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DYNAMIC NEXUS BETWEEN MACROECONOMIC FACTORS AND REAL GDP GROWTH IN INDIA: A TIME SERIES ANALYSIS

Mr. Somnath Mukhuti[1], Dr. Pradipta Banerjee[2]
[1]Research Scholar, Department of Commerce, Sidho-Kanho-Birsha University, Purulia, West Bengal, India
[2]Professor, Department of Commerce, Sidho-Kanho-Birsha University,Purulia, West Bengal, India,

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ABSTRACT
The study explores the dynamic interconnections between selected macroeconomic factors and the GDP growth in India using monthly time series data from 2012 to 2022. The study has employed time series regression, unit root test, cointegration, error correction method and cumulative sum test after performing the pre-tests like, tests for autocorrelation, serial correlation, multicollinearity, heteroscedasticity and normality. The study found a significantly negative correlation between all the selected macroeconomic factors (except interest rate) with the GDP growth. The regression could explain more than fifty percent of the variability of the movement of GDP growth. The cointegration results confirmed that the macroeconomic factors are cointegrated in the prolong direction. However, there is no prolong period of causality established from the error correction results, while short run causal relationship exists between GDP growth and Nifty 50, gold price and imports implying that GDP growth is significantly associated with stock market performance, gold prices and imports in short run periods.

KEYWORDS: *Macroeconomic variables, GDP, Unit Root, Stationarity, Multiple Correlation, Time Series Regression, Multivariate Cointegration, VECM.*

1. INTRODUCTION

The present study examines long term and short term association amongst the real GDP growth and select macroeconomic indicators namely stock price index, gold prices, crude oil prices, exchange rates, broad exchange rate, inflation rate, interest rate, consumer price index, volume of import, volume of export, money supply and industrial production for India. As it has been well documented in the existing literature that different macroeconomic factors affect GDP growth of developed and developing countries, understanding their dynamic nexus with real GDP growth is crucial for investors, economists, and policymakers [Ray, 2012; Kumar & Webber, 2013; Panga and Modak, 2014; Kotha and Sahu, 2016; Giri & Joshi, 2017; Saxena and Bansal, 2019; Sarwar et al. 2019; Shukla 2020; Tackie et al. 2022; Panagariya, 2008; Sahoo & Dash, 2012; Subramanian, 2019; Ray, 2022; World Bank Report, September 3, 2024; International Monetary Fund Report, May, 2024; Deloitte, 2025]. India is the fifth largest economy in the world based on the nominal GDP and different factors contributed to this economic growth like economic reforms, service sector development, industrial production, manufacturing, agriculture, technological advancement, etc. However, the economic growth of India has declined to 5.4 per cent in the third quarter in 2024. [Tabash et al., 2022; International Monetary Fund Report, 2023; World Bank Report, 2023; Economic Survey of India, 2023; Economic Times, June 15, 2023; Financial Times, August 12, 2023]. The crude oil prices influence the GDP growth for its impact on production costs, inflation, import-export, exchange rate, etc. The exchange rate movements can directly impact of the competitiveness and influence the overall trade balance which ultimately affects the GDP growth. [Hamilton, 1983; National Bureau of Economic Research, 1997; Barsky & Kilian, 2004; Blanchard & Gali, 2007; Elder & Serletis, 2010; Gokam, 2011]. However, high interest rates may restrict spending and investment which negatively impacts on GDP growth. Consumer price index indicates purchasing power. A higher export volume increases the domestic production and vice-versa and money supply influence GDP growth by affecting the inflation, consumer price index, trade balances and industrial production [European Central Bank, 2010; Hameed, 2011; Pan et al., 2022; Corrigan, 2022; Hossain, 2023; International Monetary Fund, 2024; Dadoh et al., 2024; Reuters, January 30, 2025].

The present empirical analysis tries to explore useful insights into how the select macroeconomic variables influence the fluctuations of real GDP growth in India that may help the policymakers to promote better economic stability for India.

2. LITERATURE REVIEW

A rich body of existing literature documented in connection with several macroeconomic determinants and the growth of GDP in different sample periods using diverse statistical and econometric methodologies around the globe. It was well documented that the

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economic growth has a positive influence on interest rates, exchange rates and inflation rates [Cuddington & Urzua, 1992; Fisher, 1993; King & Levine, 1993; Sachs & Warner, 1995; Barro & Martin, 1995; Sarel, 1996; Arestis & Demetriades, 1997; Ghosh & Phillips, 1998; Clarida & Gertler, 2000; Arestis & Baddeley, 2003; Chaudhuri & Shilpi, 2005; Mishkin, 2007; Mishkin, 2007; Brandley, 2008; Krugman & Obstfeld, 2009; Blanchard & Johnson, 2013; Jahromi & Yusoff, 2015; Behera & Mishra, 2017]. Similarly, Obamuyi (2009) investigated that real lending rates was significantly associated with economic growth and related factors in the long run including the interest rate. Obamuyi (2009) examined the long term association by using the following cointegration model where X_t is the other economic factor influencing real GDP growth.

