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Exchange rate volatility and Sustainable Economic growth in India: An Empirical Analysis

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Abstract: *This paper examines the dynamic causal relationships between the volatility of the exchange rate, the volume of trade, and economic growth in India. An empirical investigation is conducted over the period 2012 to 2024 using the Vector Auto Regression (VAR) model. The objective of this paper is to particularly examine the effect of exchange rate volatility on India's economic growth after the Global Financial Crisis of 2008 covering the Covid-19 pandemic. Findings of this paper suggest that exchange rate volatility has a negative impact on imports, export of goods, and it also negatively affects economic growth in the above-mentioned period. The results indicate that there is a significant Granger causality from the volatility of the exchange rate to economic growth, and from economic growth to both exports and imports. Indian economic growth during these periods was characterised by sustainable growth driven by sustainable increases in these factors. Investors, policymakers, and others with a common interest should understand that India did, however, benefit from currency depreciation.*

Key Word: VAR, exchange rate volatility, GDP, Net exports, India

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I. INTRODUCTION

The term exchange rate volatility indicates the tendency for foreign currencies to appreciate or depreciate in a currency's value, thereby affecting the profitability of foreign exchange trading. The exchange rate volatility is a measure of the amount by which these rates change and the frequency of these changes. There are many situations when exchange rates fluctuate, including business transactions between parties in two different countries and international investments. The exchange rate between two countries is the price at which residents of those countries trade with each other. The exchange rate is of two types, the first one is nominal exchange rate, which is the relative price of the currency of two countries. The second one is the real exchange rate, which is the price of the goods of two countries. The real exchange rate determines the rate at which we can trade the goods of one country for the goods of another country. If the real exchange rate is high, then the foreign goods are cheap and domestic goods expensive and vice versa. If this happens, it affects the economic growth of the country negatively and hence the sustainable economic growth of the country will be affected. The word sustainable economic growth means an economic growth that meets the needs of current generations by preserving resources and the environment for future generations. It is about achieving economic growth without causing price increases, resource depletion, or significant damage to the environment.

The economic growth, equivalent to GDP, of a country broadly depends on private consumption, gross fixed capital formation, government spending on goods and services and net exports. All components of the GDP are endogenous except government spending on goods and services. Private consumption in India is likely to speed up, managed by a stronger labour market, easy access to credit, and at a moderate inflation rate. India's Investment growth is expected to remain steady, supported by rising private investments, improved corporate balance sheets, and favourable financing conditions. The Emerging Market and Developing Economies have undergone significant change since 2000, now contributing about 45 per cent of global GDP, driven by three largest EMDEs; India, China, and Brazil. Government of India has taken a series of schemes and initiatives aimed at moving the nation towards sustained economic growth. The initiatives like Startup India and the Production Linked Incentive Scheme, are transforming sectors such as manufacturing, digital economy, and financial inclusion. Together, they reflect India's pledge to building a resilient, self-sustaining, and globally competitive economy. The balance of payment condition of India has remained negative across various regimes, but the magnitude remains quite lower. The issue here is that with this negative balance of payment and recently increasing export in India due to government export promotion strategy, can one be right to say that change in exchange rate has account for more improvement in Indian economy, how about the recent decline in growth and currency values? Given the low current account deficit and stronger foreign portfolio investment in India,

foreign exchange reserves reached a record hit of $676.3 billion in April 2025.However, at present, the rising costs of production and declining productivity have led to a fall in India's share of global exports - from 2.2 percent in 2010 to 3 percent in 2025.

The objective of this research paper is to determine the dynamism of the volatility of real exchange rate and its relation to sustainable economic growth by incorporating other variables of interest. We will examine impacts of exchange rate volatility on sustainable economic growth in India; the effect of exchange rate volatility on some of the selected variable that promote growth in India, and we will also find the correlation between the selected variables. It is important to mention that some researchers have tried to examine this relationship in many developed countries and even for emerging economies, but the scenario in India has yet been achieved in the last decades; hence this research will be significant in this regard and the use of vector autoregressive model makes this paper unique, with exchange rate volatility and the determinant of real exchange rate will encompass GDP, export and imports, are indicators of sustainable economic growth. The success of this paper will make a mark in the field; most importantly, it will also serve as reference to policymakers in developing countries who have similar foreign exchange scenario to India and India decision makers particularly.

