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A STATISTICAL STUDY OF PREDICTION OF INDIAN GDP

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Abstract: A lot of research have been done by Economists on the topic of economic growth in general. The Indian economy has transitioned from a mixed planned economy to a middle-income developing social market economy with notable public sectors in strategic sectors. The annual GDP growth has been 6% to 7%. The service sector makes up more than 50% of GDP and remains the fastest growing sector, while industrial sector and the agricultural sector employs a majority of the labour force. India is world’s sixth largest manufacturer, representing 2.6% of global manufacturing output. Nearly 65% of India’s population is rural and contributes about 50% of India’s GDP. India faces high unemployment, rising inequality and a drop in aggregate demand. The aim of this study to predict the GDP growth for the Year 2025. The tool used in the study is ARIMA-GARCH and the results indicate that GDP growth for year 2025 is predicted to be 6.5%.

Keywords: GDP,ARIMA-GARCH (Auto Regressive Integrated Moving Average-Generalized Autoregressive Conditional Heteroscedasticity) , ARCH GARCH Volatility for GDP, Forecasting, Dynamic,Static.

Introduction:

The collapse of the Soviet Union, which was India's major trading partner, and the Gulf War, which caused a spike in oil prices, resulted in a major balance-of-payments crisis for India, which found itself facing the prospect of defaulting on its loans.India asked for a $1.8 billion bailout loan from the International Monetary Fund (IMF), which in return demanded de-regulation.

In response, the Narasimha Rao government, including Finance Minister Manmohan Singh, initiated economic reforms in 1991. The reforms did away with the Licence Raj, reduced tariffs and interest rates and ended many public monopolies, allowing automatic approval of foreign direct investment in many sectors. Since then, the overall thrust of liberalisation has remained the same, although no government has tried to take on powerful lobbies such as trade unions and farmers, on contentious issues such as reforming labour laws and reducing agricultural subsidies. This has been accompanied by increases in life expectancy, literacy rates, and food security, although urban residents have benefited more than rural residents.

From 2010, India has risen from ninth-largest to the fifth-largest economies in the world by nominal GDP in 2019 by surpassing UK, France, Italy and Brazil.

India started recovery in 2013–14 when the GDP growth rate accelerated to 6.4% from the previous year's 5.5%. The acceleration continued through 2014–15 and 2015–16 with growth rates of 7.5% and 8.0% respectively. For the first time since 1990, India grew faster than China which registered 6.9% growth in 2015. However the growth rate subsequently decelerated, to 7.1% and 6.6% in 2016–17 and 2017–18 respectively, partly because of the disruptive effects of 2016 Indian banknote demonetisation and the Goods and Services Tax (India).

India is ranked 63rd out of 190 countries in the World Bank's 2020 ease of doing business index, up 14 points from the last year's 100 and up 37 points in just two years. In terms of dealing with construction permits and enforcing contracts, it is ranked among the 10 worst in the world, while it has a relatively favourable ranking when it comes to protecting minority investors or getting credit. The strong efforts taken by the Department of Industrial Policy and Promotion (DIPP) to boost ease of doing business rankings at the state level is said to affect the overall rankings of India.

COVID-19 pandemic and aftermath (2020–present)

During the COVID-19 pandemic, numerous rating agencies downgraded India's GDP predictions for FY21 to negative figures, signalling a recession in India, the most severe since 1979. The Indian Economy contracted by 6.6 percent which was lower than the estimated 7.3 percent decline. In 2022, the ratings agency Fitch Ratings upgraded India's outlook to stable similar to S&P Global Ratings and Moody's Investors Service's outlooks In the first quarter of financial year 2022–2023, the Indian economy grew by 13.5%.

