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Forecasting Gross Premium in India: Comparative ARIMA Model Analysis for New India Assurance

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Abstract

This research assesses the predictive efficacy of ARIMA models for projecting Gross Premium Collected in India (GPI) by New India Assurance. The study utilizes historical data from 2002 to 2023 and includes stationarity testing, model selection, and residual diagnostics. The study designates ARIMA(1,1,5) as the most efficacious model, shown by its optimal performance measures, which include the minimal Akaike Information Criterion (AIC) value and the maximal R-squared among the assessed alternatives. The projection anticipates consistent rise in GPI from 2024 to 2027, suggesting possible revenue enhancements driven by elements such as market development and heightened insurance penetration. This study enhances the current literature by underscoring the applicability of ARIMA models in projecting public sector insurance, therefore addressing a gap identified in previous studies centered on macroeconomic and efficiency evaluations. The findings corroborate the current research about ARIMA's forecasting efficacy, endorsing its use in strategic planning and risk management in the insurance sector.

Keywords: ARIMA, Gross Premium, Forecasting, Insurance Sector, New India Assurance

Introduction

The insurance sector in India is strong and varied, attributed to legislative changes, market growth, and evolving customer behavior. It is a key performance indicator that signifies the income stream of an insurance firm and its market penetration. The expansion and fortitude of New India Assurance as a leading public sector insurer, among these ongoing difficulties, is praiseworthy. The capacity to forecast future GPI based on the patterns found in this study is essential for strategic decision-making and resource allocation. Forecasting trends in GPI may provide better informed policy and operational planning within the firm and among other insurers.

Consequently, improved forecasting of their GPIs for strategic management planning, risk detection, and evaluation is essential for competitive positioning. The GPI is often influenced by macroeconomic circumstances and industry-specific variables, necessitating a predictive modeling system that can include these elements. This prognosis is seen significant by both traders and risk managers, as well as planners. Previous studies conducted by the RBI assigned comparable significance. Muthumeena and Muthusamy (2018) concentrated on the economic factors influencing public sector insurers, while Veerakumar et al. (2024) emphasized the competitive pressures between public and private insurers in India in this systematic study. These results highlight the need of specialized models to identify patterns in time series data, therefore assisting insurance companies in navigating both economic challenges and advantages.

This study seeks to determine the appropriate ARIMA model from the available alternatives for forecasting the GPI at New India Assurance. The outcome will identify the

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optimal model characterized by the minimal AIC or HIC value. This study is essential for advancing the company's entertainment projections, thereby enhancing its strategic planning. This study aims to determine the most effective method for evaluating GPI patterns and predicting them through ARIMA models, relevant for both short-term business strategies and long-term planning.

Literature Review

The Indian insurance market has seen substantial development and transition in recent decades, leading to considerable study on macroeconomic factors, financial efficiency, regulatory consequences, and operational effectiveness. Muthumeena and Muthusamy (2018) examined macroeconomic factors influencing public sector non-life insurance, highlighting the effect of external economic variables on gross premium performance. Ghose and Kumar (2019) examined the relative performance of public and private insurers, highlighting significant operational advantages and drawbacks. Yadav (2023) offered historical insights by examining general insurance patterns in the pre-liberalization period, so laying a framework for comprehending the industry's development trajectory. Veerakumar et al. (2024) performed a multivariate study comparing the performance of public and private insurance companies, while Kumar, Afifa and Sharma (2016) illustrated the efficacy of VAR modeling in predicting life insurance rates.

Investigations into financial efficiency have enhanced comprehension of the sector's production and obstacles. Chakraborty (2016) assessed the financial efficiency of public-sector insurance companies, while Sinha (2005, 2007) established the foundation for examining the development of the insurance sector, focusing on regulatory issues and structural transformations that arose after liberalization. Mathur (2001) addressed regulatory repercussions and variables affecting insurance growth, while Rao and Srinivasulu (2013) highlighted the sector's contribution to India's economic development. Ahmed et al. (2019) elucidated the difficulties and strategic transformations ensuing from industrial changes. Rajeswari and Kartheeswari (2011) observed the growing influence of private entities in defining the competitive environment, enhancing the examination of market engagement and dynamics. Gamage and Dayabandara (2013) further contributed by exploring the impact of vehicle make-based pricing in the motor insurance sector in Sri Lanka help understand premium setting in emerging markets like India.

