

Analysis of Financial Performance Pre and Post Use of Artificial Intelligence Applications Via CAMELS Lens: With Special Reference to HDFC Bank

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Abstract: Now a day, banks are focusing on more investments towards emerging technologies like artificial intelligence as customer loyalty and delight through digital transformation has become their main aim. This study is focused on examining the impact of AI techniques through CAMELS approach to crisscross the financial performance of the bank. HDFC bank is selected as sample for analysis being largest private sector bank and one of the leaders in adopting AI technology for enhancing customer experience. Authors have considered 4 pre-AI adoption years (FY2012-2016), 4 post-AI adoption years (FY2018-2021) and 2017 is considered as technology implementation cooling period. Further the study attempts to assess the HDFC performance in terms of financial parameters pre and post adoption of Artificial Intelligence applications in banking by comparing their mean values. SPSS and Microsoft Excel are used to test paired sample t on the secondary data collected and findings shows that there is a improvement in almost all the CAMELS ratios and significant improvement is observed in seven parameters namely Tier 1 Capital Ratio, BPE (Business per employee), PPE (Profit per employee), Market price (MP), Dividened per share (DPS), Cost - Income ratio, Expense to Interest Earned Ratio. Authors found that the encouraging impact of AI is being seen but significant change may take time.

Keywords: Artificial intelligence, pre and post analysis, CAMELS, HDFC bank, financial performance, AI applications.

1. Introduction

Banks are increasingly transforming their businesses and forming collaborative ecosystems with third parties. As a result, banks are integrating numerous digital services into their business operations, resulting in the creation of new digital solutions through considerable banking sector innovation. The massive quantity of data that forms the basis for productivity, efficiency, ease, and scalability is at the core of every business, industry, and government operation. Use of AI in banking industry makes banks more efficient, trustworthy and user friendly. Artificial Intelligence basically means computer's ability to perform tasks independently. It helps modern banks maintain their competitive advantage in the digital age. The adoption of AI in banking shall reduce cost of

operation, increases customer service and aid in process automation.

Banks are beginning on a rough but rewarding journey to dress in digitization to enhance their core banking services in the long run. In its recent study, global research and consultancy firm Gartner estimates that banking sector in India and security business giants would have spent \$9.10 billion approximately on IT infrastructure in the financial year 2017. In 2016, banks and security services firms increased their spending on IT services by 11.7 percent. As people increasingly use digital banking, more money is projected to pour into AI and other emerging technologies in financial services industry.

By assets and market capitalization, HDFC Bank is the largest private bank in India. The adoption of AI as a technology is encapsulated by a variety of application cases. In 2016, HDFC Bank introduced OnChat, an AI-powered chatbot on Facebook Messenger. The chatbot, developed in collaboration with Niki.ai, saw a 160 percent month-over-month increase in transactions within a year of its introduction. More than 3 lakhs customers have interacted with HDFC Bank OnChat and the amount of transaction is close to Rs.250 lakhs as per latest HDFC bank's Annual audit report. AI has been used widely in the field of customer service. HDFC Bank's virtual chatbot named Eva. It has answered over 50 lakh

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questions from over a million clients with an accuracy rate of over 85%. Every day, Eva has over 20,000 conversations with clients from all over the world.

Bill payments, ticket reservations, and more are now being managed by the bot. Also, HDFC Bank is India's first bank who introduced a humanoid robot named IRA. It provides services to the average of 60 customers on daily basis. The presence of customers is detected by the robot through vision sensors and it answers to the queries, guiding them to the nearest counter. Another Artificial intelligence application that cemented the way for an operative recruitment is HDFC's Recruit Bot. This AI application has the ability to recognize the accurate candidate across functional and personal skills which is also suitable for large scale recruitment initiatives. The time to hire has been reduced up to 80 per cent through the solution. Risk management, employee engagement, portfolio management, credit scoring is some of the several deployments made by HDFC Bank. Underwriting, credit score model and fraud detection in credit payment default are few examples where AI aids in work processes (Rathod, 2018).

2. Literature Review

Banks and other financial institutions play a major role in the economic development of any nation, the use of latest technology is not only required from bank's income point of view but also from national growth. In today's rapidly changing environment, banks must keep pace with high customer expectations (Mor and Gupta, 2021). Banks are now a days trying to find out new ways for alternate distribution channels and come out with new services in line with customer expectations. They are linking innovations with customer feedback and expectations. Banks need to find out novel ways to generate more income through unexplored ways created by digitalization and latest technology. (Wang et al., 2020). The banking industry in India is looking for diverse ways wherein AI can be implemented to enhance customer satisfaction level in near future. Hence, banks are gradually introducing emerging technologies like AI, cloud computing and block chain (Jewandah, 2018).

