

A Comparative Time Series Analysis of Arima and Exponential Smoothing Models in Forecasting Health Insurance Penetration in Post-Pandemic India (2018–2026) (With Projections Toward Insurance for All By 2047)

Ms. Gayathri N M¹, Mr. Selva Kumar M², Dr. Rajalakshmi C³, Dr. Vijayalakshmi K⁴

¹MBA, Sakthi Institute of Information and Management Studies, Pollachi

²Assistant Professor, Sakthi Institute of Information and Management Studies, Pollachi

³Associate Professor, Sakthi Institute of Information and Management Studies, Pollachi

⁴Assistant Professor, VET Institute of Arts and Science (Co-ed) College, Thindal

Abstract— This study analyses the quarterly trend of health insurance penetration in post-pandemic India from 2018 to 2024 using ARIMA and Exponential Smoothing models. Secondary data were collected from IRDAI, the General Insurance Council, and Ministry of Statistics and Programme Implementation (MoSPI). Time series forecasting techniques were applied to examine trends and generate forecasts for 2025–2030. The forecasting performance of both models was evaluated using MAE, RMSE, and MAPE. The findings indicate a steady increase in health insurance penetration, with the ARIMA model showing comparatively better forecasting accuracy. The study provides useful insights toward achieving the “Insurance for All by 2047” initiative.

Index Terms— Health Insurance Penetration, ARIMA, Exponential Smoothing, Time Series Forecasting, Post-Pandemic India, Insurance for All 2047.

I. INTRODUCTION

Health insurance has become an important component of financial security and healthcare accessibility in India. The significance of health insurance has increased rapidly due to rising medical expenses, growing health awareness, and the impact of the COVID-19 pandemic.

The pandemic highlighted the financial risks associated with medical emergencies and increased the demand for insurance coverage across the country. As

a result, the health insurance sector in India has experienced considerable growth and structural changes during the post-pandemic period.

Health insurance penetration, measured as the ratio of health insurance premium to Gross Domestic Product (GDP), is a key indicator used to assess the development of the insurance sector. Although India has shown gradual improvement in insurance penetration, the overall coverage level remains relatively low compared to global standards. To improve financial protection and healthcare access, the Government of India has introduced several initiatives under the vision of achieving “Insurance for All by 2047.”

Forecasting health insurance penetration is essential for policymakers, insurers, and regulators to understand future growth patterns and formulate effective strategies. Time series forecasting models are widely used to analyze historical trends and predict future movements in economic and financial data. Among these methods, ARIMA and Exponential Smoothing are considered effective forecasting techniques due to their ability to capture trend and variation in time series data.

This study focuses on a comparative analysis of ARIMA and Exponential Smoothing models in forecasting quarterly health insurance penetration in post-pandemic India from 2018 to 2026. The study also generates forecasts for the period 2025–2030 and

evaluates their implications for achieving the “Insurance for All by 2047” initiative. By comparing the forecasting accuracy of both models using statistical measures such as MAE, RMSE, and MAPE, the study aims to identify the most suitable forecasting model for health insurance penetration in India.

II. REVIEW OF LITERATURE

Sharma, A. et al. (2024) in their study on machine learning-driven predictive modeling for health insurance premiums in India, proposed a real-time prediction system using historical insurance data. The study emphasized that predictive analytics can support accurate premium estimation, improve healthcare accessibility, and strengthen insurance management systems.

Abhinav Bahuguna et al. (2023) in their study on forecasting COVID-19 cases, compared the performance of ARIMA and Exponential Smoothing models. The findings revealed that the ARIMA model produced better short-term forecasting accuracy, while Holt-Winters Exponential Smoothing was more effective for long-term seasonal forecasting. The study emphasized the importance of selecting suitable forecasting models for healthcare planning.

Gyima-Adu, T. A. and Gidisu, G. (2023) in their research on forecasting insurance penetration in Ghana, applied the ARIMA model to predict future insurance trends. The study identified ARIMA (3,1,0) as the most suitable model and highlighted the role of forecasting in improving insurance coverage and policy planning.

Shailender Kumar Hooda (2020) in the study on government-funded health insurance schemes in India, analyzed the penetration and actual coverage of insurance schemes using survey data. The research identified a significant gap between official claims and real coverage levels and concluded that these schemes had limited impact on reducing out-of-pocket healthcare expenditure.

Poonam Rani and Payal Chauhan (2022) in their study on the growth and development of health insurance in India, examined the expansion and challenges of the sector. The study found that low awareness, high premium costs, and claim settlement issues were major barriers affecting insurance penetration and sectoral growth.

