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INDIA AT 2050: FORECASTING INDIA'S GDP USING AUTOREGRESSIVE INTEGRATED MOVING AVERAGE (ARIMA)

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ABSTRACT

The global power structure has evolved dramatically since World War II, transitioning from a bipolar world through unipolar dominance to today's multipolar reality. While the United States maintains significant influence, emerging powers like China and Russia, alongside an increasingly assertive Global South, are reshaping international dynamics. This transformation has given rise to 'Collaborative Coexistence,' where nations prioritize pragmatic cooperation over ideological alignment. Within this context, India's emergence, particularly since 2014, represents a remarkable story of economic growth and diplomatic maturity. The country now stands as an economic competitor to the US and China while pursuing an independent political path, balancing neutrality with active participation in addressing global challenges. Drawing strength from its democratic foundations and multilateral approach, India has gained substantial international influence. Economic projections using ARIMA (Auto Regressive Integrated Moving Average) methodology suggest India's economy could exceed USD 27 trillion by 2050. This paper employs ARIMA (2,1,3) and examines this trajectory through 2050, arguing that these developments position India to define what may become the 'Indian Century.'

***Keywords**: ARIMA, Forecasting, Indian GDP, Geopolitics, Collaborative-Coexistence.*

Introduction

The traditional partnerships between countries are being replaced by the contemporary strategic alliances that have dominated the global scene. The Cold War period was characterized by two superpowers namely the United States and the Soviet Union. With the collapse of the Soviet Union, the United States assumed superpower status. However, with the rise of China and resurgence of Russia, the unipolar world found itself looking at multiple power centers giving rise to a multipolar world. The

As a country, committed to democratic values and multilateral cooperation, India's robust economic growth allows India to act as a key player in addressing global challenges to promote a sustainable future for the world. Coupled with its strategic autonomy underscores its influence on the international stage, allowing for it to foster inclusive and cooperative diplomatic engagements.

The world had not yet recovered from the fall-out of COVID-19, that it was staring at yet another calamity, having global ramifications. In February 2022, Russia invaded Ukraine, termed by the western

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allies as an act of unprovoked aggression. The conflict represents the most significant war playing out in Europe since World War II, dispelling the belief that armed wars were things of the past in Europe. This war, being played in the backyard of Europe, united the European nations and United States against Russia. NATO members supported Ukraine with military aid and slammed economic sanctions against Russia. Russia turned to strengthen its ties with China, Iran and other countries resistant to western influence. This has contributed to a more polarized international environment.

China's misadventures at the border have prompted India to respond by hurting China's economic interests. India is also striving to be the single largest beneficiary of the global backlash that China is facing. With the China plus strategy, India has made concerted efforts not just to attract new investments but also offer multinational companies an alternative destination to relocate manufacturing units in India. While India shares the stage with China on platforms such as BRICS and SCO, it also is an important ally of the QUAD grouping aimed to keep China in check. China, on the other hand, has strengthened its relations with Russia, calling their relationship, a 'no limits' partnership. China's expansionist policies and its meddling in other countries internal affairs especially in South Asia has worried India. Despite some relief between India and China on their border issues, the relationship still lacks trust. This pushes India to seek friends across the globe, while safeguarding its economic interests at the same time.

Given the global framework, it is vital to bring forth evidence of India's growth using empirical analysis. The current work utilizes the projections of advanced econometric models such as Autoregressive Integrated Moving Average (ARIMA) to anticipate India's GDP reaching USD 27 trillion by 2050, highlighting its potential as a pivotal force in global governance. The literature review follows the introduction. The techniques used along with data sources are explained in the section research methodology followed by the section on results of the empirical analysis. The current work offers its conclusion in the last section of this study. References used in the work are cited at the end of the study.

Literature Review

Economic growth represented commonly as Gross Domestic Product (GDP) is a reliable parameter to judge the health of a nation. This parameter has been used across the world to understand the performance, make comparisons and even to predict future wellness of countries. Box and Jenkins (BJ) (1976) advanced the application of ARIMA to make forecasts. Since then, ARIMA model has been used extensively to predict not only GDP but as a tool for forecasting diverse parameters.

Onideki (2014) analysed treasury bill rates for Kenya, incorporating both 91and 182 days' treasury bills. Using GARCH model (1,1), the study applied ARIMA (3,1,1) for 91 days treasury bills and ARIMA (1,1,0) for 182 days treasury bills.