AI is impacting significantly in various industries mainly Oil and gas, retail and manufacturing industry, healthcare and alike (Dubey, 2019). The bank uses AI-based anti-money laundering, anti-fraud, compliant credit underwriting and smart contract technologies in its operations in order to improve profitability and improve the quality of the decisions made at different management levels (Vedapradha R., 2018). The growing significance of Artificial intelligence is proven from the facts and figures that it can contribute nearly 15.70 trillion US dollars to the world economy. The global GDP is expected

to grow by 14 percent higher in the year 2030 mainly due to advancement of AI, which is more than combined present output of China and India (PWC, 2017). The findings of the study supported that AI complements process chain in banking industry in Nigeria and also help in smooth and effortless completion of machine aided tasks in Nigeria (Elegunde and Osagie, 2020). AI has marked the way for companies to use it as a tool to improve customer service and also to gain competitive edge over rivals. It further reduces employee workload and improved employee efficiency. It has been established in the research paper that Artificial impacts the non-financial parameters of the firm such as customer satisfaction, employee efficiency, competitive advantage and service quality (Folarin & Idris, May 2020). In India, Banking sector has to cope up with the challenges in implementing artificial intelligence like huge investment involved, coming up with useful strategies, and uplifting the level of technological infrastructure and its awareness to end user (Kurode, 2018). According to the latest statistics, US \$ 1.3 billion has been invested in financial technology projects worldwide (Dubey, 2019). The latest Accenture report clearly predicts that artificial intelligence could boost the Indian economy by \$ 957 billion by 2037.

Gap Analysis

Artificial intelligence impact on banking industry has been measured via non-financial parameters recently but still financial impact has not been studied. This paper explains in detail about the impact of use of AI applications through measuring the change in mean values of important ratios which describe the banking parameters.

Research Questions:

1. What is CAMELS Framework and how it is useful in measuring bank's performance?
2. Describe the effect of AI adoption on various financial parameters of bank through pre and post AI technique adoption?
3. Whether the financial performance of banks improves after adoption of AI techniques?

On the basis of analysis of Research questions authors have formulated following research objectives:

Research objectives

1. To analyze the effect of pre and post AI adoption financial performance of HDFC Bank using CAMELS approach
2. To compare the pre and post AI adoption effect on financial performance of HDFC Bank

Hypothesis:

Research hypothesis framed is as follows:

H₀: There is no significant difference in HDFC Bank's financial performance as per CAMELS approach pre and post Artificial intelligence adoption.

H₁: There is a significant difference in HDFC Bank's financial performance as per CAMELS approach pre and post Artificial intelligence adoption.

A paired sample for means t test at 95% confidence level has been used to test the hypothesis using SPSS on various components of CAMELS approach.

3. Research Methodology:

Data Source:

Source of data:

Research is based on secondary sources mainly data and values are collected from audited reports of HDFC Bank, RBI reports; Scopus indexed journals and other journals.

Period of study:

As per the secondary data available it appears that the bank started adopting the AI tools in the financial year 2016-2017, thus leaving it as gap year to reflect the implementation of AI, the study considers 8 years financial data that means four years prior to adoption of AI (FY 2013-2016) and four years post adoption of AI (FY 2018-2021). Financial year 2016-17 is considered as base year for integration of AI technology with existing system, infrastructure and data values on the basis of following rationale:

1. Latest report issued by Global research advisory firm named Gartner mentions that huge amount of IT spending was made the banks in the year 2017. As banks are focussing more implementation of new technologies leading to exponential business growth.
2. HDFC Bank has started using AI applications in their work processes as per audited bank balance sheet FY 2016-17.

Further, as per PWC Fintech trends report 2017, banks and other firms' investment in AI Infrastructure is hugely increasing.

Research Design:

Authors have compared mean values of pre and post time period on the basis of assumption that no major change in the bank has taken place during this event which has impacted bank's performance apart from adoption of latest technologies. HDFC Bank being one of the innovators of cutting-edge technologies and further it represents 25% of total Indian banking business which can be generalized to say for banking sector. HDFC merger with HDFC bank taken place in May 2022 has not taken into effect in this study as authors have confined to data upto FY 2020-21.

Research Technique:

SPSS and MS Excel are used for statistical analysis. To measure the financial performance, CAMELS approach is considered in this research paper. Mean values of CAMELS ratios have been compared to understand change in financial performance.

This approach was developed in USA to determine the overall position of the bank. Mean values of ratios pre AI adoption is compared to mean values of post AI adoption. In this study, two tailed paired t test is used to test the differences between pre AI adoption mean and values with Post AI adoption mean values. It is being checked whether the difference between pre mean ratio and post mean ratio is zero or not i.e. ($H_0 = \mu_{pre} - \mu_{post} = 0$, $H_1 = \mu_{pre} - \mu_{post} \neq 0$).