$$GDP_t = \alpha + \beta_1 RLR_t + \beta_2 X_t + \epsilon_t \dots \dots \dots \dots \dots (1)$$

Consequently, investigating the intermediate dynamic movement and the correction process for the sustained equilibrium in extended period, the following error correction method was considered, where ΔX_{t-j} is the changes of lag in the other economic factors, ECT_{t-1} represents the component of error correction to incorporate extended symmetrical deviations, ϕ is the adjustment speed of the model and the negative and significant results confirmed the existence of long run causality; γ, δ_i and θ_j represented the different coefficients of the following model.

$$\Delta GDP_t = \gamma + \sum_{i=1}^{p} \delta_i \Delta RLR_{t-i} + \sum_{j=1}^{q} \theta_j \, \Delta X_{t-j} + \phi ECT_{t-1} + \epsilon_t \dots \dots \dots \dots \dots (2)$$

Hussain and Malik (2011) examined the nexus between inflation and economic growth utilising the Granger causality and co-integration model in the context of Pakistan's economy. The study explored bidirectional causality between inflation and economic growth and inflation was negatively related to the economic growth. The same econometric technique was utilised in the study. Rao and Hassan (2011) investigated the long term relationship of the economic growth related key factors in Bangladesh from 1970 to 2007 applying the error correction method followed by the Solow growth model (Solow, 1956) and its extension of Mankiw, Romer and Weil model (Mankiw et al., 1992).

$$\ln\ (Y_t) = \alpha + \beta_1 \ln\ (K_t) + \beta_2 \ln (L_t) + \beta_3 \ln\ (X_t) + \epsilon_t \dots \dots \dots \dots . (3)$$

Where, the Y_t is the real GDP (dependent variable), K_t and L_t denotes two independent variables at time t, X_t is the vector of other explanatory variables influencing total factor productivity in the model and capturing the long term balance and temporary shifts or dynamics, under the following error correction technique was applied by considering a number of cointegrated vectors.

$$\Delta \ln (Y_t) = \gamma + \sum_{i=1}^{n} \delta_i \Delta \ln (Y_{t-1}) + \sum_{j=0}^{m} \theta_j \, \Delta ln X_{t-j} + \leftthreetimes ECT_{t-1} + \epsilon_t \dots \dots \dots \dots (4)$$

Where, δ_i and θ_j denotes short-run coefficient, ECT_{t-1} represents the lag error correction term which comes from the long term connection and $\leftthreetimes$ is a parameter of the speed of adjustment. The study investigated that the money supply, FDI, trade openness and financial reforms were strongly related to the economic growth, but inflation and government expenditure were adversely related to the economic growth.

Conversely, the inflation and GDP growth have a long term negative connection, but a less significant in the long run [Enu et al., 2013; Mwakanemela & Kasidi, 2013; Rohit & Divya, 2014]. These study followed a common time series regression model, where the Y_t is the dependent variable at time t, X_{1t}, X_{2t} and X_{3t} are the independent economic factors at time t and β_1, β_2 and β_3 are the coefficient of the economic factors X_{1t}, X_{2t} and X_{3t}.

$$Y_t = \beta_0 + \beta_1 X_{1t} + \beta_2 X_{2t} + \beta_3 X_{3t} + \epsilon_t \dots \dots \dots \dots . (5)$$

It also suggested that the interest rates and economic growth was positively associated because higher interest rates inspire investment and long-term savings. However, the exchange rates are negatively associated with economic growth [Mussa, 1986; Bahmani & Sohrabian, 1992; Chowdhury, 1994; Aizenman & Marion, 1999; Hussain & Malik, 2007; Isard, 2007; Gul & Hye, 2012; Enu et al., 2013; Babalola et al., 2015; Samuel & Nurina, 2015; Chughtai et al., 2015; Megaravalli & Vikram, 2016; Hussain et al., 2016; Sinaga et al., 2018]. While Foreign Direct Investment (FDI) positively influenced on exchange rate [Froot & Stein, 1991; De Mello, 1997; Chakraborty, 2001; Alfaro et al., 2004; Aizenman & Noy, 2006; Khan, 2007; Dunning & Lundan, 2008; Moran, 2011; Nauges & Van, 2014]. The impact of macroeconomic factors like inflation and interest rate on economic growth was examined by Saymeh and Orabi (2013) who suggested that long-run co-integrating associations exist among the variables. Pradhan et al., (2013) examined separately the connection of stock market development, economic growth and inflation by utilising yearly time series dataset from 1988 to 2012 of sixteen Asian countries including India. This research explored the relationship depends on panel vector autoregression model, where $Y_{i,t}$ equal to the vector of an endogenous variable for country i at a time t including the development of stock markets, economic growth and inflation, A_0 is the vector of the constant intercept term and $A(L)$ represents the polynomial matrix in the lag operator L that captures the dynamic relationship between the variables.

$$Y_{i,t} = A_0 + A(L) Y_{i,t} + \epsilon_{i,t} \dots \dots \dots \dots (6)$$

The study explored a development of the stock market is positively related to economic growth and the indicators cointegrated in the long run for the sixteen Asian countries.

