Principal Component Analysis - Comparative Study on Performance of Axis Bank and Indian Bank

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Abstract
Principal component analysis (PCA) is a technique for reducing the dimensionality of such datasets, increasing interpretability but at the same time minimizing information loss. In this article, we have applied PCA to analyse a range of financial indicators such as capital adequacy, asset quality profitability, liquidity and efficiency across Axis and Indian bank. This study has been carried out using the data from 2014 to 2023. In this article PCA analysis has grouped the both banks using thirteen years financial data into three major components such as operating Income Ratio, Net profit Ratio and Expenses ratio. The two banks Axis banks and Indian bank have been taken for analysis. Thirteen financial indicators have been taken for the study and it have been grouped into three components in AXIS bank such as Operating Ratio, Net profit Ratio and Expenses Ratio and two components in Indian bank like Operating Ratio and Net profit Ratio. The result of this analysis reveals the underlying dimensions of bank performance and highlight the most significant factors influencing bank efficient performance. Additionally, the study examines how these factors changed over time and the article provides valuable insights into complex dynamics of bank performance and contributes suggestions for efficient bank management
Keywords: PCA, Rotated Components Matrix, Financial Indicators, Axis Bank, Indian Bank, Operating Ratio, Net Profit Ratio.

Introduction

This era of banking with innovation and digitalization has been paralyzed by pandemic. This has chocked every sector with waves of transformation and in the process, banking is not an odd out. The ways customers were engaged by all the services globally has been shifted dramatically and like everyone, the banking sector must adapt to the new normal. In a survey, reported that are highlighted with an estimation over 205 million adults are using their online or digital-based banking accounts. These counts are likely to almost double in (397 million) in next five years.

This is the clear evidence of customers mind set and demand over the change in business patterns. These are the clear evidences of customers expectation over the changes and willingness to enjoy the sophistication of tech innovations. In the revolutionary changing environment money and banking are very essential needs. The need for integration across financial services is even more essential to facilitate the customers and their quest. When customer needs are growing at a high pace, to compensate the needs and fulfilling their requirements bank alone cannot meet out that, here the role of fintech(s) and NBFC(s), and other forms are begun to compete among each other's. To major extent they are fulfilling that in the society. As more and more companies embrace embedded finance, the opportunity for banks to grow through partnerships has increased exponentially. And these partnerships are enabled through none other than the Banking as a Service (BaaS) model.

Banking as Service

Imagine planning your dream vacation. A single app lets you compare flights, book hotels, and instantly apply for a travel loan to cover it all. This seamless experience is powered by Banking as a Service (BaaS). BaaS allows banks to partner with non-banking businesses, bringing financial tools like payments, loans, and insurance directly into their platforms. Forget complex banking apps - get financial solutions where you already are, like your travel website or fitness app.

This win-win model eliminates competition between banks and businesses, instead fostering strategic partnerships. Businesses offer a richer experience with integrated finance, while banks reach new customers through trusted platforms. Ultimately, BaaS creates a future where customers enjoy end-to-end services on a single platform, making financial management effortless and convenient. The possibilities are truly endless.

Example of another innovation which supports growth of banking and finance sectors - In a study conducted by Galileo in cooperation with American Banker revealed that:

- Get ready for easier banking! Banks are embracing BaaS, with 78% of top executives prioritizing its development.
- Why the sudden shift? They want to make your life easier! 77% see BaaS as the future of convenient, integrated financial services.
- And they're not just talking. Nearly 6 in 10 BaaS-focused banks are already testing or implementing solutions, meaning you could soon see financial services seamlessly embedded in favorite apps.

Literature Review

In this study, the author attempted impacting KPI for digital banking promotions amongst the digital accounts. PCA is applied to derive the key influencer of digital banking development. Some of the finding's banks to create awareness from digital money like credit cards in order to promote the digital accounts, also they have to ease off the deposits and withdrawal charges in cross bank ATM usages. Also, banks must be cautious of the free transactions and free withdrawals to defend the customer interests. The promotion has to be effective in the public and encourage them to open digital accounts will make banks development and digital life in Taiwan will make the industry and people happy (Lin and Kuo).