III. RESEARCH OBJECTIVE

- To analyze the quarterly trend and structural changes in health insurance penetration in India during the post-pandemic period using time series analysis.
- To compare the forecasting performance of ARIMA and Exponential Smoothing models and generate future projections toward the “Insurance for All by 2047” initiative.

IV. RESEARCH METHODOLOGY

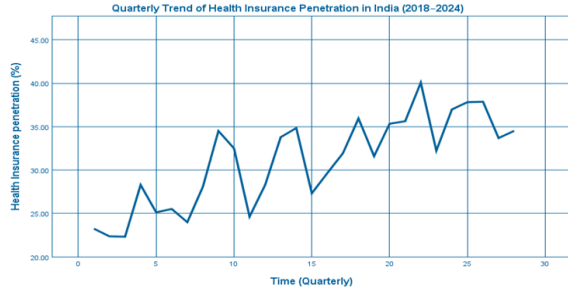
This study adopts a quantitative and comparative research design to analyze and forecast health insurance penetration in post-pandemic India. The research is based on quarterly secondary data collected from IRDAI, the General Insurance Council, and MoSPI for the period 2018 Q1 to 2024 Q4. Health insurance penetration was calculated using the ratio of health insurance premium to Gross Domestic Product (GDP). The collected data was organized and processed using Microsoft Excel for penetration calculation and preliminary trend analysis.

Time series forecasting techniques such as ARIMA and Exponential Smoothing were applied using SPSS Time Series Modeler. The Expert Modeler feature was used to automatically identify the most suitable forecasting model based on trend and variation in the data. Necessary transformations and stationarity adjustments were handled within the software during model estimation. Model performance was evaluated using MAE, RMSE, and MAPE to identify the most accurate forecasting technique. Based on the best-performing model, forecasts were generated for the period 2025–2030 and interpreted in relation to the “Insurance for All by 2047” initiative in India.

V. DATA ANALYSIS AND INTERPRETATION:

Trend Analysis

A line graph was plotted to visualize the quarterly movement of health insurance penetration.



Quarterly Trend of Health Insurance Penetration in India (2018–2024)

Interpretation

The graph indicates a steady upward trend in health insurance penetration in India from 2018 to 2024. Although minor fluctuations are observed, particularly during the pandemic period around 2020, the overall trajectory shows consistent growth. The post-pandemic phase reflects a stronger increase in penetration, suggesting rising awareness and demand for health insurance. This trend highlights gradual expansion in insurance coverage and supports the potential for further growth in the coming years.

Exponential Smoothing Analysis Forecast Table

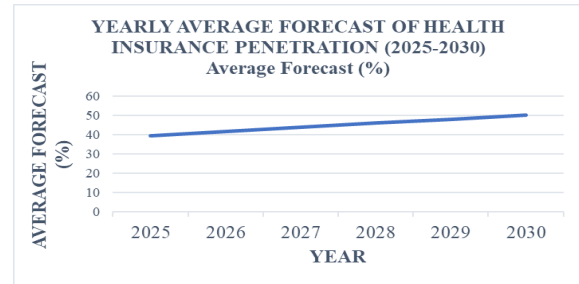
Yearly Average Forecast of Health Insurance Penetration (2025-2030)	
Year	Average Forecast (%)
2025	39.435
2026	41.6
2027	43.7625
2028	45.93
2029	48.0925
2030	50.26

Yearly Average Forecast of Health Insurance Penetration (2025–2030)

Interpretation

The yearly average forecast indicates a steady upward trend in health insurance penetration from 2025 to 2030, showing continuous expansion in insurance coverage. The gradual increase reflects growing awareness, improved accessibility, and supportive government initiatives in the health insurance sector. The forecast pattern remains stable without major fluctuations, indicating consistent long-term growth. The yearly aggregation provides a clearer understanding of overall progress by reducing short-term quarterly variations. These projections suggest positive future prospects for the development of health insurance penetration in India.

Graph



Yearly Forecast Trend of Health Insurance Penetration (2025–2030)

Arima Analysis Forecast Table

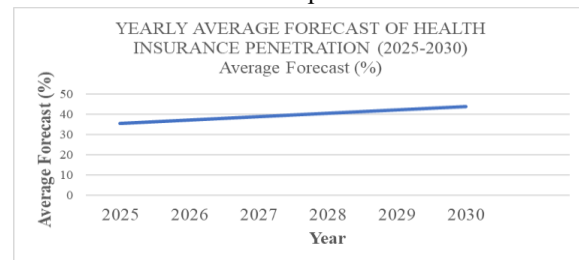
Yearly Average Forecast of Health Insurance Penetration (2025-2030)	
Year	Average Forecast (%)
2025	35.565
2026	37.2375
2027	38.9075
2028	40.58
2029	42.25
2030	43.92

Yearly Average Forecast using ARIMA Model (2025–2030)

Interpretation

The yearly average forecast generated using the ARIMA model shows a gradual and consistent increase in health insurance penetration from 2025 to 2030. The positive trend indicates continuous growth in insurance coverage over the forecast period. Compared to Exponential Smoothing, the ARIMA model captures slight fluctuations and irregular variations in the data more effectively. The increasing yearly averages reflect rising awareness, growing demand for health insurance, and supportive policy initiatives. Overall, the ARIMA forecasts provide useful insights for long-term policy planning and strategic decision-making.