Similarly, ARIMA model was appliedto forecast the economic growth of Kenya, indicating ARIMA (2,2,2) model as the model of best fit for the Kenyan economy (Abonazel & Abd-Elftah, 2019; Wabomba et al., 2016).

Fattah et al. (2018) applied ARIMA model to forecast demand in the food manufacturing sector by using BJ approach. They found that ARIMA (1,0,1) was the model of best fit in forecasting demand. Mondal et al. (2014) while studying fifty six Indian stocks from different sectors, effectively used ARIMA (1,0,2) to make reliable predictions with over 85 per cent accuracy rate.

GDP of Bangladesh has been forecasted using ARIMA (1,2,1) with the result that GDP is expected to steadily risefor Bangladesh (Uddin & Tanzim, 2021; Miah et al., 2019). In another study, Voumik and Smrity (2020) have forecasted per capita GDP of Bangladesh using ARIMA(0,1,2).

Huruta (2024) applied ARIMA to predict the unemployment rate of Indonesia. The results indicated that ARIMA has good forecasting capability.

Maity and Chatterjee (2012) applied ARIMA model to predict the GDP of India using historical data of sixty years. ARIMA (1,2,1) model indicates the best predictive capability as per validation and performance parameters like Root Mean Square Error (RMSE), Mean absolute Percentage Error (MAPE) and Mean Absolute Standard Error (MASE) to forecast the GDP of India (Hassan & Mirza, 2020). Applying the BJ technique, Arneja et al. (2020) have found ARIMA (1,1,7) to be the model of best fit in forecasting GDP of India for the period 1980-2017 with the result that the GDP will rise steadily.

Agarwal et al. (2024) predicted the GDP of India until 2035 using ARIMA (2,1,3) to make robust and accurate forecasts.

Research Methodology

The empirical analysis uses the univariate time series of India's GDP for the period 1974-2023. The data set has been sourced from the World Bank database. The tables and graphs depicted in the current study are based on this data set. The analysis is done using E-views 12 software.

Box and Jenkins (1976) proposed the model which determines the values of p and q in the ARIMA model by evaluation the autocorrelation function (ACF) and the partial autocorrelation function (PACF) of the time series. The process of forecasting with ARIMA involves four key steps-identifying the model, estimating parameters, performing diagnostic checks, and generating forecasts. The ARIMA (p,d,q) model thus is:

$$Y_t = \mathrm{C} + \kappa_p(L)\Delta d Y_t + \gamma_q(L)\varepsilon_t$$

where:

Y_t : denotes the GDP at time t

C : is the constant

L : represents the lag operator

ε : is the white noise, $(Y - \hat{Y})$

$\kappa_p(L)$: denotes non-seasonal autoregressive (AR) operator

Δd: signifies non-seasonal differencing

$\gamma_q(L)$: is a non-seasonal moving average (MA) operator

γ, κ : are the parameters that need to be estimated

The current study uses the proposed ARIMA model of Box and Jenkins for its empirical analysis and the stability of the model is checked using Ljung-Box approach. In ARIMA modelling, it is important that the residuals of the model are white noise, which can be validated through Ljung-Box Q test. Further, Augmented Dicky Fuller (ADF) test has been carried out to check for the stationarity of the series.

Empirical Results

Table 1 gives the descriptive statistics of the series. The mean value of the series is 6.34 and the median at 6.08 lies close to the mean. This implies a near symmetrical distribution. The minimum value of 4.58 is observed in the data set for the year 1975, while 2023 has recorded the highest value of 8.17. The distribution is positively skewed and is platykurtic. The Jarque-Bera indicates that the series is normally distributed.

Table 1: Summery of Descriptive Statistics

Mean	Median	Max.	Min.	Standard Deviation	Skew.	Kurt.	Jarque-Bera (p-value)	Obsns
6.3415	6.0861	8.1747	4.5898	1.0909	0.2101	1.7674	3.533034 (0.170927)	50

Table 2 shows the outcome of the Augmented Dicky Fuller (ADF) test. The series is not stationary at level. However, it is stationary at first difference at 1 per cent significance level.

