Modeling and Competitive Analysis of UPI Apps in India

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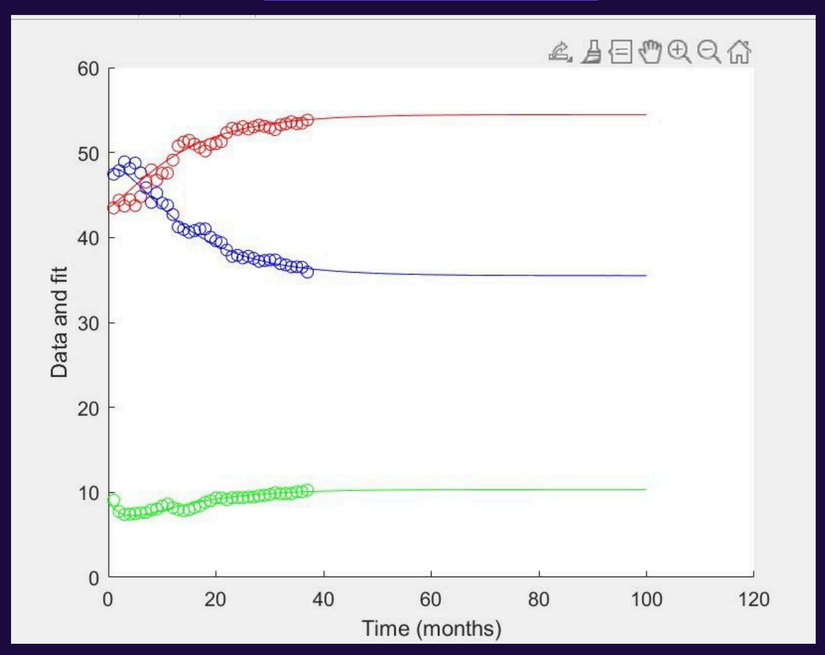
INTRODUCTION

In India's dynamic FinTech sector, accurate predictions of market behavior are essential. This study pioneers a methodology using fractional calculus to forecast market share dynamics among key UPI players: Google Pay, PhonePe, and Paytm. By adapting a prey-predator growth model and integrating fractional derivatives, we enhance predictive capabilities to understand the intense competition in the digital payment industry. Our approach, validated through numerical analysis and sensitivity testing, offers strategic insights for stakeholders, highlighting the effectiveness of fractional calculus in economic modeling. This research advances understanding of market dynamics, aiding strategic decision-making in rapidly evolving industries.

