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Research Article

Evaluating Market Competitiveness and Volatility in Loan Pricing via Nash Equilibrium and ARIMA Models

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ABSTRACT

The study deals with the dynamics of loan pricing within the Indian financial system, using Nash Equilibrium and ARIMA models, on two-wheeler loans. The objective is to assess market competitiveness among public sector banks (PSBs), private sector banks (PvtSBs), foreign banks and non-banking financial companies (NBFCs) through interest rates, processing fees, and loan tenures. It shows how Nash Equilibrium can help in the strategic decisions of competitive environments and ARIMA as a predictive trend of loan pricing. Secondary data spanning from 2012-2024 will be utilized for the study and weighted average lending rates, comparative and descriptive statistics, and the application of forecasting models to predict the future. The findings show significant differences in the loan pricing strategies employed by financial institutions, and high market competition and imperfect economic conditions significantly impact pricing stability. This study thus contributes to the understanding of the optimal pricing strategy and its implications for borrower affordability and lender profitability.

Keywords: Loan pricing, Nash Equilibrium, ARIMA, market competition, two-wheeler loans, Indian financial system, weighted average lending rates, forecasting models.

INTRODUCTION

In the modern financial landscape, loan pricing plays a significant role affecting not only consumer borrowing costs but also the profitability of the financial institutions (Brindadevi, 2013). The structure of loan pricing is an essential feature in the financial landscape which significantly influences economic stability, consumer behavior, and operational success of banks and NBFCs. The increasing complexity of economic terrain, shifting regulatory frameworks, and high consumer demands put immense pressure on financial organizations to maintain competitive and sustainable loan terms (Mockus, 2012). The research tries to analyze the dynamics of loan pricing in the Indian financial system.

Over the recent past, loan pricing methods in the Indian market have evolved due to changes in macroeconomic conditions, interest rates, inflation rates, and stability in the economy. Competition has increased in the market with the rise of non-traditional finance companies, such as fintech companies and digital lending institutions (Schied et al., 2017). The two complex models used for the purpose include Nash Equilibrium and ARIMA (Auto Regressive Integrated Moving Average). The Nash Equilibrium model provides a theoretical background for understanding strategic decision making in a

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competitive environment. This environment calls for evaluating how the pricing strategies of financial firms are influenced by the strategy of their competitors. Nash Equilibrium model suggests that the pricing strategy of every financial institution is determined by strategies of other players in the market (Luo & Schied, 2019). The ARIMA model is used for time-series forecasting to analyze historical trends and predict future variations in loan pricing. This model analyzes trends in interest rates, fees, and loan durations over time and offers important insights into fluctuations in loan pricing (Budhedeo, 2018).

The scope of the study was set on two-wheeler loan pricing, with a specific focus on what influences borrower affordability and lender competitiveness.

It gives ARIMA the ability to analyze historical data to predict the future price patterns and hence provides a comprehensive understanding of how loan pricing may fluctuate due to economic conditions, market sentiment, or the change in regulatory frameworks. The combination of Nash Equilibrium with ARIMA offers a holistic analysis of the loan pricing dynamics by including strategic competitive conduct and predictive insights regarding the future market conditions (Löschenbrand & Korpås, 2018). It aims at analyzing how competition in the market affects fluctuation in loan pricing as well as the extent at which various players in the market, for example, PSBs, PvtSBs, and NBFCs, adjust their strategies to price loans based on both external and internal triggers. It goes beyond showing the interaction of competition with price volatility to the rich contribution towards the wider issues of how financial institutions should better cope with uncertainty yet be profitable and trust-earned in the competitive unstable landscapes of a highly market setting.

Objective for the Study

To evaluate market competitiveness in loan pricing among Indian lenders by analyzing interest rates, processing fees, and loan tenures using Nash Equilibrium and ARIMA models.