Numerous studies have examined certain insurance sectors. Studies conducted by Nadkarni, Shetty, and Gadia (2017) and Radhika (2012) examined life insurance, addressing premium trends and the regulatory impact of the IRDA. Rajgopal (2013) explored whether life insurance acts more as a social security mechanism or an investment tool in post-reform Karnataka, contributing valuable socio-economic perspectives to the discourse on life insurance behavior. Nagaraju (2014) and Shahi and Gill (2013) examined the expansion of health insurance, emphasizing strategic innovations, while Binny and Gupta (2017) and Ramamoorthy and Kumar (2018) evaluated sector-specific obstacles and possibilities within health insurance. Dash (2018) performed perceptual mapping of health insurance companies, showing customer-focused evaluation trends. Priya (2018) analyzed benefit payouts using statistical techniques like ANOVA, underlining the need for robust analytical models in insurance operations. Kait and Sheoran (2022) elucidate the complexities of crop insurance schemes in rural regions, highlighting possible opportunities for expansion in these specialized insurance products. Karunarathne and Dayabandara (2013) studied the impact of policy and claims dates on investment terms, demonstrating time-sensitive variables relevant in non-life insurance operations

The theoretical underpinnings of time series forecasting have been established via seminal research, notably the ARIMA model created by Box and Jenkins (1976). The efficacy of ARIMA in managing data patterns, trends, and seasonality renders it particularly appropriate for predicting financial series like gross premiums (Stevenson, 2007). The efficacy of this model was further emphasized by Vandaele (1983) and Brockwell and Davis (2006), who demonstrated the applicability of ARIMA in time series analysis. Fattah et al. (2018) have shown applications in the insurance industry for demand forecasting, whereas Kumar et al. (2020) have focused on estimating insurance claim amounts. Li, Zhao and Zheng (2024) substantiated the model's significance by illustrating its efficacy in predicting industry trends. Vevek, Selvam and Kirithiga (2017) demonstrated the impact of sectoral volatility (e.g., auto and forex) on returns, emphasizing macro-financial linkages that are critical in modeling. The

persistence of such volatility in stock indices, discussed by Vevek, Selvam and Sivaprakkash (2022), reinforces the importance of dynamic models like ARIMA for handling financial time series. Furthermore, the comparative study of stock market assimilation between India and China by Vevek, Selvam and Ganapathy (2024) provides an advanced perspective on inter-market dependencies that may influence insurance forecasting through spillover effects.

Despite comprehensive study on the performance of the Indian insurance business, deficiencies persist in the use of predictive modeling for public sector organizations such as New India Assurance. Negash, Venugopal and Asmare (2018) found variables influencing the rise of non-life insurance; however, they did not explore forecasting via sophisticated time series methodologies. Sood, Seth, and Grima (2022) examined portfolio performance without using forecasting methodologies such as ARIMA. The technical efficiency studies conducted by Siddiqui and Das (2019) and Khan and Mitra (2015) did not investigate predictive models, while Saminathan et al. (2013) and Izadi (2013) analyzed performance but restricted their focus to time series forecasting. This study seeks to fill the research vacuum by using comparable ARIMA models to determine the optimal model for predicting gross premium income (GPI) for New India Assurance.

This research posits that the ARIMA model will provide enhanced forecasting precision for GPI relative to less complex models. This theory is predicated on the seminal work of Box and Jenkins (1976), which demonstrated the dependability of ARIMA for intricate data patterns, along with additional corroborations by Stevenson (2007) and Ho and Xie (1998). Recent research by Vevek and Selvam (2021) and Hafiz et al. (2021) on economic indicators has shown the effectiveness of ARIMA in financial forecasting. The hypothesis asserts that a model combining autoregressive and moving average components would improve the precision of GPI predictions, hence aiding strategic decision-making in public sector insurance.

