International Journal of Management and Economics
www.managementjournals.net
Online ISSN: 2664-7079
Received: 08-02-2026, Accepted: 11-03-2026, Published: 26-03-2026
Volume 8, Issue 1, 2026, Page No. 91-95

Impact of exchange rate on economic growth: Evidence from India

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Abstract
Exchange rate has been considered as one of the crucial factors affecting the economic growth via GDP growth of any country. The key objective of this study is to observe the effects of exchange rate on the economic growth of India, considering also interest rate and inflation as other exogenous variables for the period from 1996-2024.This study uses ADF unit root tests, GMM regression, co integration test and Granger causality test etc. The GMM method suggests that exchange rate has explicitly favorable impact on economic growth in India; inflation has insignificant positive impact on GDP growth in India; interest rate has significant negative impact on GDP growth. The co integration test confirmed that GDP growth, exchange rate, inflation and interest rate in India are co integrated, indicating an existence of long run equilibrium relationship among them as confirmed by the Johansen co integration test results. The Granger causality test finally confirmed no causality among GDP and exchange rate and other related variables like inflation, interest rate in any direction in India.

Keywords: Exchange rate, GDP, generalized method of moments (GMM), Granger causality test, India

Introduction

The affiliation between movement of exchange rate and economic growth is wide-ranging. Exchange rate is the price of one currency in terms of a different currency. When a currency increases in value, it is termed as appreciation and when it decreases in value, it is referred to as depreciation. Exchange rate movement, if it is stable, can inspire economic growth by providing an expected environment for trade and investment, by attracting FDI, enhancing competitiveness of exports which makes feasible for long term investment projects. Conversely, exchange rate movement, if it is more volatile and sharply depreciates, can obstruct economic growth by increasing inflationary pressures, reducing trade volumes, and deterring investment. This currency deterioration may lead to rising import costs, fuelling inflation and reducing the purchasing power of households and firms which acts a hindrance of sustainable economic growth.

Various macroeconomic factors influence exchange rates, including inflation rate, oil prices, bank rate, FDI, exports, and imports etc. Movements in the exchange rate also have twist up effects on other economic variables such as interest rate, inflation rate, import, export and output, etc. These facts accentuate the magnitude of exchange rate to the economic well-being of every country that liberates its economy to intercontinental trade in goods and services. Interest rates and inflation have a propensity to progress in the similar path because when inflation is escalating, banks will raise interest rates to persuade people to expend less and accumulate more. Amplified inflation frequently diminishes a currency's buying power, which declines it against other currencies. Exchange rates considerably affect import prices and domestic products using imported materials. So, a weak currency can boost inflation, disturbing interest rates set by central banks. When the exchange rate is predetermined and a country faces elevated inflationary pressure relative to other countries, that particular country's goods become more costly and foreign goods become cheaper and then import becomes more convenient. Exchange rates can manipulate job prospects by upsetting economic growth and employment. The significance of exchange rate originates from the truth that it unites the price systems of two diverse countries making it likely for international trade to make unswerving evaluation of traded goods. while a variety of factors like, demonetization, and bank rate, oil prices hike have been impacted to the economy of India, it is obligatory to observe the economic growth process of India in view of fluctuations of real effective exchange rate and its associated macroeconomic variables like interest, inflation etc.

Literature review

The connection between GDP growth rate and exchange rate has assorted results which may be positive, negative or no relation all over the world.

Anietie *et al.* (2004) [1], using co-integration and error correction models, analyzed the effect of real effective exchange rate on economic activities in Nepal. The result suggests that the real exchange rate drives through the combined demand channel which indicates that the downgrading of real exchange rate, boosts the international competitiveness of domestic goods, boosts net exports and ultimately broadens GDP. Odusola (2006) [7] examined the trend of Indian cumulative import demand during 1971–1995. The results designate that import volume is co-integrated with relative import price and real GDP. The econometric model estimation displays that import demand in India is basically elucidated by real GDP and usually less responsive to import price changes.Bahmani-Oskoee and Kovyryalova (2008) [2], by applying VECM, approximated the long-run impacts of exchange rate depression on the trade balance of South Africa. The results endow with substantiation supporting the observation that depreciation of the exchange rate deteriorates the trade balance of South