Agriculture and allied sectors like forestry, logging and fishing accounted for 18.4% of the GDP,[200] the sector employed 51.2 crore persons or 45.5% of the workforce in India are employed in agriculture. India is major agriculture producing country and has the most arable land in the world followed by the United States

India's foodgrain production stagnant at approximately 316 megatonnes (311 million long tons; 348 million short tons) during 2020–21. India exports several agriculture products, such as Basmati rice, wheat, cereals, spices, fresh fruits, dry fruits, cotton, tea, coffee, milk products and other cash crops to the Asian, African and other countries

India began its first few steps during the years 1978-80 when early conditions for SMEs or entrepreneurship were hostile too. 63 million MSMEs in India which contribute 35% to the country’s GDP provides employment to 111.4 million persons and accounts for more than 40% of India’s exports and are hailed as the ‘growth engines’ of the economy.China has been creating 16,000-18,000 new enterprises per day for the last 5 years. When you compare that with India, it is about 1000-1100 per day

Mining contributed to 1,75% of GDP and employed directly or undirecly 11 million people in 2021. India's mining industry was the fourth-largest producer of minerals in the world by volume, and eighth-largest producer by value in 2009. In 2013, it mined and processed 89 minerals, of which four were fuel, three were atomic energy minerals, and 80 non-fuel. The public sector accounted for 68% of mineral production by volume in 2011–12. India has the world's fourth-largest natural resources, with the mining sector contributing 11% of the country's industrial GDP and 2.5% of total GDP.

India surpassed Japan as the second largest steel producer in January 2019. As per worldsteel, India's crude steel production in 2018 was at 106.5 tonnes (104.8 long tons; 117.4 short tons), 4.9% increase from 101.5 tonnes (99.9 long tons; 111.9 short tons) in 2017, which means that India overtook Japan as the world's second largest steel production country.

Petroleum products and chemicals are a major contributor to India's industrial GDP, and together they contribute over 34% of its export earnings. India hosts many oil refinery and petrochemical operations developed with help of Soviet technology such as Barauni Refinery and Gujarat Refinery , it also includes the world's largest refinery complex in Jamnagar that processes 1.24 million barrels of crude per day.[237] By volume, the Indian chemical industry was the third-largest producer in Asia, and contributed 5% of the country's GDP. India is one of the five-largest producers of agrochemicals, polymers and plastics, dyes and various organic and inorganic chemicals.[238] Despite being a large producer and exporter, India is a net importer of chemicals due to domestic demands.[239] India's chemical industry is extremely diversified and estimated at $178 billion

The chemical industry contributed $163 billion to the economy in FY18 and is expected to reach $300–400 billion by 2025.[241][242] The industry employed 17.33 million people (4% of the workforce) in 2016

The Indian Railways contributes to ~3% of the country's gross domestic product (GDP) and has social obligations pegged at $5.3 billion annually.

Data and Methodology:

Data has been taken from the official website of Reserve Bank of India for analysis purposes.

Using ML in Eviews12.0, the trend of GDP groth has been assessed with the help of ARIMA-GARCH (Auto Regressive Integrated Moving Average-Generalized Autoregressive Conditional Heteroscedasticity)and ARCH GARCH Volatality for GDP.

ARIMA-GARCH (Auto Regressive Integrated Moving Average-Generalized Autoregressive Conditional Heteroscedasticity) Model:

The main contributions of this study are as follows :(1)ARIMA model and ARIMA-GARCH combined model have been constructed(2)The future trend of GDP is predicted, which has certain theoretical value and significance for economic development(3)Comparing with other traditional models,

we proposed model having higher prediction accuracy

Brief Introduction of ARIMA and GARCH Models

In the ARIMA(p, d, q), AR represents autoregressive, p represents the number of autoregressive terms, MA represents average move, q represents the average number of terms of moving, and d represents the difference number. If

$$Y_t = (1 - B)^d X_t, \tag{2}$$

is a sequence of ARMA(p, q), it indicates that $\{X_t\}$ is a sequence of ARMA(p, q)and the model is shown as follows:

$$\phi(B)(1 - B)^d X_t = \theta(B)\varepsilon_t, \quad t \in Z, \tag{3}$$

where B represents the operator, $(1 - B)$ represents finite difference operator, $\{\varepsilon_t\}$ represents a flanoise in zero-mean, and real polynomial $\phi(z) = 1 - \phi_1 z - \cdots - \phi_p z^p$ and $\theta(z) = \theta_0 + \theta_1 z + \cdots + \theta_q z^q$ meet the requirements of stationarity and reversibility, respectively.

