Analyzing The Transformative Impact of Diverse Artificial Intelligence Applications on the Banking Sector

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[Abstract] The main objective of this research paper is to critically evaluate the effects of various AI applications on key financial metrics within banks. Additionally, the study compares the technological adoption of private sector banks with that of public sector banks, focusing on the period from the financial year 2012-2013 to 2021-2022. The analysis includes a detailed examination of the five years preceding (FY 2013-2017) and the five years following (FY 2018-2022) the integration of AI and other emerging technologies in banking operations. The financial robustness of the banks is assessed through five key indicators: profits/revenue, cost and efficiency, asset quality, and business size. A decade-long ratio analysis was performed, and the impact of AI on bank performance was statistically measured using paired t-tests conducted in SPSS and Excel.

The hypothesis testing using paired t-tests revealed that AI applications have significantly influenced HDFC Bank's asset quality, profits/revenue, cost and efficiency, and overall business performance. As a result, in case of HDFC Bank, null hypothesis is rejected. In contrast, for SBI, only the cost and efficiency parameters showed significant improvement. The study concludes that technological advancements have enhanced the growth of banks, which is likely to contribute to overall economic growth.

[Keywords] financial parameters, ratio analysis, artificial intelligence, emerging technologies

Introduction

Banks are undergoing significant transformation by embracing digital services and forming collaborative ecosystems with third-party providers. This shift has led to the integration of various digital solutions, fostering innovation within the banking sector. The vast amounts of data that underpin productivity, efficiency, ease, and scalability are crucial to every business. In the banking industry, AI enhances efficiency, user-friendliness, and trustworthiness. The ability of computers to carry out activities on their own is known as artificial intelligence (AI), and it helps modern banks to stay competitive in the digital age. The use of AI in banking processes significantly lowers expenses, improves customer service, and automates processes.

Banks are embarking on a challenging yet promising journey toward digitization to strengthen their core services over time. HDFC Bank, the largest private sector bank by assets and market capitalization, has recently merged with HDFC Limited, resulting in the new entity named HDFC Bank. As of April 1, 2022, HDFC Bank's market capitalization was ₹8.36 lakh crore (USD 110 billion), while HDFC Limited's market capitalization stood at ₹4.46 lakh crore (USD 59 billion) according to the HDFC Bank annual report for 2021-2022. The State Bank of India (SBI), the largest lender in the country, is an Indian multinational public sector bank headquartered in

Mumbai, Maharashtra. As of 2022, its market capitalization was ₹2.60 lakh crore. SBI operates an extensive network of 22,010 branches and 58,415 ATMs across India, as detailed in the SBI annual report for 2021-2022. A study by Gartner in 2017 estimated that the Indian banking sector, along with major security firms, invested approximately $9.10 billion in IT infrastructure during the financial year 2017. In 2016, there was a significant 11.7 percent increase in IT spending among banks and security services firms. As digital banking continues to expand, it is expected that investments in AI and other emerging technologies within the financial services industry will continue to rise.

Literature Review

Banks are pivotal in the economic advancement of a nation, with the adoption of cutting-edge technologies not only enhancing their brand equity but also contributing substantially to national income. It is incumbent upon banks to adapt to the swiftly evolving technological landscape (Mor and Gupta, 2021). In the contemporary era, banks are actively exploring innovative avenues for alternative distribution channels and are developing new services that align with customer expectations. It is imperative that banks come up with creative ways to increase profits by leveraging the new opportunities that digitalization and contemporary technology provide (Wang et al., 2020). The prediction that artificial intelligence (AI) might boost the world economy by around $15.7 trillion highlights the technology's growing significance.

Advances in AI are expected to propel a 14% increase in the global GDP by 2030—a figure that will exceed the combined GDP of China and India today (PwC, 2017). The results of the study support the idea that artificial intelligence (AI) improves the banking industry's process chain by making it easier for machine-assisted operations to be completed smoothlyy (Elegunde & Osagie, 2020). Furthermore, Folarin and Idris (2020) assert that AI technology significantly influences non-financial aspects of firms, majorly employee efficiency, competitive advantage, service quality and customer satisfaction.