The authors used factor analysis with PCA in this paper to examine the financial performance with the help of ratios derived from the financial statements. The authors also used the techniques to derive some of the financial decision for institution and stake holders, which helps them to understand complex data in to a simple form. During the analysis the team used various statistical methods to eliminate the unwanted ratios or factors and cluster analysis were used to determine the factors influencing the best possible performance for the organization. Data from stock exchange like BSE were used and over fifty rations incorporated in this analysis (Manjrekar and Damani).

This article exercises the banking sector of Turkey, to establish the financial soundness. Author evaluated the various components of financial stability index prescribed in IMF (International Monitory Fund), quarterly basis over 14 years. Using the normalization techniques are used with PCA, method to standardize data. Author arrived with two components to determine the relationships between the components. Found Profitability ratios and Liquidity ratios are the best fit for first component and capital adequacy ratio and market risk ratio are combined in relationship for second component. With these findings the high and low levels are identified for the data collected period. There was a match found between this research and the Turkey's Central Bank Report (CBRT) released for the periods (Yıldırım).

This study is related to performance of private sector bank, HDFC and public sector bank, Bank of India. Principal Component Analysis applied to identify related component based on the performance of these banks. The period of the study taken for the research was between 2014 to 2023. The study used principal component analysis using 13 variables to evaluate the components and soundness of the bank. The study reveals that Bank of India and HDFC variables have grouped into three major components (income ratio, profitability ratio and expenses ratio) and each bank variables in these components varies accordingly (Rajarajeswari et al.).

Research Objectives

1. To examine the financial performance of AXIS Bank and INDIAN bank using Key Performance Indicators.
2. To identify the grouping of components using Principal Component Analysis (PCA) to evaluate the performance.

Scope of the Study & Limitations

In this article we studied two banks only. One public sector bank (Indian Bank) and one private sector bank (Axis Bank) which has been operated during the period of 2014 to 2023 (ten years). In this article the Banks performance was investigated using financial ratios and other parameters.

The findings of study expressed that the significant implications for shareholders, investors, and managers, to guide them for key financial decisions.

Methodology

Data and its sources – using online resources like research articles, company write-ups, websites with share market values and annual reports. Along with Microsoft Excel to analyze the Principal Component Analysis.

Sample Size & Period of Data Coverage – the period covered 2014 – 2023 and the data collection was covering private sector bank Axis Bank Ltd. and public sector bank Indian Bank.

Analysis and Results

Principal Component Analysis for Axis Bank

The descriptive statistics of the financial indicators taken for study is displayed in the following Table. It can be observed that the average of ROCE is 2.625, CASA (46.49), etc., with their respective standard deviations. Also, it can be noticed that the financial indicators Operating Profit Margin, and Operating Profit/Total Assets are in negative values.

Table 1 Descriptive Statistics (Axis Bank)

Financial Indicators	Mean	SD
ROCE (%)	2.625	0.497
CASA (%)	46.49	3.656
Net Profit Margin (%)	12.195	7.537
Operating Profit Margin (%)	-11.273	8.18
Return on Assets (%)	0.864	0.580
Return on Equity / Networth (%)	8.953	5.745
Net Interest Margin (X)	2.953	0.207
Cost to Income (%)	43.692	6.542
Interest Income/Total Assets (%)	6.976	0.724
Non-Interest Income/ Total Assets (%)	1.638	0.242
Operating Profit/Total Assets (%)	-.767	0.557
Operating Expenses Total Assets (%)	2.072	0.336
Interest Expenses/ Total Assets (%)	4.016	0.648

Table 2 Communalities (Axis Bank)

Financial Indicators	Mean	SD
ROCE (%)	1.000	.936
CASA (%)	1.000	.526
Net Profit Margin (%)	1.000	.978
Operating Profit Margin (%)	1.000	.992
Return on Assets (%)	1.000	.995
Return on Equity / Networth (%)	1.000	.992
Net Interest Margin (X)	1.000	.868
Cost to Income (%)	1.000	.973
Interest Income / Total Assets (%)	1.000	.958
Non-Interest Income/Total Assets (%)	1.000	.974
Operating Profit/Total Assets (%)	1.000	.987
Operating Expenses/Total Assets (%)	1.000	.895
Interest Expenses/Total Assets (%)	1.000	.944
Extraction Method: Principal Component Analysis		

The above table provides a detailed summary of the variance explained by each principal component, both before and after extraction. The cumulative percentages help in understanding how much of the total variance is explained as you consider more components. The extraction method, in this case, is Principal Component Analysis.