CAMELS Framework

CAMELS Model stands for Capital adequacy, asset quality, management efficiency, earning capacity, liquidity and sensitivity ratio. These six segments are considered as prominent ratios which aids in analysing the overall performance of the bank. These six significant parameters reflect the bank condition, financial performance, operating efficiency and soundness and regulatory compliance of the bank and other financial institutions. It was first put into effect in US in the year 1979 where it was proved to be useful and efficient tool. CAMELS basically is a ratio based model for evaluating the overall performance of bank. Different ratios forming this model are explained below:

Capital Adequacy	Formulae	Description
Capital Adequacy Ratio (CAR)	$\frac{\text{Tier I Capital} + \text{Tier II Capital}}{\text{Risk Weighted Assets}} * 100$	It assesses a bank's ability to tolerate losses resulting from risky assets.
Tier 1 Capital Ratio	$\frac{\text{Tier 1 Capital}}{\text{Total Risk Weighted Assets}}$	It calculates core capital to its total risk weighted assets.

Debt-Equity Ratio	$\frac{\text{Total Liabilities}}{\text{Shareholder's Equity}} * 100$	It is used to determine the financial leverage of a corporation.
Total Advance to Assets Ratio	$\frac{\text{Advances}}{\text{Total Assets}} * 100$	This ratio reflects the number of assets that have been given as advances.
Shareholder's Fund to Total Assets	$\frac{\text{Shareholder's Funds}}{\text{Total Assets}} * 100$	It displays how much of a company's assets are supported through stock issuance rather than borrowing money.
Assets Quality	Formulae	Description
Gross NPA to Total Advances	$\frac{\text{Gross NPA}}{\text{Gross Advances}} * 100$	This ratio reflects the company's asset quality.
Net NPA to Total Advances	$\frac{\text{Net NPA}}{\text{Net Advances}} * 100$	This ratio assesses the bank's loan quality as well as its overall soundness.
Credit Deposit Ratio	$\frac{\text{Total Advances}}{\text{Total Deposits}} * 100$	It shows amount of money lend by bank out of its deposits.
Management Efficiency	Formulae	Description
Business per Employee	$\frac{\text{Total Business (Deposits + Advances)}}{\text{No. of Employees}}$	This ratio measures the amount of business each employee contributes.
Profit per Employee	$\frac{\text{Net Profits}}{\text{No. of Employees}}$	It represents the each employee contribution in bank profitability.
Total Expenditure to Total Income Ratio	$\frac{\text{Total Expenditure}}{\text{Total Income}}$	It measures amount of expenses bank incurs and how efficiently the bank is being run.
Total Assets Turnover Ratio	$\frac{\text{Total income}}{\text{Total Assets}} * 100$	It calculates the bank income to generate from its assets.
Return on Equity (ROE)	$\frac{\text{Net Income}}{\text{Shareholder's Wealth}} * 100$	It measures net income of the bank in relation to shareholder's wealth.
Return on Assets (ROA)	$\frac{\text{Net Income}}{\text{Total Assets}} * 100$	It shows bank's net income to total assets.
Earnings Capability	Formulae	Description

Dividend Payout Ratio	$\frac{\text{Dividend per Share}}{\text{Earnings per Share}} * 100$	It represents amount of dividend decalred by bank from its earnings.
Net Interest Margin	$\frac{(\text{Interest Income} - \text{Interest Expense})}{\text{Interest Earning Assets}} * 100$	It demonstrates the bank's capacity to keep deposit interest low while keeping advance interest high.
Net Profit Margin	$\frac{\text{NET Profit}}{\text{Total Income}} * 100$	It is the amount of net profit earned as a percentage of total revenue.
Net Profit to Total Assets Ratio	$\frac{\text{Net Profit}}{\text{Total Assets}} * 100$	This ratio reflects the efficiency with which banks use their assets to generate profits.
Operating Profit / Total Assets Ratio	$\frac{\text{EBIT}}{\text{Total Assets}} * 100$	This ratio shows how much operating profit the bank generates by employing its assets.
Liquidity		
Liquidity	Formulae	Description
Liquid Assets to Total Assets Ratio	$\frac{\text{Liquid Assets}}{\text{Total Assets}} * 100$	It shows the percentage of liquid assets in the bank balance sheet's total assets.
Cash to Deposit Ratio	$\frac{\text{Cash}}{\text{Total Deposits}} * 100$	It shows how much money the bank has in its account as a result of the deposits it has received.
Interest Expended to Interest Earned ratio	$\frac{\text{Interest Expenditure}}{\text{Interest Earned}}$	It assesses a bank's capacity to cover interest expenses on deposits with interest income from advances.
Sensitivity		
Sensitivity	Formulae	Description
Demand deposits to total deposits	$\frac{\text{Demand deposits}}{\text{Total deposits}}$	It shows part of total deposits which are meant for meeting short term requirements
Price to earnings ratio	$\frac{\text{Market price per share}}{\text{Earnings per share}}$	It is the ratio for assessing the value of company that measures its market price relative to its earning per share.
Term deposits to total deposits	$\frac{\text{Term deposits}}{\text{Total deposits}}$	It shows part of total deposits which are meant for meeting long term requirements

