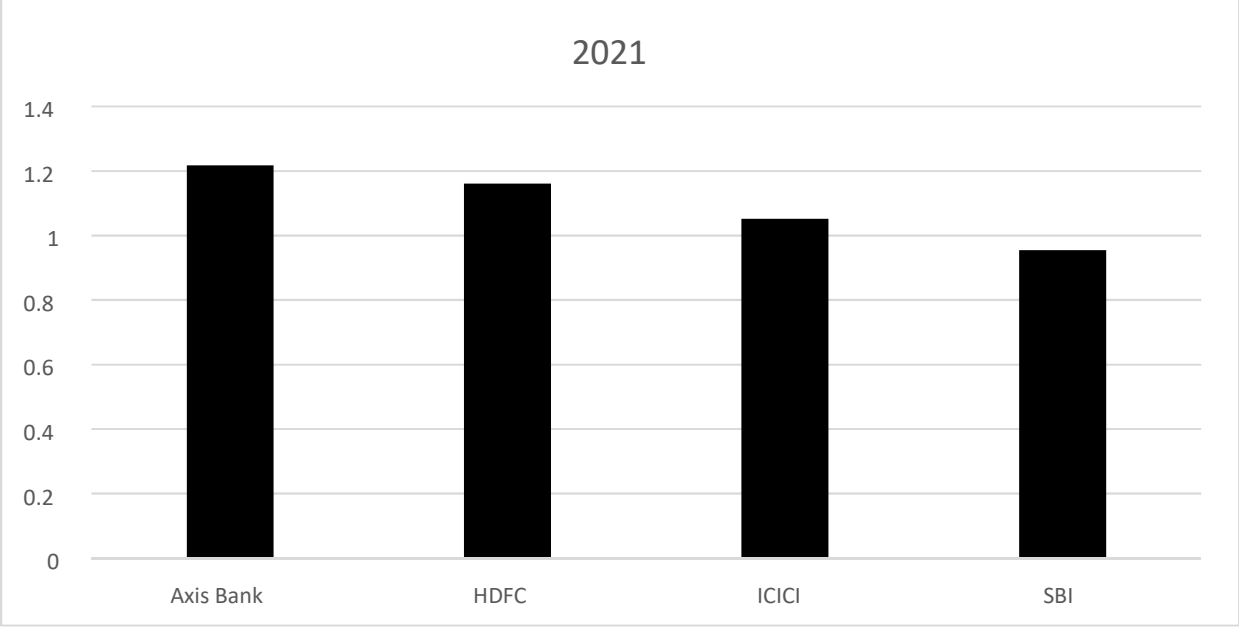
In 2019, Axis Bank maintained its position as the most productive bank with a productivity score of 1.282, surpassing its peers. HDFC followed closely behind with a slightly lower productivity score of 1.148, indicating strong efficiency but not quite reaching Axis Bank's level. Meanwhile, ICICI Bank lagged further behind with a productivity score of 1.04. However, SBI's productivity was notably lower compared to the other banks, standing at 0.988. This suggests that while most banks exhibited efficiency in their operations, SBI faced challenges in maximizing its productivity.

Chart 3: Chart showing the productivity changes of banks in the year 2020



In 2020, Axis Bank continued to lead in productivity with a score of 1.127, demonstrating its efficiency compared to other banks. HDFC Bank followed closely with a productivity score of 1.1, indicating its strong performance in operational efficiency. However, ICICI Bank and SBI showed lower productivity scores of 0.995 and 0.968 respectively, signalling inefficiencies within these two banks. This suggests that while Axis and HDFC maintained their efficiency, ICICI and SBI faced challenges in optimizing their productivity levels.