REVIEW OF LITERATURE

The dynamics of loan pricing and its determinants have been extensively explored in the literature, with a focus on market competition, regulatory influences, managerial capabilities, and institutional strategies. Zhang (2014) sheds light on the role of Nash equilibria in market impact models, demonstrating how individual decisions in competitive markets influence price dynamics over time, which parallels strategic pricing behaviors in competitive loan markets. Similarly, Spinler and Huchzermeier (2017) develop a real options model for strategic investment decisions in uncertain environments, emphasizing the need for financial institutions to adapt their pricing strategies in response to external factors such as market competition.

In the context of banking competition, Tan (2018) highlights the trade-off between enhanced customer outcomes and the risks of aggressive loan pricing, which can threaten bank profitability and stability. This trade-off is further explored by Khangai et al. (2022), who construct a Nash model for multi-period loan interest rates under Basel II solvency constraints, illustrating how regulatory standards shape banks' pricing strategies amidst competitive pressures. Bäuerle and Göll (2024) expand this perspective by investigating how strategic pricing decisions by financial institutions, accounting for market impact, can lead to competitive equilibria or price volatility, reflecting the complexities of loan pricing in competitive environments.

Empirical evidence further emphasizes the nuanced impacts of competition and regulation on loan pricing. Alhalabi et al. (2023) examine European banks from 2001 to 2016, showing that large banks adhered to risk management principles post-2008 financial crisis, while small banks engaged in moral hazard behaviors pre-crisis. These findings underscore the role of post-crisis regulations in curbing high-risk lending behaviors, especially among poorly performing banks. Similarly, Wan and Margaritis (2024) analyze the influence of shadow banking on lending rates in China, finding that regulatory arbitrage via wealth management products promotes interest rate liberalization, particularly for non-state-owned banks dependent on wholesale funding.

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The interplay of geographical factors and institutional differences in loan pricing is explored by Eichholtz et al. (2023), who find that while geographical distance influences loan spreads for banks, it has no effect on non-bank lenders, highlighting variations in incentives and lending technologies. Meanwhile, Nguyen et al. (2023) reveal that Chinese banks have managed to expand lending post-2008 financial crisis without compromising loan quality, with profitability further enhanced during the COVID-19 period due to supportive policies. Li et al. (2024) add to this by showing that shadow banking activities in China improve banks' liquidity and pricing flexibility, supporting the broader liberalization of interest rates.

Lastly, Tang et al. (2024) examine how managerial ability shapes loan pricing, revealing that competent managers secure more favorable terms by reducing corporate risk, improving information quality, and mitigating agency conflicts. This effect is particularly evident in private enterprises and competitive banking environments, emphasizing the critical role of leadership in shaping loan pricing outcomes.

Together, these studies highlight the multifaceted nature of loan pricing, influenced by market competition, regulatory frameworks, institutional differences, and managerial capabilities. They provide valuable insights into how banks navigate the complexities of pricing decisions in the face of evolving economic, regulatory, and competitive landscapes.

RESEARCH METHODOLOGY

Data Collection

A key source of data was the official Reserve Bank of India (RBI) database, particularly its lending rate statistics available at RBI Lending Rates. Weighted Lending Rate was important to be used to provide an accurate true reflection of the effective loan costs and more coherent comparison among lenders. The use of WLR was paramount because it availed a proper and standard scale of the actual cost of the loans that compared meaningfully within the various lenders. The database covered from the year 2012 to 2024, which covered about 12 years of loan pricing data and market patterns. Key parameters in understanding the pricing of two-wheeler loans include nominal and effective interest rates for public, private, and foreign banks as well as NBFCs. The analysis also covers processing fees to understand the difference in upfront charges on the borrowers, while the tenure of the loans has been analyzed with an emphasis on maximum and average repayment periods to evaluate affordability and lender strategies.