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It was also found that an increase in exports positively depends on GDP growth observed by Panda and Mohanty (2015) and Noreen et al. (2018) observed a positive relationship between the economic growth and countries exports, whereas inflation and economic growth was found to be a negative relationship. Conversely, the interest rates were positively related to the economic growth, but the exchange rate was negatively associated to the economic growth due to global business uncertainty. Some literature documented that the money supply was positive and significantly influenced on economic growth in various economies such as the United States (very earlier studies), Nigeria, India, Bangladesh, Pakistan, etc. [Jahan & Ghauri, 2014; Eze & Arize, 2016; Barhoumi & Nguyen, 2018; Saxena & Bansal, 2019; Mishra & Singh, 2019; Apergis & Rezitis, 2020; Eze & Arize, 2021; Saqib & Qureshi, 2021; Chowdhury & Ahmed, 2022], however, a negative impact was found between the GDP growth and exchange rates [Rodrik, 2008; Aghion et al., 2009; European Central Bank, 2016].

Research Gap

The existing literature documented that researchers considered many vital macroeconomic factors in their studies, but most of them did not specify which factors originally and surprisingly affect economic growth. However, the inflation, interest rates, exchange rates and money supply are very essential among the various macroeconomic factors. In respect to causal relationship, a very small number of existing literatures was found between the macroeconomic factors and real GDP growth which is essential to explore the direction and strength of causation between specific factors and real GDP growth. Overall, previous studies are not sufficient to mention the policy implications and formulate effective economic strategies, because a very limited study was found regarding developing economies like India. Alternatively, maximum previous studies utilised annual level data, but it is more reliable if the study utilises the daily, monthly or quarterly data to realise the dynamic relationship among the macroeconomic factors and real GDP growth. Similarly, some methodological gap was observed from the existing studies and if the same statistical and econometric methods are considered more innovatively, it will be a chance to include some more sophisticated results and suggestions.

3. RESEARCH QUESTIONS AND OBJECTIVES

The present study considers a variety of macroeconomic factors that can directly or indirectly affect economic growth which have been established on the basis of the following research questions and objectives.

Possible Research Questions

1. Does the select macroeconomic factors and GDP growth in India is associated in the long run?
2. How do macroeconomic factors influence real GDP growth in India?
3. What is the directional causal relationship between the select macroeconomic factors and GDP growth in India?
4. How do external factors influence the real GDP growth in India?
5. Does the select macroeconomic variables determine the long term economic stability and growth in India?

Research Objectives

As stated in the above research questions, the following three important objectives have been considered in the present research.

1. To explore the positive and negative correlation among the select macroeconomic factors and the GDP growth in India.
2. To examine the short term and long term association among the real GDP and select macroeconomic factors in India.
3. To explore the causality among the real GDP and select macroeconomic indicators in India.

4. DATA AND METHODOLOGY

4.1 Data

The time series data is considered from April 2012 to March 2022 covering 120 monthly observations and obtained from various suitable databases including the World Gold Council (WGC) database, the energy information administration database (US), the Yahoo Finance database, the National Stock Exchange official database, etc. This study used several macroeconomic factors, namely Nifty 50, gold price (Indian rupee per 10 gram), brent crude oil prices dollars per barrel, exchange rate (Dollar-Rupee exchange rate), real broad exchange rates and interest rates (discount rate for India), inflation rates and consumer price index (all items for India), volume of imports and exports, money supply (broad money) and industrial production (production of total industries in India) to investigate the performance of GDP growth in India (quarterly data converted into monthly basis).

4.2 Methodology

The study has been considered the time series regression method to determine the influence of select macroeconomic variables on the growth of real GDP in India. Under the following time series regression model is applied for predicting Y_t which is stated as a dependent (real GDP).

$$RGDP_t = \beta_0 + \beta_1 NIFTY_t + \beta_2 GP_t + \beta_3 COP_t + \beta_4 ER_t + \beta_5 RBEER_t + \beta_6 IR_t + \beta_7 IFR_t + \beta_8 CPI_t + \beta_9 IV_t + \beta_{10} EV_t + \beta_{11} MS_{11} + \beta_{12} IIP_t + \epsilon_t \dots\dots\dots\dots (7))$$