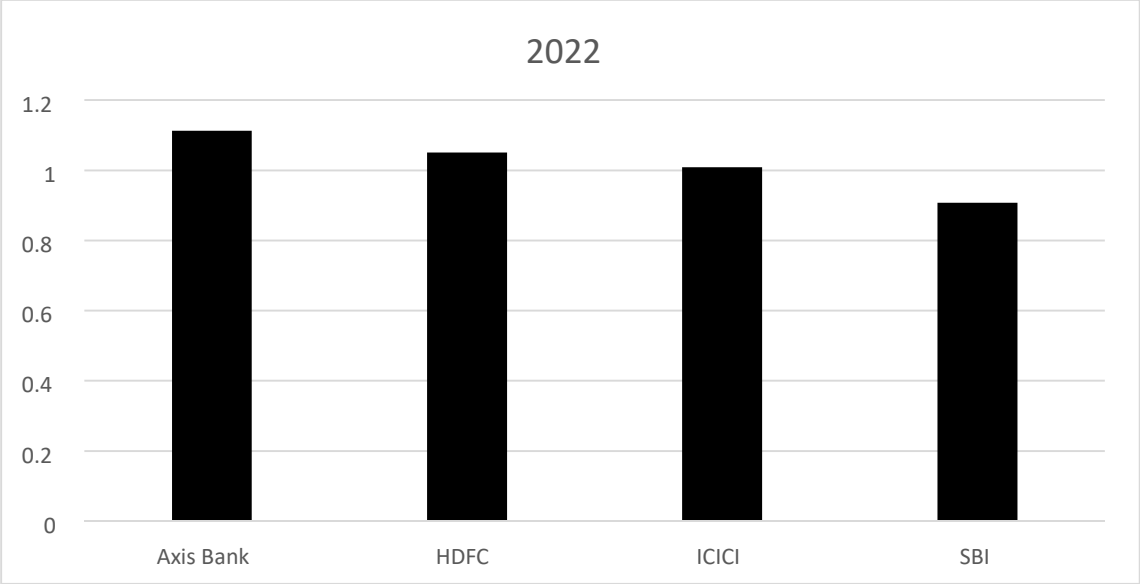
Chart 4: Chart showing the productivity changes of banks in the year 2021



In 2021, Axis Bank maintained its lead in productivity with a score of 1.218, followed by HDFC Bank at 1.161 and ICICI Bank at 1.052. These scores indicate efficient utilization of resources in these banks.

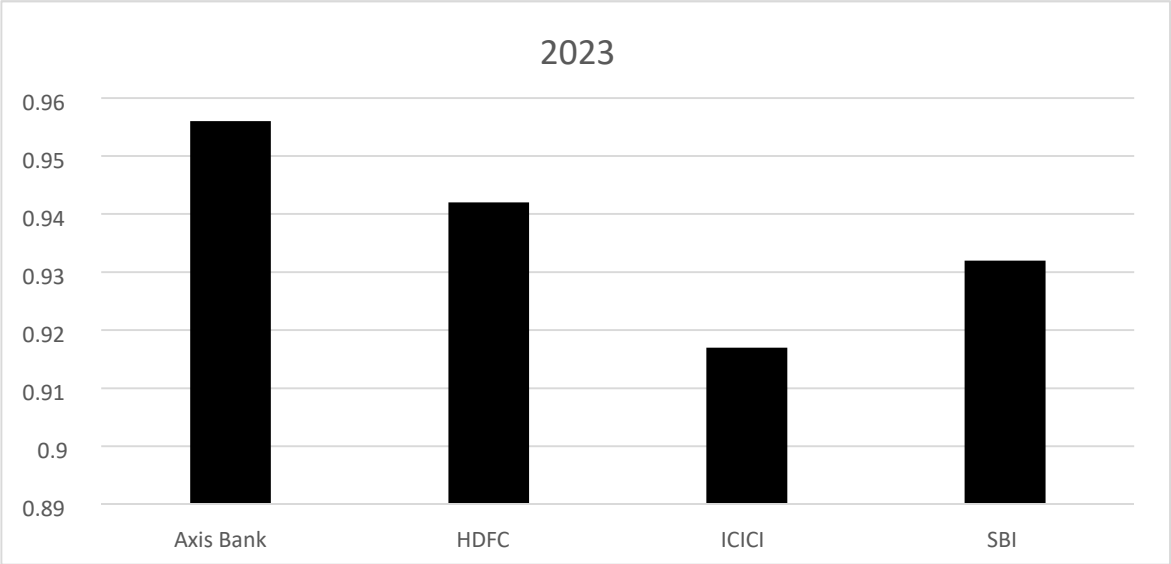
However, SBI's productivity fell below 1, reaching 0.955, suggesting inefficiencies in input utilization compared to the other banks. This highlights the need for SBI to address operational challenges to enhance its productivity and competitiveness in the market.