Data Analysis and Interpretation

Years	Capital Adequacy Ratio (%)	Debt Equity Ratio (X)	Total Advances to Total Assets (%)	Tier1 Capital Ratio	Total Shareholders' Funds to Total Assets
Pre- AI adoption					
2012-13	16.80%	10.05	59.88	11.08%	9.05
2013-14	16.07%	10.31	61.64	11.77%	8.84
2014-15	16.79%	8.52	61.90	13.66%	10.5
2015-16	15.53%	8.75	65.44	13.22%	10.25
Post- AI adoption					
2017-18	14.82%	9.01	61.88	13.25%	9.99
2018-19	17.11%	7.34	65.84	15.78%	11.99
2019-20	18.52%	7.95	64.93	17.23%	11.17
2020-21	18.79%	7.57	64.85	17.56%	11.66

Table 1: Capital Adequacy Ratios of HDFC during pre and post adoption of AI

The capital adequacy ratio explains the bank proficiency in terms of absorbing the risk and losses. CAR is used to measure the bank's capital exposure to its risk weighted assets. The increase in this ratio shows AI applications are helping the bank in enhancing bank's capital leading to stronger foundation of bank. The decline in debt equity ratio shows that with the help of AI applications bank is able to reduce its financial leverage which is a positive and encouraging sign. Tier I ration denotes bank's core Tier I capital to its total weighted assets. The said ratio is increasing which is showing significant improvement in

bank's capital base. Total advances to total asset ratio indicates is almost stable and has shown slight increase that reflects bank's ability to lend has enhanced due to latest adoption of latest technology. Total shareholder fund to total asset ratio has shown increasing trend which means shareholders funds are increasing. Shareholders funds consists of Equity shareholder fund, preference capital and reserves and surplus. Increase in these funds shows the capital adequacy of bank is strong and positive moving.

Years	Gross NPA	Net NPA	Credit Deposit Ratio	Net Interest Margin
Pre- AI adoption				
2012-13	0.97	0.20	0.81	3.94
2013-14	0.98	0.27	0.82	4.40
2014-15	0.93	0.25	0.81	4.40
2015-16	0.94	0.28	0.85	4.30
Post- AI adoption				
2017-18	1.30	0.40	0.83	4.30
2018-19	1.36	0.40	0.88	4.30
2019-20	1.26	0.36	0.86	4.30
2020-21	1.32	0.40	0.84	4.10

Table 2: Asset Quality Ratios of HDFC bank during Pre and Post adoption of AI

The second component asset Quality focuses on the asset quality of the bank. The study includes four parameters Gross NPA, Net NPA, Credit Deposit Ratio and Net Interest Margin to analyse the bank asset quality as well as financial health of the bank. Both net NPA and gross

NPA have shown stable cum increasing trend. The bank's major responsibility is maintain NPA at low level, else it would affect the profitability of the bank. In this case it can be seen, Gross NPA and Net NPA is stable and only slight increase in seen. During the decade Gross NPA

ranges between 0.93% to 1.36% and Net NPA ranges between 0.20% to 0.40% which is on very low side hence we can say NPA level is almost stable. Credit deposit ratio indicates the amount of deposit that has been lend by the bank. Higher the ratio it shows it is appropriately using its deposits. This ratio is also stable throughout the decade.

Basically, the difference between interest received and interest paid is termed as net interest margin(NIM). Credit deposit ratio is also stable throughout the mentioned tenure. This shows that asset ratios are steady and they do not vary much due to change in technologies or external conditions.

Years	Business Employee per	Profit per Employee	Total Expenses to Total Income Ratio	Return on Assets
Pre- AI adoption				
2012-13	7.5	0.10	0.84	1.90%
2013-14	8.9	0.12	0.83	2.00%
2014-15	10.1	0.10	0.82	2.02%
2015-16	11.39	0.15	0.83	1.92%
Post- AI adoption				
2017-18	15.08	0.2	0.82	1.93%
2018-19	16.87	0.23	0.82	1.90%
2019-20	18.31	0.22	0.81	2.01%
2020-21	20.55	0.26	0.79	1.97%

Table3: Management Efficiency Ratios of HDFC bank during Pre and Post adoption of AI

Management efficiency is the third component of CAMELS Model and it indicates management's ability to maximize the profit. Four parameters have been used to measure this component. In case of profit per employee, notable increment is seen during the time of assessment, which signifies due to implementation of AI the efficiency of the employees and management have enhanced. In case of Business per Employee, favourable changes can be seen, this denotes that HDFC has improved its efficiency

with the help of latest technologies mainly AI. Employee is now able to handle tasks more effectively leading to improved performance. Total Expenses to Total Income Ratio has been declining which indicates effectiveness in utilizing assets to generate more income. The said ratio is declining which shows with implementation of AI technologies cost is reducing. Return on Assets has shown slight improvement this shows technology has not shown any major improvement on return side in short run.