Table 3 Total Variance Explained (Axis Bank)

Component	Initial Eigen values			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	6.990	53.770	53.770	6.990	53.770	53.770	6.184	47.568	47.568
2	3.571	27.466	81.235	3.571	27.466	81.235	4.290	33.002	80.569
3	1.457	11.208	92.443	1.457	11.208	92.443	1.544	11.874	92.443
4	.695	5.348	97.791						
5	.234	1.798	99.589						
6	.051	.390	99.979						
7	.002	.013	99.992						
8	.001	.007	100.000						
9	2.837E-5	.000	100.000						
10	4.077E-16	3.136E-15	100.000						
11	2.497E-16	1.921E-15	100.000						
12	-1.588E-16	-1.221E-15	100.000						
13	-3.762E-16	-2.894E-15	100.000						
Extraction Method: Principal Component Analysis									

The data represents the rotated component matrix using 0.50 as a cut-off point for factor loading for naming the factors. In this way we get nine components, with measurable value and other four does not have significant Eigenvalues. Also, the last column of the Table Total Variance Explained indicates that more than 92 per cent of the total variation in the dataset can be explained by the extracted three components, i.e., the thirteen financial indicators taken for study can be grouped into three main components, and the groups are shown in the Table Rotated Components Matrix, given below.

The table expressed first three components holding significant Eigenvalues compare to the rest of them in it. But, four through nine components carries vary minimal values. This was evident in extraction sums of squared loading and also in the rotation sums of squared loading.

As per the above scree Plot graph the totally 3 factors are considered based on the Eigenvalue. Value of more than 1 Eigenvalue are to be considered for deciding factors. As per the graph there are three plots/pointers with eigenvalues more than 1 (in the elbow shape, are considered as a basis to pick factors).
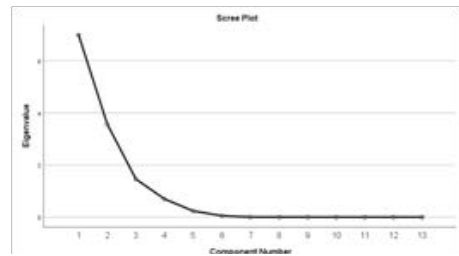
Table 4 Rotated Component Matrixª (Axis Bank)

Financial Indicators	Component		
	1	2	3
Operating Profit Margin (%)	.995		
Operating Profit/Total Assets (%)	.987		
Net Profit Margin (%)	.979		
Return on Assets (%)	.949		
Return on Equity / Networth (%)	.948		
Cost to Income (%)	-.842		
Net Interest Margin (X)	.680		
Non-Interest Income/ Total Assets (%)		.986	
Interest Expenses/ Total Assets (%)		.964	
Interest Income/Total Assets (%)		.908	

ROCE (%)		.898	
Operating Expenses/ Total Assets (%)			.789
CASA (%)			.606
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.			
a. Rotation converged in 5 iterations.			

The grouping of variables is presented for Axis Bank, Component 1 represents Operating Income Ratio, in this bank hold higher values for Operating Profit Margin & Operating Profit/Total Assets with positive values. As the same component 2 represents Net profit Ratio, four elements were, among these Non-Interest Income/Total Assets & Interest Expenses/Total Assets are top positive values and finally last component represents the Expenses Ratio, with operating expenses / Total Assets & CASA both has 0.789 & 0.606 in positive value.
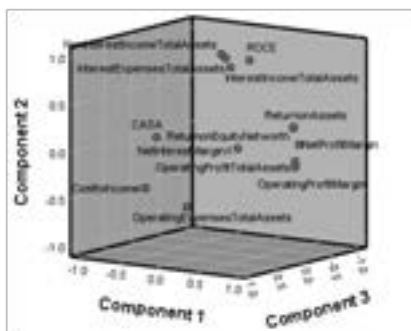
Figure 1 Components Plot in Rotated Spate (Axis Bank)

The grouping of variables is presented in the above figure Component Plot in Rotated Space which confirms the components were grouped as per the above rotated components table.