The modeling steps of ARIMA(p, d, q) model are as follows:

① The stationarity test is carried out on the original time series. If the series does not meet the stationarity condition, the difference transformation is needed to make the series meet the stationarity condition, so as to obtain the value of d in the model.

② The values of p and q in the model are determined by using ACF and PACF.

③ The unknown parameters of the model were estimated and the significance of the parameters and the applicability of the diagnostic model were tested.

④ Predict the future value of time series.

Form of the ARMA Model

The structure of the ARMA model is as follows:

$$X_t = \sum_{j=1}^{p} \phi_j X_{t-j} + \sum_{j=0}^{q} \theta_j \varepsilon_{t-j}, \quad t \in Z, \qquad \left\{ \begin{cases} \theta_0 = 1, \\ \phi_p \theta_q \neq 0, \end{cases} \right) \tag{1}$$

where $\{\varepsilon_t\}$ represents a flat noise in zero-mean , real polynomial.

$\phi(z) = 1 - \phi_1 z - \cdots - \phi_p z^p$ and $\theta(z) = \theta_0 + \theta_1 z + \cdots + \theta_q z^q$ meet the requirements of stationarity and reversibility, respectively.

$$\left\{\begin{cases} x_t = f\left(t, x_{t-1}, x_{t-2}, \ldots\right) + \varepsilon_t, \\ \varepsilon_t = \sqrt{h_t} e_t, \\ h_t = w + \sum_{i=1}^{q} \alpha_i \varepsilon_{t-i}^2, \\ e_t \sim II\ D(0,1), \end{cases}\right) \tag{4}$$

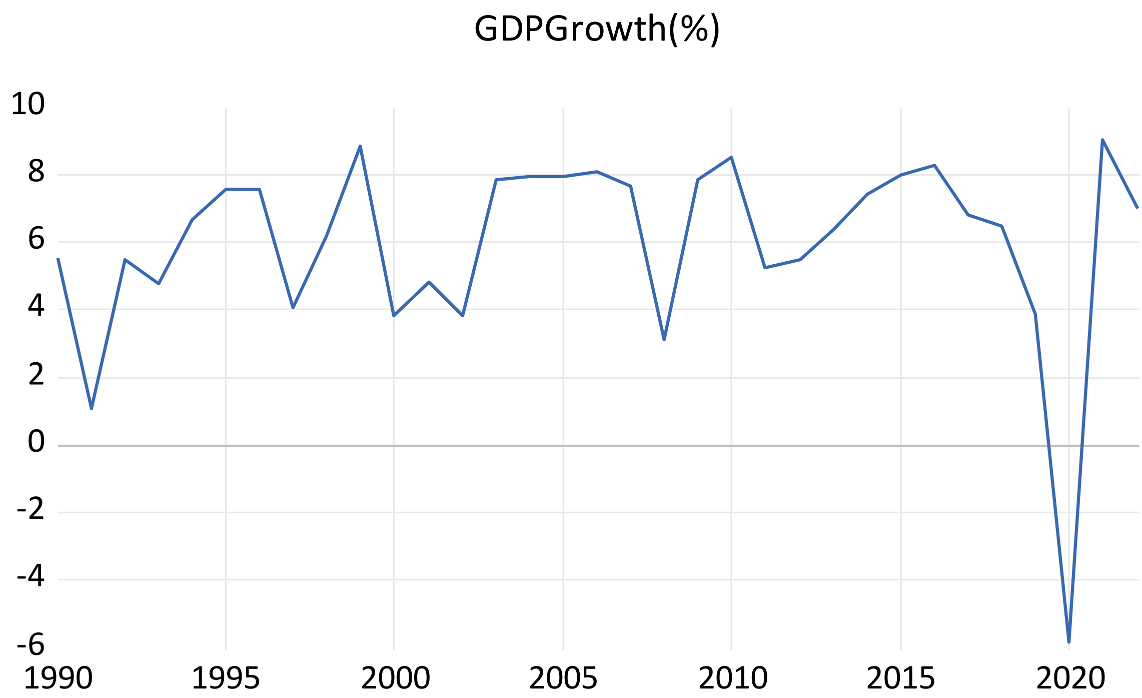
where α_i is nonnegative and $f(t, x_{t-1}, x_{t-2}, \ldots)$ is the deterministic information fitting model of $\{x_t\}$.