II. LITERATURE REVIEW

Recent studies revealed a relationship between the exchange rate and economic growth. Some researchers of study set up a robust correlation between different exchange rate regimes and economic growth. In the view of Gosh et al., (2002) mentioned that the fixed exchange rate regimes offer slight superiority to inspire economic growth, again the outgrowth of this exploration exposed on-robustness. But the authors do to conclude that there is no strong correlation between economic growth and the functional exchange rates. Ramoni et al. (2022) examines the impact of exchange rate volatility of 194 countries on their economic growth, suing panel data analysis. The study grouped the countries according to the level of corruption of the governments. In empirical analysis, they used GARCH models, and both Difference and System Generalized Method of Moments. The result of the analysis showed a significant negative impact of volatility on the economic growth of the counties. They found an important fact that the effect of volatility was more in less-corruption countries, which might be because they are not able to deal with the economic instability associated with these types of countries. In tax-Yeyati and Sturzenegger (2005), revealed that fixed regimes in non-industrialized nations seem to be connected with abridged and veritably changeable, unstable rates of economic growth. To a greater extent, the influences of exchange rate regimes on economic progress are largely dependent on the operation; inferring that no matter the exchange rates, its operation is consummate to economic development stimulation.

Notwithstanding, Hussain et al. (2005) proved that there is a positive consequence on the growth of the economy in advanced nations, following relinquishment of Reinhart flexible exchange rates, but within the named arising and developing nations, they could not determine any impact. Obstfeld et al. (2017) examines exchange rate regimes on global financial conditions to domestic financial and macroeconomic conditions for a sample of 40 emerging countries. Their findings reached a conclusion that the exchange rate matters, and the countries with flexible exchange rates are not facing the financial vulnerabilities compared to the countries with fixed exchange rates. Iuhia and Bogdan (2012) mentioned that the intermediate and floating exchange rates over the fixed ones were in stimulating advanced growth in the economy. Also, Aghion et al. (2006) following the given countries, mentioned that the real exchange rate volatility may retain significant print on the long run productivity growth rate, nevertheless this effect is largely dependent on the development of fiscal sector in the selected countries. Hence, countries with lower fiscal development experience a drop in economic growth, since the exchange rate will tend to be more flexible, but there is no significant effect in the highly financially developed countries. In another dimension, Tze-Wei and Lin (2012), using VECM analysis, mandated the actuality of co-integration between real exchange rate and unemployment rate, which implies that a higher unemployment rate would cause the price of domestic currency to go down and vice versa. The author advised that, before probing into studying exchange rate regimes, the rate of unemployment should be completely examined.

Likewise, the consequences of exchange rate change on economic growth have been approached by a different author with incarnation of different results. In real situation, most developing and emerging economies generally underrated or overrated their currencies to coincide with their economic programmes and eventually as a corrective measure. Exchange rate undervaluation means that the currency is lower than its real exchange rate, while exchange rate overvaluation implies that the exchange rate of one currency is advanced than its real exchange rate. Still, considering the relation between the RER and growth, utmost studies set up a positive relationship between RER undervaluation and economic growth, but this nexus is said to be much stronger in developing countries (Hausmann et al., 2005, Rodrik, 2008, Abida, 2011).

III. DATA AND EMPIRICAL SPECIFICATIONS

3.1 Data, Variables and Method

We have collected data for several macroeconomic variables for empirical analysis are quarterly, ranges from 1st quarter of 2012 to 3rd quarter of 2024. These data include namely, Volatility of Exchange rate of India, Growth_real effective exchange rate, Import, Export, Current Price_GDP all are related to Indian Economy. The quarterly data has been collected from the Federal Reserve Bank of St. Louis cross-country database, the World Bank and from Handbook of Statistics on Indian Economy 2023-24, RBI. The question of how exchange rate volatility of India for the above-mentioned time periods, controlling for export and import, affects economic growth in India is open to empirical investigation. We measured economic growth in terms of GDP. The dependent variable is volatility, i.e, the exchange rate volatility. We calculated the exchange rate volatility as the standard deviation of the moving average of the logarithm of the real effective exchange rate. The explanatory variables include: (a) growth rate of per capita gross domestic product (GDP); (b) export (c) import.

First, the summary statistics of the above variables are reported in Table 1 and the correlation matrix is reported in Table 2. Next, we check the non-stationary character of the variables of interest.

In case of non-stationary data, the mean, variance and covariance changes over time; hence the need for stationary tests arises to convert the non-stationary variables into stationary. Table 3 provides the unit root results for variables at their levels. Dickey-Fuller/Augmented Dickey-Fuller tests for all the variables at their levels have been conducted and tested positive to exhibit the presence of unit roots. Finally, since the use of non-stationary variables might lead to the problem of spurious regressions, here we estimate a VAR model (with lag length 2) after ensuring that each variable is stationary at levels I(1) using standard ADF (Augmented Dickey Fuller) tests.