AI has become highly significant these days. Start-ups and other companies have started deploying AI techniques for different opportunities. AI can play a crucial role not in customer satisfaction but also in fraud detection in banking sector (RBI Report, 2019). Artificial intelligence is being used in many parts of banking operations, including fraud detection, surveillance, customer service, and compliance assurance (Aggarwal et al., 2019). The usage of the newest emerging technology will not only add value to one's own business but also greatly contribute to the growth and development of a nation, since banks are essential to the nation's economic development. Technological progress refers to discovery of some new and improvised method of production of goods and services with the help of new technology (Anyanwu, 2014).

While capital accumulation and technical innovation work together to drive the nation's economic growth, institutional change plays a significant role in setting incentives that impact the economy's stable growth rate (Trinh, 2014). Adopting robust policies that foster international investment is essential for channeling capital towards development in emerging economies. Consequently, the increased investment in technology has a direct and significant impact on the sustainability of a nation's economic growth (Mohamed et al., 2022). Existing literature highlights the influence of emerging technology on the banking industry, particularly through non-financial parameters like customer service and satisfaction levels. The paper addresses the relatively unexplored area of financial aspects, especially those related to annual report data, within the existing literature. It provides a detailed analysis of the effects of AI applications on the vital financial metrics of banks.

Methodology

Data Source

This research utilizes secondary data collected from various sources, including audited financial reports of HDFC Bank and SBI, Reserve Bank of India (RBI) publications, Money Control, esteemed journals, and other scholarly articles.

Study Period

The study spans ten years, covering five years before AI adoption (FY 2012-2013 to FY 2016-2017) and five years after AI adoption (FY 2017-2018 to FY 2021-2022). Based on the available secondary data, it is observed that the banks began adopting AI tools in the year 2017.

The following points support the classification of the years following 2017 as the post-AI implementation period: A 2017 report by the international research consultancy firm Gartner indicated that banks significantly increased IT spending in 2017 to implement new technology, leading to substantial business growth. 2) Annual audit reports for FY 2017-18 from HDFC Bank and SBI show that both banks-initiated AI applications in their operational processes. 3) Furthermore, the PWC Fintech Trends Report 2017 highlights a significant rise in investments by banks and other financial institutions in AI infrastructure.

Research Design

For this study, the authors selected SBI and HDFC Bank as representatives of public and private sector banks, respectively. A quantitative approach was employed, using financial data sourced from the banks' audited balance sheets. Statistical analysis was conducted using SPSS and Microsoft Excel. A paired sample for means t test at 95% confidence level has been used to test the hypothesis using SPSS on various performance parameters of different banks considered in the study

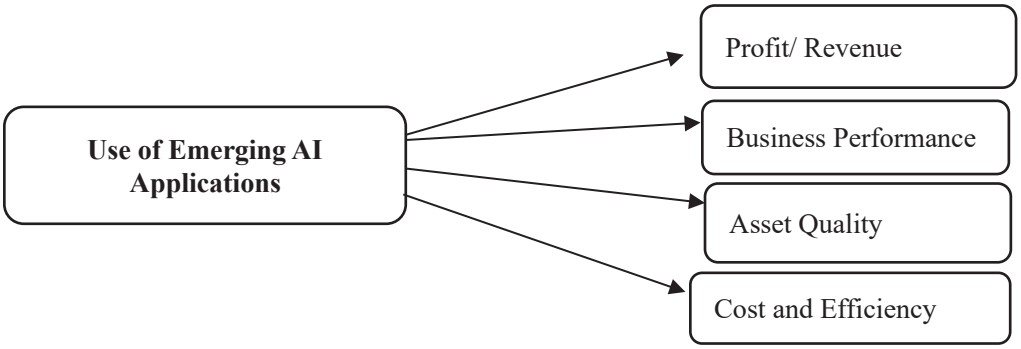
Research Questions

1. Does Artificial intelligence (AI) applications impact the bank’s productivity?
2. Whether SBI or HDFC bank performed better post AI technology usage?

Research Objectives

The research paper aims to critically assess the impact of diverse AI applications used in various departments and processes on crucial financial parameters of banks. Additionally, it compares the performance of private and public sector banks in terms of technology adoption from the financial year 2012-2013 to 2021-2022.