Data and Methodology

This study employs secondary data about Gross Premiums Collected by New India Assurance (GPI) in India. Annual reports, industry journals, and regulatory entities like the IRDAI guarantee data veracity. The period from 2002 to 2023 was selected for an in-depth examination of trends, seasonality, and structural alterations affecting GPI throughout the years. The primary variable analyzed is yearly GPI, which indicates market performance in the insurance industry. ARIMA modeling necessitates the evaluation of stationarity by the Augmented Dickey-Fuller (ADF) test, employing differencing until stationarity is established. The ADF test, in conjunction with ACF and PACF charts, informs the selection of ARIMA models, ranging from ARIMA(1,1,1) to ARIMA(1,1,5). The AIC, SC, and Hannan-Quinn Criterion assist in determining the optimal model by selecting the lowest values. Residual diagnostic assessments, such as the Ljung-Box Q-test and correlogram, validate the model's appropriateness by indicating that the residuals exhibit characteristics of white noise. The finalized model, evaluated and implemented, predicts GPI for 2024–2027, assisting New India Assurance's strategic strategy.

Result

Table 1: Stationarity Testing of Gross Premium in India (GPI) from New India Assurance

	ADF		*Test Critical Values*		
	t-Stat	*Prob*	*1% Level*	*5% Level*	*10% Level*
GPI (@ level)	-0.656	0.964	-4.468	-3.645	-3.261
D(GPI) (@ first Difference)	-4.601*	0.008	-4.498	-3.658	-3.269

Source: Author Compiled and calculated.

Table 1 displays the results of the Augmented Dickey-Fuller test performed to assess the stationarity of the Gross Premium in India (GPI) data from New India Assurance, analyzed at both its level and first difference. The GPI series exhibits a t-statistic of -0.656, exceeding the critical values at the one, five, and ten percent significance levels, accompanied by a p-value of 0.964, which exceeds the conventional threshold of 0.05. The elevated p-value

indicates that we should maintain the null hypothesis, implying the existence of a unit root in the GPI series. This result indicates that the GPI series is non-stationary at its initial level, implying the presence of patterns or trends that do not converge to a constant mean over time.

The analysis of the first difference of GPI (D(GPI)) reveals an ADF test t-statistic of -4.601, which is below the critical values at all significance levels, accompanied by a p-value of 0.008. The low p-value enables the rejection of the null hypothesis, thereby confirming that D(GPI) is stationary. A single differencing of the GPI series effectively eliminates non-stationarity, rendering it appropriate for time series modeling. The findings indicate that GPI is an integrated series of order 1, I, 1, suggesting that an ARIMA (Autoregressive Integrated Moving Average) model is suitable for analyzing and forecasting this data, as it addresses both the autoregressive characteristics and the initial non-stationarity of the GPI series.

The correlogram of the differenced Gross Premium in India (GPI) series reveals substantial autocorrelation (AC) at lags 1 to 5, with a progressive decline, indicating an autoregressive (AR) component's existence. The partial autocorrelation (PAC) exhibits robust values at lag 1 and moderate significance at lags 2, 3, and 4, indicating a potential moving average (MA) component. The Q-statistics and associated p-values suggest substantial autocorrelation up to lag 4, with p-values below 0.05, hence justifying the inclusion of both AR and MA components. Potential ARIMA models that may encapsulate the underlying structure of the series, based on these patterns, include ARIMA (1,1,1), (1,1,2), (1,1,3), (1,1,4), and (1,1,5).

Table 2: Predictive Model Estimates and Fit Statistics for ARIMA Models of GPI

	ARIMA (p,d,q) (1,1,1)	*ARIMA (p,d,q) (1,1,2)*	*ARIMA (p,d,q) (1,1,3)*	*ARIMA (p,d,q) (1,1,4)*	*ARIMA (p,d,q) (1,1,5)*
C	1445.219	1457.664	1444.002	1470.458	1314.489
AR	0.907*	0.486	0.654*	0.412	0.456*
MA	-0.521	0.260	-0.164	0.453	0.754
SIGMASQ	826524.6	895174.2*	952252.8*	853661*	628908.5
AIC	16.880	16.949	17.011	16.930	16.770
SC	17.079	17.148	17.210	17.129	16.969
HQC	16.924	16.992	17.055	16.973	16.813
R-squared	0.440	0.393	0.355	0.422	0.574

Source: Author Compiled and Calculated.