Data Analysis Tools

These data were analyzed using some of the advanced tools and models specifically tailored for public, private, and foreign banks dominating the market. The Nash Equilibrium Model was used to study the strategic decision-making behaviour of different lenders, such as public sector banks, private sector banks, and NBFCs, where optimal price strategies and stable equilibrium points in the competitive lending market were identified. The ARIMA model was used to predict the trend in loan pricing by using historical data and forecasting future rates, which helped in understanding the market dynamics and competitive positioning. It also made use of the comparison and statistical Measures - Compound Annual Growth Rate or CAGR, standard deviation, and mean values-to evaluate the market about consistency, pricing trends, and the variation over time to finally identify key trends and shifts in the competitive landscape of the two-wheeler loan pricing. These tools empowered the research to give a good analysis of data, which brought insights into the market behavior and pricing trends together with competitive dynamics in the two-wheeler loan sector of India.

RESULTS AND DISCUSSION

Weighted Average Lending Rates (WALR) by Bank Group from 2012 to 2024

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Table 1. The WALR for each year from 2012-2024 has been calculated by averaging the quarterly rates for each year.

Year	Public Sector Banks	Private Sector Banks	Foreign Banks	All SCBs
2012	12.38	12.475	11.9775	12.38
2013	12.0525	12.525	12.7125	12.185
2014	11.84	12.465	12.0825	11.9875
2015	11.4	12.0325	11.605	11.5525
2016	11.085	11.4	11.1075	11.1725
2017	10.5125	10.6925	10.7675	10.5775
2018	10.045	10.765	10.485	10.295
2019	9.6775	11.0725	10.3725	10.2025
2020	8.9875	10.61	9.1625	9.58
2021	8.4575	9.9075	8.0275	8.97
2022	8.5425	10.0375	8.49	9.1
2023	9.1975	10.7325	9.3325	9.7975
2024	9.22	10.88667	9.36	9.886667

a) Comparative Analysis of Bank Rates Across Different Bank Groups (2012–2024)

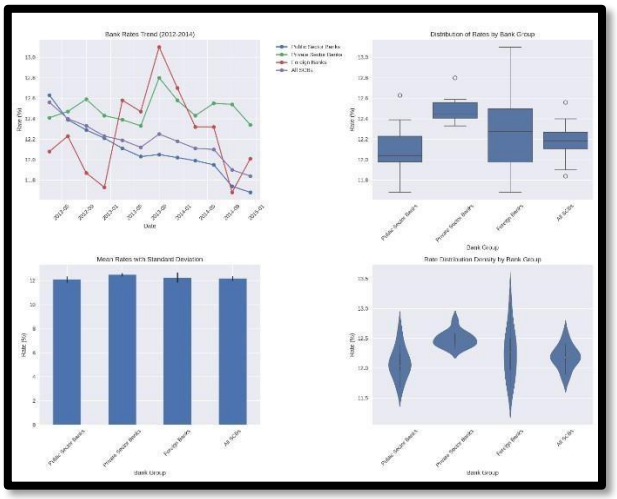

Figure 1. Tabular Representation

b) Descriptive Statistics by Bank Group

Table 2. Calculation of Descriptive Statistics

Bank Group	Mean	Median	Std Dev	Range
Public Sector Banks	10.2613	10.045	1.3203	3.9225
Private Sector Banks	11.2001	10.8867	0.8711	2.6175
Foreign Banks	10.4217	10.485	1.4084	4.685

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All SCBs	10.5913	10.295	1.116	3.41

c) Summary Statistics for All Scheduled Commercial Banks (SCBs)

Table 3. Descriptive Statistics (All SCBs)

Statistic	Value
Count	51
Mean	10.48
Standard Deviation	1.04
Minimum Value	8.74
Maximum Value	12.56
25th Percentile	9.85
50th Percentile (Median)	10.35
75th Percentile	11.23

d) Results of Augmented Dickey-Fuller (ADF) Test for Stationarity (All SCBs)

Table 4. ADF Test for Stationarity (All SCBs)

Statistic	Value
ADF Statistic	-0.364
p-value	0.91
Critical Value (1%)	-3.57
Critical Value (5%)	-2.92
Critical Value (10%)	-2.6
Conclusion	Data is non-stationary (p-value > 0.05)

e) ARIMA (1,1,1) Model Summary and Forecasts

Table 5. ARIMA Model Summary (ARIMA (1,1,1))