Years	Earnings Per Share (EPS)	Cost to Income Ratio	Dividend per share (DPS)	Market Price
Pre- AI adoption				
2012-13	28.49	49.6	2.75	312.68
2013-14	35.47	45.6	3.43	374.40
2014-15	42.15	44.6	4.00	511.35
2015-16	48.84	44.3	4.75	535.58
Post- AI adoption				
2017-18	67.76	41	6.50	964.50
2018-19	78.65	39.7	7.50	1159.45
2019-20	48.01	38.6	6.50	861.90
2020-21	56.58	36.3	6.50	1493.65

Table 4: Earning Management Ratios of HDFC bank during Pre and Post adoption of AI

Earning management, the fourth component reflects the profitability position of the banks. Out of the four

parameters to measure earning management, above four ratios are analysed (mention in Table no. 4) which

measures the cost of the bank in relation its earnings. EPS and DPS both indicate the level of company profits. From the above data, it can be seen that the said ratio is rising post AI adoption thus indicating improved profitability for the bank. DPS for FY 2019-20 is not mentioned in bank's audit report hence lower of average value of last two years or lower value of last two years is considered for fairness

in results. Market value of the share price has shown a significant increase over a period of time due to use of latest technologies, HDFC bank has gained competitive advantage, trust among people which helps in building loyal customers and larger market. Cost to income ratio is also declining which shows improved efficiency and reduced costs with AI tools.

Years	Liquid Asset to Total Assets Ratio	Cash to Deposit Ratio	Int Exp to Int Earned Ratio
Pre- AI adoption			
2012-13	0.34	0.05	0.72
2013-14	0.30	0.07	0.71
2014-15	0.34	0.06	0.70
2015-16	0.28	0.05	0.73
Post- AI adoption			
2017-18	0.34	0.13	0.64
2018-19	0.29	0.05	0.65
2019-20	0.31	0.06	0.64
2020-21	0.32	0.07	0.59

Table 5: Liquidity Position Ratios of HDFC bank during Pre and Post adoption of AI

The fifth component of the CAMELS model liquidity reflects the firm's capability to fulfill its financial obligation. To measure this, the study uses three parameters which shows the high quantum of liquid assets reflected by the ratios Cash deposit ratio and Liquid asset to total asset. This ratio has remained stable even after AI

implementation thus indicates overall stability in liquidity position of the bank. Cash to deposit ratio has shown slight increase. Interest expense to Interest earned ratio is declining due to increase in interest earnings in comparison to interest expense. With the applications of AI, interest expense has declined.

Years	Demand Deposits to Total Deposits %	Price to Earnings Ratio	Term Deposits to Total Deposits %
Pre- AI adoption			
2012-13	29.78	21.95	52.57
2013-14	28.08	21.11	55.19
2014-15	27.71	24.26	55.97
2015-16	27.06	21.93	56.75
Post- AI adoption			
2017-18	28.37	28.37	56.5
2018-19	26.94	29.48	57.62
2019-20	15.18	17.95	57.77
2020-21	15.89	26.40	53.88

Table 6: Sensitivity Ratios of HDFC bank during Pre and Post adoption of AI

The sixth component sensitivity to market risk is evaluated using three parameters, each indicating the rise in performance of the bank with adoption of AI tools.

It is observed that Price earnings ratio has been fluctuating slightly but eventually has upward trend, which indicates the stable behaviour of the share prices. Term deposit to total deposit ratio signifies the vulnerability to use bank funds for long term investments. Bank has maintained the ratio with slight variation; thus, it can be seen that bank is

consistent in utilizing funds for long term investment. This ratio seems to vary from 52.57 to 57.77 throughout the time span mentioned. Bank risk to meet the obligation towards depositors is termed as demand to total deposit ratio. Decline in the ratio can be seen for HDFC mainly in last two years due to pandemic that has forced people to purchase commodities at higher prices. Price to earnings ratio depicts the market price that the buyer is willing to pay to purchase the bank share. Increase shows market sentiments for the bank is positive.

Figures depicting the mean values of Pre and Post Artificial intelligence adoption