Table 2 includes the estimates for many ARIMA models, such as ARIMA(1,1,1), (1,1,2), (1,1,3), (1,1,4), and (1,1,5). Finding the best model for forecasting the Gross Premium in India (GPI) series is the goal of this table 2. Notable variables include the AR coefficient in ARIMA(1,1,1) and ARIMA(1,1,5), among others. Each model has its own unique set of parameters for the AR and MA parts of the model. The ARIMA(1,1,5) model has the lowest AIC, score of 16.770 out of all the models that were considered. This means the model outperforms the alternatives in terms of data fit. This model outperforms the competition with an R-squared score of 0.574. A larger portion of the variation in the differenced GPI series may be explained by this. The ARIMA(1,1,5) model is appropriate for capturing the dynamics in the GPI data since the Schwarz Criterion (SC) and the Hannan-Quinn Criterion (HQC) have decreasing values. Taken into account, the ARIMA(1,1,5) model seems to be the most suitable prediction model for the series.

The correlogram of the residuals, in conjunction with the Ljung-Box Q-statistic test, indicates that the residuals from the fitted ARIMA(1,1,5) model display properties consistent with white noise. The autocorrelation (AC) and partial autocorrelation (PAC) values for the residuals across all lags are minimal and remain within the significance thresholds, indicating the absence of substantial spikes. The null hypothesis that the residuals are white noise cannot be rejected, since the Q-statistic p-values above the 0.05 level, indicating a lack of significant autocorrelation. The Ljung-Box Q-statistic supports this conclusion, as the high p-values indicate a lack of significant autocorrelation in the residuals, confirming their randomness and unpredictability. The

ARIMA(1,1,5) model effectively captures the intrinsic patterns in the Gross Premium in India (GPI) series, as evidenced by the absence of discernible patterns in the residuals. The presence of white noise in the residuals validates the appropriateness of the ARIMA(1,1,5) model for forecasting purposes.

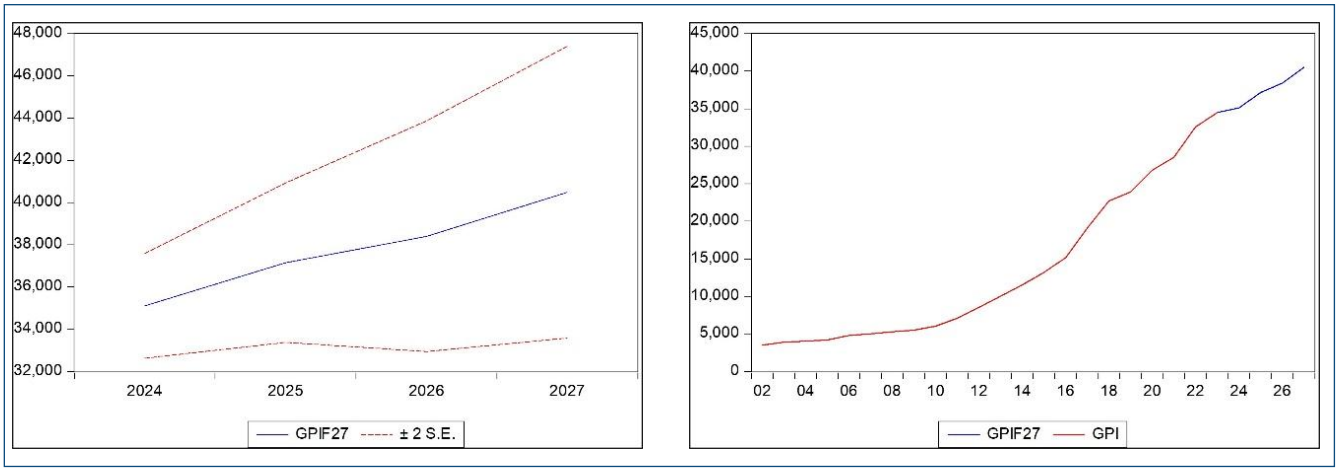

Fig. 1 and 2: Forecasted Growth of Gross Premium in India (GPI) Using ARIMA(1,1,5)