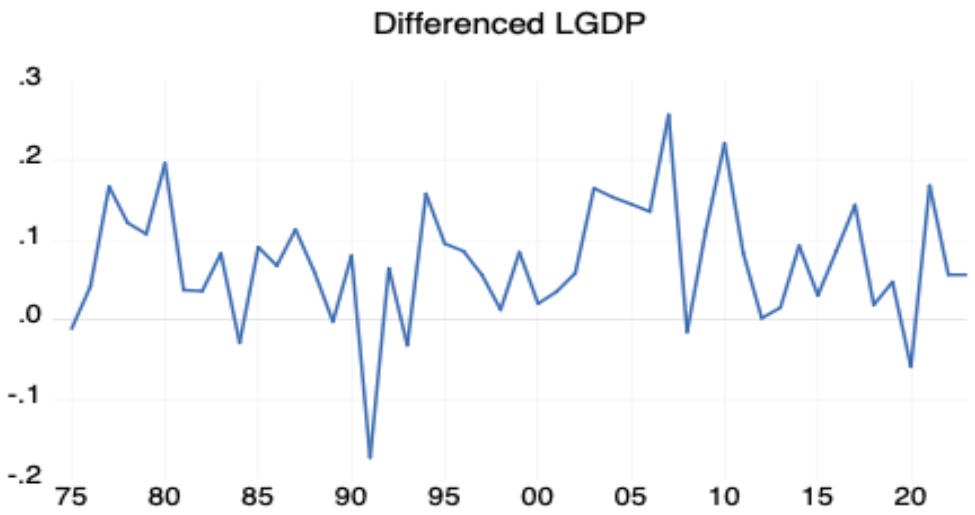
Table 2: Augmented Dicky Fuller (ADF) Test"

		I(0)	I(1)
		LGDP	LGDP
With Constant	t-Statistic (p-value)	0.048 (0.9582)	-6.757 (0.000)***
With Constant & Trend	t-Statistic (p-value)	-1.5415 (0.8012)	-6.6753 (0.0000)***
Without Constant & Trend	t-Statistic (p-value)	6.5146 (1.0000)	-2.1261 (0.0335)**

* significant at 10% level, ** significant at 5% level, ***significant at 1% level"

Figure 1 gives the graphical representation of the series at I(1).

Figure 1: Graphical Representation of the Series at First Difference



ARIMA Modelling

Identification of the Model

Table 3 shows the criteria of selecting the appropriate model for ARIMA. The model AR(2), MA(2), MA(3) is selected to be applied for forecasting the time series. To determine the most suitable model, first, the significance of the Sigma Square is checked. In Table 3, Sigma Square (SIGMASQ), which highlights the ability of the model to capture residual variance, is significant for both the models. As a second step, the suitability of Akaike Information with Schwarz Criterion is checked, and that model with the lowest value in both the criterion is selected as the model of best fit.

Table 3: Selection of the ARIMA Model

	Models	Akaike info criterion (AIC)	Schwarz criterion (SC)	SIGMASQ (p-value)
1	AR(2) MA(2) MA(3)	-2.22278	-2.029738	0.0049 (0.0001)***
2	AR(1) AR(2) MA(2) MA(3)	-2.18403	-1.952378	0.0048 (0.0002)***

*: Significance at 10%; **: Significance at 5%; ***: Significance at 1%"

Parameter Estimation

From Table 4, the constant shows a 0.073 average growth rate at 1 per cent significance level. AR(2) is negatively influencing GDP at 0.52 at 5 per cent significance level. MA(2) and MA(3) are positively influencing GDP at 0.81 and 0.35 respectively at 1 per cent significance level.

Table 4: Estimation of the Selected Model

Variables	Coefficient	Std. Error	t-Statistic	p-value
C	0.0730	0.0164	4.4486	0.0001***
AR(2)	-0.5200	0.2203	-2.3597	0.0228**
MA(2)	0.8121	0.2008	4.0441	0.0002***
MA(3)	0.3561	0.1283	2.7737	0.0081***
Inverted Roots of AR	-.00+.72i	-.00-.72i		
Inverted Roots of MA	.19+.96i	.19-.96i	-0.37	

*:Significance at 10%; **: Significance at 5%; ***: Significance at 1%"

All roots lie within the unit root circle confirming stationarity and stability of the model supporting the model's validity for forecasting.