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Where, $Real\ GDP_t$ is the dependent variable in the model, β_0 is the intercept term of the dependent variable, $\beta_1\ to\ \beta_{12}$ equal to the coefficient of different independent variables, $\beta_0 + \beta_1 Nifty\ 50_t$ is the individual linear component of the equation and ϵ_t is the random error component in the time series regression model. The significance level has been selected based on MacKinnon (1990) and MacKinnon (2002) which is normally fixed and equal to the values of 1 per cent, 5 per cent and 10 per cent.
The cointegration and error correction technique has been employed based on the Johansen model to determine the long and short term linkage and it has required a pre-qualifying test for unit root. Similarly, the most of the models are preferred for the cointegrated variables having different order, $I(0)$, $I(1)$ or both [Sims, 1980; Engle & Granger, 1987; Johansen, 1988; Johansen & Juselius, 1990; Phillips & Loretan, 1991; Gonzalo, 1994; Harris & Sollis, 2003; Lutkepohl, 2005; Enders, 2014]. Therefore, the only ADF test has been utilised for making a reliable prediction which follows the equation stated below.

$$\Delta Y_t = \alpha + \beta_t + \gamma Y_{t-1} + \sum_{i=1}^{p} \delta_i \Delta Y_{t-i} + \epsilon_t \dots\dots\dots\dots\dots (8)$$

From the above equation, Y_t represents the considering individual dependent variables (Nifty 50, gold price, crude oil price, exchange rate, etc.), ΔY_t is equal to $Y_t - Y_{t-1}$ (first difference of Y_t), α is the constant intercept term, β_t is the deterministic time trends (when used), γ represents the lag level term Y_{t-1} of the coefficient that determines stationarity (when γ equal to zero, the unit root series represents non-stationarity and when γ less than zero, the series is stationarity), $\sum_{i=1}^{p} \delta_i \Delta Y_{t-i}$ is the capturing term of short-term dynamics and ϵ_t represents the residual or error component. The ADF test for detecting unit roots as per the hypothesis stated below:

Null Hypothesis (H_0): The series is non-stationary.

Alternative Hypothesis (H_1): The series has no unit root and it is stationary.

Autocorrelation structure, forecast accuracy, statistical inference, avoiding spurious correlation and regression are the main reasons to select unit root and stationary tests in this study [Box & Jenkins, 1970; Granger & Newbold, 1974; Dickey & Fuller, 1979; Phillips & Perron, 1988; Kwiatkowski et al., 1992; Diebold, 1998; Stock & Watson, 2011; Hyndman & Athanasopoulos, 2018; Rakhshandehroo & Rajabdorri, 2019; Nguyen & Martinez, 2021; Zhang & Kim, 2022; Fowler et al., 2023].

The Johansen co-integration test is applicable more than two variables and the results are considered based on the following equation of trace statistic and the eigenvalue statistic:

$$\lambda_{trace}(X) = -T \sum_{i=X+1}^{g} ln\,(1 - \bar{\Upsilon}_i) \dots\dots\dots\dots (9)$$

$$\lambda_{max}(X, X+1) = -T\ ln(1 - \bar{\Upsilon}_{x+1}) \dots\dots\dots\dots (10)$$

In the above two equations where *X* represents the identified cointegrating vectors and analysing the short term relationship, the normal form of the VECM model is stated below.

$$\Delta Y_t = C + \Pi Y_{t-1} + \sum_{i=1}^{p-1} \acute{\Gamma}_i\, \Delta Y_{t-1} + \varepsilon_t \dots\dots\dots\dots (11)$$

Where, Δ equal to operator differencing i.e., $\Delta\, Y_t$ equal to $Y_t - Y_{t-1}$ and the first lag of endogenous variable representing Y_{t-1}, ε_t denotes residual of vector, C equal to intercept term of vector, Π= matrix coefficient of co-integration, $\acute{\Gamma}_i$ is a matrix including k into k order of endogenous coefficient of i^{th} variable [Usman et al., 2017; Mosab et al., 2022]. The optimal lag length has been fixed based on the minimum values of the criteria of the Akaike Information Criterion (AIC) and Schwarz Information Criterion (SIC). Finally, the Cumulative Sum (CUSUM) test is used to detect the quality control and stability based on the following hypothesis.

Null Hypothesis (H_0): No significant evidence of a change in the process (within the red line).

Alternative Hypothesis (H_1): The cumulative sums have exceeded a threshold limit, indicating a change in the process (crossing the red line).

5. RESULTS, INTERPRETATION AND DISCUSSION

5.1 Stationarity Test

The estimated result of the Augmented Dickey-Fuller (ADF) unit root test of various macroeconomic variables at a level and first difference using two specifications such as constant and constant with trend reflects the selected variables are non-stationarity at the level I(0) because the p-value is greater than the significance level i.e., 1%, 5% and 10%, meaning that do not reject the null hypothesis (Table 1.1). The result reflects only real GDP and the index of industrial production are stationarity at level and the other variables are non-stationarity. However, after differencing the series is stationarity at the integrated order I(1) for all the variables. It implied that the variables are not stationarity in nature and the average and variability change over time due to the presence of trends or cycles (Table 1.1).
If the real GDP is non-stationary at level, the following equation will be followed:

$$RGDP_t = \beta_0 + \beta_{1,t} + \mu_t \dots\dots\dots\dots (12), (Non-stationary\ series)$$