It can be observed from the Rotated Component Matrix Table that the financial indicators Operating Profit Margin (%), Operating Profit/Total Assets (%), Net Profit Margin (%), Return on Assets (%), Return on Equity / Networth (%), Cost to Income (%), and Net Interest Margin (X) were loaded in the first component. This implies that these indicators perform in the same direction.

The financial indicators Non-Interest Income/ Total Assets (%), Interest Expenses/Total Assets (%), Interest Income/Total Assets (%), and ROCE

(%) were loaded in the second component. This implies that these indicators perform in the same direction.

The financial indicators Operating Expenses/ Total Assets (%) and CASA (%) were loaded in the third component. This implies that these indicators perform in the same direction.

Principal Component Analysis for Indian Bank

The descriptive statistics of the financial indicators taken for study is displayed in the following Table. It can be observed that the average ROCE is 1.859, CASA (35.659), etc. with their respective standard deviations. Also, it can be noticed that the financial indicators and Operating Profit/Total Assets are in negative values.

Table 5 Descriptive Statistics (Indian Bank)

Financial Indicators	Mean	SD
ROCE (%)	1.859	.229
CASA (%)	35.659	5.436
Net Profit Margin (%)	6.918	3.062
Operating Profit Margin (%)	-6.166	3.098
Return on Assets (%)	.474	.193
Return on Equity/Networth (%)	8.190	3.491
Net Interest Margin (X)	2.441	.176
Cost to Income (%)	36.541	6.206
Interest Income/Total Assets (%)	7.054	.845
Non-Interest Income/Total Assets (%)	.899	.147
Operating Profit/Total Assets (%)	-.418	.204
Operating Expenses/Total Assets (%)	1.532	.099
Interest Expenses/Total Assets (%)	4.607	.980

Table 6 Communalities (Indian Bank)

Financial Indicators	Initial	Extraction
ROCE (%)	1.000	.767
CASA (%)	1.000	.919
Net Profit Margin (%)	1.000	.961
Operating Profit Margin (%)	1.000	.939
Return on Assets (%)	1.000	.937
Return on Equity/Networth (%)	1.000	.928
Net Interest Margin (X)	1.000	.670
Cost to Income (%)	1.000	.949
Interest Income/Total Assets (%)	1.000	.921
Non-Interest Income/Total Assets (%)	1.000	.581

Operating Profit/Total Assets (%)	1.000	.911
Operating Expenses/Total Assets (%)	1.000	.690
Interest Expenses/Total Assets (%)	1.000	.935
Extraction Method: Principal Component Analysis.		

The above table 6 provides a detailed summary of the variance explained by each principal component, both before and after extraction. The cumulative percentages help in understanding how much of the total variance is explained as you consider more components. The extraction method, in this case, is Principal Component Analysis.

The data represents the rotated component matrix using 0.50 as a cut-off point for factor loading for naming the factors. In this way we get nine components, with measurable value and other four does not have significant Eigenvalues. Also, the last column of the Table Total Variance Explained indicates that more than 85 per cent of the total variation in the dataset can be explained by the extracted three components, i.e., the thirteen financial indicators taken for study can be grouped into three main components, and the groups are shown in the Table Rotated Components Matrix, given below.

The table expressed first two components holding significant Eigenvalues compare to the rest of them in it. But, four through nine components carries vary minimal values. This was evident in extraction sums of squared loading and also in the rotation sums of squared loadings.

Table 7 Total Variance Explained (Indian Bank)

| Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	6.736	51.819	51.819	6.736	51.819	51.819	6.587	50.667	50.667
2	4.372	33.634	85.453	4.372	33.634	85.453	4.522	34.785	85.453
3	.915	7.040	92.492						
4	.635	4.882	97.374						
5	.223	1.714	99.088						
6	.063	.482	99.570						
7	.053	.411	99.981						
8	.002	.013	99.994						
9	.001	.006	100.000						
10	2.641E-16	2.032E-15	100.000						
11	-2.302E-16	-1.770E-15	100.000						
12	-3.386E-16	-2.604E-15	100.000						
13	-1.029E-15	-7.915E-15	100.000						
Extraction Method: Principal Component Analysis									
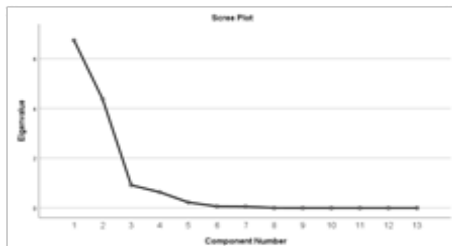
Figure 2 Scree Plot (Indian Bank)

As per the above scree Plot graph the totally 3 factors are considered based on the Eigenvalue. Value of more than 1 Eigenvalue are to be considered for deciding factors. As per the graph there are two plots/pointers with eigenvalues more than 1 (in the elbow shape, are considered as a basis to pick factors).