Africa in the long run. Chen (2012) [3] examined the function of the real exchange rate upon economic growth and in the convergence of growth rates among provinces in China. Using panel data from 28 Chinese provinces for 1992-2008 jointly with dynamic panel data evaluation, he found conditional convergence among coastal provinces and also among inland provinces. The results authenticated the positive effect of real exchange rate appreciation on economic growth in the provinces. Modi, Chandrashekar, and Chittedi (2016) [6] observed the affiliation between macroeconomic variable and capital inflows in India during 2004–2014 by applying Augment Dickey Fuller (ADF), Variance Decompositions Technique and Impulse Response Function methods and reported a greater part of the macroeconomic variables have completely related with capital inflows. Oteng-Abayie *et al*. (2018) [8] examined impact of a real exchange rate on Ghana's economic growth between 1975 and 2015. The result showed that Ghana's economic development is favourably impacted by the appreciation of the currency rate. Etale and Ochuba (2019) [4] attempted to appraise the impact of trade balance and exchange rate performance on Nigerian output for the period 2000 -2017. The results reveal that the exchange rate played a significant role in the GDP. Vadivel, Veeramani, and Raghutla (2020) [10] explored the affiliation between exchange rate and whole sale price index for India by applying Flexible Least Square method and established that exchange rate changes whole sale price and painted that both the imports and exports also changes exchange and whole sale price in local market. Wang, J., *et al* (2022) [11] observed that exchange rate predictions has a considerable control on the founding of international trade and currency markets and oil price shocks are recurrently employed as the chief determinant for explaining the real exchange rate.Sanusi *et al*. (2023) [9] explored the connection among trade balance, exchange rate, FDI, and economic growth of South Africa for the quarterly data from 1970 to 2022. The results suggests that exports, as a constituent of the trade balance and the performance of the exchange rate, boost economic growth in the preferred route.

Research Gap

Despite copious empirical research on nexus between exchange rate and economic growth prevails all over the world, very restricted research analysis addressing the long-term effect of exchange rate volatility on economic growth in India is found in the literature. This study seeks to fill this gap by conducting an extensive analysis of the connection between exchange rate volatility and economic growth in India from 1996 to 2024, considering also other related macroeconomic variables like interest rate and inflation.

Therefore, the key objective of this study is to examine the effects of exchange rate on the economic growth of India, considering also interest rate and inflation as other exogenous variables for the period from 1996-2024.

Methodology

In order to analyse the above objectives, the data for the study are collected from secondary sources such as World Development indicator (WDI), Handbook of Statistics on Indian Economy(several issues,RBI), International Financial Statistics (IFS). The study period has covered the period from 1996 to 2024 on the following variables such as gross domestic price (GDP) as proxy for economic growth, real exchange rate (REER), inflation rate (INFLATION), interest rate (INTEREST). The study examines how the economic growth (GDP) in India gets affected using exchange rate variables such as real exchange rate, inflation rate, interest rate, as the exogenous variables. Interest rate on central and state government dated securities (weighted average) has been taken as interest rate in the current study and finally CPI index (annual %) has been proxied for inflation. All variables are converted into natural logarithms to avoid heteroscdasticity to the maximum possible extent.

The functional linear regression equation is confirmed as follows:

GDP = f (REER, INFLATION, INTEREST)

The econometric model is articulated as follows:

$$GDP = \beta_0 + \beta_1 \, REER + \beta_2 \, INFLATION + \beta_3 \, INTEREST + u$$

The entire estimation procedure consists of three steps: first, unit root test; second, diagnostic test like Breusch-Godfrey Serial Correlation LM Test, ARCH Heteroskedasticity Test to establish the power of the results in terms robustness, biasness and efficiency of the estimates, Regression analysis by Generalized Method of Moments (GMM), and Johansen cointegration test for long run association; lastly, granger causality evaluation to evaluate short run connections.

Hypothesis

H_0: There is no positive relationship between GDP growth rate and exchange rate in India.

H_1: There is a positive relationship between GDP growth rate and exchange rate in India.