Table 1: Summary Statistics (Variables in levels)

Variable	Obs	Mean	Std. Dev.	Min	Max
reer	52	100.254	5.017	87.805	106.632
exchrt	52	65.713	10.058	44.671	82.68
export	51	1.013e+13	3.521e+12	5.518e+12	1.868e+13
import	51	8.879e+12	3.119e+12	4.869e+12	1.596e+13
gdp	51	3.114e+13	6.337e+12	2.133e+13	4.257e+13

Source: author's calculations.
Note:reer= real effective exchange rate, exchrt= nominal exchange rate, volatility= volatility of exchange rate, gdp=Current price Gross Domestic Product

Table 2: Matrix of correlations

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) reer	1.000						
(2) volatility	0.138	1.000					
(3) exchrt	0.654	0.217	1.000				
(4) volexchrt	0.163	0.998	0.242	1.000			
(5) export	0.493	0.289	0.780	0.297	1.000		
(6) import	0.529	0.308	0.851	0.320	0.981	1.000	
(7) gdp	0.762	0.236	0.933	0.257	0.861	0.892	1.000

Source: author's calculations.
Note: exchrt= nominal exchange rate, gdp=Current price Gross Domestic Product

Table 3: Unit Root Tests Using Augmented Dickey-Fuller Test.

Variables	**Model**	Calculated Value for ADF test I (0)	Critical Value for ADF test (5% level)	Calculated Value for ADF test I (1)	Critical Value for ADF test (5% level)
Real effective exchange rate	Constant	-1.409	-2.933	-4.679	-3.594
Exchange rate	Constant, Trend	-1.662	-2.933	-5.057	-3.594
Import	Constant, Trend	0.506	-2.936	-3.130	-2.938

Export	Constant, Trend	-0.277	-2.933	-3.526	-2.938
Current price GDP	Constant, Trend	-0.166	-2.936	-7.067	-2.938

Source: author's calculations.

3.2 VECTOR AUTOREGRESSION MODEL

We test the Lagrange multiplier for potential autocorrelation where the null hypothesis is that no autocorrelation at lag order cannot be rejected at orders 1 through 2 at any conventional significance level, so there is no question to contradict the validity of our VAR model used in this paper. For selecting lag lengths for a series of vector auto regressions in stata, we use varsoc command which reports the final prediction error (FPE), Akaike's information criterion (AIC), Schwarz's Bayesian information criterion (SC), and the Hannan and Quinn information criterion (HQIC) lag-order selection statistics for VAR models. The result of the Lag Length Selection-order criteria is given in table-4.

Table 4: Lag Length Selection-order criteria

Sample: 1961q2 - 1973q1 Number of obs. = 48

lag	LL	LR	df	P	FPE	AIC	HQIC	SBIC
0	-3576.6				7.3e+59	149.192	149.251	149.348*
1	-3548.75	55.701	16	0.000	4.5e+59*	148.698	148.993*	149.478
2	-3532.63	32.234	16	0.009	4.5e+59	148.693*	149.223	150.096
3	-3519.19	26.892*	16	0.043	5.2e+59	148.799	149.565	150.827

Endogenous: volatility export_d1 import_d1 gdp_d1
Exogenous: _cons
Source: author's calculations.

3.2.1 Empirical results: Vector Autoregression Model

The "VAR" model seems to be a natural choice in this case because it allows us to read through the internal dynamics among the variables in the short term, as well as in the long term, with a single equation estimation model with a few lag lengths would be incapable of uncovering. The essence of this paper is to ascertain the relationship between exchange rate volatility and economic growth by applying the vector autoregression (VAR) analysis in determining the connection between volatility, GDP, Export and Import. The result of the VAR analysis is presented in the following table:

Table-5: Result of Estimated VAR Model-1

(Among the variables volatility, real effective exchange rate, nominal exchange rate, export, import, Current price GDP)