GARCH MODEL

$$\left\{\begin{cases} x_t = f\left(t, x_{t-1}, x_{t-2}, \ldots\right) + \varepsilon_t, \\ \varepsilon_t = \sqrt{h_t} e_t, \\ h_t = w + \sum_{i=1}^{q} \alpha_i \varepsilon_{t-i}^2 + \sum_{j=1}^{p} \gamma_j h_{t-j}, \\ e_t \sim II\ D(0,1), \end{cases}\right) \tag{5}$$

where α_i and γ_j are nonnegative and $f(t, x_{t-1}, x_{t-2}, \ldots)$ is the deterministic information fitting model of $\{x_t\}$. It is an extension of the ARCH model and claims that h_t has AR $\sum_{j=1}^{p} \gamma_j h_{t-j}$ and ARCH term is $\sum_{i=1}^{q} \alpha_i \varepsilon_{t-i}^2$. In general, the GARCH model is easier to identify and estimate, and the GARCH model can capture the flat period and fluctuation period of time series.

Results and Discussions:



The above graph shows constant mean and variance over time, it suggests a stationary series, ADF test also indicates stationary at level with 5% as p-value is 0.0001 which is less than 0.05.

Null Hypothesis: GDPGROWTH has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.283840	0.0001
Test critical values:	1% level	-3.653730	
	5% level	-2.957110	
	10% level	-2.617434	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(GDPGROWTH)
Method: Least Squares
Date: 10/27/23 Time: 10:10
Sample (adjusted): 1991 2022
Included observations: 32 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GDPGROWTH(-1)	-0.965787	0.182781	-5.283840	0.0000

C	5.783620	1.203225	4.806763	0.0000

R-squared	0.482035	Mean dependent var	0.045937
Adjusted R-squared	0.464769	S.D. dependent var	4.007270
S.E. of regression	2.931697	Akaike info criterion	5.049501
Sum squared resid	257.8454	Schwarz criterion	5.141110
Log likelihood	-78.79202	Hannan-Quinn criter.	5.079867
F-statistic	27.91897	Durbin-Watson stat	1.912483
Prob(F-statistic)	0.000010		

Date: 10/27/23 Time: 10:10
Sample: 1990 2022
Included observations: 33

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
. |. |	. |. |	1	0.034	0.034	0.0418	0.838
. *|. |	. *|. |	2	-0.119	-0.120	0.5669	0.753
. *|. |	. |. |	3	-0.066	-0.059	0.7361	0.865
. *|. |	. *|. |	4	-0.107	-0.119	1.1911	0.880
. *|. |	. *|. |	5	-0.095	-0.108	1.5662	0.905
. |. |	. |. |	6	0.010	-0.019	1.5708	0.955
. |. |	. |. |	7	0.025	-0.016	1.5992	0.979
. |. |	. |. |	8	0.016	-0.012	1.6116	0.991
. |. |	. |. |	9	0.054	0.034	1.7536	0.995
. |. |	. |. |	10	-0.050	-0.064	1.8805	0.997
. |*. |	. |*. |	11	0.132	0.154	2.7959	0.993
. |*. |	. |*. |	12	0.116	0.112	3.5362	0.990
. *|. |	. *|. |	13	-0.202	-0.176	5.8939	0.950
. *|. |	. *|. |	14	-0.156	-0.114	7.3790	0.919
. *|. |	. *|. |	15	-0.100	-0.121	8.0197	0.923
. *|. |	. *|. |	16	-0.119	-0.147	8.9790	0.914