When, the real GDP is followed stationarity for eliminating the trends and random walk, the following equation is,

$$\Delta RGDP_t = RGDP_t - RGDP_{t-1} \dots\dots\dots\dots (13), (Stationary\ series)$$

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As per the objectives, the result of ADF unit root also suggests that the normal classical linear regression model (CLRM) and a cointegration model can be followed to examine the prolong period of stable connection among the variables [Dickey & Fuller, 1979; Engle & Granger, 1987; Phillips & Ouliaris, 1990; Johansen, 1991; Banerjee et al., 1993; Cheung & Lai, 1995; Granger, 2004]. Similarly, the VECM is applied when the selected indicators are cointegrated and it describes both the short and long term association, while VAR method is considered only for the connection in the short periods of dynamics when the indicators are not cointegrated in integrated order I(1) [Hamilton, 1994; Johansen, 1995; Lutkepohl, 2005; Enders, 2014; Diaz, 2017; Suharsono, 2024; Law, 2024].

Table 1.1: Results of ADF Statistical Test

Variables	Integrated Order Zero [I(0)]				Integrated Order One [I(1)]			
	Constant (Unchanging Factor)		Constant with Trend		Constant (Unchanging Factor)		Constant with Trend	
	t-Stat.	Prob. Value	t-Stat.	Prob. Value	t-Stat.	Prob. Value	t-Stat.	Prob. Value
LOGRGDP***	-4.98	0.00	-5.05	0.00	-7.59	0.00	-7.55	0.00
LOGNIFTY***	-0.57	0.87	-2.71	0.24	-11.76	0.00	-11.70	0.00
LOGGP***	0.54	0.99	-1.37	0.87	-8.84	0.00	-8.10	0.00
LOGCOP***	-1.72	0.42	-1.28	0.89	-8.15	0.00	-8.25	0.00
LOGER***	-2.06	0.26	-3.03	0.13	-9.38	0.00	-9.33	0.00
LOGRBEER***	-1.56	0.50	-2.50	0.33	-10.77	0.00	-10.73	0.00
LOGIR***	-0.07	0.95	-2.47	0.34	-10.57	0.00	-10.57	0.00
LOGIFR***	-2.25	0.19	-2.21	0.48	-8.37	0.00	-8.36	0.00
LOGCPI***	-1.86	0.35	-2.97	0.14	-6.93	0.00	-7.15	0.00
LOGIV***	-1.77	0.39	-2.76	0.21	-12.62	0.00	-12.64	0.00
LOGEV***	-3.40	0.01	-3.80	0.02	-10.48	0.00	-10.50	0.00
LOGMS**	-1.73	0.41	-1.70	0.75	-3.67	0.01	-3.68	0.03
LOGIIP***	-4.14	0.00	-5.32	0.00	-10.18	0.00	-10.14	0.00

Notes: *** 1%, ** 5% and * 10% levels of significance.
Source: Self contribution using Eviews 12.

5.2 Descriptive Statistics

The summary results of the descriptive analysis (Table 1.2) capture the preliminary signal and act based on the average return, standard deviation, skewness and kurtosis, data normality etc. Results show that the mean value of the Nifty 50 return (9.1307), Gold price (10.3051), import volume (8.9649) and export volume (7.4508) is greater and the GDP growth (1.8191) comparatively very small implying on average, the Nifty 50 returns, gold prices, import volume and export volume are the higher performing variable and higher expectations towards the investors in the market. The lowest average values explain the lower expectations towards the investors in the market.

The standard deviation reflects that the GDP growth and other variables are very small in respect to the mean values indicating a sign of less variability and lower volatility of values. The lower standard deviation also suggests a more stable environment and less uncertainty or risk. Results also suggest the left-skewed distribution except the Nifty 50 return, gold price and import volume. It specifies that the investors can believe the repeated minor profits and quite huge losses. Similarly, the skewness of Nifty 50, gold price and import values implies the right-skewed distribution and suggests constant major profits and very small losses towards the investors. All the favourable kurtosis values are showing heavier tails than normal distribution, but inflation rate, broad effective exchange rate, GDP, import and export volume, money supply and industrial production showing leptokurtic distribution.