Figure 1
Emerging Artificial Intelligence Applications Affecting Bank's Profits/ Revenue, Cost And Efficiency, Asset Quality And Business Performance



Hypotheses

- H_{01}: There is no significant impact on HDFC bank Profit/ Revenue parameters using Artificial Intelligence (AI) technology.
- H_{a1}: There is a significant impact on HDFC bank Profit/ Revenue parameters using Artificial Intelligence (AI) technology.

- H_{02}: There is no significant impact on SBI Profit/ Revenue parameters using Artificial Intelligence (AI) technology.
- H_{a2}: There is a significant impact on SBI Profit/ Revenue parameters using Artificial Intelligence (AI) technology.

- H_{03}: There is no significant impact on HDFC bank Cost and efficiency parameters using Artificial Intelligence (AI) technology.
- H_{a3}: There is a significant impact on HDFC bank Cost and efficiency parameters using Artificial Intelligence (AI) technology.

- H_{04}: There is no significant impact on SBI Cost and efficiency parameters using Artificial Intelligence (AI) technology.
- H_{a4}: There is a significant impact on SBI Cost and efficiency parameters using Artificial Intelligence (AI) technology.

- H_{05}: There is no significant impact on HDFC bank Asset quality parameters using Artificial Intelligence (AI) technology.
- H_{a5}: There is a significant impact on HDFC bank Asset quality parameters using Artificial Intelligence (AI) technology.

- H_{06}: There is no significant impact on SBI Asset quality parameters using Artificial Intelligence (AI) technology.
- H_{a6}: There is a significant impact on SBI Asset quality parameters using Artificial Intelligence (AI) technology.

- H_{07}: There is no significant impact on HDFC bank Business performance parameters using Artificial Intelligence (AI) technology.
- H_{a7}: There is a significant impact on HDFC bank Business performance parameters using Artificial Intelligence (AI) technology.

- H_{08}: There is no significant impact on SBI Business performance parameters using Artificial Intelligence (AI) technology.
- H_{a8}: There is a significant impact on SBI Business performance parameters using Artificial Intelligence (AI) technology.

Note: H_0 denotes null hypothesis and H_a denotes alternate hypothesis. In this case, we have eight pairs of hypotheses.

Data Analysis

The strength of the above proposed hypotheses was assessed using the paired sample t-test analysis summarized in the following tables.

Table 1

Impact of AI on HDFC Bank and SBI Profit/ Revenue Parameters

Parameters	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
HDFC Bank								
Profit After Tax	-16126.72	4690.4	2097.61	-21950.62	-10302.81	-7.688	4	0.002
Return On Average Assets	-0.024	0.09	0.04	-0.136	0.08	-0.59	4	0.587
Return On Equity	2.548	1.48	0.66	0.7	4.39	3.83	4	0.019
Earnings Per Share	-27.7	7.63	3.41	-37.18	-18.22	-8.13	4	0.001
State Bank of India								
Profit After Tax	-471.20	16480.20	7370.17	-20934.07	19991.67	-0.06	4	0.952
Return On Average Assets	0.36	0.56	0.25	-0.33	1.05	1.45	4	0.220
Return On Equity	4.86	10.39	4.65	-8.05	17.76	1.05	4	0.355
Earnings Per Share	68.58	110.40	49.37	-68.50	205.65	1.39	4	0.237

The paired t test result shows Significance (two tailed) value of Profit after tax is 0.002 which is lower than 0.05. Hence, Profit after tax is showing significant change before and after AI implementation. Significance value of return on average assets is 0.587 which is higher than the 0.05. Hence, Impact of AI applications on ROAA is not significant. Significance value of Return on equity is 0.019 which is lower than 0.05. Hence, ROE has shown a significant impact due to AI implementation. Earnings per share significance value is 0.001 which is lower than 0.05. Hence, EPS has shown a significant change due to AI implementation. Out of four parameters in Profit/ Revenue, three has shown significant change hence null hypothesis is rejected and alternate hypothesis (***Ha$_1$***) is accepted in this case.

The paired t test result shows Significance (two tailed) value for Profit after tax is 0.952 which is higher than 0.05. Hence, t value in this case is found to be insignificant. Significance value of return on average assets is 0.22 which is higher than the 0.05. Hence, Impact of AI applications on SBI's ROAA is not significant. Significance value of Return on equity is 0.355 which is higher than 0.05. Hence, ROE has shown insignificant impact due to AI implementation. Earnings per share significance value is 0.237 which is higher than 0.05. Hence, EPS also has shown significant change due to AI implementation. All four parameters of Revenue/ Profit have shown insignificant change hence null hypothesis (***Ho$_2$***) is accepted in this case.