Parameter	Value
AIC	24.76
BIC	31.12
Log-Likelihood	-8.38
AR (1) Coefficient	0.37 (p-value = 0.017)
MA (1) Coefficient	-0.99 (p-value = 0.000)
Differencing (d)	1st difference
Residuals	No significant autocorrelation
Forecast for Q1 2025	9.86
Forecast for Q2 2025	9.84
Forecast for Q3 2025	9.83

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Forecast for Q4 2025	9.82
Forecast for Q1 2026	9.81

f) Payoff Matrix for Loan Pricing Strategies in Nash Equilibrium Analysis

Table 6. Nash Equilibrium Analysis (Loan Pricing Strategies) - Payoff Matrix (Loan Pricing Strategies)

	Public Sector Banks (Low)	**Public Sector Banks (High)**
Private Sector Banks (Low)	(6.0, 7.2, 4.5)	(5.8, 6.5, 4.3)
Private Sector Banks (High)	(7.2, 6.0, 4.2)	(6.5, 5.8, 4.0)

g) Nash Equilibrium Insights for Loan Pricing Strategies

Table 7. Nash Equilibrium Insights

Bank Group	**Equilibrium Strategy**
Public Sector Banks	Low WALR
Private Sector Banks	Low WALR
Foreign Banks	Medium WALR (inferred)

The analysis shows significant trends and variations among public sector banks, private sector banks, foreign banks, and all Scheduled Commercial Banks. Public sector banks have shown a steady decline in WALR over the years, from 12.38% in 2012 to 9.22% in 2024, indicating efforts to streamline lending rates and improve competitiveness. Private sector banks maintained relatively higher rates, with an average of 11.20% for the period. Foreign banks reflected moderate rates with an average of 10.42%. Descriptive statistics reflected that public sector banks had the largest range, at 3.92%, and the highest variability, that is, the standard deviation is 1.32, thereby indicating greater fluctuation in lending policies. In contrast, private sector banks had the lowest variability of 0.87%, thus reflecting a stable lending strategy. The Augmented Dickey-Fuller (ADF) test had indicated that WALR data is not stationary; therefore, time series modeling required first-order differencing. The ARIMA (1,1,1) model offered robust predictions; hence, WALR for SCBs would be stabilizing towards 9.81% during Q1 2026. Nash equilibrium analysis pointed out a propensity of low WALR strategies from public and private sector banks while foreign banks adopted medium rates for the balancing of competitiveness with profitability. Collectively, these findings highlight the dynamic nature of lending rate adjustments influenced by market competition, regulatory changes, and macroeconomic conditions, with implications for bank strategy optimization and borrower affordability.

CONCLUSION

The research throws light on the changing dynamics of loan pricing in the Indian financial system, which is influenced by economic, competitive, and regulatory factors. Public sector banks, private sector banks, and NBFCs showed different pricing strategies that were influenced by market competition, as revealed through the application of Nash Equilibrium and ARIMA models. It is evident that the interest rate fluctuation, processing fees, and loan tenures are very significant factors that affect loan pricing. Moreover, there are external triggers such as macroeconomic changes and regulatory policies that have a strong influence on loan pricing. ARIMA forecasts helped in predicting market trends and lending strategies.

Adopting a strategic and predictive approach is imperative in dealing with a highly volatile market if sustainable and competitive loan pricing is to be ensured. Therefore, these findings are significant for

policymakers and financial institutions, as they are going to optimize their frameworks for loan pricing and increase financial inclusion. Other loan categories could be added, and primary data can be expanded to conduct a more granular analysis of the behaviour of borrowers and the strategies deployed by lenders. However, the reliance solely on secondary data presented some limitations, which may potentially restrict the granularity of insights. Additionally, variations in data reporting standards across lenders posed challenges to maintaining uniformity in the analysis.

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