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	volatility	reer_d1	exchrt_d1	export_d1	import_d1	gdp_d1
L2.volatility	-5.599	-42.57***	59.22***	-1.424e+11**	-2.840e+11***	-4.451e+11**
	(3.536)	(14.43)	(9.516)	(6.749e+10)	(9.515e+10)	(1.792e+11)
L2.reer_d1	-0.0551	0.495***	0.255**	4.389e+08	-6.661e+08	-2.575e+09
	(0.0407)	(0.0793)	(0.110)	(7.776e+08)	(1.096e+09)	(2.065e+09)
L2.exchrt_d1	0.0423	0.233***	-0.406***	1.701e+09*	1.468e+09	2.740e+09
	(0.0471)	(0.0437)	(0.127)	(8.985e+08)	(1.267e+09)	(2.386e+09)
L2.export_d1	0	-0	0	-0.0165	0.149	-0.143
	(0)	(0)	(0)	(0.198)	(0.279)	(0.526)
L2.import_d1	-0**	0	-0	0.335**	0.209	-0.00403
	(0)	(0)	(0)	(0.165)	(0.232)	(0.437)
L2.gdp_d1	0*	-0	0	-0.126	-0.199*	-0.168
	(0)	(0)	(0)	(0.0788)	(0.111)	(0.209)
Constant	0.278**	36.73***	-0.561*	3.748e+09*	7.723e+09**	1.137e+10**
	(0.113)	(6.647)	(0.304)	(2.153e+09)	(3.035e+09)	(5.716e+09)

Observations	49	49	49	49	49	49

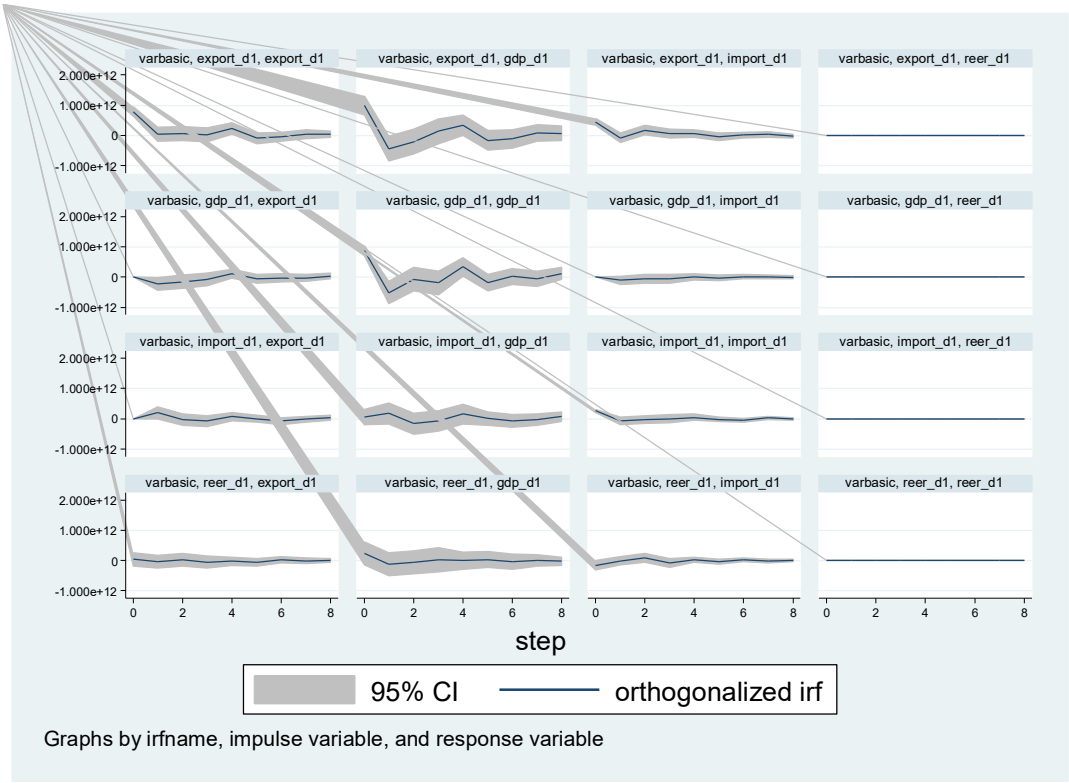
Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: author's calculations.

Table-5 displays the VAR results, which reveals that volatility as a dependent variable, is positively related to nominal exchange rate, export and GDP but also negatively related to previous value of volatility, REER, import; though these results are only significant with lagged value of import and GDP. In economic theory, we know economic growth may respond to nominal exchange rate appreciation, but in our analysis, we found a positive impact on NER (expressed as Rupee per unit of US Dollar), which implies value of home currency falls in comparison to foreign currency. Also, the volatility of exchange rate has negative impacts on REER, means REER falls, which implies that foreign goods are relatively dearer and domestic goods are relatively cheap i.e., net exports of the domestic country will increase. In the second regression where REER as a dependent variable, it has negative and significant impact on volatility, but it has positive and significant impact on both NER and REER.