Table 2

Impact of AI Technology on the Cost and Efficiency Parameters of HDFC Bank and SBI

Parameters	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
HDFC BANK								
Cost To Income Ratio	7	1.22	0.54	5.47	8.5	12.79	4	0.00
Profit Per Employee	-7.69	0.23	0.107	-7.98	-7.4	-72.87	4	0.00
Business Per Employee	-0.11	0.01	0	-0.13	-0.09	-17.1	4	0.00
State Bank of India								
Cost To Income Ratio	-3.63	1.47	0.66	-5.46	-1.80	-5.51	4	0.005
Profit Per Employee	0.00	0.06	0.03	-0.07	0.08	0.12	4	0.91
Business Per Employee	-8.35	1.32	0.59	-9.99	-6.72	-14.19	4	0.00

The paired t test result shows Significance (two tailed) value of Cost to income ratio is 0.00 which is lower than 0.05. Hence, Cost to income ratio is showing significant change before and after AI implementation. Significance value of Profit per employee is 0.00 which is lower than the 0.05. Hence, Impact of AI applications on profit per employee is highly significant. Significance value of Business per employee is 0.00 which is lower than 0.05. Hence, Business per employee has shown a significant impact due to AI implementation. Out of three parameters in Cost and efficiency, all three has shown significant change hence null hypothesis is rejected and alternate hypothesis (H_{a3}) is accepted in this case.

The paired t test result shows Significance (two tailed) value of Cost to income ratio is 0.005 which is lower than 0.05. Hence, Cost to income ratio is showing significant change before and after AI implementation. Significance value of Profit per employee is 0.91 which is higher than the 0.05. Hence, Impact of AI applications on profit per employee is insignificant. Significance value of Business per employee is 0.00 which is lower than 0.05. Hence, Business per employee has shown a significant impact due to AI implementation. Out of three parameters in Cost and efficiency, two have shown significant change hence null hypothesis is rejected and alternate hypothesis (H_{a4}) is accepted in this case.

Table 3

Impact of AI on the Asset Quality Parameters of HDFC Bank and SBI

Parameters	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
HDFC BANK								
Gnpa To Net Advances	-0.3	0.1	0.04	-0.44	-0.17	-6.37	4	0.003
Nnpa To Net Advances	-0.1	0.0753	0.03367	-0.2015	-0.0145	-3.207	4	0.033
Advances	-609143.41	150689.49	67390.39	-796249.13	-422037.69	-9.03	4	0.001
Net Interest Income	-32798.664	5910.5394	2643.2736	-40137.568	-25459.76	-12.4	4	0.000
State Bank of India								
Gnpa To Net Advances	-0.80	4.29	1.92	-6.13	4.54	-0.41	4	0.700
Nnpa To Net Advances	0.46	2.96	1.32	-3.22	4.14	0.35	4	0.746
Advances	-1007852.40	99876.01	44665.91	-1131864.85	-883839.95	-22.56	4	0.000
Net Interest Income	-45005.00	11321.70	5063.22	-59062.74	-30947.26	-8.89	4	0.001

The paired t test result shows Significance (two tailed) value for Gross NPA to net advances is 0.003 which is lower than 0.05. Hence, t value in this case is found to be highly significant. Significance value of NNPA to net advances is 0.033 which is lower than the 0.05. Hence, Impact of AI applications on HDFC's NNPA is significant. Significance value of Advances is 0.001 which is lower than 0.05. Hence, Advances has shown significant impact due to AI implementation. Net Interest income (NII) significance value is 0.00 which is lower than 0.05. Hence, NII also has shown significant change due to AI implementation. All four parameters of Asset quality have shown significant change hence null hypothesis is rejected and Alternate hypothesis (H_{a5}) is accepted in this case.