Analysis of results

The following table-1 presents the Residual Test like Breusch-Godfrey Serial Correlation LM Test, Heteroskedasticity Test by Breusch-Pagan-Godfrey before employing regression technique. The test regression used to carry out the test is reported the statistics. The Obs*R-squared statistic is the Breusch-Godfrey LM test statistic. The statistic labeled "Obs*R-squared" is the LM test statistic for the null hypothesis of no serial correlation.

Table 1: Residual Test

Breusch-Godfrey Serial Correlation LM Test			
F-statistic	18.26164	Prob. F(2,23)	0.0000
Obs*R-squared	17.79430	Prob. Chi-Square(2)	0.0001
Heteroskedasticity Test: ARCH			
F-statistic	17.02153	Prob. F(1,26)	0.0003
Obs*R-squared	11.07824	Prob. Chi-Square(1)	0.0009

Source: Author's own estimate

The (effectively) zero probability value corresponding to 'Obs*R-squared' powerfully indicates the presence of serial correlation in the residuals. Similarly, on the otherhand, the Heteroskedasticity Test: ARCH test results strongly suggest the presence of heteroskedasticity in the residuals as probability corresponding to Obs*R-squared is zero or near zero.

Table 2: Unit Root test

Variable Name	ADF Test		
	Level	P Value	Conclusion
LNGDI	-4.879250	0.0006	I(1)
REER	-6.287244	0.0000	I(1)
INFLATION	-7.164391	0.0000	I(1)
INTEREST	-4.136829	0.0037	I(1)
Critical value	1% level	-3.699871	
	5% level	-2.976263	
	10% level	-2.627420	

Source: Author's own estimate
Ho: series has unit root; **H_1:** series is trend stationary
*MacKinnon critical values for rejection of hypothesis of a unit root.

Table 2 present the results of the unit root test. The results show that all variables in our study attain stationary at first difference, I(1), using ADF test. The results indicate that the null hypothesis of a unit root can be rejected for the all given variables as all the ADF statistic value are smaller than the critical t-value at 1%, 5% and 10%level of significance for all variables and, hence, one can conclude that the variables under consideration attained stationary at their first difference, I(1) in ADF test.
According to the table-3, exchange rate has positive impact on economic growth in India via GDP growth at 10% level of significance. The slope of REER in equation is 0.045834. This demonstrates that a 1%increase in the rate of exchange will cause GDP growth rate to increase by 0.045%. This is indicative of the fact that that there is a positive relationship between GDP growth rate and exchange rate in India and REER is having positive impact on economic growth via GDP growth in India. This optimistic impact of exchange rate on economic growth in India might be owing to the fact that depreciation of currency allows Indian goods to turn out to be cheaper in global markets, escalating demand for exports and accordingly enhancing GDP growth in India.
Inflation has insignificant positive impact on GDP growth in India. This major finding of the study suggests that restrained inflation encourages flow of investment and country's production, at the same time, it diminishes consumers' purchasing power and pattern of consumption. The effect is frequently trivial owing to wage-price discrepancy in the informal sector and augmented production costs, balancing out the growth benefits.
On the other hand, interest rate has significant negative impact on GDP growth. This might be because of the fact that high interest rates, largely hiked by the RBI to administer inflation, pessimistically affect India's GDP growth by escalating borrowing costs, that restrains corporate investment. Elevated interest rates also decrease consumers' spending on loans like home loan, auto loans and can instigate worsen foreign investment inflows.

Table 3: Regression result by Generalized Method of Moments (GMM)

Independent variables	**Dependent variable:** LNGDP **Method:** Generalized Method of Moments **Sample:** 1996- 2024 **Included observations:** 29 **Estimation weighting matrix:** HAC (Bartlett kernel, Newey-West Fixed Band width=4.0000)			
	Coefficient	SE	t ratio	Prob.
C	24.93957	3.021572	8.253838	0.0000
REER	0.045834	0.024827	1.846137	0.0767
INFLATION	0.097737	0.063782	1.532377	0.1380
INTEREST	-0.266053	0.047892	-5.555292	0.0000
R-squared	0.500513	Mean dependent var	27.89334	
Adjusted R-squared	0.440575	S.D. dependent var	0.768568	
S.E. of regression	0.574849	Sum squared resid	8.261278	
Durbin-Watson stat	0.458698	J-statistic	1.79E-43	

Source: Authors' own estimate

This research blend concentrates on the experiential affiliation between exchange rates and GDP, applying residual analysis—particularly the Actual-Fitted-Residual (AFR) approach—to evaluate the extrapolative power and structural solidity of economic models. The connection between exchange rates and Gross Domestic Product (GDP) is a central part of open-economy macroeconomics.