Graph



Yearly Forecast Trend using ARIMA Model (2025–2030)

Model Comparison Comparison Table

MODEL	MAE	RMSE	MAPE
Exponential Smoothing	1.881	2.303	6.264
ARIMA	3.267	4.170	10.758

Comparison of Forecast Accuracy (ARIMA vs Exponential Smoothing)

Interpretation

Both ARIMA and Exponential Smoothing models were found to be effective in forecasting health insurance penetration. The Exponential Smoothing model is more suitable for capturing stable trends and seasonal patterns, providing smoother and easily interpretable forecasts. In contrast, the ARIMA model effectively captures irregular fluctuations and short-term variations in the data. While Exponential Smoothing supports long-term forecasting, ARIMA provides deeper insights into dynamic changes. Therefore, the combined use of both models improves the overall reliability of forecasting results.

Interpretation toward Insurance for All by 2047

The forecast results obtained from both ARIMA and Exponential Smoothing models indicate a steady increase in health insurance penetration from 2025 to 2030. This reflects growing awareness, improved accessibility, and gradual expansion of insurance coverage in India. However, the projected growth rate suggests that the current pace may not be sufficient to achieve the goal of “Insurance for All by 2047.” Achieving universal coverage will require stronger government initiatives, affordable insurance products, enhanced digital accessibility, and increased public awareness. Therefore, continuous policy support and strategic interventions are essential to accelerate insurance penetration and achieve the long-term national objective.

VI. SUGGESTIONS

1. Increase awareness programs in rural and semi-urban areas to improve understanding and adoption of health insurance policies.
2. Introduce affordable and flexible insurance products to increase coverage among low-income groups and economically weaker sections.

3. Strengthen digital insurance platforms to improve accessibility, transparency, and ease of policy purchase and claim settlement.
4. Encourage collaboration between government and private insurers to expand insurance coverage and improve service delivery efficiency.
5. Conduct regular forecasting and monitoring of insurance penetration trends to support effective policy formulation and long-term planning toward “Insurance for All by 2047.”

VII. CONCLUSION

The study examined the quarterly trend and forecasting of health insurance penetration in India using ARIMA and Exponential Smoothing models. The analysis showed a gradual increase in health insurance penetration during the post-pandemic period, reflecting rising awareness and growing demand for financial protection. Both forecasting models indicated a positive growth trend for the period 2025-2030. However, the ARIMA model demonstrated comparatively better forecasting accuracy in capturing variations and structural changes in the data.

The forecast results suggest that health insurance coverage in India is expected to expand steadily in the coming years. Despite this progress, achieving the vision of “Insurance for All by 2047” will require stronger policy support, improved accessibility, and increased public awareness. Overall, the study highlights the importance of forecasting techniques in supporting strategic decision-making and long-term development of the health insurance sector in India.

REFERENCES

- [1] Bahuguna, A. Uniyal, N. Sharma, and J. Semwal, “Comparison of exponential smoothing and ARIMA models for forecasting COVID-19 cases,” 2023.
- [2] M. M. Dutta, “Health insurance sector in India: An analysis of its performance,” 2020.
- [3] T. A. Gyima-Adu and G. Gidisu, “Predicting insurance penetration rate in Ghana using ARIMA model,” 2023.
- [4] S. K. Hooda, “Penetration and coverage of government-funded health insurance schemes in India,” 2020.

- [5] S. Panda, B. Purkayastha, D. Das, M. Chakraborty, and S. K. Biswas, “Health insurance cost prediction using regression models,” 2022.
- [6] S. Qutab and V. Kumar, “Public health insurance accessibility scenario in India,” 2022.
- [7] R. Raghuwanshi, “Analytical study of health insurance schemes offered by central and state governments of India,” 2025.
- [8] P. Rani and P. Chauhan, “Growth and development of health insurance in India,” 2022.
- [9] Sharma, A. Malik, I. Batra, S. Sharma, and M. Hussain, “Machine learning-driven predictive modelling for health insurance premiums in India,” 2024.
- [10] Yadav, S. Kaur, S. Devi, and S. Manocha, “Critical performance analysis of the health insurance sector in India during COVID-19 outbreak,” 2021.