The paired t test result shows Significance (two tailed) value for Gross NPA to net advances is 0.70 which is higher than 0.05. Hence, t value in this case is found to be insignificant. Significance value of NNPA to net advances is 0.746 which is higher than the 0.05. Hence, Impact of AI applications on SBI's NNPA is insignificant. Significance value of Advances is 0.00 which is lower than 0.05. Hence, Advances has shown significant impact due to AI implementation. Net Interest income (NII) significance value is 0.001 which is lower than 0.05. Hence, NII also has shown significant change due to AI implementation. Out of four parameters of Asset quality, two have shown significant change hence null hypothesis (H_{06}) is accepted.

Table 4

Impact of AI on the Business Performance Parameters of HDFC Bank and SBI

Parameters	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
HDFC BANK								
Deposits	-689849.28	171511.4	76702.23	-902808.82	-476889.75	-8.99	4	0.001
Market Price	-698.91	223.98	100.16	-977.02	-420.8	-6.97	4	0.002
Tier 1 Capital	-3.8	1.08	0.48	-5.17	-2.49	-7.92	4	0.001
Capital Adequacy Ratio	-1.66	2.4	1.07	-4.64	1.32	-1.54	4	0.197
State Bank of India								
Deposits	-1728549.40	237762.57	106330.65	-2023770.62	-1433328.18	-16.26	4	0.000
Market Price	623.96	1000.04	447.23	-617.75	1865.67	1.40	4	0.235
Tier 1 Capital	-0.66	0.20	0.09	-0.90	-0.42	-7.54	4	0.002
Capital Adequacy Ratio	0.04	0.25	0.11	-0.27	0.35	0.39	4	0.713

The paired t test result shows Significance (two tailed) value for Deposits is 0.001 which is lower than 0.05. Hence, t value in this case is found to be highly significant. Significance value of Market price is 0.002 which is lower than the 0.05. Hence, Impact of AI applications on SBI's Market price is highly significant. Significance value of Tier1 capital is 0.001 which is lower than 0.05. Hence, Tier1 capital has shown significant impact due to AI implementation. CAR significance value is 0.197 which is higher than 0.05. Hence, CAR has shown insignificant change due to AI implementation. Out of four parameters of Business performance, three have shown significant change hence alternate hypothesis (H_{a7}) is supported.

The paired t test result shows Significance (two tailed) value for Deposits is 0.00 which is lower than 0.05. Hence, t value in this case is found to be highly significant. Significance value of Market price is 0.235 which is higher than the 0.05. Hence, Impact of AI applications on SBI's Market price is insignificant. Significance value of Tier1 capital is 0.002 which is lower than 0.05. Hence, Tier1 has shown significant impact due to AI implementation. CAR significance value is 0.713 which is higher than 0.05. Hence, CAR has shown insignificant change due to AI implementation. Following a conservatism approach, out of four parameters of Business performance, only two have shown significant change hence null hypothesis (H_{08}) seems to be supported.

Conclusion

Previously, banking operations relied on traditional methods, with limited awareness of globalization and digitalization trends. Over the years, various governmental reforms have been introduced to improve the financial health as well as the efficiency in the diverse banking operations of banks and other financial institutions. Banking procedures today include enormous volumes of data and are getting more and more complicated. Artificial intelligence (AI) and other developing technologies are becoming more widely used as a result of rising cyber dangers, longer decision-making times, and higher customer expectations.

The present study highlights the significant improvement in banking processes resulting from the application of AI. Technological advancements have touched every sector, enhancing operational efficiency. This study specifically assesses the impact of AI techniques on HDFC Bank and SBI, examining their ten-year key financial parameters. The analysis focuses on revenue, costs and efficiency, asset quality, and business performance, revealing that AI has led to notable, albeit gradual, progress in financial ratios. According to the study's findings, banks have been much more efficient and successful since implementing AI, as seen by their impressive financial results. Additionally, studies show that higher productivity and lower costs in banks have boosted GDP development. Economic progress is being facilitated by the enhancement of the calibre and range of banking services offered. As key players in economic growth, banks and financial institutions must continue to leverage AI algorithms.

Limitation and Future work

The main topic of this study is HDFC Bank's and SBI's financial performance in connection to their utilization of cutting-edge technology. To learn more about how AI is affecting the banking industry, future research could take two approaches: a qualitative analysis of non-financial parameters, or a quantitative examination of other public sector and private sector banks not covered in this study.

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