Chart 5: Chart showing the productivity changes of banks in the year 2022



In 2022, Axis Bank maintained its high productivity level at 1.12, indicating effective resource utilization. However, both HDFC and ICICI Banks showed slightly lower productivity levels, with scores of 1.05 and 1.009 respectively, suggesting potential inefficiencies in input utilization despite being productive. On the other hand, SBI's productivity remained notably lower at 0.907, indicating significant inefficiencies in resource management compared to other banks. This underscores the importance for HDFC, ICICI, and especially SBI to address operational inefficiencies to improve their productivity and competitiveness in the banking sector.

Chart 6: Chart showing the productivity changes of banks in the year 2023

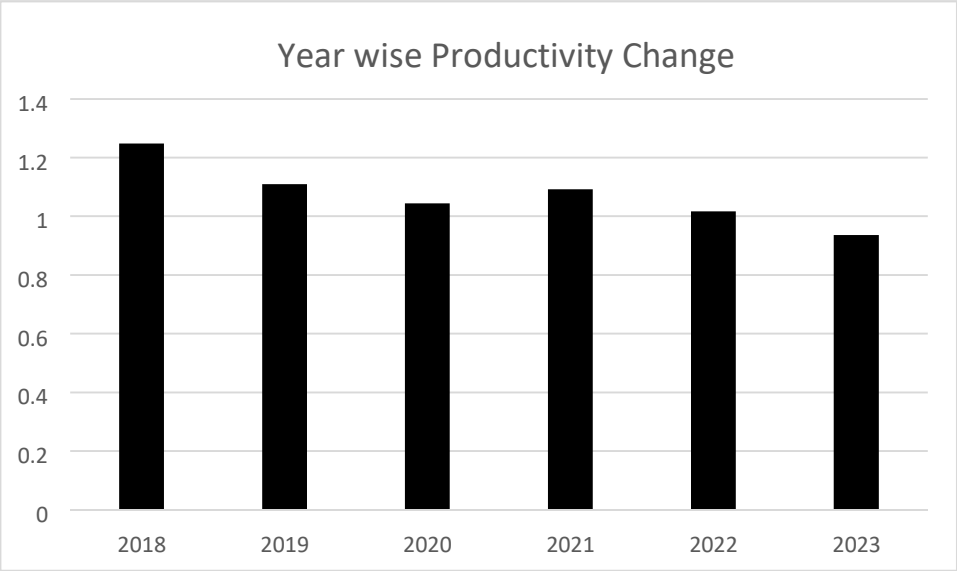


In 2023, all banks experienced decreased productivity, indicating overall inefficiency in resource utilization. Despite this decline, Axis Bank maintained a relatively higher productivity score compared to other banks, standing at 0.956. However, HDFC Bank's productivity decreased to 0.942, while SBI's score was slightly lower at 0.932, both indicating significant inefficiencies. Remarkably, ICICI Bank exhibited the lowest productivity among the banks, with a score of 0.917, highlighting substantial challenges in optimizing resource allocation and operational processes.

Table 3: Table showing the productivity changes of banks from the year 2018 to 2023

Year	Year No.	effch	techch	pech	sech	tfpch
2018	2	0.921	1.356	1	0.921	1.249
2019	3	0.992	1.117	1	0.992	1.109
2020	4	1.017	1.028	1	1.017	1.045
2021	5	0.979	1.115	1	0.979	1.092
2022	6	0.983	1.034	1	0.983	1.017
2023	7	1.022	0.916	1	1.022	0.937

Chart 7: Chart showing the productivity changes of banks from the year 2018 to 2023