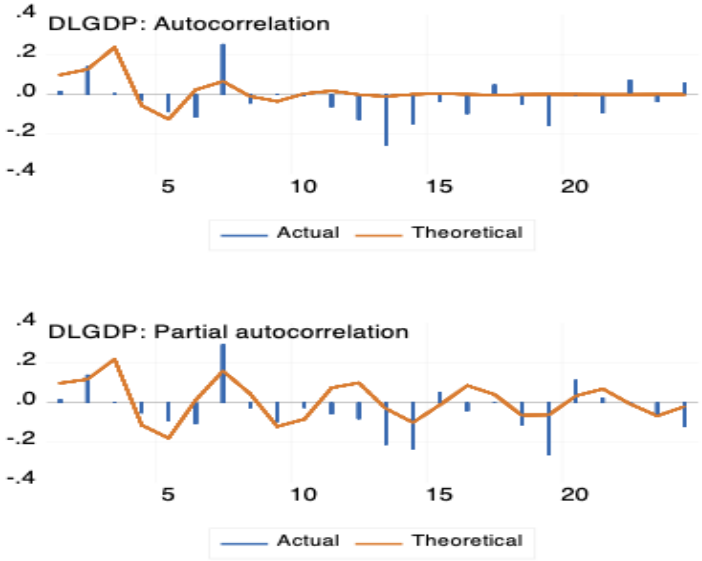
Diagnostic Checking

The diagnostics of the model are done using the Ljung-Box test, which indicate no significant autocorrelation in the residuals of the model. The p-value for the lags exceeds 0.05 threshold, implying that the residuals are white noise. This confirms that the ARIMA model has adequately captured the temporal structure of the data, making it a reliable tool for forecasting.

Figure 2 shows the autocorrelation function and partial autocorrelation function plots for the differenced values of natural logarithm of India's GDP. The ACF shows significant autocorrelations at lower lags with an oscillatory pattern, indicating the presence of moving average (MA) components.

Similarly, the PACF plot shows significant partial autocorrelation up to lag 2, suggesting the inclusion of autoregressive (AR) term in the model. Both plots confirm the stationarity of the series at 5 per cent significance level and hence support the validity of chosen ARIMA model's structure and parameterization.

Figure 2: Autocorrelation and Partial Autocorrelation plot of DLGDP



Forecasting the Model

Figure 3: Static and Dynamic Forecasting of the Model

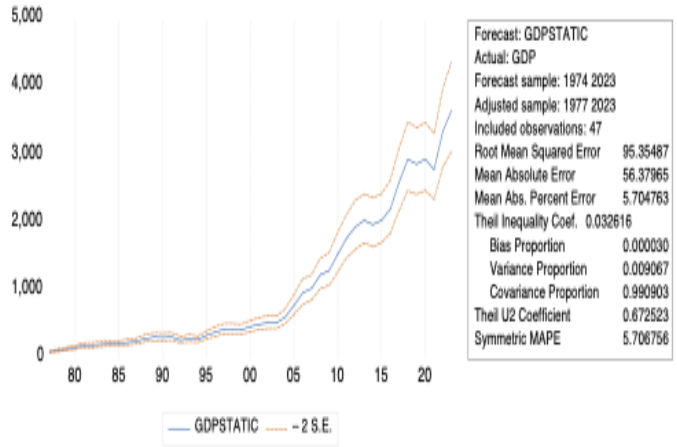


Figure 3-A: STATIC Forecast Model

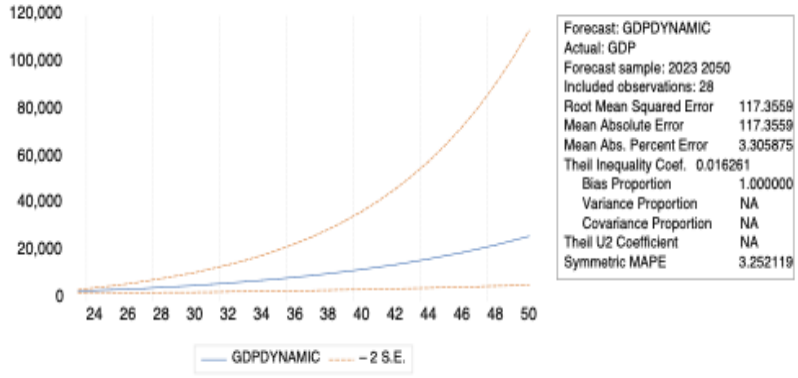


Figure 3-B: DYNAMIC Forecast Model

In Figure 3-A shows the Static Forecast Model. The forecasted value of the model lies within ± 2 standard error. The mean absolute percent error (MAPE) is 5.70. MAPE gives the model accuracy predication metric. Since, for the selected model, MAPE ≤ 10, indicating highly accurate forecasting. On the basis of static forecasting, dynamic forecasting is done as shown in figure 3-B, where India's GDP is constantly increasing and lies within ± 2 standard error bounds.