Table 8 Rotated Component Matrix^a
(Indian Bank)

Financial Indicators	Component	
	1	2
Interest Expenses/Total Assets (%)	-.962	
Interest Income/Total Assets (%)	-.959	
Cost to Income (%)	.956	
CASA (%)	.934	
ROCE (%)	.875	
Net Interest Margin (X)	.763	
Non-Interest Income/Total Assets (%)	.754	
Return on Assets (%)		.966
Return on Equity/Networth (%)		.929
Net Profit Margin (%)		.917
Operating Profit/Total Assets (%)		.818
Operating Profit Margin (%)		.742
Operating Expenses/Total Assets (%)		.685
Extraction Method: Principal Component Analysis.		
a. Rotation converged in 3 iterations.		

The grouping of variables presented for Indian Bank, Component 1 represents Operating Income Ratio, top contributions are Interest Expenses/Total Assets -.962, Interest Income/Total Assets -.959, Cost to Income .956 & CASA .934. The second component Net profit Ratio, cover stop four elements were Return on Assets .966, Return on Equity / Networth .929, Net Profit Margin .917 & Operating Profit/Total Assets .818. And third component is not covered under this bank.
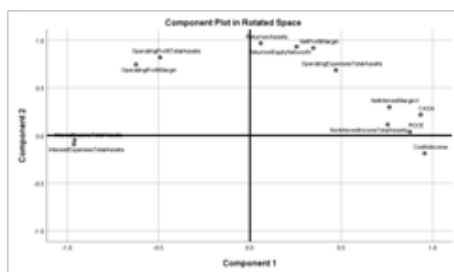
Figure 3 Component Plot in Rotated Spate
(Indian Bank)

It can be observed from the Rotated Component Matrix Table that the financial indicators Interest Expenses/Total Assets (%), Interest Income/Total Assets (%), Cost to Income (%), CASA (%), ROCE (%), Net Interest Margin, and Non-Interest Income/ Total Assets (%) were loaded in the first component. This implies that these indicators perform in the same direction.

The financial indicators Return on Assets (%), Return on Equity / Networth (%), Net Profit Margin (%), Operating Profit/Total Assets (%), Operating Profit Margin (%), Operating Expenses/Total Assets (%) were loaded in the second component. This implies that these indicators perform in the same direction.

Conclusion

Principal component analysis emerges as a formidably for banks seeking clarity amid the complexities of financial data. This helps in optimizing portfolio, refining credit assessment, fortifying risk management, refining credit assessment. This analysis has grouped the Axis bank thirteen financial data into three major components such as operating Income Ratio, Net profit Ratio and Expenses ratio. Indian bank financial indicators have been grouped into two major component such as Operating Income ration and Net profit Ratio. The Indian bank should focus on Risk management, digital transformation, customer centric approach by tailoring the product and services to customer requirements and also employee talent development and Axis bank have to focus on diversification of services, digital payment solution, enhancing CRM program including AI, Block chain technology to handle risk and also need to manage liquid cash and regulate capital adequacy to ensure compliance with regulatory requirements of banks.

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Annexure

Bank	Component 1 (op. Income Ratio)	Component 2 (Net profit Ratio)	Component 3 (Exp. Ratio)
Axis Bank	Operating Profit Margin (%)	Non-Interest Income/ Total Assets (%)	Operating Expenses/ Total Assets (%)
	Operating Profit/Total Assets (%)	Interest Expenses/Total Assets (%)	CASA (%)
	Net Profit Margin (%)	Interest Income/Total Assets (%)	
	Return on Assets (%)	ROCE (%)	
	Return on Equity/Networth (%)		
	Cost to Income (%)		
	Net Interest Margin (X)		
Indian Bank	Interest Expenses/Total Assets (%)	Return on Assets (%)	
	Interest Income/Total Assets (%)	Return on Equity / Networth (%)	
	Cost to Income (%)	Net Profit Margin (%)	
	CASA (%)	Operating Profit/Total Assets (%)	
	ROCE (%)	Operating Profit Margin (%)	
	Net Interest Margin (X)	Operating Expenses/ Total Assets (%)	
	Non-Interest Income/Total Assets (%)		

Data

Axis Bank Ltd.