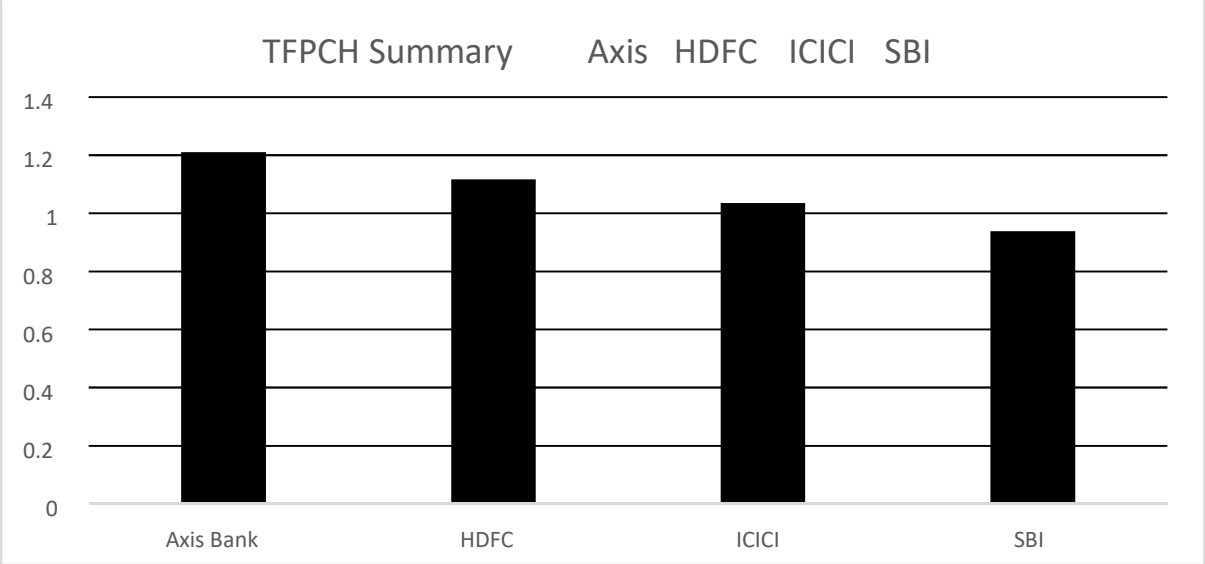


The chart provides a clear visualization of the productivity trends within the banking sector, encompassing Axis Bank, HDFC, ICICI, and SBI, from 2018 to 2023. It highlights a peak in productivity in 2018, with a score of 1.249, followed by a gradual decline over the subsequent years, reaching 1.109 in 2019 and further decreasing to 1.045 in 2020. Although there was a slight uptick in productivity in 2021, rising to 1.092, the trend reversed in 2022, with productivity dropping to 1.017, albeit still relatively high compared to earlier years. However, the most significant decline occurred in 2023, with productivity plummeting to 0.937, signaling a notable inefficiency in resource utilization across the banking sector. Overall, the data underscores 2018 as the most productive year for the banking industry

Table 4: Table showing the productivity changes of banks

Banks	**effch**	**techch**	**pech**	**sech**	**tfpch**
Axis Bank	1	1.211	1	1	1.211
HDFC	0.95	1.176	1	0.95	1.117
ICICI	1	1.035	1	1	1.035
SBI	0.993	0.945	1	0.993	0.939

Chart 7: Chart showing the total factor productivity changes of banks from the year 2018 to 2023



The chart presents the total factor productivity changes within the banking sector from 2017 to 2023. Axis Bank exhibits the highest productivity, scoring 1.211, indicating its efficient utilization of resources. Following closely, HDFC ranks second with a productivity score of 1.117, highlighting its commendable efficiency. ICICI secures the third position with a productivity score of 1.035, demonstrating respectable resource management. Conversely, SBI lags behind with the lowest productivity score of 0.939, indicating inefficient utilization of inputs compared to other banks in the sector.

There is a significance difference between the efficiency and factor productivity changes in the banks throughout the years. Hence, Hypothesis 1 (H1) is proved.

Limitations

The study's reliance on publicly available data from bank websites may limit the depth of analysis, overlooking potential nuances in performance. Aggregated data obscures differences in productivity across bank segments, and the study's timeframe may not capture longer-term trends or external influences. Additionally, external factors like regulations and economic conditions aren't explicitly considered, and the findings might not generalize beyond the Indian banking sector.

Conclusion

Based on the productivity trends observed in the banking sector from 2017 to 2023, it's evident that there are fluctuations in efficiency levels among Axis Bank, HDFC, ICICI, and SBI. To enhance overall

productivity, banks should focus on performance analysis, benchmarking against industry standards, investing in training and technology, optimizing processes, prioritizing customer experience, strengthening risk management, fostering strategic partnerships, ensuring regulatory compliance, and implementing continuous monitoring and evaluation practices. By addressing these areas, banks can improve operational efficiency, maximize resource utilization, and sustain long-term growth in the dynamic banking landscape.

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