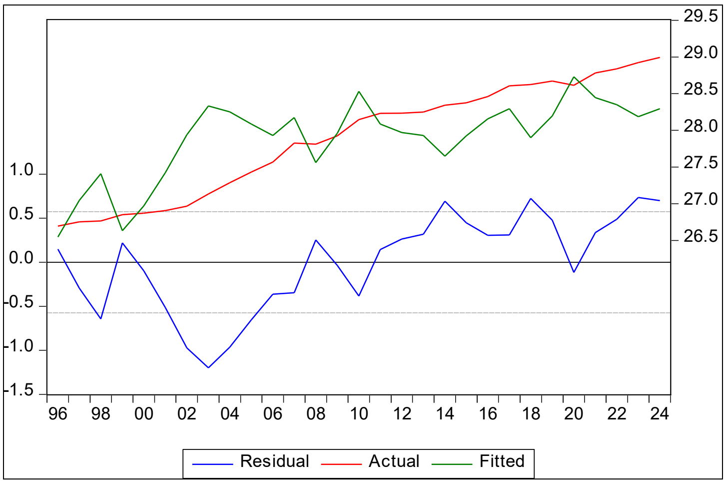

Fig 1: Residual function analysis

In the above fig-1, we evaluate the Actual GDP data, the Fitted (predicted) values from the model, and the Residuals (the unexplained component) to detect the consistency of the affiliation. Studies have shown that when a "shock" is applied to the exchange rate, the residual behavior changes. In our study, a 1-standard deviation shock in the exchange rate has caused negative residuals (lower than predicted GDP) in certain periods, suggesting temporary negative shocks, followed by positive residuals as the economy adjusts.

More specifically, the Residual Function analysis of GDP to Exchange rate in the above Figure 1 reveals that one standard deviation shock of Exchange rate variables to GDP was negative between the periods 1996-2009 but became positive from period 2011 -2019. The shock was again negative beginning from period 2020-2021. In our study, as fitted values strictly follow actual values, the residuals are small, indicating that exchange rates and other variables efficiently explicate GDP behavior.

After recognizing the time series properties of the data, the test for existence of long-run relationship between the variables using the Johansen and Juselius (1992) [5] LR statistic for cointegration was conducted. The crucial approach which is used in this study to test cointegration is called the Johansen cointegration approach. The Johanson approach can determine the number of cointegrated vectors for any given number of non-stationary variables of the same order. The results of Trace value statistic reported in table (4) suggest that the null hypothesis of no cointegrating vectors can be rejected at the 1% level of significance. It can be seen from the Likelihood Ratio (L.R.) of Trace value that we have one co-integration equations and maximum eigen value suggests two cointegrating equation. In other words, there exist linear combinations of the variables indicating long run co integrating relations among observed variables.

Table 4: Johansen Cointegration Tests

Hypothesized N0. of CE (s)	Eigen value	Likelihood Ratio	5% critical value	1% critical value
Unrestricted Cointegration Rank Test (Trace)				
None *	0.598277	49.60243	47.85613	0.0339
At most 1	0.402210	24.97860	29.79707	0.1622
At most 2	0.276316	11.08666	15.49471	0.2062
At most 3	0.083522	2.354865	3.841466	0.1249
Trace test indicates 1 cointegrating eqn(s) at the 0.05 level * denotes rejection of the hypothesis at the 0.05 level **MacKinnon-Haug-Michelis (1999) p-values				

Ho: has no co-integration; **H_1:** has co-integration
Source: Author's own estimate

Having approximated the long-run relationship, the results are depicted in table-5 which shows negative relationship between economic growth via GDP growth and real effective exchange rate (REER). Precisely, 1% increase in real effective exchange rate decreases the level of GDP growth by 0.43%.Therefore, the normalized co integration equation reveals that there is a negative relationship between economic growth (LNGDP) and real effective exchange rate, negative relations between inflation and economic growth via GDP growth and positive relations between GDP growth and interest. Looking at the results, the normalized cointegrating equation reveals that in the long-run, real effective exchange rate affects economic growth via GDP growth negatively, interest rate affects GDP growth positively and inflation affects GDP growth negatively in India.