Key Ratios	23-Mar	22-Mar	21-Mar	20-Mar	19-Mar	18-Mar	17-Mar	16-Mar	15-Mar	14-Mar
ROCE (%)	1.57	2.20	2.70	2.68	2.47	2.34	3.05	3.15	2.99	3.10
CASA (%)	47.15	44.99	44.92	41.19	44.37	53.75	51.41	47.33	44.78	45.01
Net Profit Margin (%)	11.24	19.33	10.35	2.59	8.50	0.60	8.26	20.06	20.73	20.29
Operating Profit Margin (%)	-8.12	-3.25	-12.96	-22.2	-15.37	-23.35	-17.98	-2.80	-2.83	-3.87
Return on Assets (%)	0.72	1.10	0.66	0.17	0.58	0.03	0.61	1.56	1.59	1.62
Return on Equity/Networth (%)	7.63	11.3	6.48	1.91	7.01	0.43	6.59	15.46	16.46	16.26
Net Interest Margin (X)	3.26	2.81	2.93	2.75	2.71	2.69	3.00	3.20	3.07	3.11
Cost to Income (%)	49.05	42.77	47.76	50.03	44.28	51.64	46.42	35.7	34.74	34.53
Interest Income/Total Assets (%)	6.46	5.73	6.38	6.84	6.86	6.62	7.40	7.80	7.68	7.99
Non-Interest Income/Total Assets (%)	1.25	1.29	1.48	1.69	1.63	1.58	1.94	1.78	1.81	1.93
Operating Profit/Total Assets (%)	-0.52	-0.18	-0.82	-1.51	-1.05	-1.54	-1.33	-0.21	-0.21	-0.3
Operating Expenses/Total Assets (%)	3.01	2.00	1.84	1.89	1.97	2.02	2.02	1.92	1.99	2.06
Interest Expenses/Total Assets (%)	3.20	2.91	3.45	4.08	4.15	3.92	4.39	4.59	4.60	4.87

Indian Bank

Key Ratios	23-Mar	22-Mar	21-Mar	20-Mar	19-Mar	18-Mar	17-Mar	16-Mar	15-Mar	14-Mar
ROCE (%)	2.20	1.94	1.89	2.14	1.78	2.02	1.88	1.53	1.61	1.60
CASA (%)	41.98	41.76	42.29	34.64	34.7	36.95	37.08	31.27	28.77	27.15
Net Profit Margin (%)	11.75	10.15	7.68	3.51	1.67	7.35	8.76	4.37	6.34	7.60
Operating Profit Margin (%)	-4.14	-7.64	-7.86	-11.95	-8.13	-6.70	-5.02	-6.58	-2.25	-1.39
Return on Assets (%)	0.74	0.58	0.47	0.24	0.11	0.49	0.64	0.34	0.52	0.61
Return on Equity/Networth (%)	12.61	10.52	11.88	3.94	1.97	7.95	9.72	5.27	8.00	10.04
Net Interest Margin (X)	2.84	2.49	2.50	2.45	2.50	2.47	2.35	2.18	2.31	2.32
Cost to Income (%)	42.40	43.03	41.47	41.12	40.72	37.96	32.61	30.6	27.99	27.51
Interest Income/Total Assets (%)	6.32	5.78	6.24	6.91	6.85	6.77	7.34	7.97	8.22	8.14
Non-Interest Income/Total Assets (%)	1.00	1.02	0.97	1.07	0.67	0.95	1.01	0.87	0.7	0.73
Operating Profit/Total Assets (%)	-0.26	-0.44	-0.49	-0.82	-0.55	-0.45	-0.36	-0.52	-0.18	-0.11
Operating Expenses/Total Assets (%)	1.70	1.62	1.65	1.42	1.43	1.45	1.53	1.56	1.45	1.51
Interest Expenses/Total Assets (%)	3.47	3.29	3.74	4.45	4.34	4.29	4.99	5.79	5.90	5.81

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