Table 1.2: Descriptive Statistics

	Mean	Std. Dev.	Skewness	Kurtosis	J. B. Stat.	Prob.	Obs.
LOGRGDP	1.8191	0.6496	-2.5118	16.5204	1040.1850	0.0000	120
LOGNIFTY	9.1308	0.3236	0.0900	2.3927	2.0061	0.3668	120
LOGGP	10.3051	0.2120	0.9182	2.4394	18.4315	0.0001	120
LOGCOP	4.1854	0.3707	-0.2914	2.7349	2.0498	0.3588	120
LOGER	4.1886	0.0979	-0.5443	2.5570	6.9059	0.0317	120
LOGRBEER	4.5674	0.0518	-0.9426	3.1601	17.8981	0.0001	120

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LOGIR	1.8941	0.2737	-0.4542	1.9705	9.4247	0.0090	120
LOGIFR	1.7398	0.4607	-0.9877	4.8316	36.2855	0.0000	120
LOGCPI	4.6779	0.1544	-0.1193	2.0811	4.5062	0.1051	120
LOGIV	8.9650	0.2150	0.5447	3.7762	8.9469	0.0114	120
LOGEV	7.4508	0.1636	-0.9775	10.5360	303.0625	0.0000	120
LOGMS	2.3687	0.2171	-1.0923	4.2322	31.4517	0.0000	120
LOGIIP	4.6493	0.1152	-2.3557	15.6891	916.0581	0.0000	120
Source: Self contribution using Eviews 12.							

5.3 Time Series Regression Analysis

The time series regression model is applied and satisfied after using one-period lag of real GDP. The R^2 value indicates that the selected economic indicators explain 54 per cent of the variability of real GDP. In favour of rejecting the H_0 and accepting H_1, the p-values of Nifty 50 (0.0347), gold price (0.0350), inflation (0.0458), consumer price index (0.07), interest rates (0.09) and industrial production (0.0234) are significant and strongly related with real GDP growth (Table 1.3). As per the assumptions of regression model, there is no positive autocorrelation, serial correlation in the model (Table 1.4). But, the multicollinearity problem is present in the model because the values of variance inflation factors are higher than the normal level.

The result also reflects the residuals are not homoscedastic (p-value 0.0037) and not normally distributed (higher J. B. statistic and p-value 0.0000). However, if the only objective is to forecast the real GDP (dependent variable), multicollinearity, heteroscedasticity and normality does not influence to the final prediction (Siegel, 2016), because if the study select a large dataset, many times it is a common issue that the residuals are not homoscedastic and normally distributed in the time series analysis. Therefore, the final checking should be done when the data analysis is fully completed.

Table 1.3: Regression Analysis (OLS Method) taking lag (1) of DV
Dependent Variable Real GDP

Variable	Coefficient	Std. Error	t-Statistic	Prob.	
LOGRGDP(-1)	0.549184	0.077183	7.115345	0.0000	**Note**: R-squared 0.5455 F-statistic 9.6941 Prob.(F-statistic) 0.0000
C	25.77222	20.63553	1.248925	0.2145	
LOGNIFTY**	1.677241	0.783754	2.140009	0.0347	
LOGGP**	-1.663050	0.778565	-2.136045	0.0350	
LOGCOP	0.390508	0.396256	0.985495	0.3266	
LOGER	4.463398	2.908800	1.534447	0.1279	
LOGRBEER	0.323713	3.062276	0.105710	0.9160	
LOGIR*	-1.678359	0.997285	-1.682929	0.0954	Akaike info criterion 1.418880 Schwarz criterion 1.745836 Durbin-Watson stat 1.878114
LOGIFR**	0.336846	0.166643	2.021365	0.0458	
LOGCPI*	-5.749669	3.149328	-1.825681	0.0707	
LOGIV	-0.038649	0.624644	-0.061873	0.9508	
LOGEV	-0.652180	0.846051	-0.770851	0.4425	
LOGMS	-0.391613	0.345210	-1.134419	0.2592	
LOGIIP**	-2.002528	0.870378	-2.300758	0.0234	

Note: *** 1%, ** 5% and * 10% levels of significance.
Source: Self contribution using Eviews 12.

Table 1.4: Test of Autocorrelation and Serial Correlation

Autocorrelation Test					
Before taking lag of DV			**After taking lag of DV**		
1.128924			1.878114		
Serial Correlation Test					
R-squared	25.26	Prob. of Chi-Square	0.0000	Serial Correlation	
After taking lag of DV					
R-squared	2.18	Prob. of Chi-Square	0.3354	No Serial Correlation	

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Table 1.5: Test of Multicollinearity			
Variable	**Centered VIF Before taking lag of DV**	**Centered VIF After taking lag of DV**	**Decision**
LOGNIFTY	34.73017	34.41320	Multicollinearity
LOGGP	14.74366	14.94579	Multicollinearity
LOGCOP	11.28853	11.59921	Multicollinearity
LOGER	39.89643	42.16237	Multicollinearity
LOGRBEER	12.89233	13.79861	Multicollinearity
LOGIR	40.54298	40.48479	Multicollinearity
LOGIFR	3.202131	3.192673	No Multicollinearity
LOGCPI	121.7452	125.1630	Multicollinearity
LOGIV	8.648974	9.826469	No Multicollinearity
LOGEV	9.753155	10.51303	Multicollinearity
LOGMS	3.058581	3.059806	No Multicollinearity
LOGIIP	5.247987	5.451966	No Multicollinearity
Source: Self contribution using Eviews 12.			