Table 5: Normalized cointegrating coefficients (standard error in parentheses)

Lngdp	Reer	Inflation	Interest
1.000000	-0.433445	-0.717606	0.335925
	(0.07242)	(0.14204)	(0.15034)

Source: Authors' own computation;*Figure in the parenthesis indicates S.E

In table-6 below, we have found that for the Ho of "REER does not Granger Cause LNGDP", we cannot reject the Ho since the F-statistics are rather small and most of the probability values are close to or even greater than 0.1 at the lag length of 2. Therefore, we accept the Ho and conclude that REER does not Granger Cause LNGDP; similarly, for Ho of "LNGDP does not Granger Cause REER", we also cannot reject Ho and conclude that LNGDP does not Granger Cause REER.

Table 6: Pairwise Granger Causality Tests

Null Hypothesis:	Obs	F-Statistic	Prob.	Decision	No causality
REER does not Granger Cause LNGDP	27	1.34287	0.2817	Did not reject	No causality
LNGDP does not Granger Cause REER		0.97329	0.3935	Did not reject	No causality
INFLATION does not Granger Cause REER	27	1.63669	0.2174	Did not reject	No causality
REER does not Granger Cause INFLATION		0.35575	0.7046	Did not reject	No causality
INTEREST does not Granger Cause REER	27	0.76817	0.4759	Did not reject	No causality
REER does not Granger Cause INTEREST		1.10166	0.3500	Did not reject	No causality

H_0: X does not Granger causeY; H_1: X Granger causes Y
Source: Source: Author's own estimate

This means that real effective exchange rate cannot solitarily accelerate economic growth via GDP growth and vice versa. In other cases also, we have found no causality between inflation and real effective exchange rate; between interest rate and real effective exchange rate in any direction.

Summary and Conclusion

The article tries to observe the effects of exchange rate on the economic growth of India, considering also interest rate and inflation as other exogenous variables for the period from 1996-2024 which has been conducted by using generalized method of moment (GMM), Johansen cointegration and granger causality test. The unit root properties of the data were examined using the Augmented Dickey Fuller test (ADF) after which the cointegration and causality tests were conducted.

The study observed the following research findings

The generalized method of moment Method suggests that exchange rate has positive impact on economic growth in India via GDP growth at 10% level of significance. Inflation has insignificant positive impact on GDP growth in India, interest rate has significant negative impact on GDP growth. The unit root test conducted by Augmented Dickey Fuller test (ADF) clarified that GDP growth, exchange rate, inflation and interest are non-stationary at level but, they are found to be stationary at first difference using Augmented Dickey Fuller test (ADF) test for unit root. The co integration test confirmed that GDP growth, exchange rate, inflation and interest rate in India are cointegrated, indicating an existence of long run equilibrium relationship among them as confirmed by the Johansen cointegration test results. The Residual Function analysis of GDP to Exchange rate in the above Figure 1 reveals that one standard deviation shock of Exchange rate variables to GDP was negative between the periods 1996-2009 but became positive from period 2011 to2019. The shock was again negative beginning from period 2020-2021.The Granger causality test finally confirmed no significant causal connections between exchange rate and GDP implicitly; and also no similar causality among other exogenous variables under consideration.

Policy makers should also make it certain that resources are put to utmost use through the accurate and precise way by means of mobilizing domestic resources through technical edification, superior enticement and motivation for effective and resourceful performance allowing enormous production enhancement which will meet domestic demand and surplus, if any, to be exported abroad to earn foreign exchange.

Acknowledgements: The authors are thankful to anonymous referees for their useful comments in the earlier draft of the article. However, despite our sincere attempts, if any pitfall remains in the article, the responsibility solely lies on us.

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