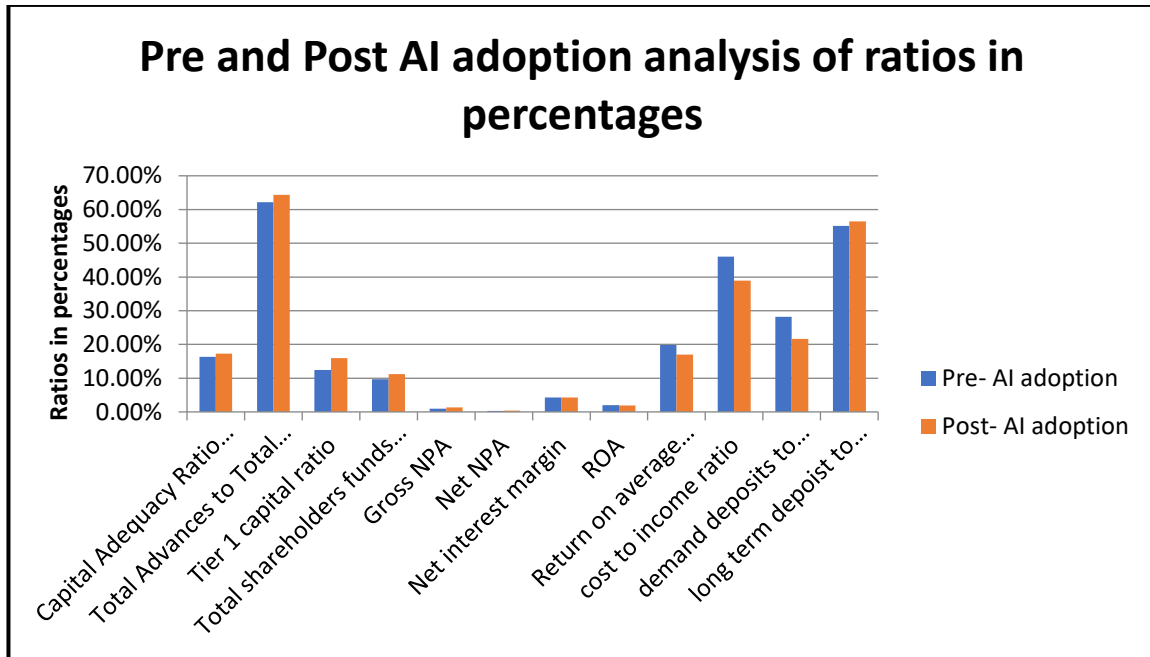


Figure 1: Pre and Post AI adoption analysis of ratios in percentages

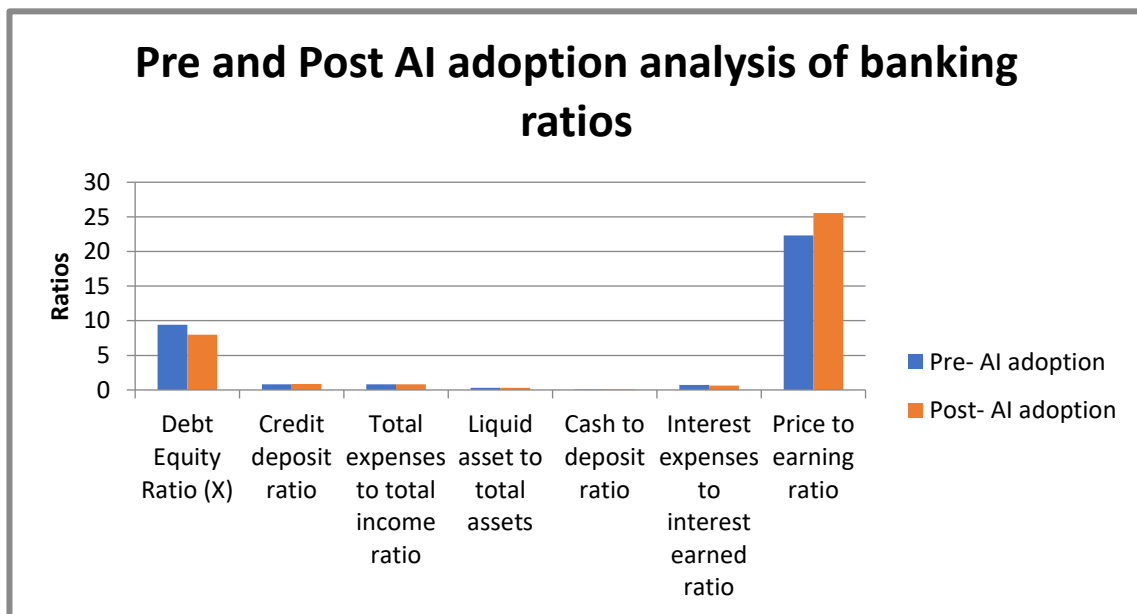


Fig 2: Pre and Post AI adoption analysis of ratios

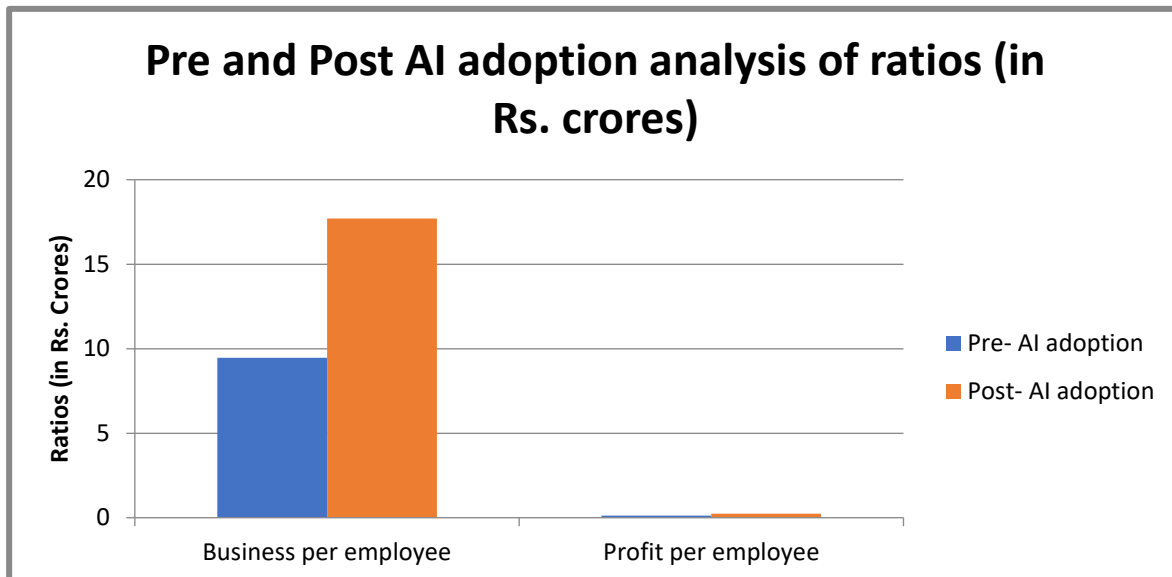


Fig 3: Pre and Post AI adoption analysis of ratios (in Rs. crores)

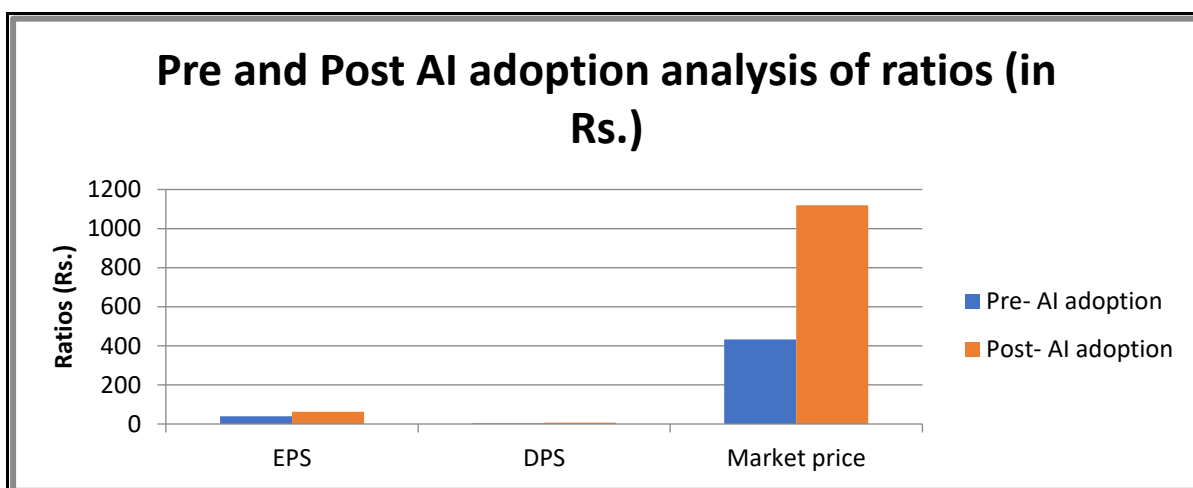


Fig 4: Pre and Post AI adoption analysis of ratios (in Rs.)

Ratios	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Capital Adequacy Ratio (%)	-1.01250	2.20014	1.10007	-4.51342	2.48842	-0.920	3	.425
Debt Equity Ratio (X)	1.44000	1.05284	.52642	-.23530	3.11530	2.735	3	.072
Total Advances to Total Assets (%)	-2.16000	2.04178	1.02089	-5.40893	1.08893	-2.116	3	.125
Tier 1 Capital Ratio	-3.52250	.95524	.47762	-5.04251	-2.00249	-7.375	3	.005
Total Shareholders' Funds to Total Assets	-1.54250	1.11443	.55722	-3.31581	.23081	-2.768	3	.070