Based on above correlogram it is observed that ACF remains large for a long time and PAC cuts off at lag1, therefore we start with the simplest model: AR(1), MA(1) and ARIMA(1,1,1) until we get a model with significant coefficients.

Date: 10/27/23 Time: 10:23
Sample: 1990 2022
Q-statistic probabilities adjusted for 2 ARMA terms

<table>
<tr><th>Autocorrelation</th><th>Partial Correlation</th><th></th><th>AC</th><th>PAC</th><th>Q-Stat</th><th>Prob</th></tr>
<tr><td>. |*. |</td><td>. |*. |</td><td>1</td><td>0.125</td><td>0.125</td><td>0.5605</td><td></td></tr>
<tr><td>. |. |</td><td>. |. |</td><td>2</td><td>-0.031</td><td>-0.047</td><td>0.5954</td><td></td></tr>
<tr><td>. |. |</td><td>. |. |</td><td>3</td><td>-0.031</td><td>-0.021</td><td>0.6315</td><td>0.427</td></tr>
<tr><td>. *|. |</td><td>. *|. |</td><td>4</td><td>-0.084</td><td>-0.080</td><td>0.9132</td><td>0.633</td></tr>
<tr><td>. *|. |</td><td>. |. |</td><td>5</td><td>-0.080</td><td>-0.062</td><td>1.1760</td><td>0.759</td></tr>
<tr><td>. |. |</td><td>. |. |</td><td>6</td><td>0.014</td><td>0.026</td><td>1.1844</td><td>0.881</td></tr>
<tr><td>. |. |</td><td>. |. |</td><td>7</td><td>0.031</td><td>0.017</td><td>1.2268</td><td>0.942</td></tr>
<tr><td>. |. |</td><td>. |. |</td><td>8</td><td>0.023</td><td>0.010</td><td>1.2523</td><td>0.974</td></tr>
<tr><td>. |. |</td><td>. |. |</td><td>9</td><td>0.056</td><td>0.045</td><td>1.4014</td><td>0.986</td></tr>
<tr><td>. |. |</td><td>. |. |</td><td>10</td><td>-0.042</td><td>-0.056</td><td>1.4888</td><td>0.993</td></tr>
<tr><td>. |*. |</td><td>. |*. |</td><td>11</td><td>0.116</td><td>0.143</td><td>2.1906</td><td>0.988</td></tr>
<tr><td>. |*. |</td><td>. |. |</td><td>12</td><td>0.091</td><td>0.064</td><td>2.6417</td><td>0.989</td></tr>
<tr><td>. *|. |</td><td>.**|. |</td><td>13</td><td>-0.205</td><td>-0.220</td><td>5.0583</td><td>0.928</td></tr>
<tr><td>. *|. |</td><td>. *|. |</td><td>14</td><td>-0.173</td><td>-0.121</td><td>6.8771</td><td>0.866</td></tr>
<tr><td>. *|. |</td><td>. *|. |</td><td>15</td><td>-0.134</td><td>-0.111</td><td>8.0347</td><td>0.841</td></tr>
<tr><td>. *|. |</td><td>. *|. |</td><td>16</td><td>-0.147</td><td>-0.123</td><td>9.4932</td><td>0.798</td></tr>
</table>

SUMMARY OF THE DERIVED MODELS:

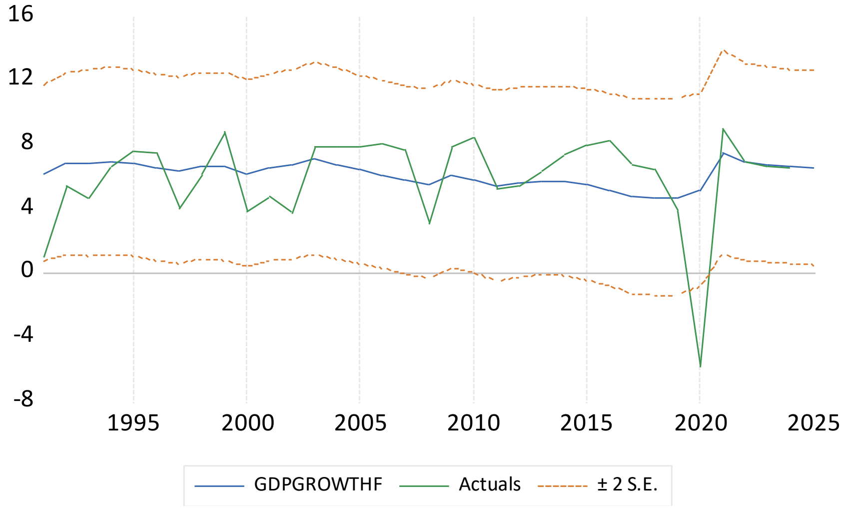
Model	Coefficient(s)	White Noise	AIC	SIC
AR(1,1,1)	Significant	-	5.07315 3	5.25454 8
AR(2,1,2)	Significant	-	5.09664 1	5.27803 6
NOTE:-AR(1,1,1) is based suited depending upon AIC and SC values				

The above correlogram of residuals are mostly small in magnitude, falling inside the 95% confidence interval, suggesting that residuals are independently distributed (no autocorrelation in the residuals), implying the fitted(1,1,1) model is adequate. Moreover, the Q-statistics are greater than alpha=0.05, therefore we arecertain that theerror terms of the selected model are white noise.
We have also tried for overfitting as per above table which that only AR(1,1,1) has been found to be the best depending upon coefficients significance and AIC, SIC values. Which should be minimum for bestfitted model

Before fitting GARCH(1,1) into ARIMA(1,1 ,1)	F-Statistic	0.1580	Prob.F(2,34)	0.6938
	Obs* R-Squared	0.1676	Prob. Chi-square(1)	0.6822
	Obs* R-Squared	0.392049	Prob. Chi-square(1)	0.5312

The ARCH-LM test is conduced to see weather there is a presence of heteroscedasticity in variance. As can be seen that before fitting GARCH(1,1) into ARIMA(1,1,1) model.The p-values are more than 0.05(Significance level), therefore we accept null hypothesis indicating that heteroscedasticity is not present in residual. Which shows the no presence of ARCH effect.
The above model ARIMA(1,1,1) is better model with statistically significant coefficients, fulfilled the assumption of NID residuals and AIC,SIC are smaller than that ARIMA(2,1,2) model. Therefore, we ensure that the ARIMA(1,1,1) model is our best model for GDP growth.
ARIMA(1,1,1) model Forecasting

ARCH(1,1,0)-GARCH(1,1) Forecasting



Forecast: GDPGROWTHF	
Actual: GDPGROWTH	
Forecast sample: 1990 2025	
Adjusted sample: 1991 2025	
Included observations: 35	
Root Mean Squared Error	2.655945
Mean Absolute Error	1.824711
Mean Abs. Percent Error	43.09022
Theil Inequality Coef.	0.206709
Bias Proportion	0.003302
Variance Proportion	0.587064
Covariance Proportion	0.409635
Theil U2 Coefficient	0.580971
Symmetric MAPE	32.06573