Table 1.6: Test of Heteroscedasticity				
R-squared	66.8045	Prob. Chi-Square	0.0000	Heteroscedasticity
Test of Heteroscedasticity after taking lag of Dependent Variable Real GDP				
R-squared	30.6965	Prob. Chi-Square	0.0037	Heteroscedasticity
Source: Self contribution using Eviews 12.				

5.4 Long Term and Short Term Analysis

The cointegration is performed to explore the extended period of association based on the Johansen method which follows three common assumptions i.e., all the dataset is stationary at integrated order 1, error correction technique and appropriate lag selection. It establishes the co-integrating vectors for the association among the variables. The short run analysis is conducted using VAR-Causality or immediate adjustments and changing responses in the economic conditions based on the Wald test. Both investigations provide a balanced viewpoint on economic phenomena.

5.4.1 Optimum Lag Selection Method

Applying error correction technique, a minimum value of Akaike Information Criterion (AIC) and Schwarz Information Criteria (SIC) have considered for capturing the suitable lag to get the meaningful results. Table 3.7 shows that the one lag is the appropriate lag length in the SIC criteria.

5.4.2 Long-Run Relationship Analysis (Johansen Co-integration)

The cointegration method is used to examine the prolong period of stable connection within the set of selected variables considering the trace and Eigen value statistics suggests that two cointegrating relationship are identified which implied that the variables are cointegrated in a prolong period of time (Table 3.8.1 and Table 3.8.2).

5.4.3 Vector Error Correction Model (VECM)

The VECM captures the temporary dynamics that correct the process back to its prolonging direction. The results are typically reflected in standard errors and within brackets (t-statistics) along the coefficient estimates. The coefficient of error terms provide the adjustment speed at which disequilibrium of the selected variables is back to the long term stability. The lag values of the variables capture the short run dynamics, while co-integrating relationships and error correction terms reflect long-term equilibrium relationships.

5.4.4 Diagnostic Checking

Before taking the decision, some validation tests are considered to confirm the reliability, validity and correctness of the model. The stationary data has previously confirmed that the model is correctly specified. After getting error correction results, again the model is free from the serial correlation and heteroscedasticity problems (Table 3.9).

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Table 3.8.1: Cointegration Results						Table 3.8.2: Cointegration Results					
Trace Test						Maximum Eigen Value Test					
Hypothesized No. of CE(s)	**Eigen value**	**Trace Statistic**	**0.05 Critical Value**	**Prob.****	**Decision**	**Hypothesized No. of CE(s)**	**Eigen value**	**Max-Eigen Statistic**	**0.05 Critical Value**	**Prob.****	**Decision**
None	0.5843	541.3812	NA	NA	Variables are Co-integrated	None	0.5843	103.6058	NA	NA	Variables are Co-integrated
At most 1 *	0.5454	437.7753	374.9076	0.0000		At most 1 *	0.5454	93.0237	80.8702	0.0030	
At most 2 *	0.4659	344.7515	322.0692	0.0046		At most 2	0.4659	74.0064	74.8374	0.0594	
At most 3	0.4385	270.7451	273.1889	0.0632		At most 3	0.4385	68.1136	68.8120	0.0580	
At most 4	0.3659	202.6314	228.2979	0.4008		At most 4	0.3659	53.7551	62.7521	0.2795	
At most 5	0.2355	148.8762	187.4701	0.7765		At most 5	0.2355	31.6899	56.7051	0.9869	
At most 6	0.2217	117.1863	150.5585	0.7515		At most 6	0.2217	29.5796	50.5998	0.9459	
At most 7	0.1794	87.6066	117.7082	0.7726		At most 7	0.1794	23.3311	44.4972	0.9725	
At most 8	0.1642	64.2755	88.8038	0.7250		At most 8	0.1642	21.1678	38.3310	0.8979	
At most 9	0.1242	43.1076	63.8761	0.7315		At most 9	0.1242	15.6505	32.1183	0.9255	
At most 10	0.1015	27.4571	42.9152	0.6544		At most 10	0.1015	12.6336	25.8232	0.8306	
At most 11	0.0649	14.8235	25.8721	0.5892		At most 11	0.0649	7.9273	19.3870	0.8279	
At most 12	0.0567	6.8961	12.5179	0.3555		At most 12	0.0567	6.8961	12.5179	0.3555	

Source: Authors own calculation using Eviews 12.

Table 3.9: Estimated Result of Serial Correlation Test					
Lag	**Likelihood Ratio Stat.**	**Prob. Value**	**F Stat. (Alternative of Likelihood Ratio)**	**Prob. Value**	**Decision**
1	176.13	0.3377	1.0442	0.3501	No Serial Correlation
Estimated Result of Heteroscedasticity Test					
Value of Chi-square		**Prob. Value**	**Decision**		
2789.47		0.2095	No Heteroscedasticity		
Source: Authors own calculation using Eviews 12.					