Asset Quality	Gross NPA	-.35500	.02887	.01443	-.40093	-.30907	-24.595	3	.000
	Net NPA	-.14000	.04082	.02041	-.20496	-.07504	-6.859	3	.006
	CREDIT DEPOSIT RATIO	-.03000	.03162	.01581	-.08032	.02032	-1.897	3	.154
	Net Interest Margin	.01000	.25113	.12557	-.38961	.40961	.080	3	.942
Management Efficiency	Business per Employee	-8.23000	.67216	.33608	-9.29956	-7.16044	-24.488	3	.000
	Profit per Employee	-.11000	.00816	.00408	-.12299	-.09701	-26.944	3	.000
	Total Expenses to Total Income	.02000	.01414	.00707	-.00250	.04250	2.828	3	.066
	Return on Assets	.00750	.06652	.03326	-.09835	.11335	.225	3	.836
Earnings	Earnings Per Share (EPS)	-24.01250	19.95405	9.97702	-55.76384	7.73884	-2.407	3	.095
	DPS	-3.01750	1.08300	.54150	-4.74080	-1.29420	-5.572	3	.011
	Market Price	-686.3725	256.5979	128.2989	-1094.677	-278.06802	-5.350	3	.013
	Cost to Income Ratio	7.12500	1.37931	.68966	4.93021	9.31979	10.331	3	.002
Liquidity Position	Liquid Asset to Total Assets Ratio	.00000	.02944	.01472	-.04684	.04684	.000	3	1.000
	Cash to Deposit Ratio	-.02000	.04320	.02160	-.08875	.04875	-.926	3	.423
	Int Exp to Int Earned Ratio	.08500	.03786	.01893	.02476	.14524	4.490	3	.021
Sensitivity	Demand Deposits to Total Deposits %	6.56250	6.13166	3.06583	-3.19434	16.31934	2.141	3	.122
	Price to Earnings Ratio	-3.23750	6.56111	3.28056	-13.67770	7.20270	-.987	3	.396
	Term Deposits to Total Deposits %	-1.32250	2.93432	1.46716	-5.99166	3.34666	-.901	3	.434

Table 7: Pre and Post AI adoption in HDFC bank (Hypothesis testing- Paired Samples t test)

The above table shows the final result of paired sample t test run on six parameters considered in CAMELS approach to study impact of AI on HDFC Bank.

Capital adequacy ratios are moving in a positive direction but significant change is observed in Tier1 capital ratio. Improvement in ratios shows AI applications are accepted and trusted by bank's customers and they have shown loyalty towards bank by enhancing their stake in bank in the form of capital /shares and also preferring to take loan from HDFC Bank due to use of latest technologies.

Assets Quality ratios are showing improvement in Credit deposit ratio and net interest margin but significant change is not observed in any ratio. Gross NPA and Net NPA is steady stable which shows with the use of AI applications bad loans are not increasing and slowly with time NPAs will reduce.

Management efficiency ratios are moving in positive direction showing improvement in employee efficacy due to use of AI applications but significant changes are observed in Business per employee and profit per employee. With the use of latest technology employee is able to perform his task with more efficiency and accuracy leading to improved output and enhanced profits.

Earnings ratios shows a positive movement in all the ratios which shows AI applications will lead to cost reduction and building brand in the market due to competitive advantage gained by bank. Significant improvement has been shown in DPS, Market Price and Cost to Income Ratio.

Liquidity ratios shows liquid asset and cash position of bank has improved. Interest expense ratio has also improved significantly depicting improved management of interest expense due to AI applications.

Sensitivity ratio shows a positive movement in term deposits and price to earnings ratio showing customer's faith in bank. Customers feel safe and secure with the bank due to use of various AI applications.

Almost all the ratios are either stable or improving which shows technologies are serving bank in a big way depicting difference in ratios of bank and significance value of seven parameters under various components namely Tier 1 Capital Ratio, Business per Employee, Profit per Employee, DPS, Market Price, Cost to Income Ratio and Interest Expense to Interest Earned Ratio is lesser than 0.05 which indicates significant difference in financial performance of the bank pre and post implementing AI tools. Encouraging changes are seen and with time significant improvements can be noticed. From the results of the analysis, most of the performance parameters improve after implementation of AI tools; this suggests that there is need to inject Artificial intelligence-based applications into banking sector. This sector has greater impact and responds to the introduction of AI for sustainable growth and development. The parameters indicating the efficiency of the banking system revealed evidence of effectiveness and improvement in the banking system operations after implementation of AI.

4. Conclusion

Earlier commercial banks in India were not aware about liberalisation and globalisation, over the past decades government of India has launched numerous banking reforms to improvise the operational efficiency and financial health of banks. Today, banking sector in India has become more complex and complicated. Massive amount of data, increasing online threats, delay in decision making and rising customer expectations are leading to adoption of new emerging technologies like artificial intelligence. In the said research paper, authors have tried to prove that application of AI has been used by banks and they have started showing significant improvements in work processes. Technological advancements have touched all the sectors to improve the operational efficiency of the sector. The study is developed to assess the impact of AI techniques in HDFC Bank through secondary data analysis via CAMELS approach. The study estimated the six components of CAMELS approach using various parameters for each component to evaluate the bank's financial performance. The results pointed out that the progress of the bank in terms of financial ratios with the introduction of AI seems high and sound, though it is gradual. The study concludes that adoption of AI in bank has led to improved efficiency and effectiveness which is clearly shown by better financials of the bank. The Banking industry should continue implementing and adopting the various AI tools that would lead to robust financial health of the bank.

5. Limitations and Future Work

This study is focussed on movements in financial performance on HDFC Bank with respect to AI adoption. To gain more about impact of AI in banking sector, extension to the study could be other aspects like non-financial parameters and in case of financial study then other ratios not dealt in this paper can be examined.

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