1990
6.23182209
1991 82
6.83229069
1992 57
6.85992895
1993 93
6.99369063
1994 45
6.86077231
1995 44
6.60567938
1996 55
6.36708733
1997 54
6.68235710
1998 20
6.64955269
1999 74
6.18787642
2000 97
6.56934624
2001 36
6.77401564
2002 11
7.14616411
2003 87
6.81047362
2004 04
6.47743061
2005 13
2006 6.15616281

	04
2007	5.8204725766
2008	5.5661584012
2009	6.1413711764
2010	5.8344512351
2011	5.4191181012
2012	5.6133080070
2013	5.7608260731
2014	5.7311862810
2015	5.5114496347
2016	5.1860039166
2017	4.8187548827
2018	4.7354086164
2019	4.7192977557
2020	5.1941631724
2021	7.5128220671
2022	6.9252787178
2023	6.7457017150
2024	6.6282592588
2025	6.5329217844

Conclusion:

Poverty rates in India's poorest states are three to four times higher than those in the more advanced states. While India's average annual per capita income was $1,410 in 2011 – placing it among the poorest of the world's middle-income countries – it was just $436 in Uttar Pradesh (which has more people than Brazil) and only $294 in Bihar, one of India's poorest states.

A critical problem facing India's economy is the sharp and growing regional variations among India's different states and territories in terms of poverty, availability of infrastructure, and socio-economic development.

Demonetisation & stressed banking sector, GST implementation and problem of Agricultural sector are real impediments for slower growth of economy. Even The Organisation for Economic Co-operation and Development(OECD) predicts that India's economy will slow down further to 6.1% in FY25 compared to earlier projection of 6.3%.

There are some of the challenges faced by Indian economy. Population density, poverty problem, unemployment, payment deterioration, poor education and private debt are some of the main challenges. These challenges need to be addressed in order to make the Indian economy stronger.

References:

Agrawal, Varun. "GDP modelling and forecasting using ARIMA: an empirical study from India." *Central European University* (2018).

Hassan, M.M. and Mirza, T., 2021. Using time series forecasting for analysis of GDP growth in India. *International Journal of Education and Management Engineering*, *11*(3), pp.40-49.

Gupta, M. and Minai, M.H., 2019. An empirical analysis of forecast performance of the GDP growth in India. *Global Business Review*, *20*(2), pp.368-386.

Kumar, J. and Mishra, A.K., 2016. Modelling Sectoral Gdps for Forecasting Indian GDP Using Arma Models.

Iyer, T. and Gupta, A.S., 2019. Quarterly forecasting model for india's economic growth: Bayesian vector autoregression approach. *Asian Development Bank Economics Working Paper Series*, (573).

Raj, A. and Singh, S.K., 2022, September. Forecasting GDP of India and its neighbouring countries using Time Series Analysis. In *2022 IEEE Global Conference on Computing, Power and Communication Technologies (GlobConPT)* (pp. 1-6). IEEE.

Jamir, I., 2020. Forecasting potential impact of COVID-19 outbreak on India's GDP using ARIMA model. *Available at SSRN 4862773*.

Maiti, D., Kumar, N., Jha, D. and Sarkar, S., 2024. Post-COVID recovery and long-run forecasting of Indian GDP with Factor-Augmented Error Correction Model (FECM). *Computational Economics*, *63*(3), pp.1095-1120.

Modi, S. and Jindal, P., 2021. Forecasting Potential Impact of COVID-19 on India and Indonesia's GDP. *Available at SSRN 3884823*.

Modis, T., 2013. Long-term GDP forecasts and the prospects for growth. *Technological Forecasting and Social Change*, *80*(8), pp.1557-1562.

Bhattacharya, R., Chakravartti, P. and Mundle, S., 2019. Forecasting India's economic growth: a time-varying parameter regression approach. *Macroeconomics and finance in emerging market economies*, *12*(3), pp.205-228.

Prabu, V. and Karthika, R., 2021. Time series analysis and forecasting of indian economy. *Kongunadu Research Journal*, *8*(1), pp.73-79.