5.4.5 Testing for Long-Run Causality

After estimating the co-integration and error correction model, it is also found that the variables are not involved in the long term causal relationship because the estimated coefficient (C_1) of Real GDP growth is negative and insignificant (Table 3.10). It implied that there is no evidence to determine the macroeconomic variables associated with the C_1 coefficient and significantly affects the real GDP growth in India.

Table 3.10: Results of Long Term Causality					
	Estimated Coeff.	**S. E.**	**t-Stat.**	**Prob. Value**	**Decision**
C(1)	-0.0506	0.0461	-1.0986	0.2745	C(1) is negative and not significant
Akaike info criterion 1.5914, Schwarz criterion 1.9671, DW stat. 2.1240					
If we select the all variables, the total coefficients are 208					

5.4.6 Testing for Short-Run Causality

However, in the context of the error correction mechanism (VECM), the Wald test has been considered to capture the short-run causality after estimating the long-run analysis. Results confirmed the three different short-run causalities i.e., Real GDP to Nifty 50, Real GDP to Gold price and real GDP to import value which suggests that the Real GDP provides information that helps to predict Nifty 50, gold price and import value in the short-run (Table 3.11).

Table 3.11: Results of Wald Tests Dependent variable: D(LOGRGDP)				
Excluded	**Chi-square**	**Prob.**	**Hypotheses Decision**	**Causal Effect**
D(LOGNIFTY)	8.409615	0.0037	Significant	Short-Run Causal Effect
D(LOGGP)	7.948160	0.0048	Significant	Short-Run Causal Effect
D(LOGCOP)	0.143363	0.7050	Not Significant	No Causal Effect
D(LOGER)	0.001068	0.9739	Not Significant	No Causal Effect
D(LOGRBEER)	0.029650	0.8633	Not Significant	No Causal Effect
D(LOGIR)	0.090456	0.7636	Not Significant	No Causal Effect
D(LOGIFR)	0.770071	0.3802	Not Significant	No Causal Effect
D(LOGCPI)	0.000527	0.9817	Not Significant	No Causal Effect
D(LOGIV)	4.217195	0.0400	Significant	Short-Run Causal Effect
D(LOGEV)	0.558859	0.4547	Not Significant	No Causal Effect
D(LOGMS)	0.545742	0.4601	Not Significant	No Causal Effect
D(LOGIIP)	0.268028	0.6047	Not Significant	No Causal Effect

5.4.7 Stability Test (CUSUM Test)

Normally, it involves the difference between the observations and the reference value. Practically, an increasing CUSUM line indicates an upward shift, while a decreasing CUSUM line suggests a downward shift. But the CUSUM line stays within the top and bottom threshold baseline and it is confirmed that no significant changes is present in the process. Therefore, the model is stable.

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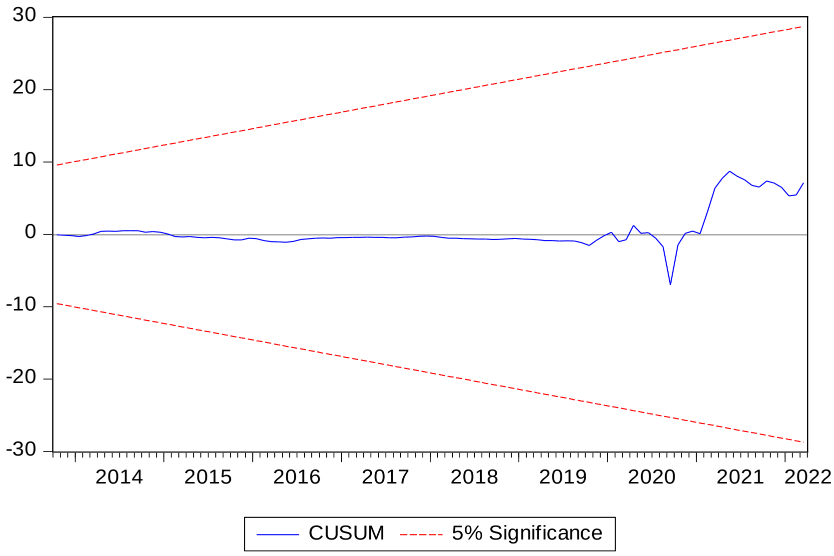

6. FINDINGS AND CONCLUSIONS

The empirical investigation using time series econometric models after conducting the necessary diagnostic tests specifies for understanding the relationship among the selected macroeconomic variables and real GDP growth in India documents that the Nifty 50, inflation rates, consumer price index, interest rates and industrial production are significantly associated with the real GDP growth. The result of Johansen co-integration established a two co-integrating vectors and the relationship exits in the long run, which indicates that the selected macroeconomic variables are going in a positive direction towards real GDP growth in the long run. The results of the Wald test confirmed an existence of short run causality running between the real GDP and Nifty 50 index, real GDP and gold prices, and the real GDP and volume of imports. The findings offer valuable insights for the investors, policymakers, industries, companies in formulating their long-run and also short-run investment decisions.

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