The VAR results further tells that both exports and imports have negative and significant impacts on volatility of the exchange rate at 1% level of significance, when both the variables acted as a dependent variable. The dependent variable export also has positive and significant impacts on NER and import of India. Moreover, given NER as a dependent variable, it has positive and significant impacts on both volatility and REER, but itself has negative impacts on its previous value. Lastly, when GDP acts as a dependent one, it has affected volatility negatively, and it has significant impacts at the 5% level. We can conclude that volatility of the exchange rate in India has a negative and significant impact on import while it has positive and significant impact on GDP, but the magnitude is small. All other variables except volatility when acted as a dependent variable, all have significant impacts on volatility, but the sign of impact is negative for exports, imports and GDP. Basically, it implies that increased volatility is having a negative impact on India's exports, imports and hence sustainable economic growth.

Figure 1: Graph showing impulse response to a one standard deviation shock among the variables in order as volatility, real effective exchange rate, nominal exchange rate, export, import, Current price GDP.



To examine the validity of our VAR model, we test the stability condition and autocorrelation of the residuals. The varstable command in Stata examines the dynamic stability of the system. Here, all the eigenvalues of the underlying reduced form coefficient matrix are less than unity and also the roots of the companion matrix graph

show that all eigenvalues lie within the circle, close to the circle but not lie on the circle. This condition is also satisfied, as evident from Table 5, so our system satisfies the stability condition.

Figure 2: Eigenvalues of the underlying VAR

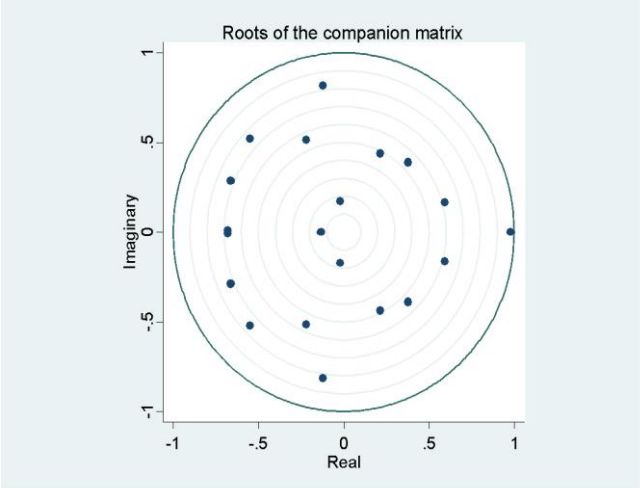


Table 6: Lagrange-multiplier test

Lagrange-multiplier test

lag	chi2	df	Prob > chi2
1	11.0372	16	0.80718
2	9.4335	16	0.89449

H0: no autocorrelation at lag order

Table 7: Eigenvalue stability condition

Eigenvalue	Modulus
-.7450479 + .4649295i	.878212
-.7450479 - .4649295i	.878212
-.7427979	.742798
.8983581	.898358
.7168766	.716877
-.6556231 + .2032787i	.686414
-.6556231 - .2032787i	.686414
.08325437 + .6434137i	.648778
.08325437 - .6434137i	.648778
-.259557 + .459654i	.527875
-.259557 - .459654i	.527875
-.2186108	.218611

All the eigenvalues lie inside the unit circle.
VAR satisfies stability conditions.

IV. CONCLUSION

The aim of this paper was to determine the relationship between the volatility of exchange rate and economic growth, using the variables that might involve in affecting sustainable economic growth, and thereby describing how Volatility, RER, GDP, EXP and IMP are interrelated. We found that the volatility of the exchange rate has a significant negative effect on the economic growth of India. The findings of this article contradict theoretical projections and show that a decrease in the value of the currency exchange rate has a

negative influence on the quantity of goods exported as well as imported. This may be because exports in emerging market countries depend heavily on imports. One reason for the negative relationship between exchange rate volatility and trade flows is that real exchange rate volatility can directly affect exports through uncertainty and cost adjustment for risk-averse export investors. Another reason for the negative relationship is that exchange rate volatility may have an indirect effect through its impact on output structure, investment, and government policies of foreign trade. We further showed that the volatility of the exchange rate unambiguously decreases GDP growth for India across a variety of specifications. The main results of this paper identify that the presence of exchange rate volatility affects GDP given other macroeconomic variables. The above results have important implications to look into the policies of exchange rates. Given the significance of international trade and exchange rate fluctuations in affecting economic growth, India must try to follow an exchange rate policy, keeping in mind the other macroeconomic indicators to stabilise exchange rates to achieve higher economic growth. A less volatile exchange rate will help the countries to engage more in international trade, and hence it seems to be more important to enhance the economic growth of the country.

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