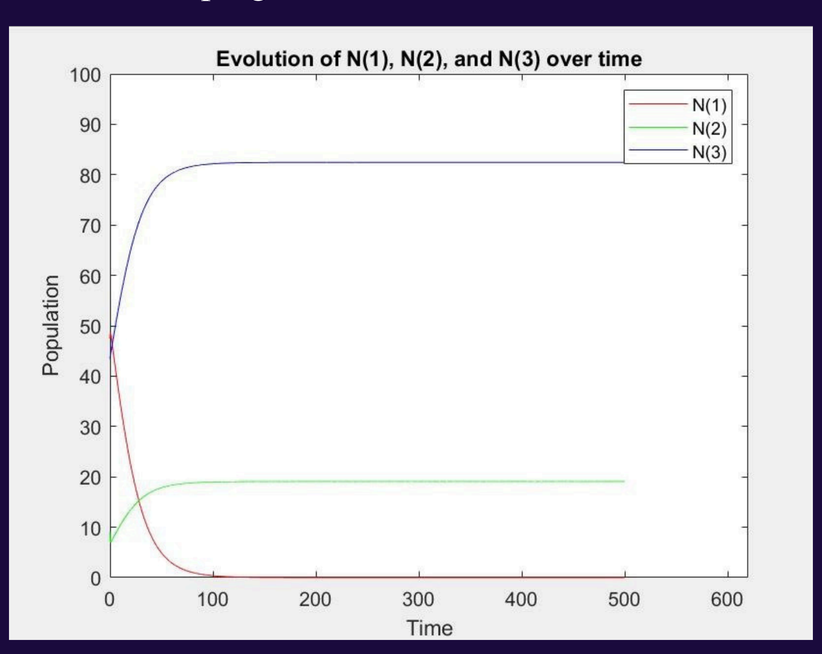
ABSTRACT

This study presents a novel method for predicting the market share of Google Pay, PhonePe, and Paytm using fractional calculus. We employ a prey-predator growth model with the Caputo fractional derivative to capture memory effects and complex competitive dynamics. Historical market share data is used to estimate model parameters, and future shares are projected through a detailed numerical procedure, validated by robust numerical results. A sensitivity analysis shows that adjusting the derivative order optimizes the model's fit, enhancing predictive accuracy. This approach provides valuable insights for strategic planning in the digital payment sector, demonstrating substantial improvements over traditional methods.

RESULTS



The dots in this graph represent actual data and the lines represents the predicted and fitted model with the data it is inferred from the graph that the overall system is showing a stabilising behaviour over the upcoming years if everything remains same and no other external factor affects the data. Moreover it shows the future system are near the current levels of market share so this margaret will be stabled for a longer period of time keeping the externalities as constans.



This graph shows the extreme situation when External factors are way too high like india cut-off from rest of the world it shows that google pay looses all of its share and share is distributed in between phone-pay and paytm in the ratio of 4:1. Also recent trend of paytm involving extrenalities like baking of paytm did not bring much of change in market share of paytm as it remains stable.

METHODOLOGY

Our methodology integrates established theories from population ecology and mathematical modeling to analyze the competitive dynamics within the UPI market. We utilize the Lotka-Volterra equations, adapted from Competition models, to construct a system of first-order nonlinear differential equations that describe the interactions between Google Pay, PhonePe, and Paytm. This approach captures the impact of competitive pressures and growth potentials on market shares.

The model is calibrated using historical market data, ensuring it accurately reflects observed trends. We perform an equilibrium analysis by assessing the stability of equilibrium points through eigenvalue analysis and phase portraits, providing insights into the long-term behavior of the system. Finally, by solving these equations, we forecast future market shares, offering strategic insights into the competitive dynamics within the UPI ecosystem. This rigorous and systematic approach ensures a robust analysis, contributing to a deeper understanding of the market's evolution.

COMPETITION MODEL | FRACTIONAL CALCULUS | MARKET SHARE PREDICTION

NUMERICAL PROCEDURES | SENSITIVITY ANALYSIS | VALIDATION & MODEL ENHANCEMENT

MODEL

$$\frac{d^{\alpha}N_1}{dt^{\alpha}} = N_1(a_1 - a_{11}N_1 - a_{12}N_2 - a_{13}N_3)$$

$$\frac{d^{\alpha}N_2}{dt^{\alpha}} = N_2(a_2 - a_{21}N_1 - a_{22}N_2 - a_{23}N_3)$$

$$\frac{d^{\alpha}N_3}{dt^{\alpha}} = N_3(a_3 - a_{31}N_1 - a_{32}N_2 - a_{33}N_3)$$

Here, (N1, N2, N3) represent the market shares of Google Pay, PhonePe, and Paytm respectively, a_{ij} are parameters reflecting growth potential and competitive effects. These equations provide a mathematical framework for understanding how the market shares of each UPI company evolve in response to internal and external factors. Here (g1 , g2) represents the growth rate of the model. Where $\alpha = 1$.

CONCLUSION

In conclusion, our research marks a significant milestone in understanding competition and profitability within the UPI ecosystem. Through the integration of fractional calculus and advanced mathematical modeling, we've developed a robust framework that predicts market behaviors with unparalleled accuracy. These insights are invaluable for stakeholders like market players, policymakers, and researchers.

Our findings provide actionable guidance for strategic decision-making in digital payments, offering insights into investment strategies, regulatory interventions, and business expansion initiatives. Moreover, our study opens avenues for future research, showcasing the potential of fractional calculus in modeling complex systems across diverse domains within the FinTech industry.

Ultimately, our research contributes to the evolution of India's FinTech landscape and the global advancement of digital payments. It represents a pioneering effort to drive innovation and inform strategic decision-making, shaping the trajectory of the digital payment sector.