Table 5 shows the forecasted values of India's GDP in billion USD.The projected GDP of India is estimated to reach 27 trillion by the year 2050 from 3.6 trillion in the year 2023. In 2027, India's GDP is projected to cross USD 5 trillion. The GDP is expected to cross USD 10 trillion in the year 2037. When India celebrates its 100 years of independence, its GDP is forecasted to be over USD 21 trillion.

Table 5: Forecasted Annual GDP Values (2023-2050)

(in billion USD)

Year	GDP	Year	GDP	Year	GDP	Year	GDP
2023	3,667.27	2030	6,266.29	2037	10,484.60	2044	17,475.27
2024	4,153.17	2031	6,749.49	2038	11,272.86	2045	18,798.79
2025	4,427.82	2032	7,288.12	2039	12,127.91	2046	20,222.03
2026	4,637.59	2033	7,835.05	2040	13,050.19	2047	21,754.01
2027	5,012.25	2034	8,412.10	2041	14,038.08	2048	23,402.37
2028	5,467.41	2035	9,052.41	2042	15,099.32	2049	25,175.03
2029	5,867.30	2036	9,748.04	2043	16,243.51	2050	27,081.77

Figure 4 gives the forecasted results of India's GDP as a bar diagram. The value of GDP is given in billion USD and is represented on the Y-axis.

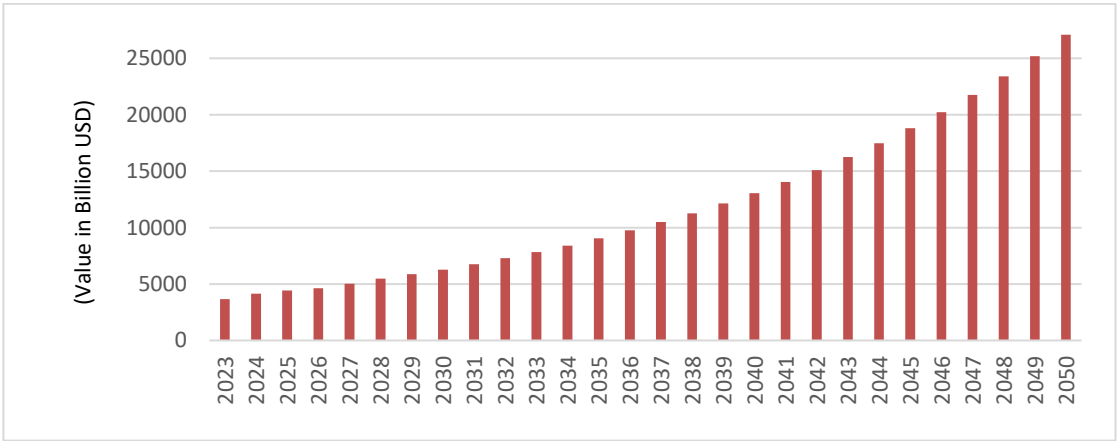


Figure 4: The forecasted Results of India's GDP (2025-2050)

Conclusion

India's response involves strengthening alliances, enhancing domestic manufacturing and investing in defence modernisation. Active participation in multilateral platforms, such as the G20 and BRICS, allow India to advocate for equitable global governance. Additionally, India's emphasis on cultural diplomacy and democratic values reinforces its soft power.

India's strategic rise is emblematic of its resilience and pragmatic approach to global challenges. By maintaining a balanced foreign policy, fostering economic growth, and addressing geopolitical complexities, India positions itself as a pivotal player in a multipolar world. As it navigates the evolving global order, India's commitment to strategic autonomy and collaborative engagement underscores its aspirations to shape the 21st century as a transformative global leader.

India's strategic rise, its economic trajectory, and the geopolitical implications of its ascent, envisioning its emergence as a transformative global power by 2050 will make the 21st century as "India's Century".

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