The ARIMA(1,1,5) model has generated forecasted values for Gross Premium in India (GPI) over a four-year period from 2024 to 2027. According to the forecast, GPI is expected to increase steadily each year. Starting from an estimated value of 35,107.76 in 2024, the GPI is projected to rise to 37,151.09 in 2025, followed by 38,399.94 in 2026, and reaching 40,487.81 in 2027. This consistent upward trend suggests a gradual increase in gross premium collections over time, indicating growth within the industry. The forecasted growth may reflect underlying factors such as expanding market demand, inflation, or increasing insurance penetration within India. However, it is essential to consider the model assumptions, as unexpected economic or industry-specific changes could impact the accuracy of these predictions. These results provide a useful baseline for planning and strategy within New India Assurance or the broader insurance industry, particularly for resource allocation and risk management.

Limitations and Future Research

This study has few limitations making its generalizability narrow because it is based on secondary data information only from New India Assurance so the same may not represent well about bigger picture of industry or differences with other companies. Further, the study uses a univariate ARIMA model to forecast Gross Premium Collected in India (GPI) and does not take into account external variables like economic changes, regulatory regulations or competition between other insurance players which may have substantial impact on GPI. ARIMA models, since they are built only on historical data, assume that the patterns worth considering in past will also exist in future — a hypothesis which might not always hold true; especially when you have to deal with rapidly changing business ecosystems. Additionally, the estimates reflect data as recorded at that point in time and may not account for updates to a company's filings over time.

As a next step, it suggests the collection of data from all major Indian insurance companies would be recommended to provide an overall picture of market conditions. Adopting multivariate models like Vector Autoregression (VAR) or ARIMAX would allow inclusion of external economic data, regulatory forces and competitive parameters; making the predictions advanced. Additionally, applying machine learning methods such as Neural Networks or Long Short-Term Memory (LSTM) models could be beneficial for detecting more intricate patterns in GPI An ongoing data refresh needed to take place allowing a more regular model evaluation that would allow corrections and tuning in predictions more especially under market volatility where past trend based estimates may lose relevance.

Conclusion

This research sought to determine the optimal ARIMA model for predicting Gross Premium Collected in India (GPI) by New India Assurance. The findings reveal that ARIMA(1,1,5) is the superior model, surpassing other configurations because to its decreased Akaike Information Criterion (AIC) values and elevated R-squared metrics. Thorough stationarity tests and diagnostic assessments confirmed the model's resilience in identifying the intrinsic patterns within the GPI data, establishing it as a dependable instrument for strategic forecasting. The anticipated GPI growth from 2024 to 2027 indicates a consistent rise driven by expected economic stability and increasing market needs. The results correspond with the findings of Kumar, Afifa and Sharma (2016), who illustrated the effectiveness of predictive modeling in insurance trends, and Stevenson (2007), who validated ARIMA's capability in managing intricate time series data. This research builds upon previous evaluations by concentrating on public sector data and correcting the deficiencies identified in the works of Negash, Venugopal and Asmare (2018), which overlooked sophisticated forecasting methodologies. Furthermore, it opposes the narrow emphasis shown in Sood, Seth and Grima (2022), whereby predictive analysis was not included despite the evaluation of performance measures.

Contribution to Literature entails addressing a significant deficiency in research pertaining to predictive modeling in the Indian public insurance industry. This research uniquely blends performance measurements, regulatory implications, and macroeconomic trends with advanced time series forecasting, in contrast to most of the prior work that has focused on analyzing these elements separately. The study demonstrates that the use of ARIMA modeling to GPI data may improve forecasting accuracy for public insurers using customized time series methodologies. This study enhances the scholarly discourse on financial forecasting and offers a pragmatic framework for insurers aiming to bolster strategic planning. It emphasizes the conclusions of Box and Jenkins (1976) about the efficacy of ARIMA in time series forecasting, corroborating its significance as noted in research such as Vevek and Selvam (2021). These contributions provide the groundwork for future research to integrate multivariate or machine learning methodologies, guaranteeing responsiveness to changing economic situations and data trends.

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